

VIPA System SLIO FM 050

FM | 050-1BA10 | Manual

HB300 | FM | 050-1BA10 | GB | 15-11

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1 General

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1.2 Über dieses Handbuch

Objective and contents

This manual describes the FM 050-1BA10 of the System SLIO from VIPA. It contains a description of the structure, project engineering and deployment.

This manual is part of the documentation package with order number VIPA HB300E_FM and relevant for:

| Product | Order number | as of state: |
|---------|--------------|--------------|
| | | HW |
| FM 050 | 050-1BA10 | 01 |

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 or likely danger. Personal injury is possible.

**CAUTION!**

Damages to property is likely if these warnings are not heeded.



Supplementary information and useful tips.

1.3 Safety information

Applications conforming with specifications

The system is constructed and produced for:

- communication and process control
- industrial applications
- operation within the environmental conditions specified in the technical data
- installation into a cubicle

**DANGER!**

This device is not certified for applications in
– in explosive environments (EX-zone)

Documentation

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 ...)

Disposal

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

2 Basics and Assembly

2.1 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.

Shipping of modules

Modules must be shipped in the original packing material.

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.

Modifying electrostatic sensitive modules you should only use soldering irons with grounded tips.



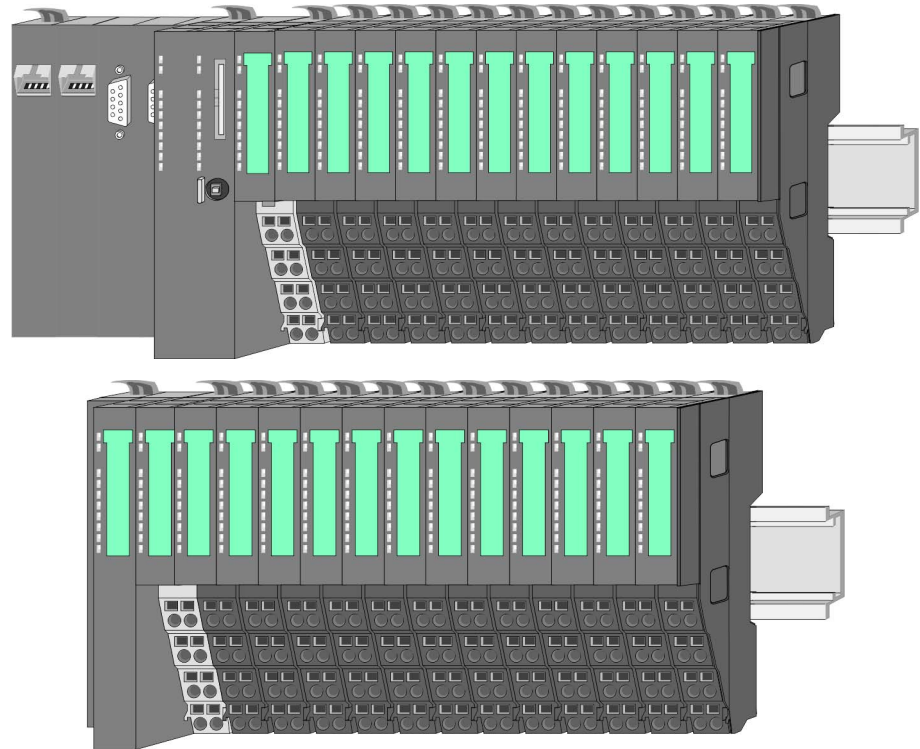
CAUTION!

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

2.2 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 colours 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

- CPU (head module)
- Bus coupler (head module)
- Periphery modules
- Power modules
- Accessories



CAUTION!

Only modules of VIPA may be combined. A mixed operation with third-party modules is not allowed!

CPU



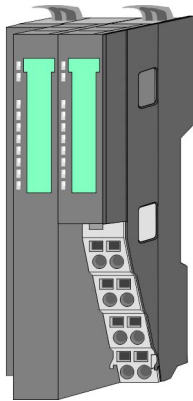
With a CPU, CPU electronic and power module are integrated to one casing. As head module via the integrated power module for power supply the CPU electronic is supplied as well as the electronic of the connected periphery modules. The DC 24 power section supply for the linked periphery modules is established via a further connection at the power module. By installing of up to 64 periphery modules at the CPU, 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.



CAUTION!

CPU part and power module of a CPU may not be separated! Here you may only exchange the electronic module!

Bus coupler



With a bus coupler bus interface and power module are integrated to one casing. With the bus interface you get access to a subordinated bus system. As head module 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 at the power module. 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.

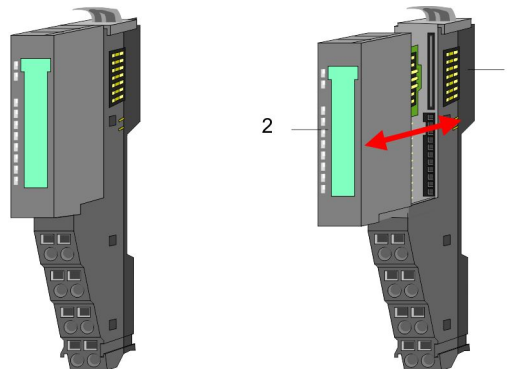


CAUTION!

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

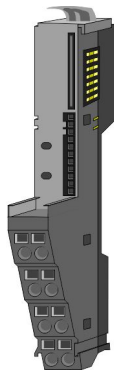
Periphery modules

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



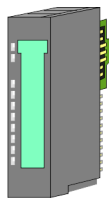
- 1 Terminal module
- 2 Electronic module

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.

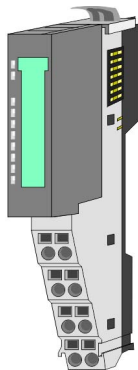
Electronic module



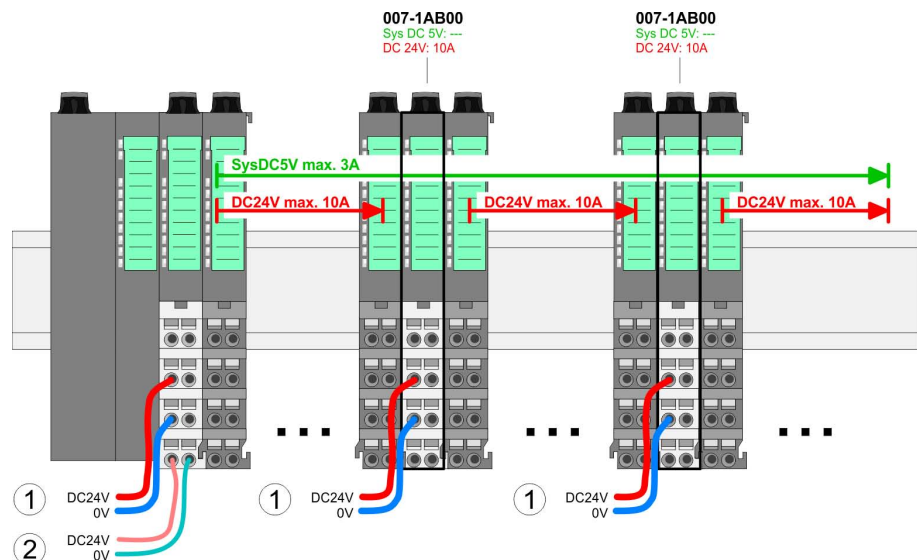
The functionality of a SLIO periphery module is defined by the *electronic module*, which is mounted to the terminal module by a safe sliding mechanism. With an error the defective module may be exchanged for a functional module with standing installation.

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.

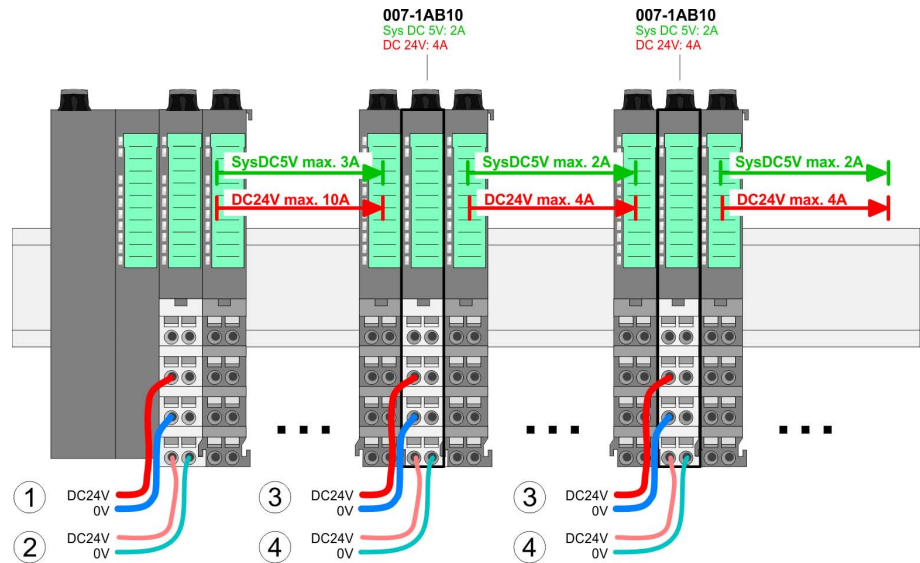
Power module



In the System SLIO the power supply is established by power modules. These are either integrated to the head module 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 colour of the power modules are contrasting to the periphery modules.



System conception



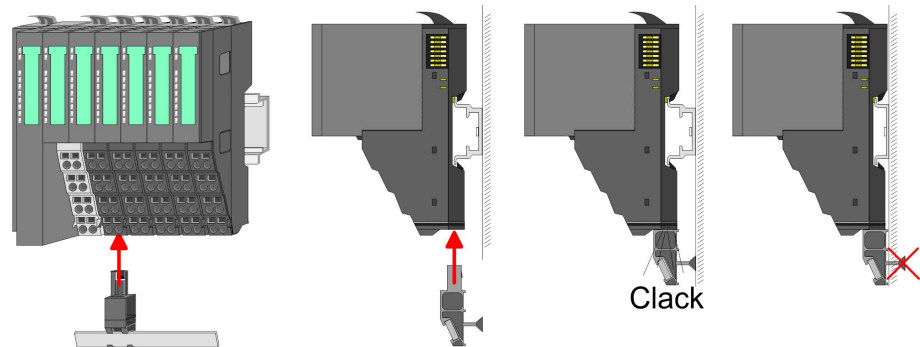
- (1) DC 24V for power section supply I/O area (max. 10A)
- (2) DC 24V for electronic power supply bus coupler and I/O area
- (3) DC 24V for power section supply I/O area (max. 4A)
- (4) DC 24V for electronic power supply I/O area

Accessories

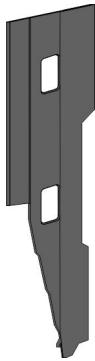
Shield bus carrier



The shield bus carrier (order no. 000-0AB00) 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 adaption 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.

The bus cover has the order no. 000-0AA00.

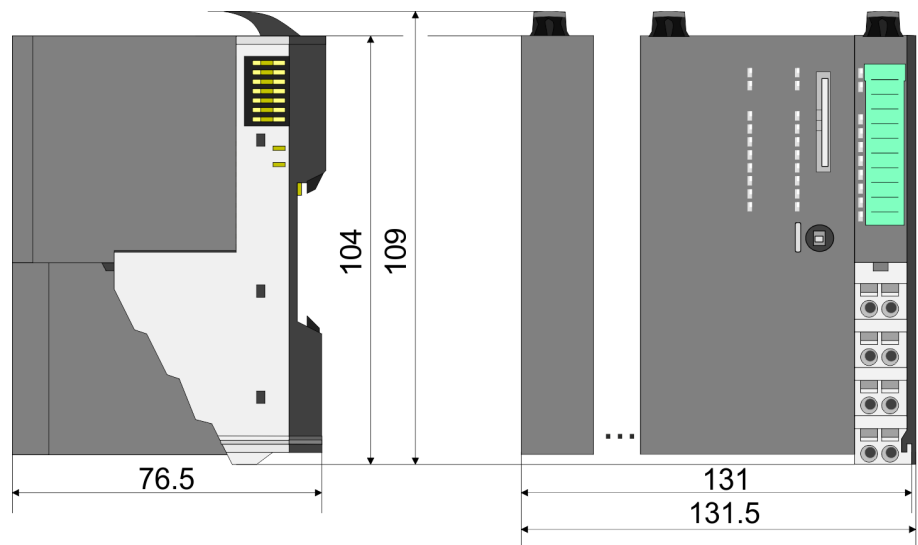
Coding pins



There is the possibility to fix the assignment of electronic and terminal module. Here coding pins (order number 000-0AC00) from VIPA can be used. The coding pin consists of a coding jack and a coding plug. By combining electronic and terminal module with coding pin, the coding jack remains in the electronic module and the coding plug in the terminal module. This ensures that after replacing the electronics module just another electronic module can be plugged with the same encoding.

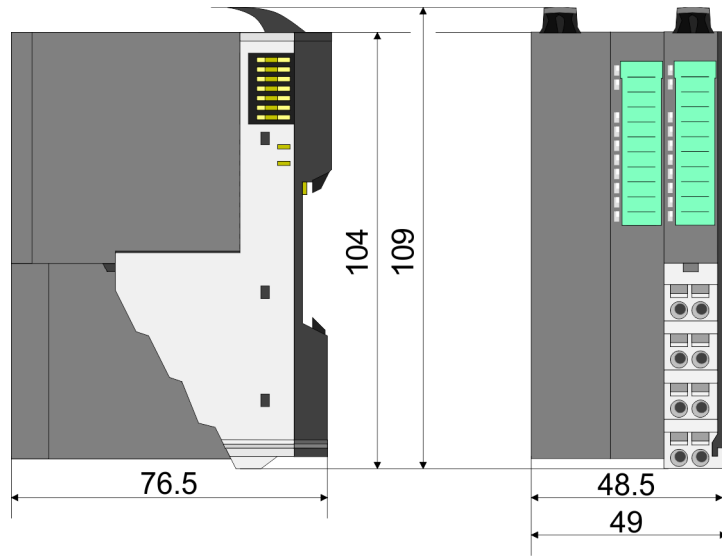
2.3 Dimensions

Dimensions CPU

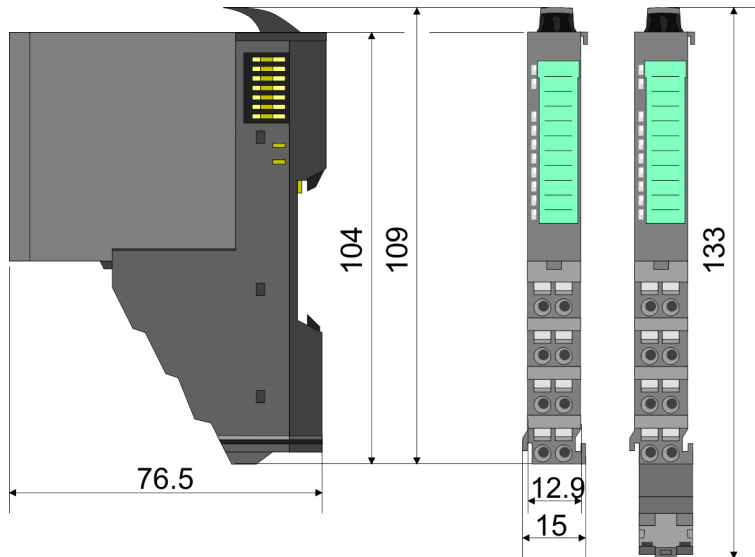


Dimensions

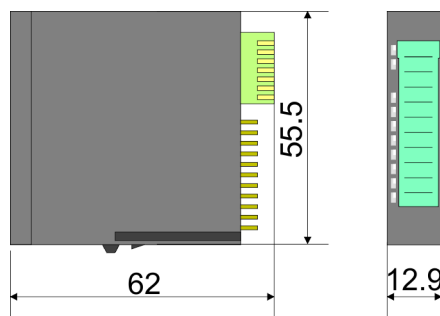
Dimensions bus coupler



Dimensions periphery module



Dimensions electronic module

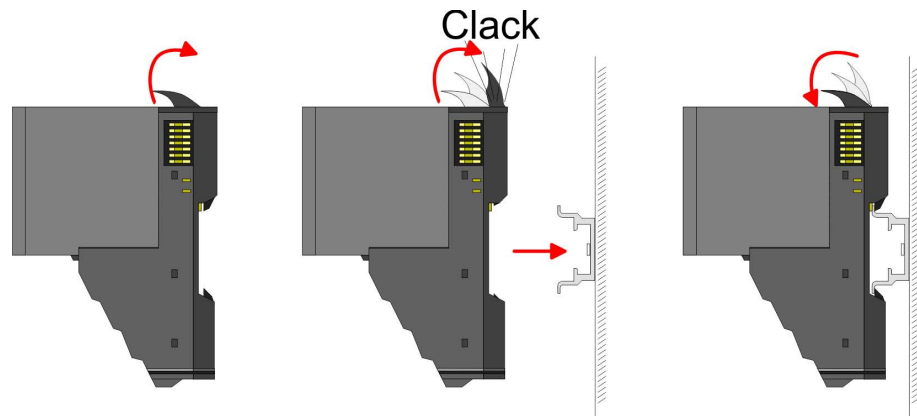


Dimensions in mm

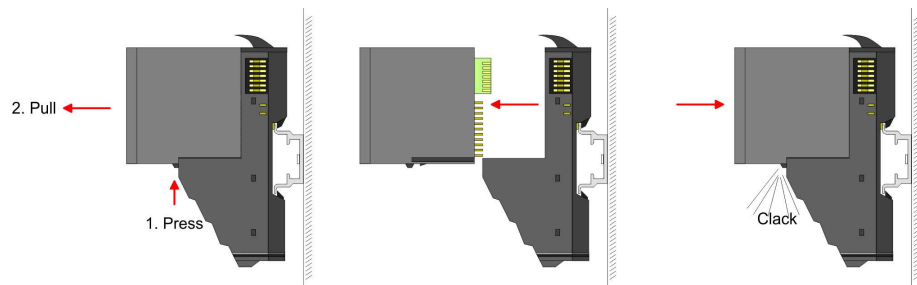
2.4 Installation

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. Now the module may be pulled forward. 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.



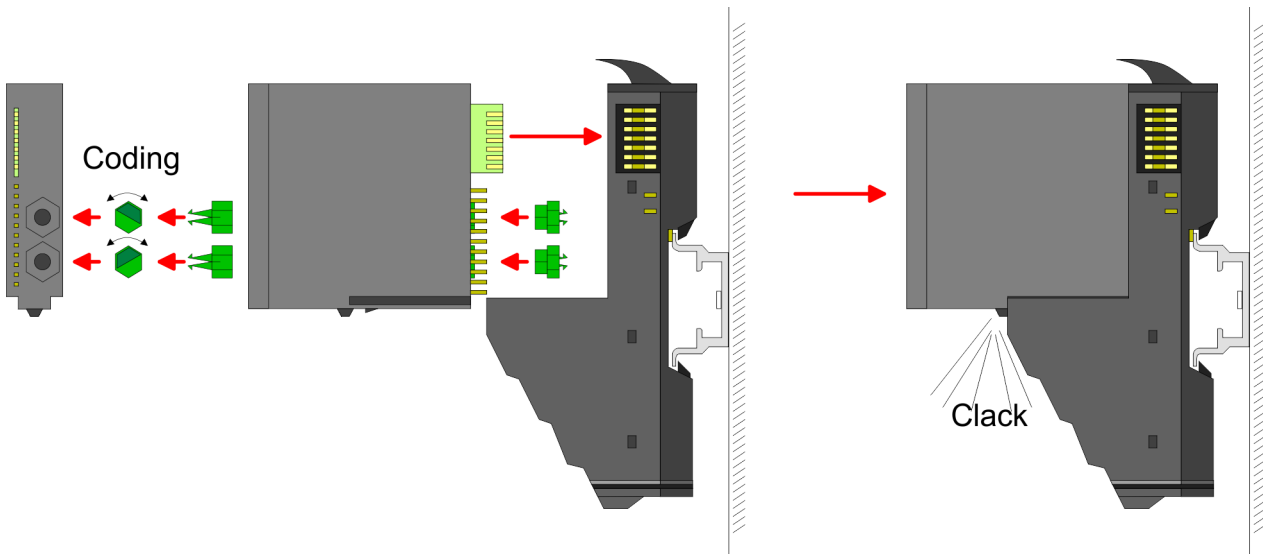
For the exchange of a electronic module, the electronic module may be pulled forward after pressing the unlocking lever at the lower side of the module. For installation plug the electronic module guided by the strips at the lower side until this engages audible to the terminal module.



Coding



There is the possibility to fix the assignment of electronic and terminal module. Here coding pins (order number 000-0AC00) from VIPA can be used. The coding pin consists of a coding jack and a coding plug. By combining electronic and terminal module with coding pin, the coding jack remains in the electronic module and the coding plug in the terminal module. This ensures that after replacing the electronics module just another electronic module can be plugged with the same encoding.



Each electronic module has on its back 2 coding sockets for coding jacks. Due to the characteristics, with the coding jack 6 different positions can be plugged, each. Thus there are 36 possible combinations for coding with the use of both coding sockets.

1. ► Plug, according to your coding, 2 coding jacks in the coding sockets of your electronic module until they lock.
2. ► Now plug the according coding plugs into the coding jacks.
3. ► To fix the coding put both the electronic and terminal module together until they lock.



CAUTION!

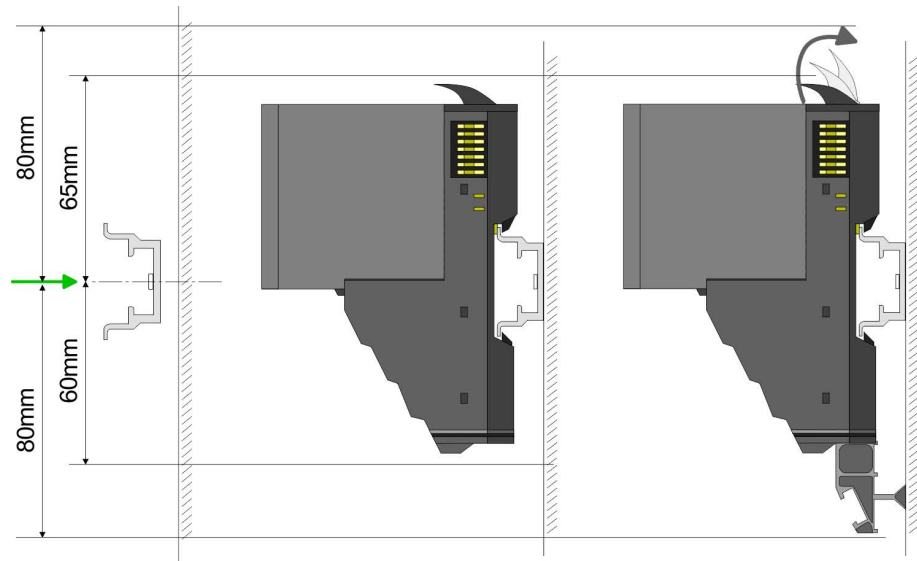
Please consider that when replacing an already coded electronic module, this is always be replaced by an electronic module with the same coding.

Even with an existing coding on the terminal module, you can plug an electronic module without coding. The user is responsible for the correct usage of the coding pins. VIPA assumes no liability for incorrectly attached electronic modules or for damages which arise due to incorrect coding!

Mounting Proceeding

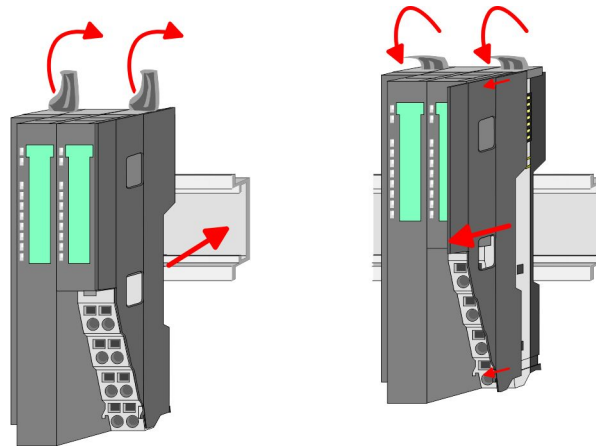
The modules were directly be mounted to the mounting rail and so connected to the backplane bus and the power supply for the electronic and power section. Up to 64 modules may be mounted. Please consider here that the sum current of the electronic power supply does not exceed the maximum value of 3A. By means of the power module 007-1AB10 the current of the electronic power supply may be expanded with 2A. ↪ *Chapter 2.6 'Wiring' on page 23*

Mounting rail



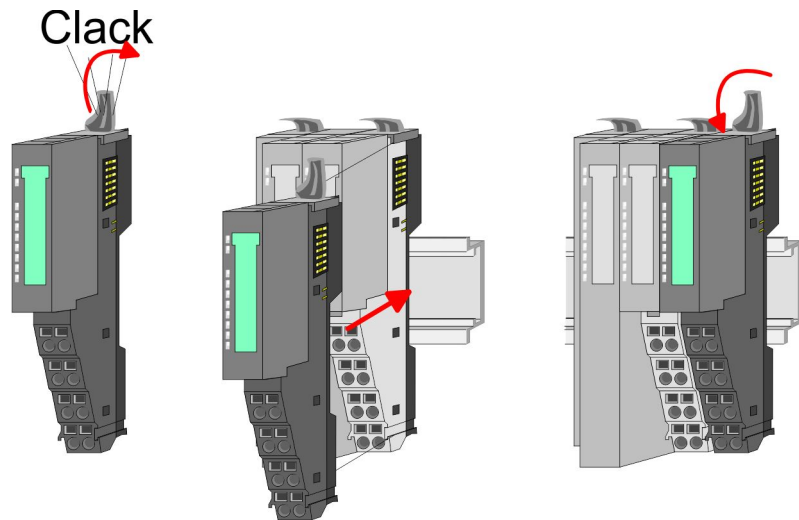
➔ Mount the mounting rail! Please consider that a clearance from the middle of the mounting rail of at least 80mm above and 60mm below, respectively 80mm by deployment of shield bus carriers, exist.

Mounting Head module (e.g. bus coupler)



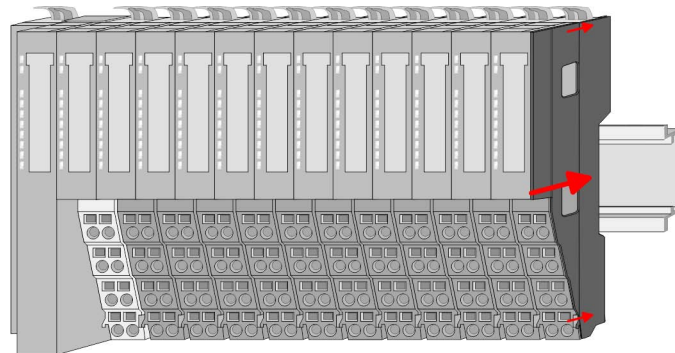
1. ➔ Start at the left side with the head module (e.g. bus coupler). For this turn both locking lever upwards, put the head module to the mounting rail and turn both locking lever downward.
2. ➔ Before mounting the periphery modules you have to remove the bus cover at the right side of the Head module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

Mounting periphery modules



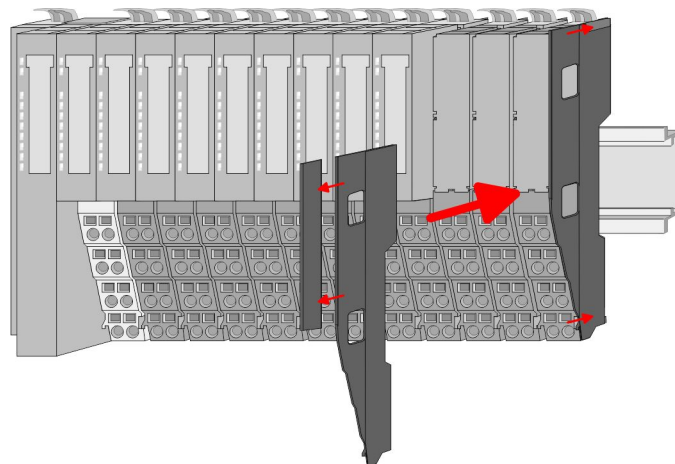
➔ Mount the periphery modules you want.

Mounting the bus cover



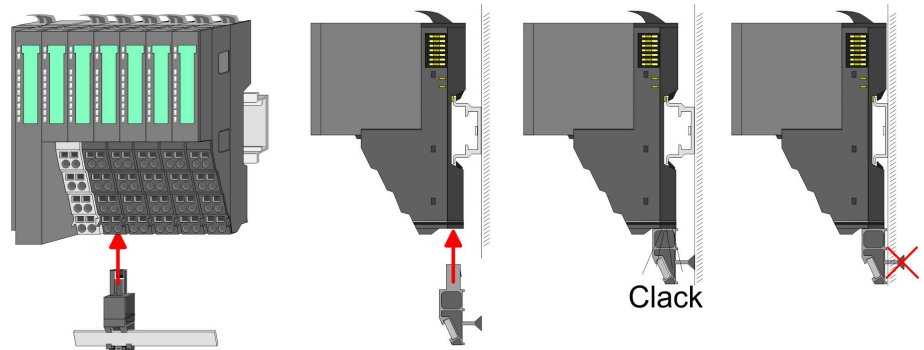
➔ After mounting the whole system, to protect the backplane bus connectors at the last module you have to mount the bus cover, now.

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



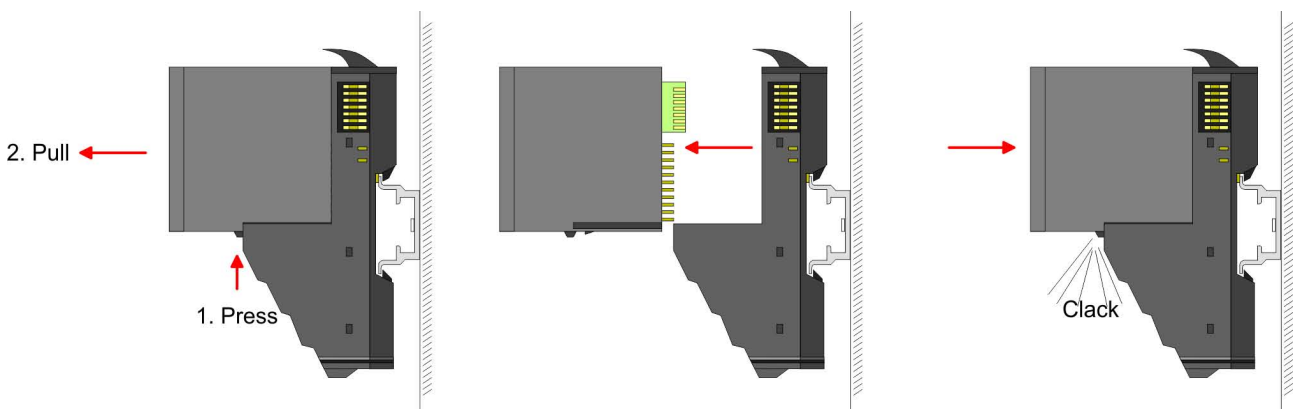
➔ The shield bus carrier (available as accessory) serves to carry the shield bus to connect cable shields. The shield bus carrier is mounted underneath the terminal of the terminal module. With a flat mounting rail for adaption to a flat mounting rail you may remove the spacer of the shield bus carrier.

2.5 Demounting and module exchange

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.

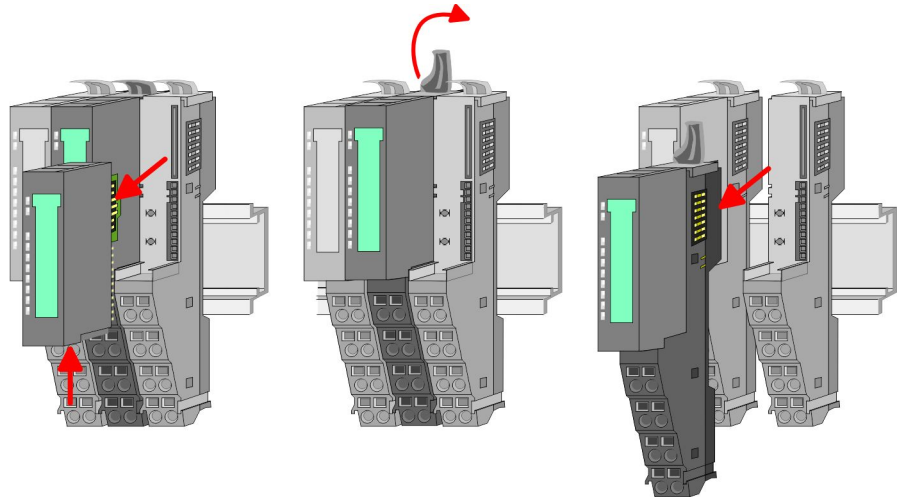
Exchange of an electronic module



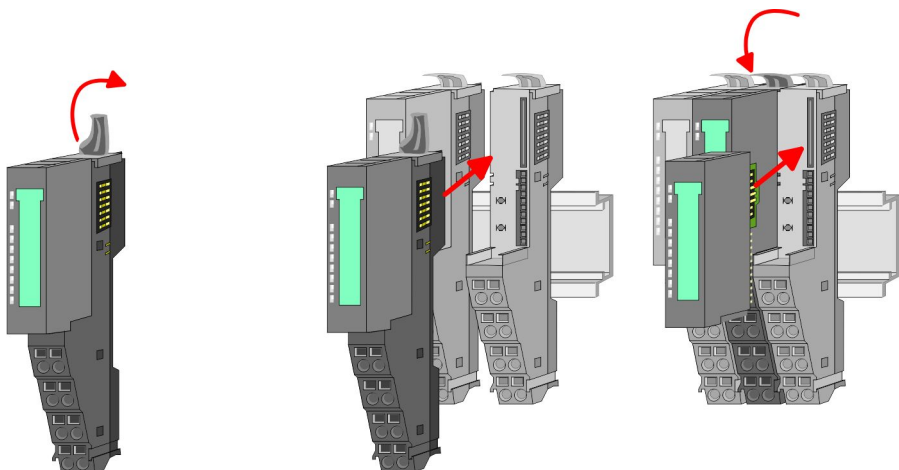
1. ➔ For the exchange of an electronic module, the electronic module may be pulled forward after pressing the unlocking lever at the lower side of the module.
2. ➔ For installation plug the electronic module guided by the strips at the lower side until this engages audible to the terminal module.

Exchange of a module

1. ▶ Remove if exists the wiring. ↪ Chapter 2.6 'Wiring' on page 23.



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.

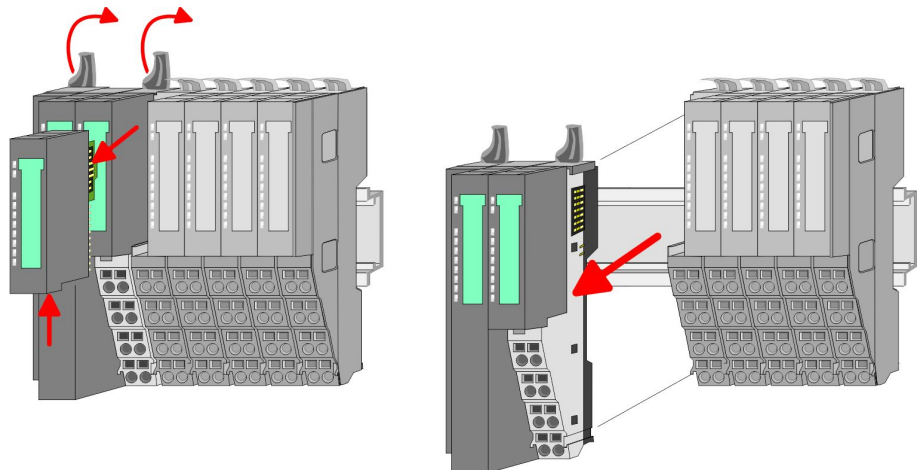
Exchange of a head module (e.g. bus coupler)

**CAUTION!**

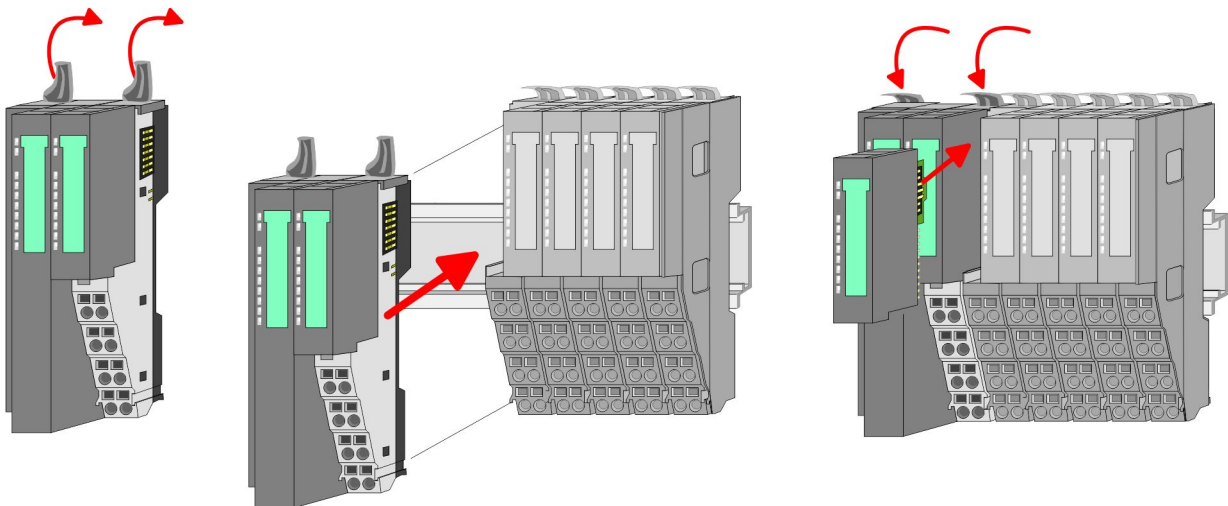
Bus interface and power module of a head module may not be separated!

Here you may only exchange the electronic module!

1. Remove if exists the wiring of the head module. ↪ *Chapter 2.6 'Wiring' on page 23.*



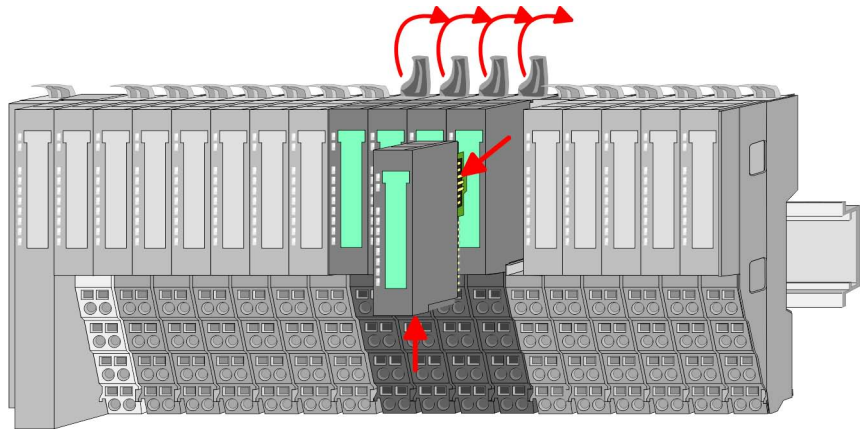
2. Press the unlocking lever at the lower side of the just mounted right module and pull it forward.
3. Turn all the locking lever of the head module to be exchanged upwards.
4. Pull the head module forward.



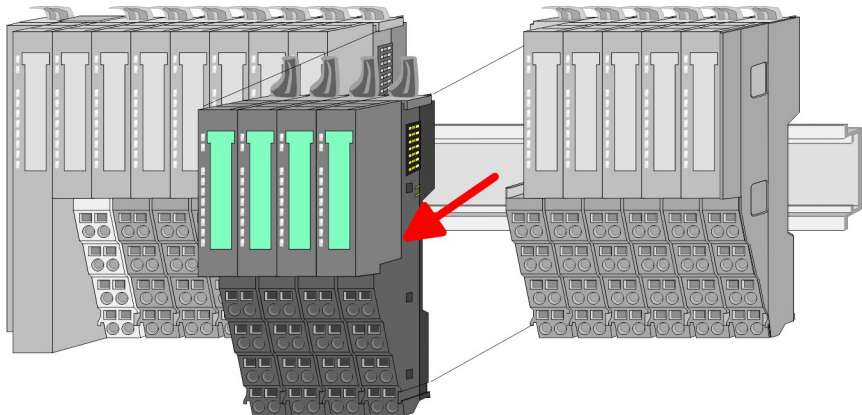
5. For mounting turn all the locking lever of the head module to be mounted upwards.
6. To mount the head module put it to the left module and push it, guided by the stripes, to the mounting rail.
7. Turn all the locking lever downward again.
8. Plug again the electronic module, which you have removed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

Exchange of a module group

1. ▶ Remove if exists the wiring of the module group. ↪ *Chapter 2.6 'Wiring' on page 23.*

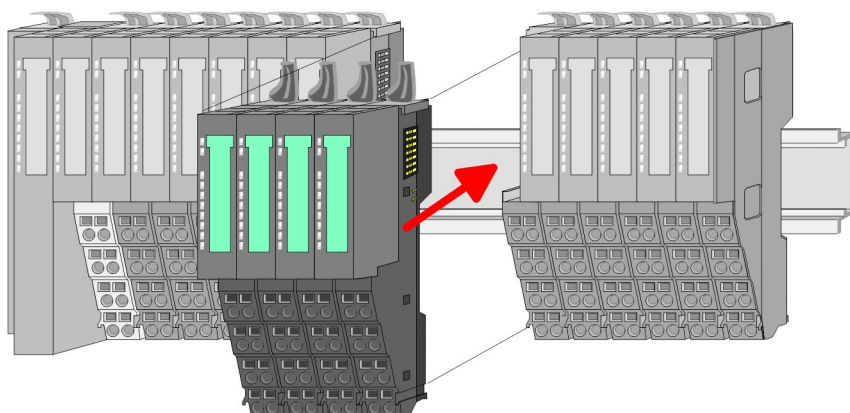
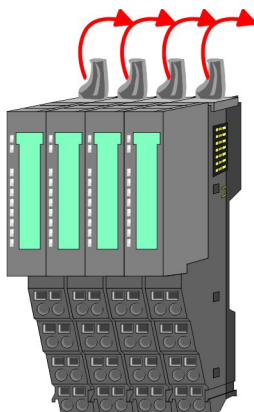


2. ▶ Press the unlocking lever at the lower side of the just mounted right module of the module group and pull it forward.



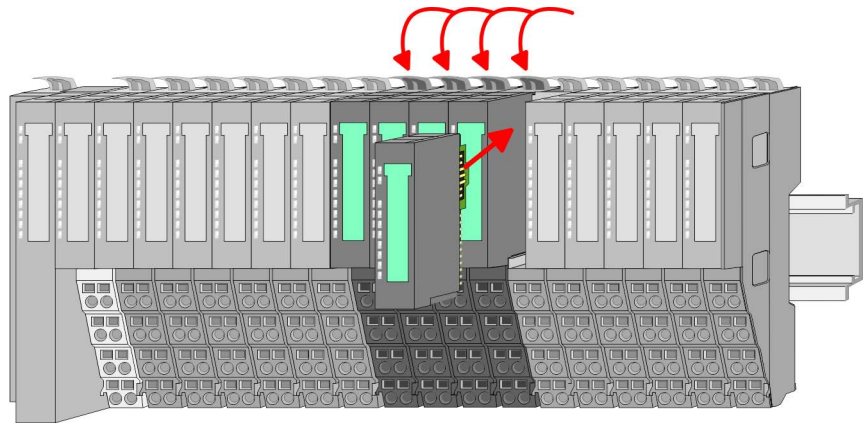
3. ▶ Turn all the locking lever of the module group to be exchanged upwards.

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.

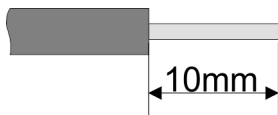
2.6 Wiring Connectors

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.

Data



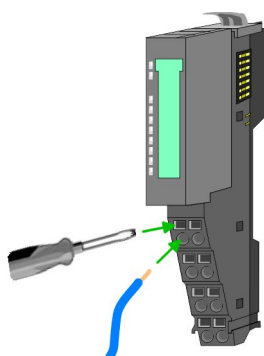
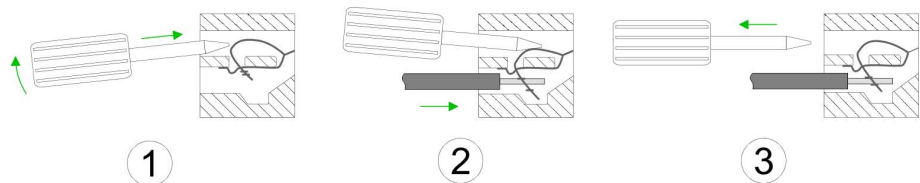
U_{max} : 240V AC / 30V DC

I_{max} : 10A

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

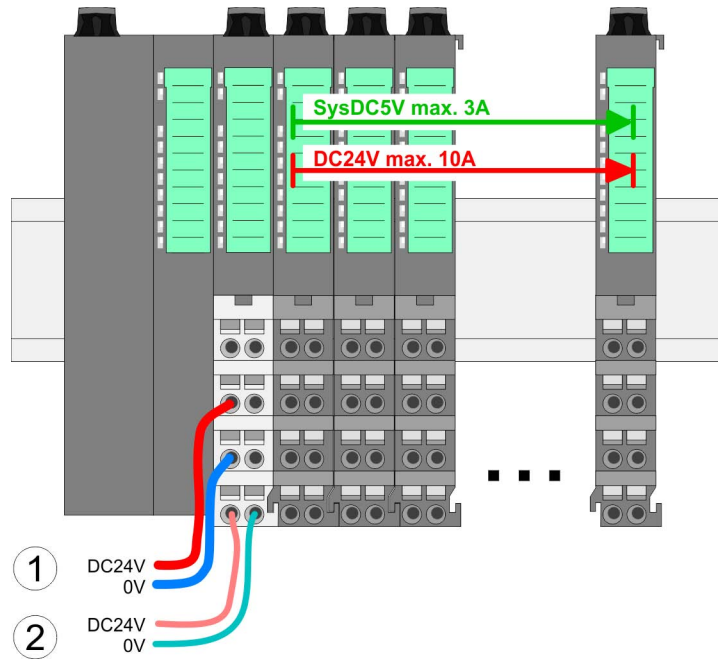
Stripping length: 10mm

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 to 1.5mm².
3. By removing the screwdriver, the wire is securely fixed via the spring contact to the terminal.

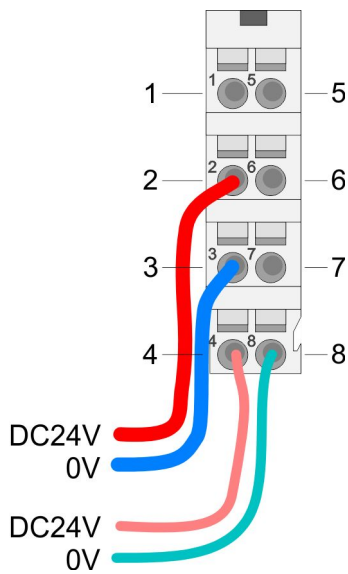
Standard wiring



- (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

PM - Power module

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



| Pos. | Function | Type | Description |
|------|------------|------|--------------------------------------|
| 1 | --- | --- | not connected |
| 2 | DC 24V | I | DC 24V for power section supply |
| 3 | 0V | I | GND for power section supply |
| 4 | Sys DC 24V | I | DC 24V for electronic section supply |
| 5 | --- | --- | not connected |
| 6 | DC 24V | I | DC 24V for power section supply |
| 7 | 0V | I | GND for power section supply |
| 8 | Sys 0V | I | GND for electronic section supply |

I Input



CAUTION!

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.

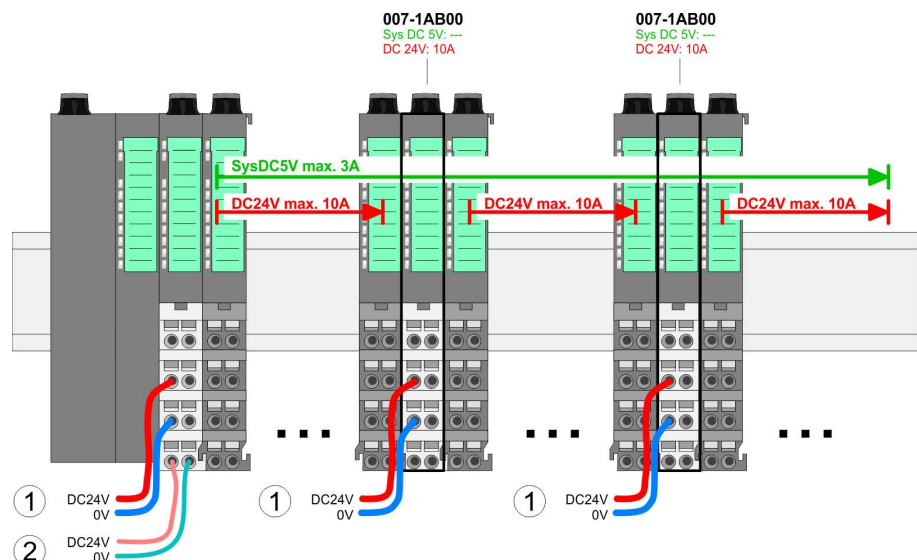
Deployment of the power modules

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.

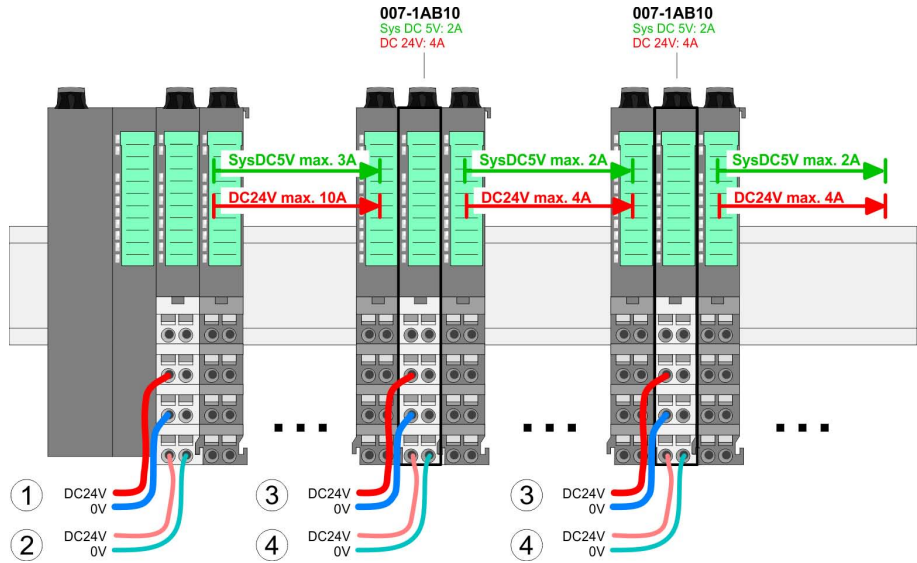
The power module with the order number 007-1AB10 is to be used if the 3A for the electronic power supply at the backplane bus is no longer sufficient. Additionally you get an isolated group for the DC 24V power section supply with 4A.

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

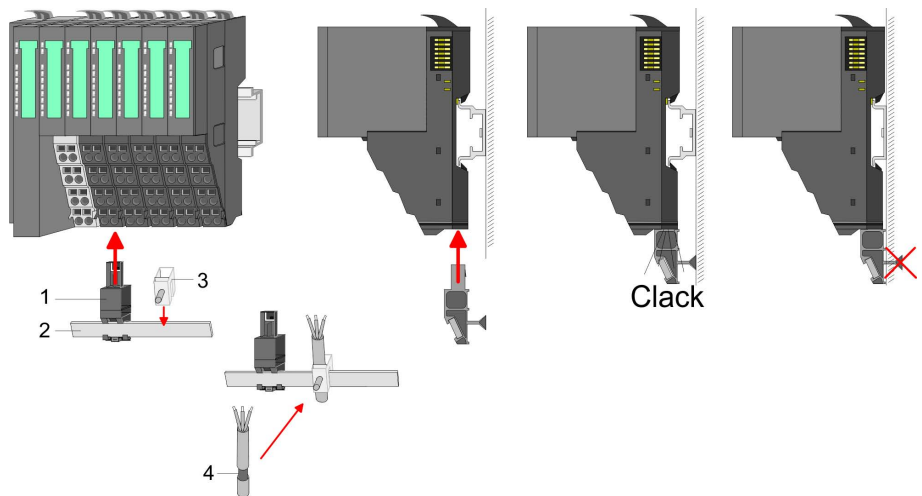
Shield attachment

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 adaption 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

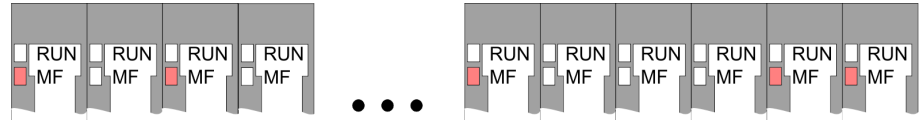
2.7 Trouble shooting - LEDs

General

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

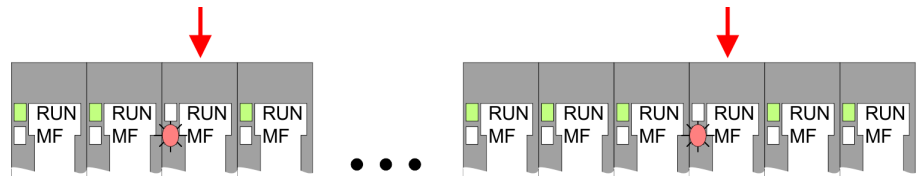


Behaviour: After PowerON the RUN LED of each module is off and the MF LED of each module is sporadically on.

Reason: 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 2.6 'Wiring' on page 23.

Error in configuration

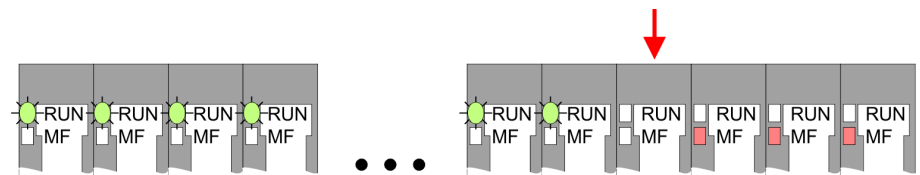


Behaviour: After PowerON the MF LED of one module respectively more modules flashes. The RUN LED remains off.

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

Remedy: Match configuration and hardware structure.

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.

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

Remedy: Replace the defective module.

2.8 Installation guidelines

General

The installation guidelines contain information about the interference free deployment of a PLC system. 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.
- The components of VIPA 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.
 - 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.
 - Please consider luminescent lamps can influence signal lines.
- 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 your PLC 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 your PLC 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

General data

2.9 General data

| Conformity and approval | | |
|-------------------------|-------------|---|
| Conformity | | |
| CE | 2006/95/EG | Low-voltage directive |
| | 2004/108/EG | EMC directive |
| Approval | | |
| UL | UL 508 | Approval for USA and Canada |
| others | | |
| RoHS | 2011/65/EU | Product is lead-free; Restriction of the use of certain hazardous substances in electrical and electronic equipment |

| 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 | | - |
| 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 | EN 61131-2 | 0...+60°C |
| Vertical installation | EN 61131-2 | 0...+60°C |
| Air humidity | EN 60068-2-30 | RH1 (without condensation, rel. humidity 10... 95%) |
| Pollution | EN 61131-2 | Degree of pollution 2 |
| Mechanical | | |
| Oscillation | EN 60068-2-6 | 1g, 9Hz ... 150Hz |
| Shock | EN 60068-2-27 | 15g, 11ms |

Mounting conditions

| | | |
|-------------------|---|-------------------------|
| Mounting place | - | In the control cabinet |
| Mounting position | - | Horizontal and vertical |

| 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 * |

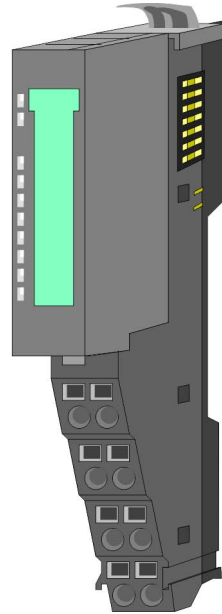
*) Due to the high-energetic single pulses with Surge an appropriate external protective circuit with lightning protection elements like conductors for lightning and overvoltage is necessary.

3 Hardware description

3.1 Properties

Features

- 1 counter 32bit (AB) invertible, DC 5V (difference signal)
- Counting frequency max. 2MHz (AB 1/2/4-fold evaluation or pulse and direction)
- Comparison value, set value, input filter, reset
- Interrupt and diagnostics function with μ s time stamp
- μ s time stamp for counter value (e.g. for speed calculation)

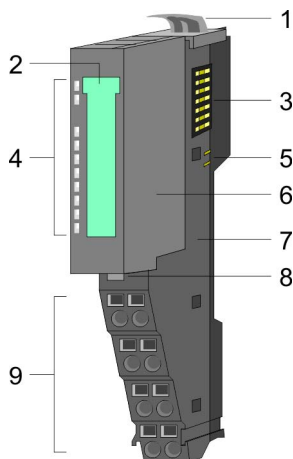


Order data

| Type | Order number | Beschreibung |
|--------|--------------|--|
| FM 050 | 050-1BA10 | Counter module 5V differential 1x32Bit |

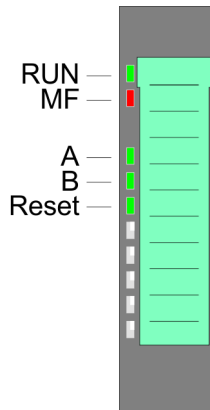
3.2 Structure



050-1BA10



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

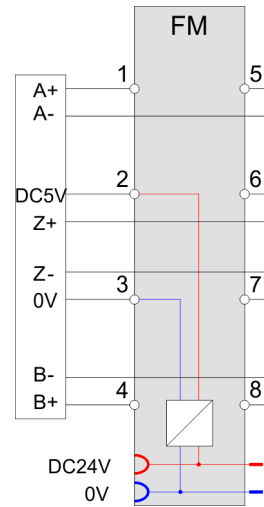
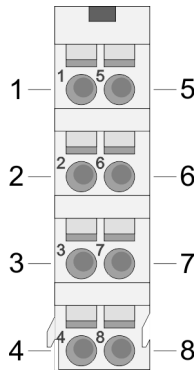
Status indication



| LED | | Description | |
|---|---|--|------------------------------------|
| RUN | MF | | |
| 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 | |
| X | B | Error in configuration (see Basics) Chapter 2.7 <i>'Trouble shooting - LEDs'</i> on page 27 | |
| A | green | ● | Inputs 1, 5 A/pulse are set |
| B | green | ● | Inputs 4, 8 B/direction are set |
| Reset | green | ● | Inputs 6, 7 Resets are set |
| on: ● off: ○ blinks with 2Hz: B not relevant: X | | | |

Pin assignment

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



| Pos. | Function | Type | Description |
|------|----------|------|---|
| 1 | A+ | I | A / pulse Difference input for counter signal res. track A of an encoder for 1-, 2- or 4-fold evaluation |
| 2 | DC 5V | O | DC 5V for encoder (max. 500mA) |
| 3 | 0V | O | GND |
| 4 | B+ | I | B / direction Difference input for direction signal res. track B of an encoder (invertible via parameterization) |
| 5 | A- | I | A / pulse Difference input for counter signal res. track A of an encoder for 1-, 2- or 4-fold evaluation |
| 6 | Z+ | I | Difference input for Reset |
| 7 | Z- | I | Difference input for Reset |
| 8 | B- | I | B / direction Difference input for direction signal res. track B of an encoder (invertible via parameterization) |

I: Input, O: Output

3.3 Technical data

| | |
|---------------------------------------|------------------|
| Order no. | 050-1BA10 |
| Type | FM 050 |
| Module ID | 08C2 3801 |
| Current consumption/power loss | |

| Order no. | 050-1BA10 |
|---|---------------------------|
| Current consumption from backplane bus | 70 mA |
| Power loss | 0.85 W |
| Technical data digital inputs | |
| Number of inputs | - |
| Cable length, shielded | 100 m |
| Cable length, unshielded | - |
| Rated load voltage | DC 20.4...28.8 V |
| Reverse polarity protection of rated load voltage | - |
| Current consumption from load voltage L+ (without load) | 20 mA |
| Rated value | - |
| Input voltage for signal "0" | Differential signal RS422 |
| Input voltage for signal "1" | Differential signal RS422 |
| Input voltage hysteresis | - |
| Frequency range | - |
| Input resistance | 120 Ω |
| Input current for signal "1" | - |
| Connection of Two-Wire-BEROs possible | - |
| Max. permissible BERO quiescent current | - |
| Input delay of "0" to "1" | 0.8 μs |
| Input delay of "1" to "0" | 0.8 μs |
| Number of simultaneously utilizable inputs horizontal configuration | - |
| Number of simultaneously utilizable inputs vertical configuration | - |
| Input characteristic curve | - |
| Initial data size | 8 Byte |
| Technical data digital outputs | |
| Number of outputs | - |
| Cable length, shielded | - |
| Cable length, unshielded | - |
| Rated load voltage | - |
| Current consumption from load voltage L+ (without load) | - |
| Output delay of "0" to "1" | - |
| Output delay of "1" to "0" | - |
| Minimum load current | - |

Technical data

| Order no. | 050-1BA10 |
|---|----------------------|
| Lamp load | - |
| Parallel switching of outputs for redundant control of a load | - |
| Parallel switching of outputs for increased power | - |
| Actuation of digital input | - |
| Switching frequency with resistive load | - |
| Switching frequency with inductive load | - |
| Switching frequency on lamp load | - |
| Internal limitation of inductive shut-off voltage | - |
| Short-circuit protection of output | - |
| Trigger level | - |
| Number of operating cycle of relay outputs | - |
| Switching capacity of contacts | - |
| Output data size | 10 Byte |
| Technical data counters | |
| Number of counters | 1 |
| Counter width | 32 Bit |
| Maximum input frequency | 500 kHz |
| Maximum count frequency | 2 MHz |
| Mode incremental encoder | ✓ |
| Mode pulse / direction | ✓ |
| Mode pulse | - |
| Mode frequency counter | - |
| Mode period measurement | - |
| Gate input available | - |
| Latch input available | - |
| Reset input available | ✓ |
| Counter output available | - |
| Status information, alarms, diagnostics | |
| Status display | yes |
| Interrupts | yes, parameterizable |
| Process alarm | yes, parameterizable |
| Diagnostic interrupt | yes, parameterizable |
| Diagnostic functions | yes, parameterizable |
| Diagnostics information read-out | possible |
| Module state | green LED |

| | |
|---|----------------------------|
| Order no. | 050-1BA10 |
| Module error display | red LED |
| Channel error display | none |
| Isolation | |
| Between channels | - |
| Between channels of groups to | - |
| Between channels and backplane bus | ✓ |
| Between channels and power supply | - |
| Max. potential difference between circuits | - |
| Max. potential difference between inputs (Ucm) | - |
| Max. potential difference between Mana and Mintern (Uiso) | - |
| Max. potential difference between inputs and Mana (Ucm) | - |
| Max. potential difference between inputs and Mintern (Uiso) | - |
| Max. potential difference between Mintern and outputs | - |
| Insulation tested with | DC 500 V |
| Datasizes | |
| Input bytes | 8 |
| Output bytes | 10 |
| Parameter bytes | 23 |
| Diagnostic bytes | 20 |
| Housing | |
| Material | PPE / 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 | |
| UL508 certification | yes |

4 Deployment

4.1 Fast introduction

Counter range

| Limits | Valid range of values |
|---------------------|-------------------------------|
| Lower counter limit | -2 147 483 648 (-2^{31}) |
| Upper counter limit | +2 147 483 647 ($2^{31}-1$) |

The maximum counter frequency is 2MHz.

Address area

Input area

At CPU, PROFIBUS and PROFINET the input respectively output area is embedded to the corresponding address area.

IX - Index for access via CANopen

SX - Subindex (6000h + EtherCAT-Slot) for access via EtherCAT

More can be found in the according manual of your bus coupler.

| Addr. | Name | Bytes | Function | IX | SX |
|-------|--------|-------|---------------------|-------|-----|
| +0 | CV_I | 4 | Counter value | 5400h | 01h |
| +4 | CSTS_I | 2 | Counter status | 5402h | 02h |
| +6 | C_US | 2 | 16bit μ s value | 5403h | 03h |

Output area

At CPU, PROFIBUS and PROFINET the output area is embedded to the corresponding address area.

IX - Index for access via CANopen

SX - Subindex (7000h + EtherCAT-Slot) for access via EtherCAT

More can be found in the according manual of your bus coupler.

| Addr. | Name | Bytes | Function | IX | SX |
|-------|---------|-------|------------------|-------|-----|
| +0 | CC_I | 4 | Comparison value | 5600h | 01h |
| +4 | CS_I | 4 | Set value | 5601h | 02h |
| +8 | CCTRL_I | 2 | Control word | 5602h | 03h |

CSTS_I Counter status

| Bit | Name | Function |
|-----|---------------|---|
| 0 | STS_SYNC | Reset was active |
| 1 | STS_CTRL_COMP | is set when <i>comparison</i> bit is enabled |
| 2 | STS_SW-GATE | Status software gate (set when <i>SW gate</i> is active) |
| 3 | STS_RST | Status reset input |

| Bit | Name | Function |
|-----------|-----------|--|
| 4 | - | reserved |
| 5 | STS_GATE | Status internal gate (set when internal gate active) |
| 6 | STS_COMP | Status <i>comparison</i> bit |
| 7 | STS_C_DN | Status set at counter direction backward |
| 8 | STS_C_UP | Status set at counter direction forward |
| 9 | STS_CMP* | Status comparison is set when the comparison condition is met. If comparison is parameterized <i>never</i> , the bit is never set |
| 10 | STS_END* | Status is set when <i>end value</i> was reached |
| 11 | STS_OFLW* | Status is set at overflow |
| 12 | STS_UFLW* | Status is set at underflow |
| 13 | STS_ZP* | Status is set at zero run |
| 14 ... 15 | - | reserved |

*) The bits remain set until reset with RES_SET (bit 6 *control word*).

CCTRL_I Control word

| Bit | Name | Function |
|-----------|-----------------|--|
| 0 | CTRL_SYNC_SET | activates the reset mode |
| 1 | CTRL_COMP_SET | enables the <i>comparison</i> bit |
| 2 | SW_GATE_SET | sets the software gate |
| 3 | - | reserved |
| 4 | - | reserved |
| 5 | COUNTERVAL_SET | sets counter temporarily to the value of <i>set value</i> |
| 6 | RES_SET | resets the bits STS_CMP, STS_END, STS_OFLW, STS_UFLW and STS_ZP with edge 0-1 |
| 7 | - | reserved |
| 8 | CTRL_SYNC_RESET | deactivates the reset mode |
| 9 | CTRL_COMP_RESET | disables the <i>comparison bit</i> |
| 10 | SW_GATE_RESET | resets the software gate |
| 11 ... 15 | - | reserved |

Parameters

DS - Record set for access via CPU, PROFIBUS and PROFINET
 IX - Index for access via CANopen
 SX - Subindex (3100h + EtherCAT-Slot) for access via EtherCAT
 More can be found in the according manual of your bus coupler.

| Name | Bytes | Function | Default | DS | IX | SX |
|---------|-------|-------------------------|---------|-----|-------------------|-----|
| DIAG_EN | 1 | Diagnostic interrupt* | 00h | 00h | 3100h | 01h |
| CH0A | 1 | Input frequency track A | 02h | 01h | 3101h | 02h |
| CH1B | 1 | Input frequency track B | 02h | 01h | 3102h | 03h |
| CH2R | 1 | Input frequency Reset | 02h | 01h | 3103h | 04h |
| CH3 | 1 | reserved | 00h | 01h | 3104h | 05h |
| INT_I | 1 | Interrupt behavior* | 00h | 80h | 3105h | 06h |
| FCT_I | 1 | Counter function* | 00h | 80h | 3106h | 07h |
| MODE2_I | 1 | Counter mode 2* | 00h | 80h | 3107h | 08h |
| MODE3_I | 1 | Counter mode 3* | 00h | 80h | 3108h | 09h |
| END_I | 4 | End value | 00h | 81h | 3109h... 310Ch | 0Ah |
| LOAD_I | 4 | Load value | 00h | 81h | 310Dh... 3110h | 0Bh |
| HYST_I | 1 | Hysteresis | 00h | 81h | 3111h | 0Ch |
| CRES | 1 | reserved | 00h | 81h | 3112h | 0Dh |

*) This parameter may only be transferred at STOP state.

Control counter

The counter is controlled via the internal gate (I gate). The I gate corresponds to the software gate (SW gate).

SW gate:

Open (activate):

in user program by edge 0-1 of SW_GATE_SET in the *control word*.

Close (deactivate):

in user program by edge 0-1 of SW_GATE_RESET in the *control word*.

Comparison bit

The following behavior for the *comparison bit* STS_COMP in the *counter status* may be set via the parameterization:

- No comparison: Comparison bit is not influenced
- Counter value ≥ comparison value: Comparison bit is set
- Counter value ≤ comparison value: Comparison bit is set
- Counter value = comparison value: Comparison bit is set

Please consider that the *comparison bit* may only be set, when the bit STS_CTRL_COMP in the *counter status* is set.

4.2 In-/Output area

4.2.1 Input area 8byte

Input area

At CPU, PROFIBUS and PROFINET the input respectively output area is embedded to the corresponding address area.

IX - Index for access via CANopen

SX - Subindex (6000h + EtherCAT-Slot) for access via EtherCAT

More can be found in the according manual of your bus coupler.

8byte

| Addr. | Name | Bytes | Function | IX | SX |
|-------|--------|-------|---------------------|-------|-----|
| +0 | CV_I | 4 | Counter value | 5400h | 01h |
| +4 | CSTS_I | 2 | Counter status | 5402h | 02h |
| +6 | C_US | 2 | 16bit μ s value | 5403h | 03h |

CV_I Counter value

The *counter value* always contains the current value of the counter.

CSTS_I Counter status

| Bit | Name | Function |
|-----------|---------------|--|
| 0 | STS_SYNC | Reset was active |
| 1 | STS_CTRL_COMP | is set when <i>comparison bit</i> is enabled |
| 2 | STS_SW-GATE | Status software gate (set when <i>SW gate</i> is active) |
| 3 | STS_RST | Status reset input |
| 4 | - | reserved |
| 5 | STS_GATE | Status internal gate (set when internal gate active) |
| 6 | STS_COMP | Status <i>comparison bit</i> |
| 7 | STS_C_DN | Status set at counter direction backward |
| 8 | STS_C_UP | Status set at counter direction forward |
| 9 | STS_CMP* | Status comparison is set when the comparison condition is met. If comparison is parameterized <i>never</i> , the bit is never set |
| 10 | STS_END* | Status is set when <i>end value</i> was reached |
| 11 | STS_OFLW* | Status is set at overflow |
| 12 | STS_UFLW* | Status is set at underflow |
| 13 | STS_ZP* | Status is set at zero run |
| 14 ... 15 | - | reserved |

*) The bits remain set until reset with RES_SET (bit 6 *control word*).

In-/Output area > Output area 10byte

C_US 16bit μ s value

In the SLIO module there is a timer (μ s ticker). With PowerON the timer starts counting with 0. After 65535 μ s the timer starts with 0 again. With each change of the *counter value* the timer value is stored as 16bit μ s value together with the *counter value* in the *input area*.

4.2.2 Output area 10byte

Output area

At CPU, PROFIBUS and PROFINET the output area is embedded to the corresponding address area.

IX - Index for access via CANopen

SX - Subindex (7000h + EtherCAT-Slot) for access via EtherCAT

More can be found in the according manual of your bus coupler.

10byte

| Addr. | Name | Bytes | Function | IX | SX |
|-------|---------|-------|------------------|-------|-----|
| +0 | CC_I | 4 | Comparison value | 5600h | 01h |
| +4 | CS_I | 4 | Set value | 5601h | 02h |
| +8 | CCTRL_I | 2 | Control word | 5602h | 03h |

CC_I Comparison value

With *comparison value* a value may be preset that may influence the *comparison bit* res. throw a process interrupt when compared with the recent *counter value*. The behavior of the *comparison bit* respectively the process interrupt may be set via the parameter MODE2_I respectively INIT_I.

CS_I Set value

By means of the *set value* there is the possibility to preset the counter with the *set value*. The value is kept by the counter by an changing edge 0-1 of the bit COUNTERVAL_SET in the *control word*.

CCTRL_I Control word

| Bit | Name | Function |
|---------|-----------------|--|
| 0 | CTRL_SYNC_SET | activates the reset mode |
| 1 | CTRL_COMP_SET | enables the <i>comparison bit</i> |
| 2 | SW_GATE_SET | sets the software gate |
| 3 ... 4 | - | reserved |
| 5 | COUNTERVAL_SET | sets counter temporarily to the value of <i>set value</i> |
| 6 | RES_SET | resets the bits STS_CMP, STS_END, STS_OFLOW, STS_UFLOW and STS_ZP with rising edge |
| 7 | - | reserved |
| 8 | CTRL_SYNC_RESET | deactivates the reset mode |
| 9 | CTRL_COMP_RESET | disables the <i>comparison bit</i> |

| Bit | Name | Function |
|-----------|---------------|--------------------------|
| 10 | SW_GATE_RESET | resets the software gate |
| 11 ... 15 | - | reserved |

4.3 Parameter data

Via parameterization you may define among others:

- Interrupt behavior
- Input filter
- Counter operating mode res. behavior
- *Load value and end value*

DS - Record set for access via CPU, PROFIBUS and PROFINET

IX - Index for access via CANopen

SX - Subindex (3100h + EtherCAT-Slot) for access via EtherCAT

More can be found in the according manual of your bus coupler.

Parameters

| Name | Bytes | Function | Default | DS | IX | SX |
|---------|-------|-------------------------|---------|-----|-------------------|-----|
| DIAG_EN | 1 | Diagnostic interrupt* | 00h | 00h | 3100h | 01h |
| CH0A | 1 | Input frequency track A | 02h | 01h | 3101h | 02h |
| CH1B | 1 | Input frequency track B | 02h | 01h | 3102h | 03h |
| CH2R | 1 | Input frequency Reset | 02h | 01h | 3103h | 04h |
| CH3 | 1 | reserved | 00h | 01h | 3104h | 05h |
| INT_I | 1 | Interrupt behavior* | 00h | 80h | 3105h | 06h |
| FCT_I | 1 | Counter function* | 00h | 80h | 3106h | 07h |
| MODE2_I | 1 | Counter mode 2* | 00h | 80h | 3107h | 08h |
| MODE3_I | 1 | Counter mode 3* | 00h | 80h | 3108h | 09h |
| END_I | 4 | End value | 00h | 81h | 3109h... 310Ch | 0Ah |
| LOAD_I | 4 | Load value | 00h | 81h | 310Dh... 3110h | 0Bh |
| HYST_I | 1 | Hysteresis | 00h | 81h | 3111h | 0Ch |
| CRES | 1 | reserved | 00h | 81h | 3112h | 0Dh |

*) This parameter may only be transferred at STOP state.

Parameter data

DIAG_EN Diagnostic interrupt

| Byte | Bit 7 ... 0 |
|------|--|
| 0 | Diagnostic interrupt <ul style="list-style-type: none"> ■ 00h = disable ■ 40h = enable |

- Here you activate res. de-activate the diagnostic function.

CHxx Input frequency

| Byte | Function | Possible values |
|------|-------------------------|--|
| 0 | Input frequency track A | <ul style="list-style-type: none"> ■ 00h: 500kHz ■ 01h: 300kHz ■ 02h: 100kHz ■ 03h: 60kHz ■ 04h: 30kHz ■ 06h: 10kHz ■ 07h: 5kHz ■ 08h: 2kHz ■ 09h: 1kHz Other values are not permissible! |
| 1 | Input frequency track B | |
| 2 | Input frequency Reset | |
| 3 | reserved | |

- *Input frequency* allows you to preset a filter for input track A, track B and reset. With the help of filters you may e.g. filter signal peaks at a blurred input signal.

INT_I Interrupt behavior

| Byte | Bit 7 ... 0 |
|------|---|
| 0 | <ul style="list-style-type: none"> ■ <i>Bit 5 ... 0: Interrupt behavior</i> ■ Bit 0: 0 (fix) ■ Bit 1: 0 (fix) ■ Bit 2: Proc. interrupt overflow ■ Bit 3: Proc. interrupt underflow ■ Bit 4: Proc. interrupt <i>comparison value</i> ■ Bit 5: Proc. interrupt <i>end value</i> ■ <i>Bit 7 ... 6: 0 (fix)</i> |

- Setting the appropriate bit activates the associated process interrupt.

FCT_I Counter function

| Byte | Bit 7 ... 0 |
|------|--|
| 0 | <ul style="list-style-type: none"> ■ <i>Bit 5 ... 0: Counter function</i> <ul style="list-style-type: none"> – 000000b = Count endless – 000001b = Once: forward – 000010b = Once: backwards – 000100b = Once: no main direction – 001000b = Periodic: forward – 010000b = Periodic: backwards – 100000b = Periodic: no main direction ■ <i>Bit 7 ... 6: 0 (fix)</i> |

MODE2_I Counter mode
2

| Byte | Bit 7 ... 0 |
|------|--|
| 0 | <ul style="list-style-type: none"> ■ <i>Bit 2 ... 0: Comparison bit is set</i> (... when following condition is met) <ul style="list-style-type: none"> – 000b = never – 001b = <i>counter value</i> ≥ <i>comparison value</i> – 010b = <i>counter value</i> ≤ <i>comparison value</i> – 100b = <i>counter value</i> = <i>comparison value</i> ■ <i>Bit 3: Count direction track B inverted</i> <ul style="list-style-type: none"> – 0 = No (not inverted) – 1 = Yes (inverted) ■ <i>Bit 6 ... 4: Reset</i> <ul style="list-style-type: none"> – 000b = de-activated – 001b = high level – 011b = edge 0-1 – 101b = edge 0-1 once ■ <i>Bit 7: 0 (fix)</i> |

- For activation of the comparison bit STS_COMP the bit CTRL_COMP_SET (bit 1) of the *control word* must be set!
- For activation of reset the bit CTRL_SYNC_SET (bit 0) of the *control word* must be set!

MODE3_I Counter mode
3

| Byte | Bit 7 ... 0 |
|------|--|
| 0 | <ul style="list-style-type: none"> ■ <i>Bit 2 ... 0: Signal evaluation</i> <ul style="list-style-type: none"> – 000b = Counter de-activated – 001b = Rotary encoder single (at A and B) – 010b = Rotary encoder double (at A and B) – 011b = Rotary encoder quadruple (at A and B) – 100b = Direction (pulse at A and direction at B) ■ <i>Bit 6 ... 3: 0 (fix)</i> ■ <i>Bit 7: Gate function (internal gate)</i> <ul style="list-style-type: none"> – 0 = abort – 1 = interrupt |

- At de-activated counter the further parameter settings are ignored.
- With gate function "abort" counting begins again at the load value. With "interrupt" counting is continued with the count.

END_I End value,
LOAD_I Load value

You may set an upper and a lower limit by setting a *load value* as start and an *end value*.

HYST_I Hysteresis

The *hysteresis* serves the avoidance of many toggle processes of the *comparison bit* and the interrupt, if the *counter value* is in the range of the *comparison value*. You may set a range of 0 to 255. The settings 0 and 1 deactivate the *hysteresis*. The *hysteresis* influences zero run, comparison, over- and underflow.

4.4 Counter - Functions

Overview

You may count forward and backwards and choose between the following counter functions:

- Count endless, e.g. distance measuring with incremental encoder
- Count once, e.g. count to a maximum limit
- Count periodic, e.g. count with repeated counter process

In the operating modes "Count once" and "Count periodic" you may define a counter range as start and end value via the parameterization. For every counter additional parameterizable functions are available like gate function, comparison, hysteresis and process interrupt.

Main counting direction

Via the parameterization you have the opportunity to define a main counting direction for every counter. If "none" is chosen, the complete counting range is available:

| Limits | Valid value range |
|-------------------|-------------------------------|
| Lower count limit | -2 147 483 648 (-2^{31}) |
| Upper count limit | +2 147 483 647 ($2^{31}-1$) |

Main counting direction forward

Upper restriction of the count range. The counter counts 0 res. *load value* in positive direction until the parameterized *end value* -1 and jumps then back to the load value with the next following encoder pulse.

Main counting direction backwards

Lower restriction of the count range. The counter counts from the parameterized start- res. *load value* in negative direction to the parameterized *end value* +1 and jumps then back to the start value with the next following encoder pulse.

Gate function abort/ interrupt

If the HW gate is enabled, only the HW gate may be influenced by the gate functions. An opening and closing of the SW gate only interrupts the count process.

Abort count process

The count process starts after closing and restart of the gate beginning with the *load value*.

Interrupt count process

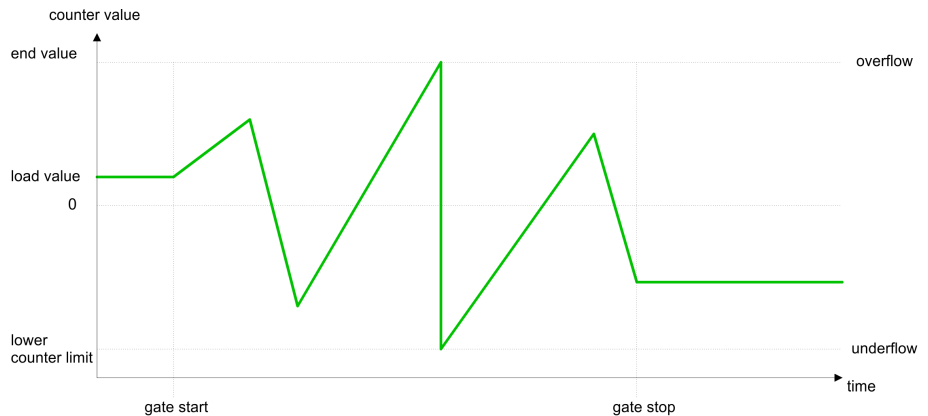
The count process continuous after closing and restart of the gate beginning with the last recent counter value.

Count continuously

In this operating mode, the counter counts from the load value. When the counter counts forward and reaches the upper count limit and another counting pulse in positive direction arrives, it jumps to the lower count limit and counts from there on. When the counter counts backwards and reaches the lower count limit and another counting pulse in negative direction arrives, it jumps to the upper count limit and counts from there on. The count limits are set to the maximum count range.

| Limits | Valid value range |
|-------------------|-------------------------------------|
| Lower count limit | -2 147 483 648 (-2 ³¹) |
| Upper count limit | +2 147 483 647 (2 ³¹ -1) |

With overflow or underflow the status bits STS_OFLW respectively STS_UFLW are set. These bits remain set until these are reset with RES_STS. If enabled additionally a process interrupt is triggered.



Count Once

No main counting direction

- The counter counts once starting with the *load value*.
- You may count forward or backwards.
- The count limits are set to the maximum count range.
- At over- or underflow at the count limits, the counter jumps to the according other count limit and the internal gate is automatically closed and the status bits STS_OFLW respectively STS_UFLW are set. If enabled additionally a process interrupt is triggered.
- To restart the count process, you have to re-open the internal gate.
- At interrupting gate control, the count process continuous with the last recent *counter value*.
- At aborting gate control, the counter starts with the *load value*.

| Limits | Valid value range |
|-------------------|-------------------------------------|
| Lower count limit | -2 147 483 648 (-2 ³¹) |
| Upper count limit | +2 147 483 647 (2 ³¹ -1) |

Interrupting gate control:



Aborting gate control:



Main counting direction forward

- The counter counts starting with the *load value*.
- When the counter reaches the end value -1 in positive direction, it jumps to the load value at the next positive count pulse and the gate is automatically closed.
- To restart the count process, you must create a positive edge of the gate. The counter starts with the load value.

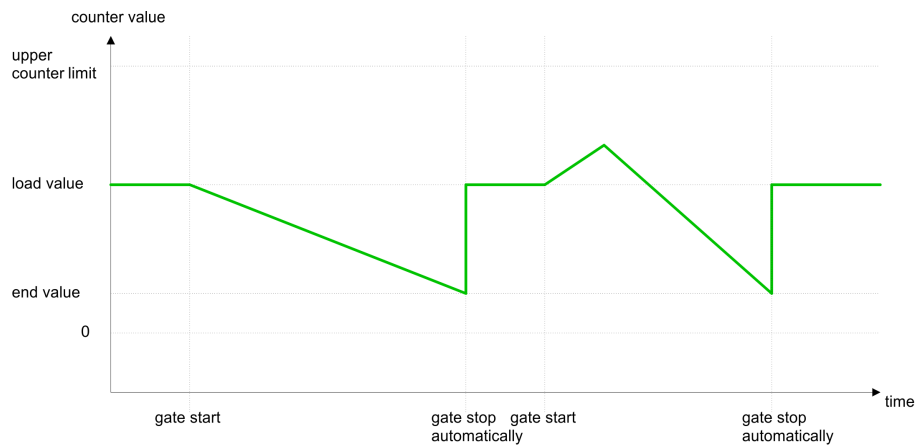
| Limits | Valid value range |
|-------------------|--|
| Limit value | -2 147 483 647 ($-2^{31} + 1$) to +2 147 483 647 ($2^{31} - 1$) |
| Lower count limit | -2 147 483 648 (-2^{31}) |



Main counting direction backwards

- The counter counts backwards starting with the *load value*.
- When the counter reaches the end value +1 in negative direction, it jumps to the load value at the next negative count pulse and the gate is automatically closed.
- To restart the count process, you must create a positive edge of the gate. The counter starts with the load value.

| Limits | Valid value range |
|-------------------|--|
| Limit value | -2 147 483 648 (-2^{31}) to +2 147 483 646 ($2^{31} - 2$) |
| Upper count limit | +2 147 483 647 ($2^{31} - 1$) |



Count Periodically

No main counting direction

- The counter counts forward or backwards starting with the *load value*.
- At over- or underrun at the count limits, the counter jumps to the according other count limit and counts from there on.
- The count limits are set to the maximum count range.

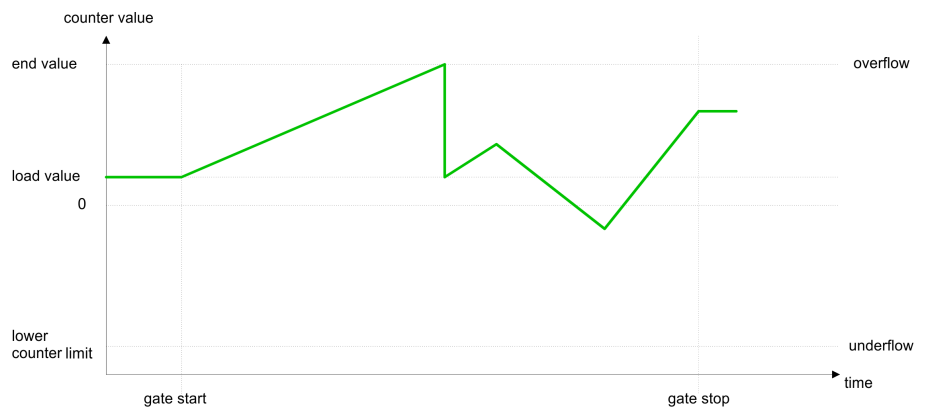
| Limits | Valid value range |
|-------------------|---------------------------------|
| Lower count limit | -2 147 483 648 (-2^{31}) |
| Upper count limit | +2 147 483 647 ($2^{31} - 1$) |



Main counting direction forward

- The counter counts forward starting with the *load value*.
- When the counter reaches the end value -1 in positive direction, it jumps to the *load value* at the next positive count pulse.

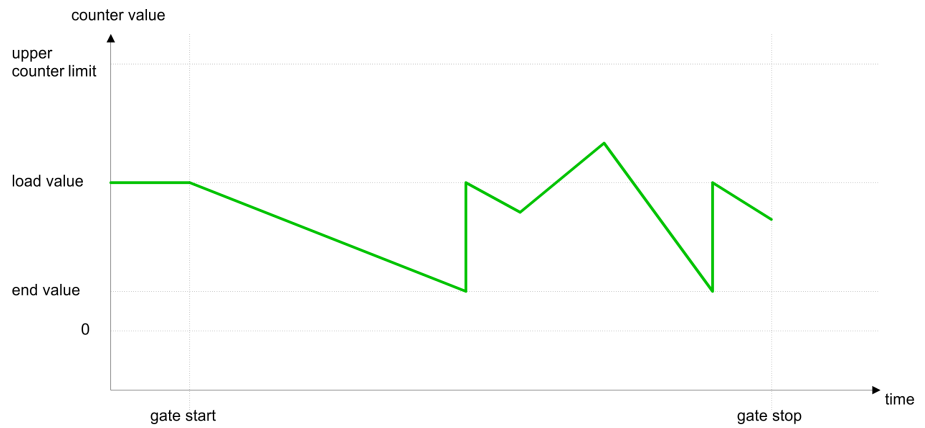
| Limits | Valid value range |
|-------------------|--|
| Limit value | -2 147 483 647 ($-2^{31} + 1$) to +2 147 483 647 ($2^{31} - 1$) |
| Lower count limit | -2 147 483 648 (-2^{31}) |



Main counting direction backwards

- The counter counts backwards starting with the *load value*.
- When the counter reaches the *end value* $+1$ in negative direction, it jumps to the *load value* at the next negative count pulse.
- You may exceed the upper count limit.

| Limits | Valid value range |
|-------------------|--|
| Limit value | -2 147 483 648 (-2^{31}) to +2 147 483 646 ($2^{31} - 2$) |
| Upper count limit | +2 147 483 647 ($2^{31} - 1$) |



4.5 Counter additional functions

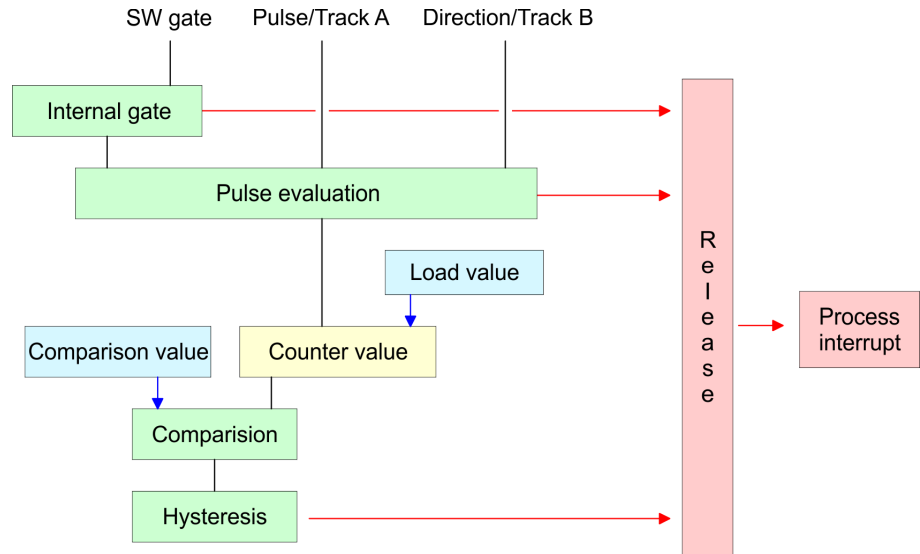
Overview

The following additional functions may be set for each counter via the parameterization:

- Gate function
 - The gate function serves for the start, stop and interrupt of a count function.
- Comparison
 - You may set a *comparison value* that activates res. de-activates the digital output res. releases a process interrupt depending on the *counter value*.
- Hysteresis
 - The setting of a *hysteresis* avoids for example a high interrupt toggling when the value of an encoder signal shifts around a comparison value.

Schematic structure

The illustration shows how the additional functions influence the counting behavior. The following pages describe these functions in detail:



Gate function

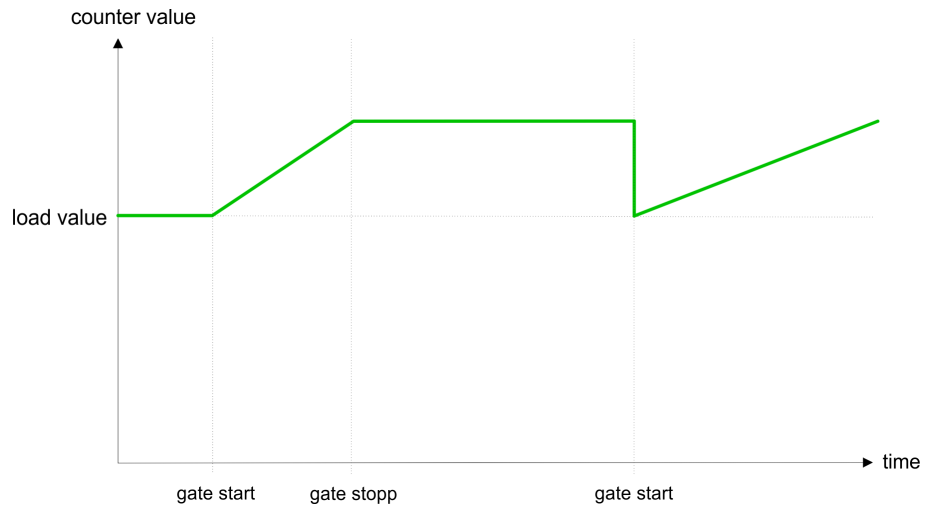
The activation/res. de-activation of the counter happens via an internal gate (I gate). The I gate corresponds to the software gate (SW gate). The SW gate is opened (activated) via your user application by an edge 0-1 of the bit SW_GATE_SET of the control word in the output area. The software gate is closed (de-activated) by an edge 0-1 of the bit SW_GATE_RESET. If the I gate was automatically closed at "counting once", so this may only be opened with an edge 0-1 on SW_GATE_SET. The following states influence the I gate:

| SW gate | influences I gate |
|---------------|-------------------|
| 0 | 0 |
| 1 | 1 |
| with edge 0-1 | 1 |

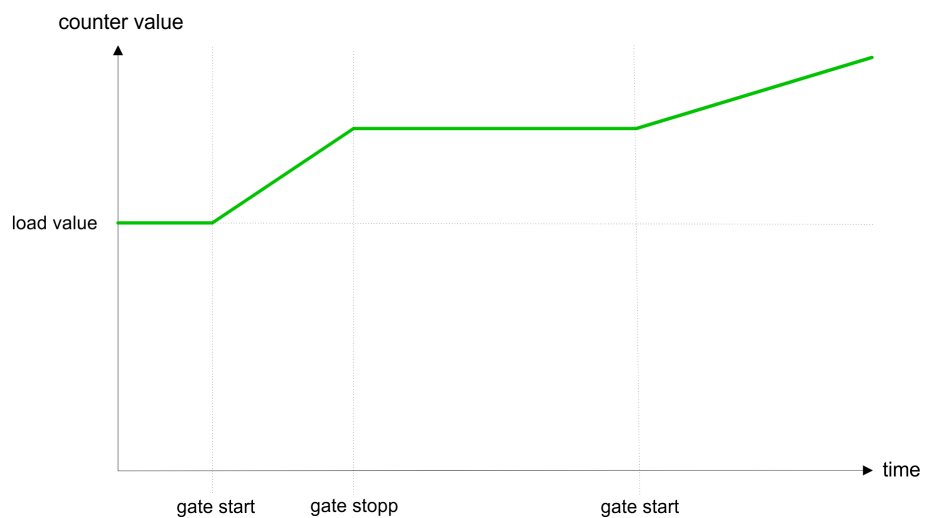
Gate function abort and interrupt

The parameterization defines if the gate interrupts or aborts the counter process.

- At *abort function* the counter starts counting with the *load value* after gate restart.



- At *interrupt function*, the counter starts counting with the recent *counter value* after gate restart.



Comparison function

The *compare value* is to be pre-defined by the *output area*. The *comparison bit* may be found at the *counter status* at STS_COMP. Please consider that the bit STS_COMP may only be influenced when in the counter status the bit STS_CTRL_COMP is set. The following behavior for the *comparison bit* may be pre-defined via the parameterization:

- no comparison: *Comparison bit* is not influenced
- *Counter value* ≥ *comparison value*: *Comparison bit* is set
- *Counter value* ≤ *comparison value*: *Comparison bit* is set
- *Counter value* = *comparison value*: *Comparison bit* is set

no comparison

The *comparison bit* is not influenced.

Comparison bit is set when counter value ≥ comparison value

The *comparison bit* remains set as long as the *counter value* is higher or equal *comparison value*.

Comparison bit is set when counter value ≤ comparison value

The *comparison bit* remains set as long as the *counter value* is lower or equal *comparison value*.

Comparison bit is set when counter value = comparison value

When the counter reaches the *comparison value* the *comparison bit* is set. The *comparison bit* remains set as long as the comparison condition is met. When you've set a main counting direction the *comparison bit* is only set at reaching the *comparison value* from the main counting direction.

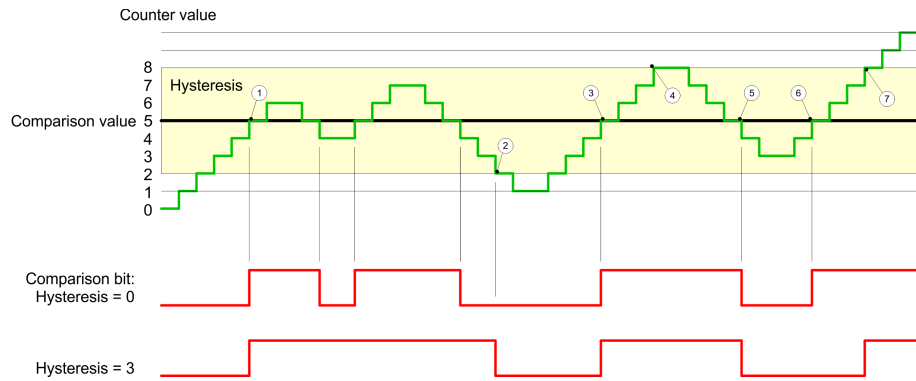


The bit *STS_COMP* is set together with the bit *STS_CMP* in the counter status. In contrast to the bit *STS_COMP* this bit remains set as long as it is reset by setting the bit *RES_SET* in the control word.

Hysteresis

The *hysteresis* serves e.g. the avoidance of many toggle processes of the interrupt, if the counter value is in the range of the *comparison value*. You may set a range of 0 to 255. The settings 0 and 1 deactivate the hysteresis. The *hysteresis* influences the zero run, over-/underflow and *comparison value*. An activated *hysteresis* remains active after a change. The new *hysteresis* range is taken over at the next *hysteresis* event. The following pictures illustrate the behavior of the *comparison bit* for *hysteresis* 0 and *hysteresis* 3 for the according conditions:

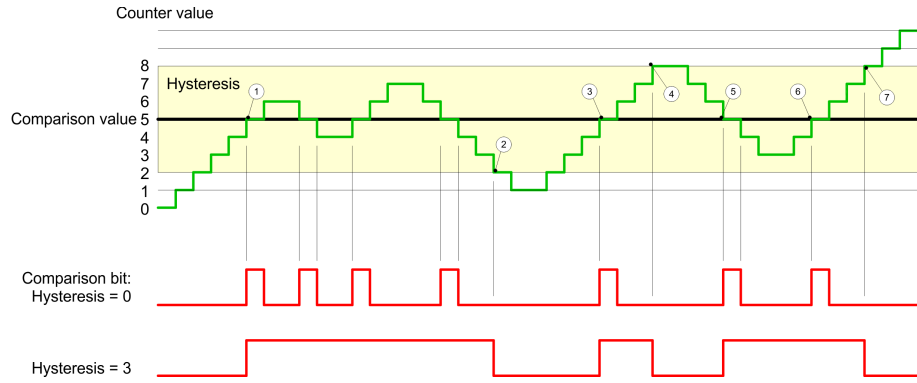
Effect at counter value \geq comparison value



- 1 Counter value \geq comparison value \rightarrow comparison bit is set and hysteresis activated
- 2 Leave hysteresis range \rightarrow comparison bit is reset
- 3 Counter value \geq comparison value \rightarrow comparison bit is set and hysteresis activated
- 4 Leave hysteresis range, comparison bit remains set for counter value \geq comparison value
- 5 Counter value $<$ comparison value and hysteresis active \rightarrow comparison bit is reset
- 6 Counter value \geq comparison value \rightarrow comparison bit is not set for hysteresis active
- 7 Leave hysteresis range, comparison bit remains set for counter value \geq comparison value

With reaching the comparison condition the *hysteresis* gets active. At active *hysteresis* the comparison result remains unchanged until the counter value leaves the set *hysteresis* range. After leaving the *hysteresis* range a new *hysteresis* is only activated with again reaching the comparison conditions.

Effect at counter value = comparison value



- 1 Counter value = comparison value → comparison bit is set and hysteresis activated
- 2 Leave hysteresis range → comparison bit is reset and Counter value < comparison value
- 3 Counter value = comparison value → comparison bit is set and hysteresis activated
- 4 Comparison bit is reset for leaving hysteresis range and counter value > comparison value
- 5 Counter value = comparison value → comparison bit is set and hysteresis activated
- 6 Counter value = comparison value and hysteresis active → comparison bit remains set
- 7 Leave hysteresis range and counter value > comparison value → comparison bit is reset

With reaching the comparison condition the *hysteresis* gets active. At active *hysteresis* the comparison result remains unchanged until the *counter value* leaves the set *hysteresis* range. After leaving the *hysteresis* range a new *hysteresis* is only activated with again reaching the comparison conditions.

4.6 Diagnostic and interrupt

Overview

| Event | Process interrupt | Diagnostics interrupt | parameterizable |
|-----------------------------|-------------------|-----------------------|-----------------|
| Overflow | X | - | X |
| Underflow | X | - | X |
| Comparison value | X | - | X |
| End value | X | - | X |
| Diagnostics buffer overflow | - | X | - |
| Process interrupt lost | - | X | - |
| Power supply is missing * | - | X | X |

*) The module may only send a diagnostic interrupt if at the time of power loss the diagnostic interrupt was already enabled. If the power supply is already missing during startup (diagnostic interrupt is off), no diagnostic interrupt may be sent.

Process interrupt

So you may react to asynchronous events, there is the possibility to activate a process interrupt. A process interrupt interrupts the linear program sequence and jumps depending on the master system to a corresponding Interrupt routine. Here you can react to the process interrupt accordingly.

With CANopen the process interrupt data a transferred via an emergency telegram.

Operating with CPU, PROFIBUS and PROFINET the process interrupt data were transferred via diagnostics telegram.

SX - Subindex (5000h) for access via EtherCAT

More can be found in the according manual of your bus coupler.

| Name | Bytes | Function | Default | SX |
|---------|-------|------------------------|---------|-------------|
| PRIT_A | 1 | Process interrupt data | 00h | 02h |
| PRIT_B | 1 | State of the inputs | 00h | 03h |
| PRIT_US | 2 | µs-Ticker | 00h | 04h ... 05h |

PRIT_A Process interrupt data

| Byte | Bit 7 ... 0 |
|------|--|
| 0 | Process interrupt data <ul style="list-style-type: none"> ■ Bit 1 ... 0: reserved ■ Bit 2: Overflow, underflow or end value reached ■ Bit 3: Comparison value reached ■ Bit 7 ... 4 reserved |

PRIT_B State of the inputs

| Byte | Bit 7 ... 0 |
|------|--|
| 0 | State of the inputs at the moment of the process interrupt <ul style="list-style-type: none"> ■ Bit 0: Input value channel 0 (Track A) ■ Bit 1: Input value channel 1 (Track B) ■ Bit 2: Input value channel 2 (Reset) ■ Bit 7 ... 3: reserved |

PRIT_US µs-Ticker

| Byte | Bit 7 ... 0 |
|---------|---|
| 0 ... 1 | Value of the µs ticker at the moment of the process interrupt |

Diagnostic data

Via the parameterization you may activate a diagnostic interrupt for the module. With a diagnostic interrupt the module serves for diagnostic 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. All events of a channel between diagnostic interrupt_{incoming} and diagnostic interrupt_{going} are not stored and get lost. Within this time window (1. diagnostic interrupt_{incoming} until last diagnostic interrupt_{going}) the MF-LED of the module is on.

DS - Record set for access via CPU, PROFIBUS and PROFINET. The access happens by DS 01h. Additionally the first 4 bytes may be accessed by DS 00h.

IX - Index for access via CANopen. The access happens by IX 2F01h. Additionally the first 4 bytes may be accessed by IX 2F00h.

SX - Subindex (5005h) for access via EtherCAT.

More can be found in the according manual of your bus coupler.

| Name | Bytes | Function | Default | DS | IX | SX |
|---------------------|-------|-------------------------------------|---------|-----|-------|----------------|
| ERR_A | 1 | Diagnostic | 00h | 01h | 2F01h | 02h |
| MODTYP | 1 | Module information | 18h | | | 03h |
| ERR_C | 1 | reserved | 00h | | | 04h |
| ERR_D | 1 | Diagnostic | 00h | | | 05h |
| CHTYP | 1 | Channel type | 76h | | | 06h |
| NUMBIT | 1 | Number diagnostics bits per channel | 08h | | | 07h |
| NUMCH | 1 | Number channels of the module | 01h | | | 08h |
| CHERR | 1 | Channel error | 00h | | | 09h |
| CH0ERR | 1 | Channel-specific error | 00h | | | 0Ah |
| CH1ERR... CH7ERR | 7 | reserved | 00h | | | 0Bh ... 11h |
| DIAG_US | 4 | µs-Ticker | 00h | | | 13h |

ERR_A Diagnostic

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

MODTYP Modul information

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

ERR_C reserved

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

Diagnostic and interrupt

ERR_D Diagnostic

| Byte | Bit 7 ... 0 |
|------|--|
| 0 | <ul style="list-style-type: none"> ■ Bit 2 ... 0: reserved ■ Bit 3: set at internal diagnostics buffer overflow ■ Bit 5 ... 4: reserved ■ Bit 6: Process interrupt lost ■ Bit 7: 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"> – 76h: Counter module ■ Bit 7: reserved |

NUMBIT Diagnostic bits

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

NUMCH Channels

| Byte | Bit 7 ... 0 |
|------|---|
| 0 | Number of channels of the module (here 01h) |

CHERR Channel error

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

CH0ERR Channel-specific

| Byte | Bit 7 ... 0 |
|------|--|
| 0 | Diagnostic interrupt due to process interrupt lost at ... <ul style="list-style-type: none"> ■ Bit 1 ... 0: reserved ■ Bit 2: Overflow/underflow/end value ■ Bit 3: Comparison value reached ■ Bit 7 ... 4: reserved |

CH1ERR ... CH7ERR reserved

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

DIAG_US μ s ticker

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