YASKAWA

System SLIO

FM | 050-1BA50 | Manual

HB300 | FM | 050-1BA50 | en | 26-06

Counter module advanced RS422/TTL 1x32Bit - FM 050

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050-1BA50_000_FM050,1,EN -

Table of contents

1 General

1.1 About this manual

Objective and contents

This manual describes the FM 050-1BA50 of the System SLIO.

- It describes the structure, configuration and application.
- The manual is targeted at users with good basic knowledge in automation technology.
- The manual does not replace sufficient basic knowledge of automation technology or sufficient familiarity with the specific product.
- The manual consists of chapters. Each chapter describes a completed topic.
- For guidance, the manual provides:
  - An overall table of contents at the beginning of the manual
  - References with pages numbers
    Usually, press *[Alt]+[←]* to return to the previous view.

Validity of the documentation

Product	Order no.	as of version:
FM 050	050-1BA50	HW: 01

Documentation

In the context of the use of the pertinent Yaskawa product, the manual is to be made accessible to the pertinent qualified personnel in:

- Project engineering
- Installation department
- Commissioning
- Operation

Icons and 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.

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.

1.2 Copyright © YASKAWA Europe GmbH

Download Center

By entering the product order number in the *'Download Center'* at www.yaskawa.eu.com, the pertinent manuals, data sheets, declarations of conformity, certificates and other helpful information for your product can be found.

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Tel.: +49 6196 569 500 (hotline)
Email: support@yaskawa.eu

1.3 Safety instructions

General safety instructions

DANGER

Danger to life due to non-compliance with safety instructions

Non-compliance with the safety instructions in the manual can result in serious injury or death. The manufacturer is not responsible for any injuries or damage to the equipment.

CAUTION

Before commissioning and operating the components described in this manual, it is essential to note the following:

- Modifications to the automation system must only be done in a voltage-free state!
- Connection and modification only by trained electricians
- National regulations and guidelines in the respective country of use must be observed and complied with (installation, protective measures, EMC, etc.)

Intended use

- It is the customer's responsibility to comply with all pertinent standards, codes, or regulations applicable to the use of the product, including those that apply when the Yaskawa product is used in combination with other products.
- The customer must confirm that the Yaskawa product is suitable for the customer's plant, machinery and equipment.
- If the Yaskawa product is used in a manner not specified by this manual, the protection provided by the Yaskawa product may be impaired and the use may result in material or immaterial damage.
- Contact Yaskawa to determine whether use is permitted in the following applications. If the use in the respective application is permissible, the Yaskawa product is to be used by considering additional risk assessments and specifications, and safety measures are to be provided to minimise the dangers in the event of a fault. Special caution is required and protective measures must be taken in the case of:
  - Outdoor use, use with possible chemical contamination or electrical interference, or use under conditions or in environments which are not described in product catalogs or manuals.
  - Nuclear control systems, combustion systems, railway systems, aviation systems, automotive systems, medical devices, amusement machines and equipment that is specifically regulated by industry or government.
  - Systems, machines and devices that can pose a risk to life or property.
  - Systems that require a high degree of reliability, such as gas, water or electricity supply systems or systems that operate 24 hours a day.
  - Other systems that require a similarly high level of security.
- Never use the Yaskawa product in an application where failure of the product could cause serious danger to life, limb, health or property without first ensuring that the system is designed to provide the required level of safety with risk warnings and redundancy to avoid the realisation of such dangers and that the Yaskawa product is properly designed and installed.
- The connection examples and other application examples described in the product catalogs and manuals of Yaskawa are for reference purposes. Check the functionality and safety of the devices and systems actually to be used before using the Yaskawa product.
- To avoid accidental harm to third parties, read and understand all prohibitions on use and precautions, and operate the Yaskawa product correctly.

Field of application

- The Yaskawa product is not suited for use in life-support machines or systems.
- Please contact your Yaskawa representative or Yaskawa distributor if considering the use of the Yaskawa product for special purposes, such as machines or systems used in passenger cars, in medical, aircraft and aerospace applications, for power supply of networks, for electrical power distribution or for underwater applications.

DANGER

The device is not permitted for use

– in explosive environments (EX zone)

The system is designed and manufactured for proper use and use in accordance with the user manual and is designed for:

- Communication and process control
- general control and automation tasks
- for industrial use
- operation within the environmental conditions specified in the technical data
- installation in a cabinet

DANGER

If this Yaskawa product is used in applications where failure of the device can result in the loss of human life, a serious accident or physical injury, you must install appropriate safety devices.

– Death or serious injury can result if you do not install the safety devices properly.

Disclaimer

(1) The contractual and legal liability of Yaskawa and the legal representatives and vicarious agents of Yaskawa for compensation and reimbursement of expenses in relation to the content of this documentation is excluded or limited as follows:

a) For slightly negligent breaches of *Essential Contractual Duties* arising from the contractual obligation, for Yaskawa the amount of liability is limited to the foreseeable damage typical for the contract. *'Essential Contractual Duties'* are those duties that characterise the performance of the contract and on which the Yaskawa customer may reasonably rely.

(b) In each case, Yaskawa is not liable for (i) the slightly negligent breach of duties arising from the duties that are not *Essential Contractual Duties*, as well as (ii) force majeure, i.e. external events that have no operational connection and cannot be averted even by exercising the utmost care that can reasonably be expected.

(2) The aforementioned limitation of liability does not apply (i) in cases of mandatory statutory liability (in particular under the product liability law), (ii) if and to the extent that Yaskawa has assumed a guarantee or same as guaranteed procurement risk according to § 276 BGB, (iii) for culpably caused injuries to life, limb and/or health, also by representatives or vicarious agents, as well as (iv) in case of delay in the event of a fixed completion date.

(3) A reversal of the burden of proof is not associated with the provisions above.

Disposal

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

2 Basics and mounting

2.1 Safety notes for the user

DANGER

Protection against dangerous voltages

- When using System SLIO modules, the user must be protected from touching hazardous voltage.
- You must therefore create an insulation concept for your system that includes safe separation of the potential areas of extra-low voltage (ELV) and hazardous voltage.
- Here, observe the insulation voltages between the potential areas specified for the System SLIO modules and take suitable measures, such as using PELV/SELV power supplies for System SLIO modules.

Handling of electrostatic sensitive modules

The modules are equipped with highly integrated components in MOS technology. These components are highly sensitive to over-voltages that occur, e.g. with electrostatic discharge. The following symbol is used to identify these hazardous modules:

The symbol is located on modules, module racks or on packaging and thus indicates electrostatic sensitive modules. Electrostatic sensitive modules can be destroyed by energies and voltages that are far below the limits of human perception. If a person who is not electrically discharged handles electrostatic sensitive modules, voltages can occur and damage components and thus impair the functionality of the modules or render the modules unusable. Modules damaged in this way are in most cases not immediately recognized as faulty. The error can only appear after a long period of operation. Components damaged by static discharge can show temporary faults when exposed to temperature changes, vibrations or load changes. Only the consistent use of protective devices and responsible observance of the handling rules can effectively prevent malfunctions and failures on electrostatic sensitive modules.

Shipping of modules

Please always use the original packaging for shipping.

Measurement and modification of electrostatic sensitive modules

For measurements on electrostatic sensitive modules the following must be observed:

- Floating measuring instruments must be discharged before use.
- Measuring instruments used must be grounded.

When modifying electrostatic sensitive modules, ensure that a grounded soldering iron is used.

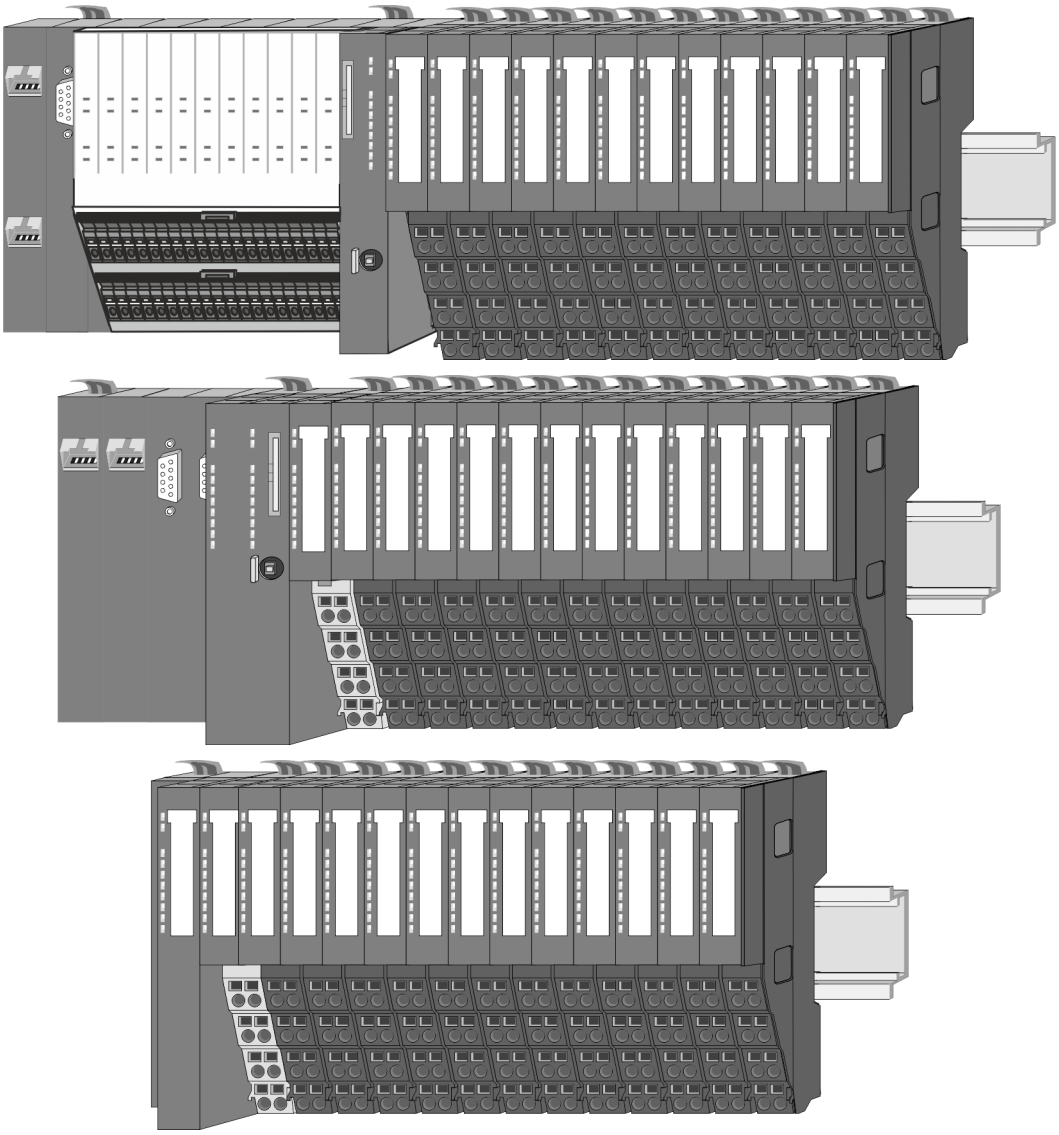
CAUTION

When working with and on electrostatic sensitive modules, make sure that personnel and equipment are adequately grounded.

2.2 System conception

2.2.1 Overview

The System SLIO is a modular automation system for assembly on a 35mm profile rail. By means of the periphery modules with 2, 4, 8 and 16 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 supply 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.



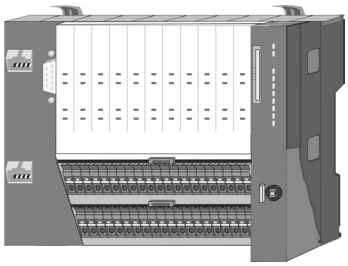
2.2.2 Components

- CPU (head module)
- Bus coupler (head module)
- Line extension
- 8x periphery modules
- 16x periphery modules
- Power modules
- Accessories

CAUTION

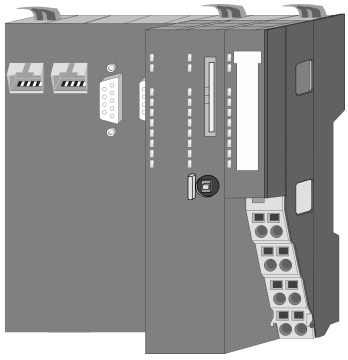
Only Yaskawa modules may be combined. A mixed operation with third-party modules is not allowed!

CPU 01xC



With the CPU 01xC electronic, input/output components and power supply are integrated to one casing. In addition, up to 64 periphery modules of the System SLIO can be connected to the backplane bus. As head module via the integrated power module for power supply CPU electronic and the I/O components are supplied as well as the electronic of the periphery modules, which are connected via backplane bus. To connect the power supply of the I/O components and for DC 24V power section supply of via backplane bus connected periphery modules, the CPU has removable connectors. By installing of up to 64 periphery modules at the backplane bus, 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.

CPU 01x



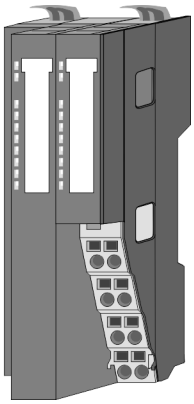
With this CPU 01x, CPU electronic and power supply are integrated to one casing. As head module, via the integrated power module for power supply, CPU electronic and the electronic of the connected periphery modules are supplied. The DC 24V power section supply for the linked periphery modules is established via a further connection of the power module. By installing of up to 64 periphery modules at the backplane bus, 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 may not be separated!

Here you may only exchange the electronic module!

Bus coupler



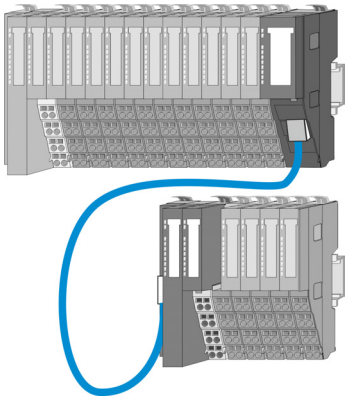
With a bus coupler bus interface and power module is integrated to one casing. With the bus interface you get access to a subordinated bus system. As head module, via the integrated power module for power supply, bus interface and the electronic of the connected periphery modules are supplied. The DC 24V power section supply for the linked periphery modules is established via a further connection of 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 may not be separated!

Here you may only exchange the electronic module!

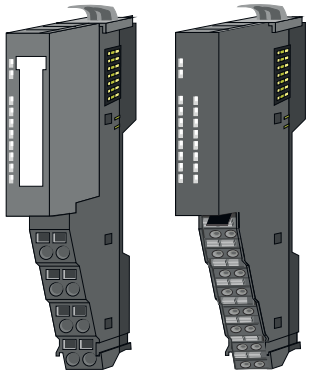
Line extension



In the System SLIO there is the possibility to place up to 64 modules in on line. By means of the line extension you can divide this line into several lines. Here you have to place a line extension MainDevice at each end of a line and the subsequent line has to start with a line extension SubDevice. MainDevice and SubDevice are to be connected via a special connecting cable. In this way, you can divide a line on up to 5 lines. Depending on the line extension, the max. number of pluggable modules at the System SLIO bus is decreased accordingly. To use the line extension no special configuration is required.

Please note that some modules do not support line extensions due to the system. For more information, please refer to the compatibility list. This can be found in the 'Download Center' of www.yaskawa.eu.com under 'System SLIO Compatibility list'.

Periphery modules

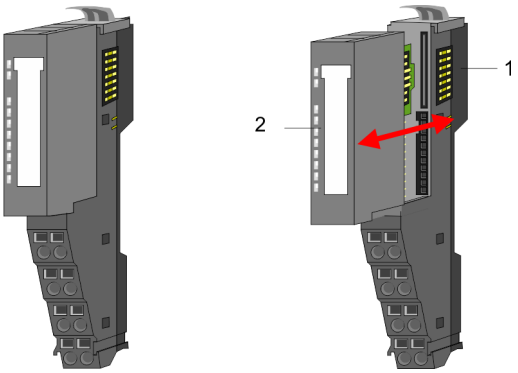


The periphery modules are available in the following 2 versions, whereby of each the electronic part can be replaced with standing wiring:

- 8x periphery module for a maximum of 8 channels.
- 16x periphery module for a maximum of 16 channels.

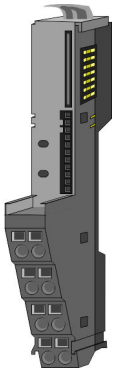
8x periphery modules

Each 8x periphery module consists of a *terminal* and an *electronic module*.



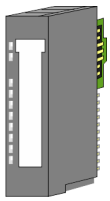
1 Terminal module
2 Electronic module

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 profile rail. By means of this locking system your system may be assembled outside of your switchgear cabinet to be later mounted there as whole system.

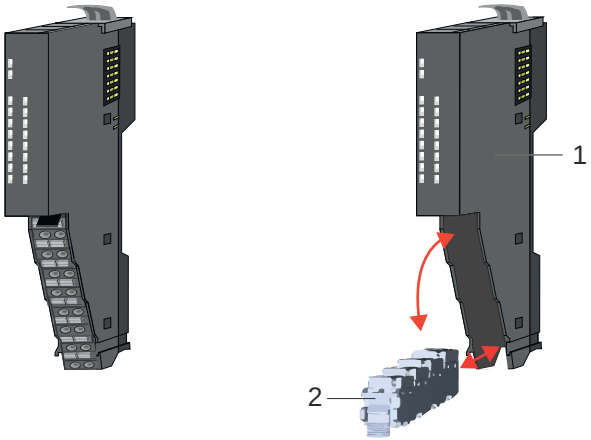
Electronic module



The functionality of a periphery module is defined by the *electronic module*, which is mounted to the terminal module by a sliding mechanism. With an error the defective electronic 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 corresponding connection information at the front and at the side.

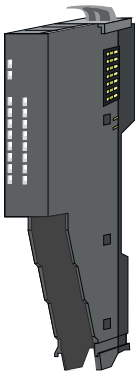
16x periphery modules

Each 16x periphery module consists of an *electronic unit* and a *terminal block*.



1 Electronic unit
2 Terminal block

Electronic unit

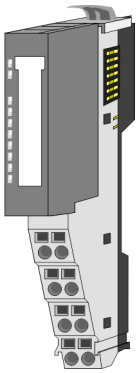


With the 16x periphery module the terminal block is connected to the *electronic unit* via a secure flap mechanism. In the case of an error you can exchange the defective electronic unit for a functional unit with standing wiring. At the front side there are LEDs for status indication. For easy wiring each electronic unit shows corresponding connection information at the side. The electronic unit provides the slot for the terminal block for the wiring and contains the backplane bus with power supply for the electronic and the connection to the DC 24V power section supply. Additionally the electronic unit has a locking system for fixing it at a profile rail. By means of this locking system your system may be assembled outside of your switchgear cabinet to be later mounted there as whole system.

Terminal block

The *terminal block* provides the electrical interface for the signalling and supplies lines of the module. When mounting the terminal block, it is attached to the bottom of the electronic unit and turned towards the electronic unit until it clicks into place. With the wiring a "push-in" spring-clip technique is used. This allows a quick and easy connection of your signal and supply lines. The clamping off takes place by means of a screwdriver.

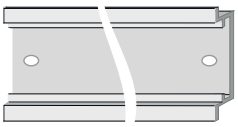
Power module



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.

2.2.3 Accessories

Profile rail



Order no.	Description
290-1AF00	35 mm profile rail length 2000mm
290-1AF30	35 mm profile rail length 530mm

NOTICE

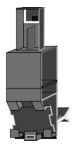
To ensure EMC, the profile rail must be grounded!

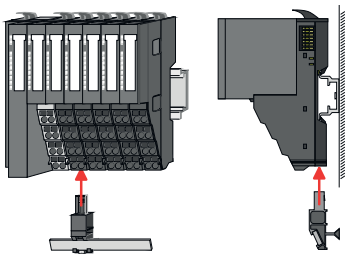
- Ensure that the profile rail is reliably and professionally grounded.
- By mounting them on the grounded profile rail, the modules are automatically connected to the grounding system.

➥ *'Grounding guidelines'...page 20*

➥ *'Installation guidelines'...page 44*

Shield bus carrier

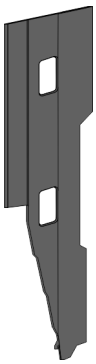




Please note that a shield bus carrier cannot be mounted on a 16x periphery module!

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 profile rail for adaptation to a flat profile rail you may remove the spacer of the shield bus carrier.

Bus cover



With each head module, 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 head module before mounting a System 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

Please note that a coding pin cannot be installed on a 16x periphery module! Here you have to make sure that the associated terminal block is plugged again when the electronics unit is replaced.

There is the possibility to fix the assignment of electronic and terminal module. Here coding pins (order number 000-0AC00) 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 electronic module just another electronic module can be plugged with the same encoding.

Spare parts

The following spare parts are available for the System SLIO:

Spare part	Order no.	Description	Packaging unit
	092-9BH00	Terminal block for System SLIO 16x periphery module.	5 pieces
	092-9BK00	Connector for System SLIO CPU 013C.	5 pieces

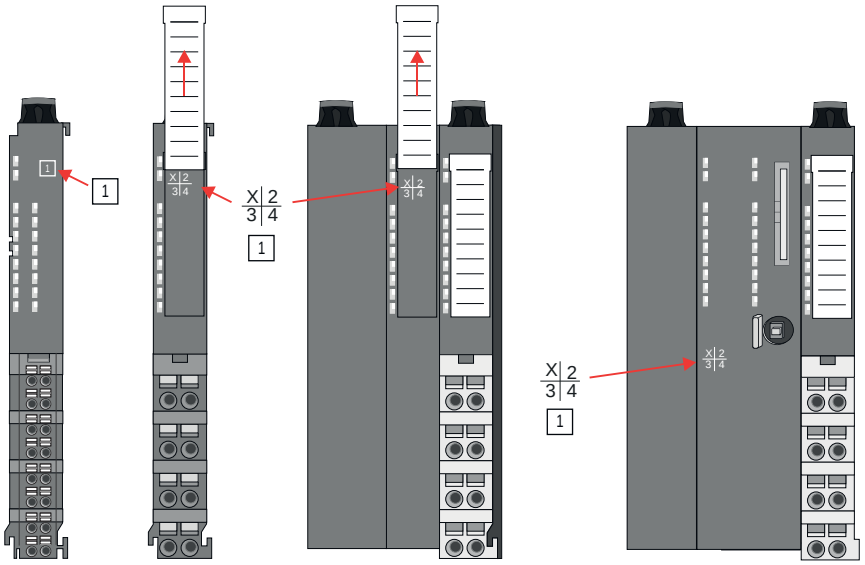
CAUTION

Please note that you may only use the spare parts with Yaskawa modules. Use with third-party modules is not allowed!

2.2.4 Hardware revision

Hardware revision on the front

- The hardware revision is printed on every System SLIO module.
- Since a System SLIO 8x periphery module consists of a terminal and electronic module, you will find a hardware revision printed on each of them.
- Authoritative for the hardware revision of a System SLIO module is the hardware revision of the electronic module. This is located under the labeling strip of the corresponding electronic module.
- Depending on the module type, there are the following 2 variants e.g. to indicate hardware revision 1:
  - With current labelling there is a 1 on the front.
  - With earlier labelling, the 1 is marked with *'X'* on a number grid.



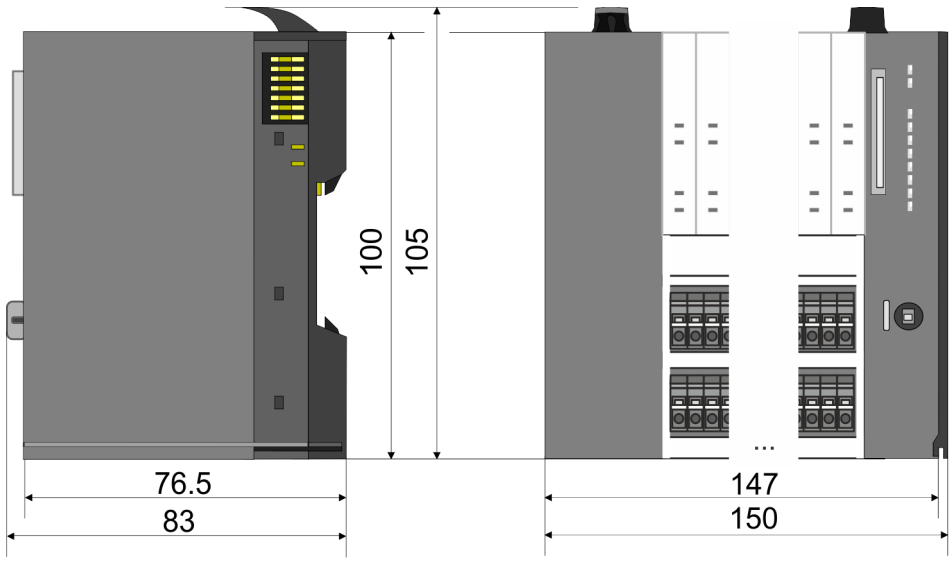
Hardware revision via web server

On the CPUs and some bus couplers, you can check the hardware revision *'HW Revision'* via the integrated web server.

2.3 Dimensions

CPU 01xC

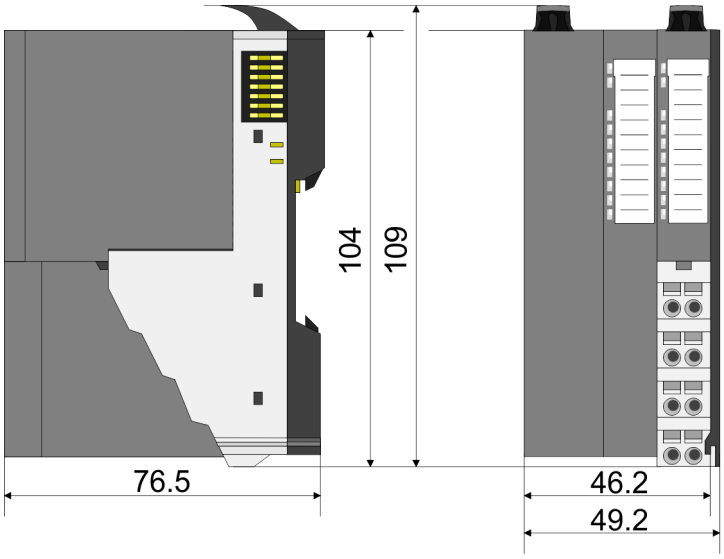
All dimensions are in mm.



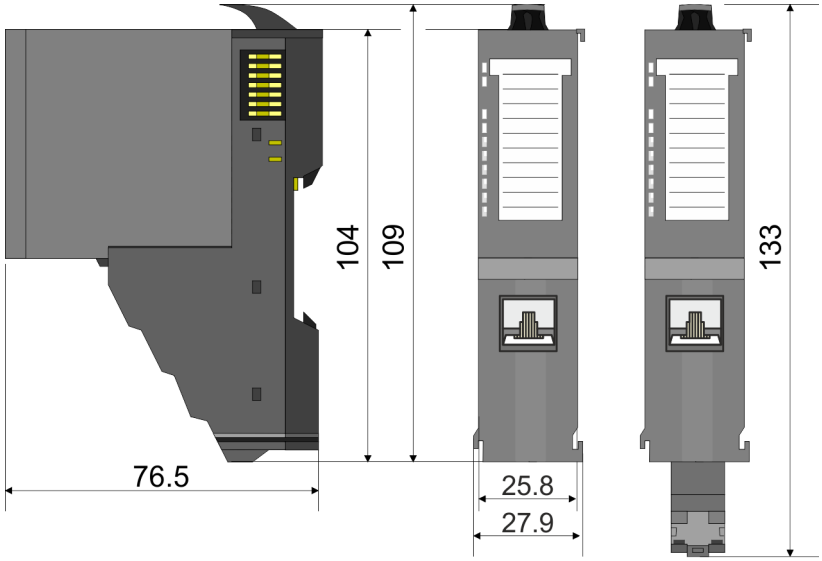
Dimensions

CPU 01x

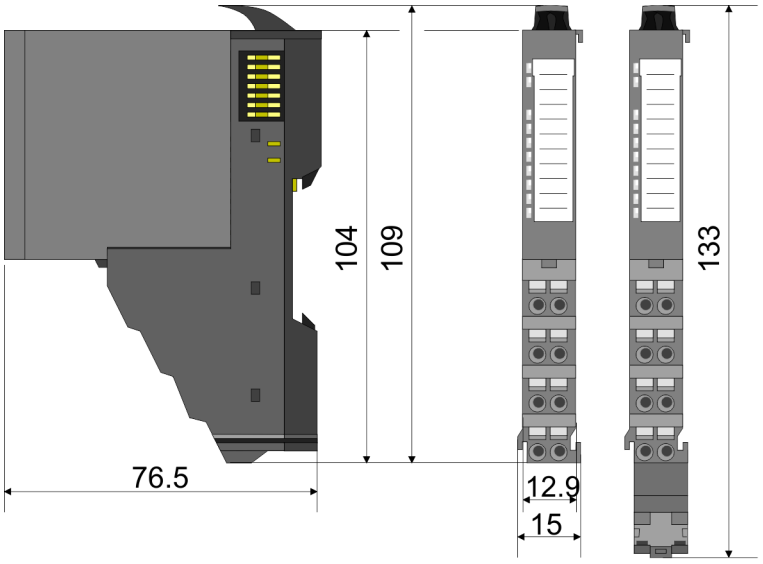
Bus coupler and line extension SubDevice



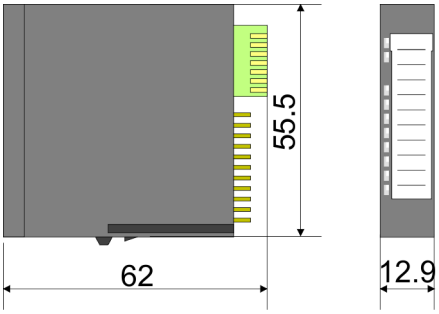
Line extension MainDevice



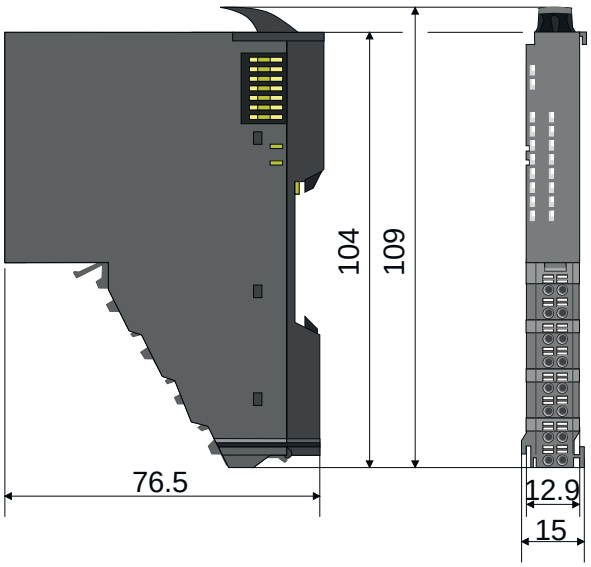
8x periphery module



Electronic module



16x periphery module



2.4 Grounding concept

Grounding guidelines

For reliable grounding, ensure that all common ground connections and the functional earth (FE) of your System SLIO and all connected devices are connected to a central point and grounded there.

NOTICE

To ensure EMC, the profile rail must be grounded!

- Ensure that the profile rail is reliably and professionally grounded.
- By mounting them on the grounded profile rail, the modules are automatically connected to the grounding system.

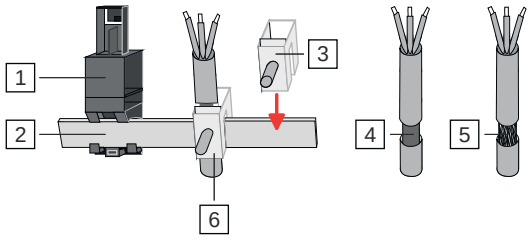
➦ *'Installation guidelines'...page 44*

- To avoid potential differences, use grounding cables that are as short as possible and have a large cross-section.
- When selecting grounding points, observe the applicable safety regulations.
- When assembling your components, ensure that the inactive metal parts are properly grounded over a large area.
  - Connect all inactive metal parts over a large area and with low impedance.
  - Avoid using aluminium parts if possible. Aluminium is easily oxidizing and is therefore less suitable for grounding.

2.4.1 Shielding

Overview

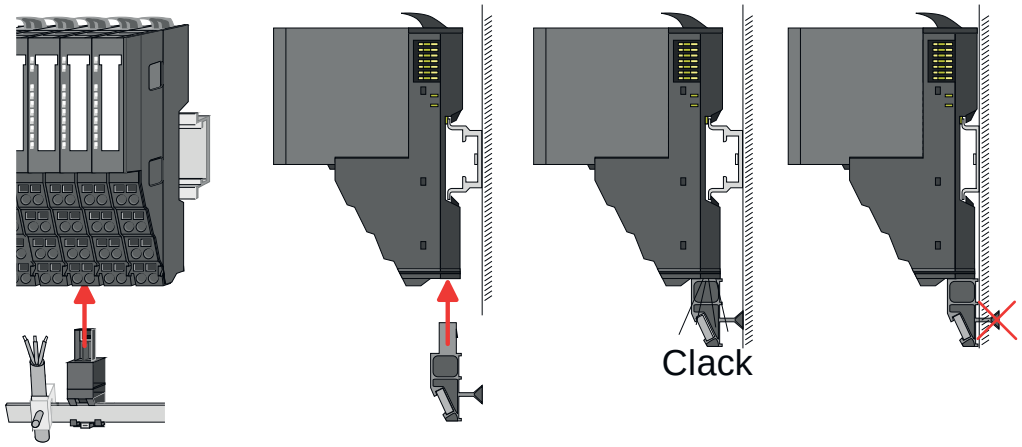
Shielding is required for interference-free signal transmission. This weakens electrical, magnetic or electromagnetic interference fields. To attach the shield the mounting of shield bus carriers are necessary. The shield bus carrier (available as accessory) serves to carry the shield bus to connect cable shields. ➦ *'Installation guidelines'...page 44*



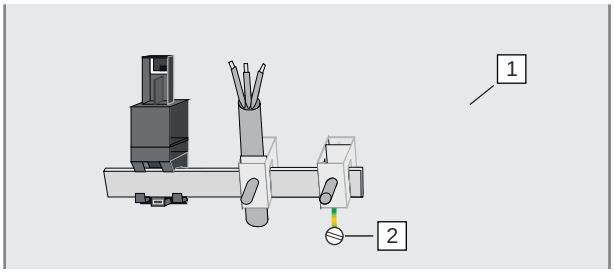
1 Shield bus carrier
2 Shield bus (10mm x 3mm)
3 Shield clamp
4 Cable shield with metal foil
5 Cable shield with wire mesh (close-meshed)
6 Cable shield mounted with shield clamp

Shield attachment

1. System SLIO head and 8x periphery modules have a carrier hole for the shield bus carrier. Push the shield bus carrier, until they engage into the module. With a flat profile rail for adaptation to a flat profile rail you may remove the spacer of the shield bus carrier.
2. Put your shield bus into the shield bus carrier.



3. Attach the cables with the accordingly stripped cable screen and fix it by the shield clamp with the shield bus.
4. The shield bus must always be grounded. Keep all cable connections as short as possible. To ground the shield bus, connect a FE conductor to the shield bus via a shield clamp and screw it to the base plate as close as possible and with low impedance.



1 Base plate
2 FE conductor screwed to base plate

2.5 Mounting 8x periphery modules

CAUTION

Requirements for UL compliance use

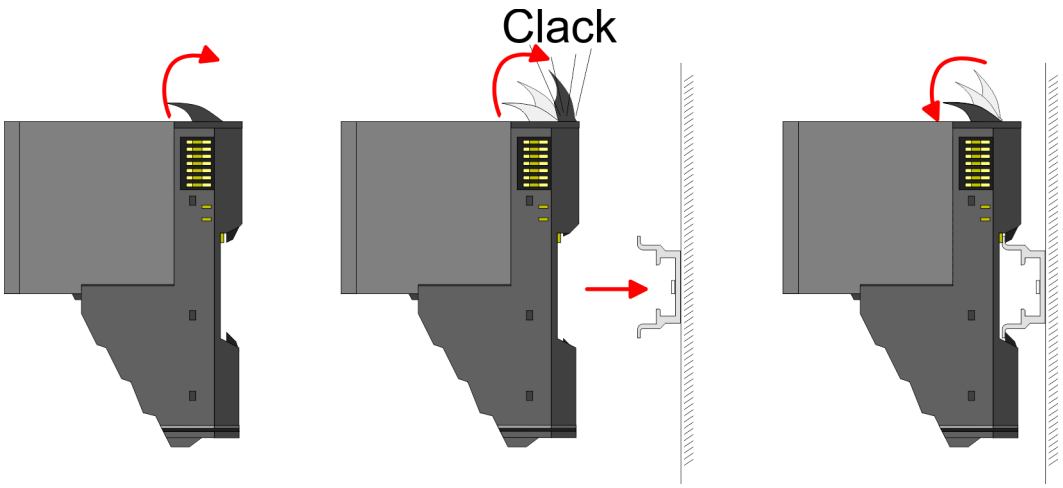
- Use for power supply exclusively SELV/PELV power supplies.
- The System SLIO must be installed and operated in a housing according to IEC 61010-1 9.3.2 c).

CAUTION

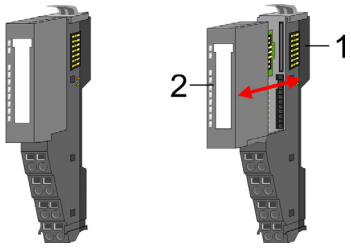
Danger of injury from electrical shock and damage to the unit!

Put the System SLIO in a safe, powered down state before starting installation, disassembly or wiring of the System SLIO modules!

There is a locking lever at the top side of the module. For mounting and demounting this locking lever is to be turned upwards until this engages. For mounting place the module to the module installed before and push the module to the profile rail guided by the strips at the upper and lower side of the module. The module is fixed to the profile rail by pushing downward the locking lever. The modules may either separately be mounted to the profile rail or as block. Here is to be considered that each locking lever is opened. The modules are each installed on a profile rail. The electronic and power section supply are connected via the backplane bus. 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 accordingly.



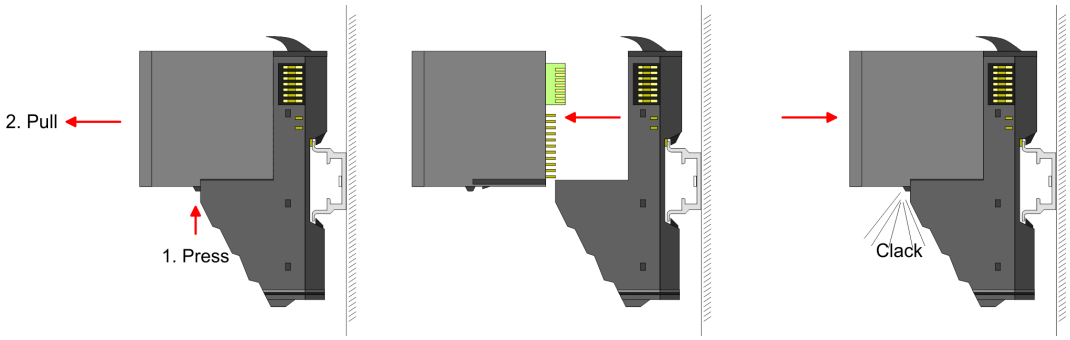
Terminal and electronic module



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

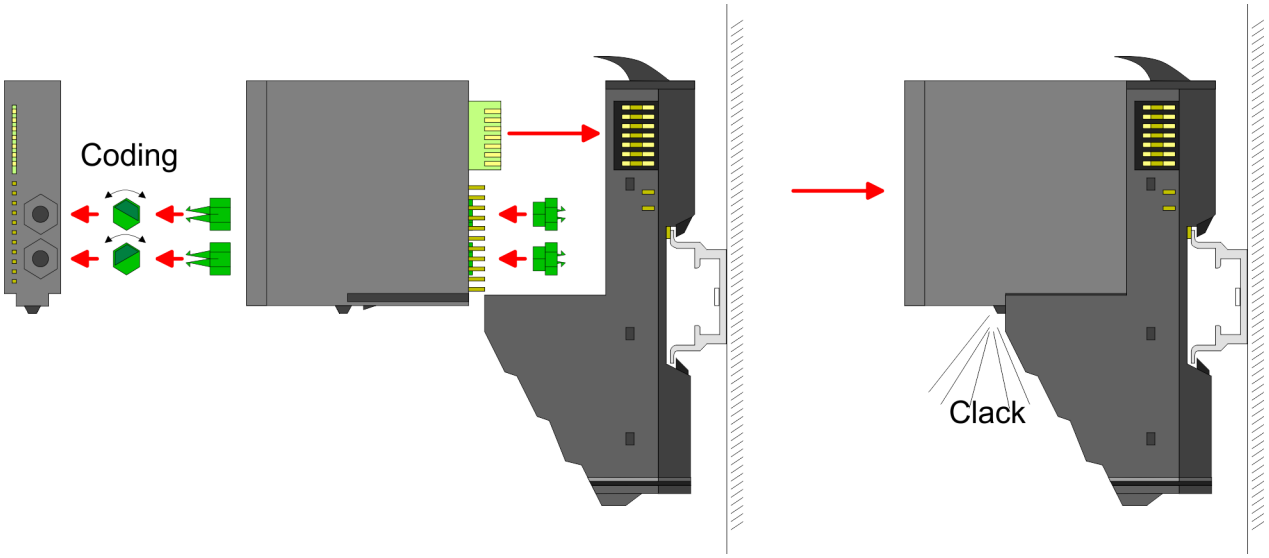
1 Terminal module
2 Electronic module

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) 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.

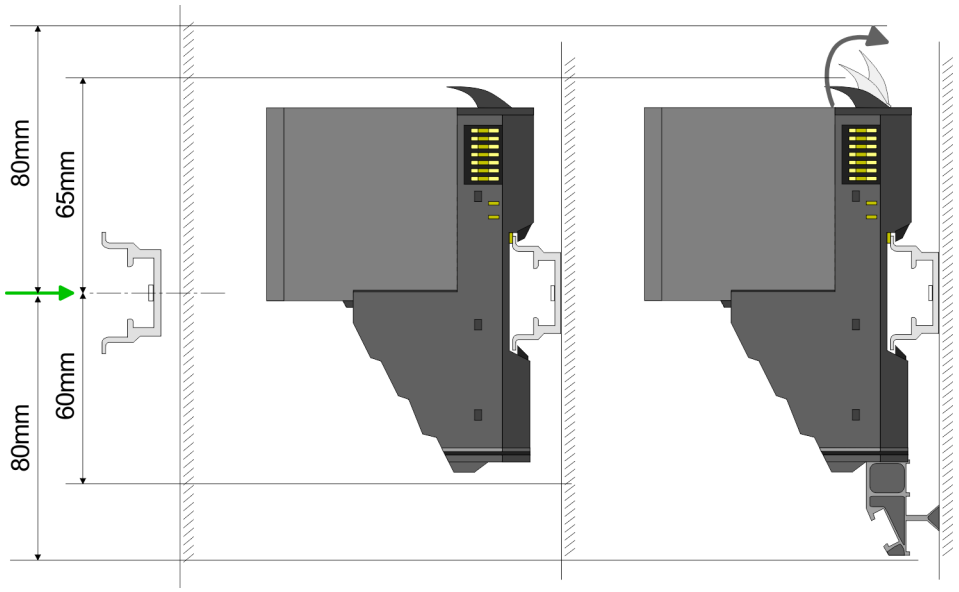
1. Plug, according to your coding, 2 coding jacks in the coding sockets of your electronic module until they lock
2. Now plug the according coding plugs into the coding jacks.
3. To fix the coding put both the electronic and terminal module together until they lock

CAUTION

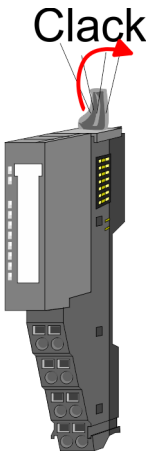
Please consider that when replacing an already coded electronic module, this is always be replaced by an electronic module with the same coding.

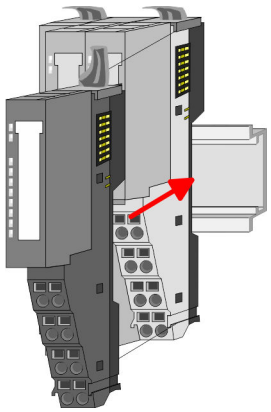
Even with an existing coding on the terminal module, you can plug an electronic module without coding. The user is responsible for the correct usage of the coding pins. Yaskawa assumes no liability for incorrectly attached electronic modules or for damages which arise due to incorrect coding!

Mounting periphery modules

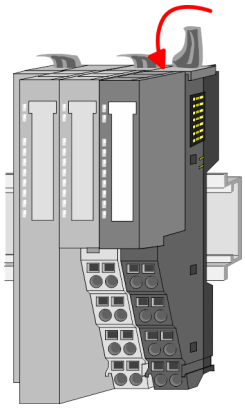


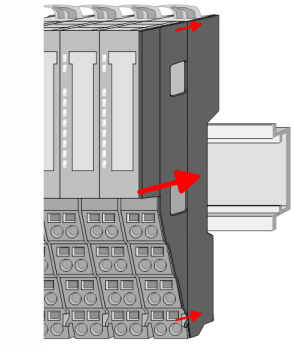
1. Mount the profile rail. Please consider that a clearance from the middle of the profile rail of at least 80mm above and 60mm below, respectively 80mm by deployment of shield bus carriers, exist.
2. Mount your head module such as CPU or field bus coupler.
3. Before mounting the periphery modules you have to remove the bus cover at the right side of the head module by pulling it forward. Keep the cover for later mounting.

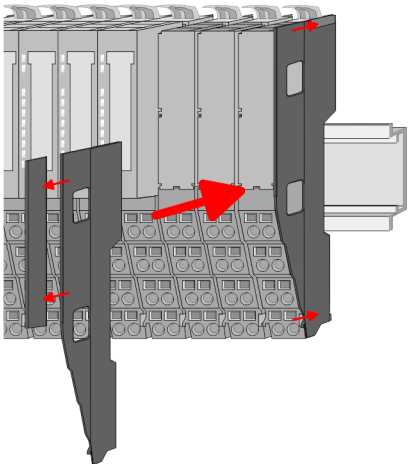




4. For mounting turn the locking lever of the module upwards until it engages.
5. For mounting place the module to the module installed before and push the module to the profile rail guided by the strips at the upper and lower side of the module.
6. Turn the locking lever of the periphery module downward, again.







7. After mounting the whole system, to protect the backplane bus connectors at the last module you have to mount the bus cover, now. If the last module is a clamp module, for adaptation the upper part of the bus cover is to be removed.

2.6 Mounting 16x periphery modules

CAUTION

Requirements for UL compliance use

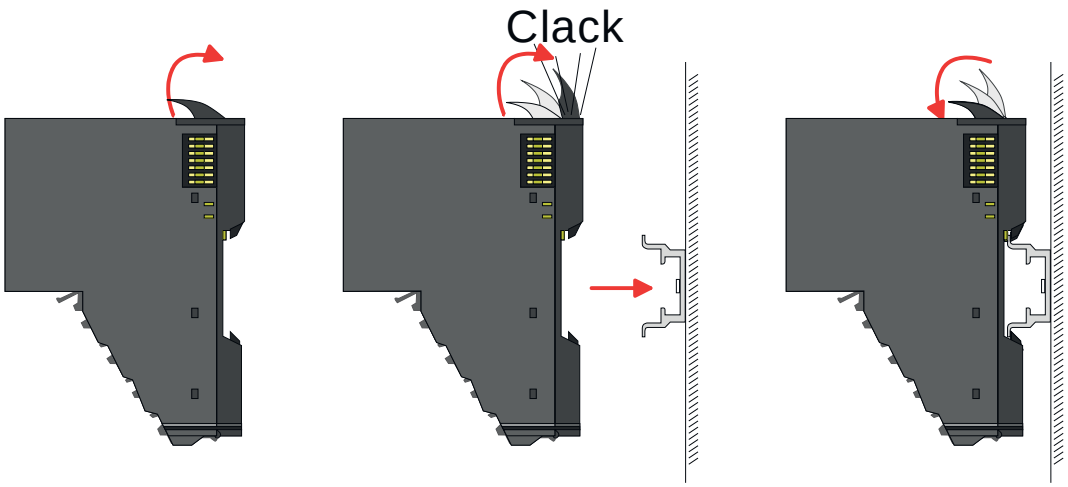
- Use for power supply exclusively SELV/PELV power supplies.
- The System SLIO must be installed and operated in a housing according to IEC 61010-1 9.3.2 c).

CAUTION

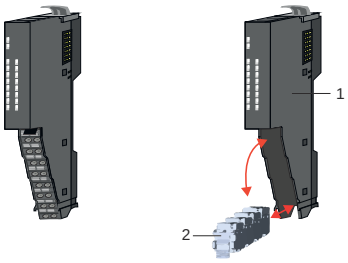
Danger of injury from electrical shock and damage to the unit!

Put the System SLIO in a safe, powered down state before starting installation, disassembly or wiring of the System SLIO modules!

There is a locking lever at the top side of the module. For mounting and demounting this locking lever is to be turned upwards until this engages. For mounting place the module to the module installed before and push the module to the profile rail guided by the strips at the upper and lower side of the module. The module is fixed to the profile rail by pushing downward the locking lever. The modules may either separately be mounted to the profile rail or as block. Here is to be considered that each locking lever is opened. The modules are each installed on a profile rail. The electronic and power section supply are connected via the backplane bus. 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 accordingly.



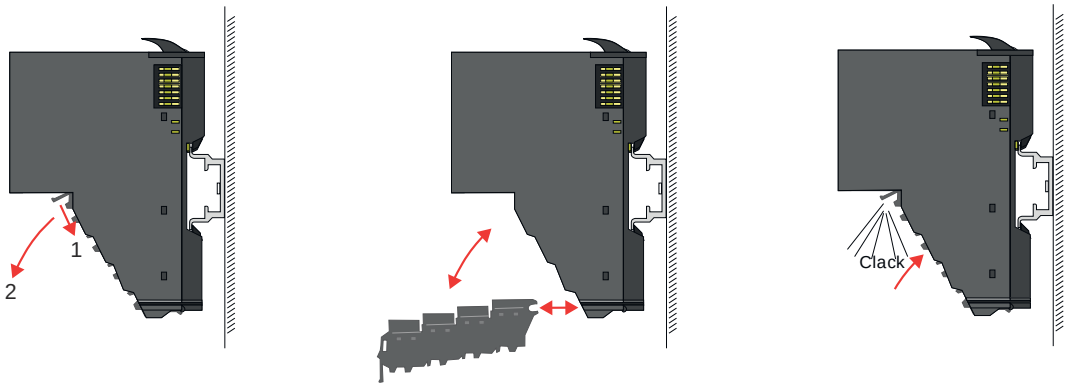
Electronic unit and terminal block



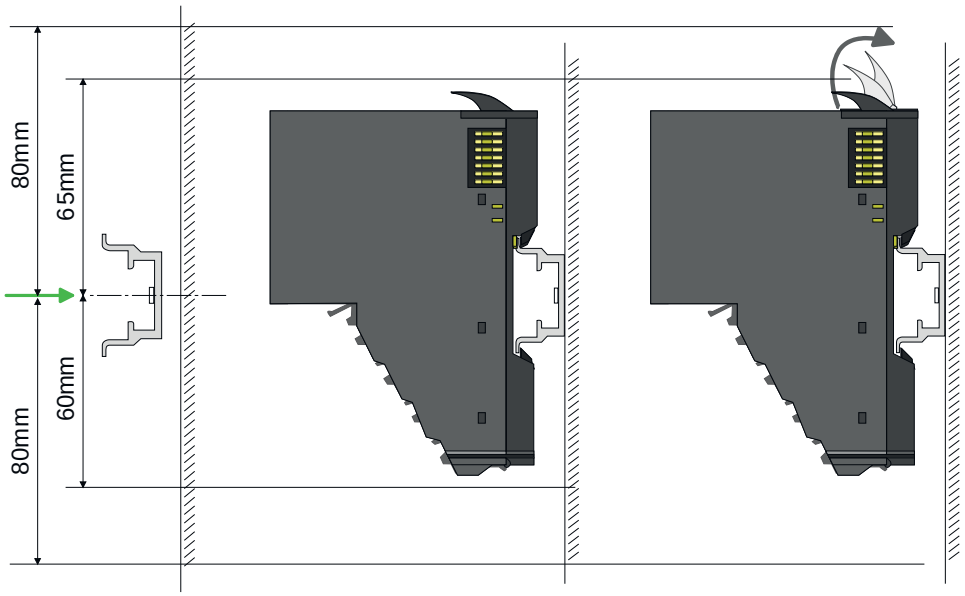
Each 16x periphery module consists of an *electronic unit* and a *terminal block*.

1 Electronic unit
2 Terminal block

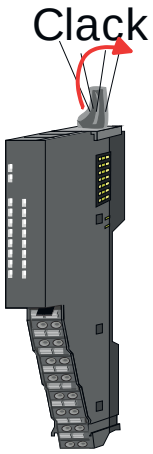
To replace an electronic unit, you can push down and pull off the terminal block after releasing the lock. To mount the terminal block, place it horizontally on the lower side of the electronic unit and push it towards the electronic unit until it clicks into place.

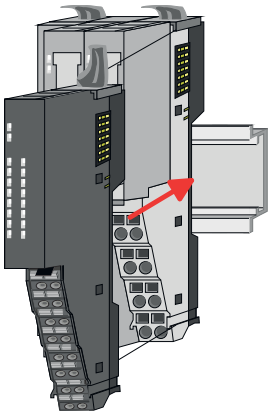


Mounting periphery module

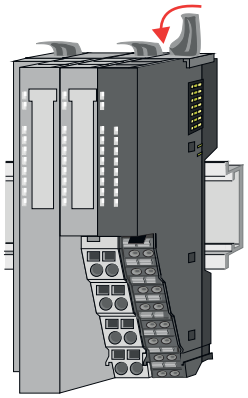


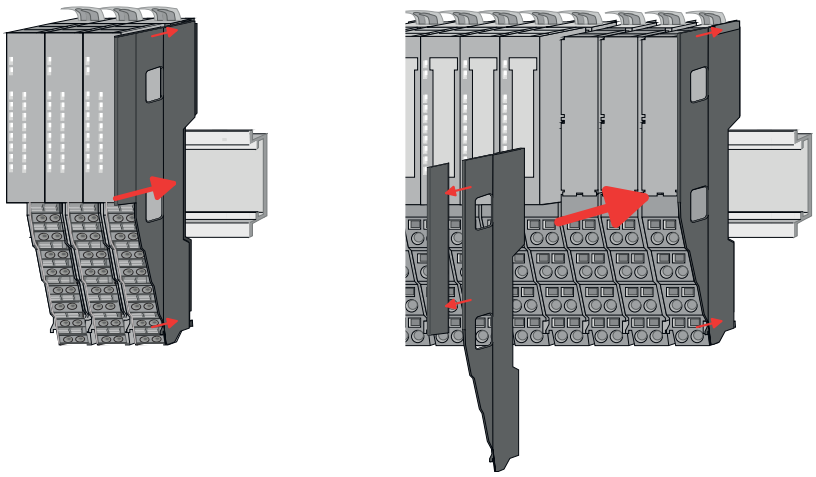
1. Mount the profile rail. Please consider that a clearance from the middle of the profile rail of at least 80mm above and 80mm below exist.
2. Mount your head module such as CPU or field bus coupler.
3. Before mounting the periphery modules you have to remove the bus cover at the right side of the head module by pulling it forward. Keep the cover for later mounting.





4. For mounting turn the locking lever of the module upwards until it engages.
5. For mounting place the module to the module installed before and push the module to the profile rail guided by the strips at the upper and lower side of the module.
6. Turn the locking lever of the periphery module downward, again.





7. After mounting the whole system, to protect the backplane bus connectors at the last module you have to mount the bus cover, now. If the last module is a clamp module, for adaptation the upper part of the bus cover is to be removed.

2.7 Wiring 8x periphery modules

Terminal module terminals

CAUTION

Do not connect hazardous voltages!

If this is not explicitly stated in the corresponding module description, hazardous voltages are not allowed to be connected to the corresponding terminal module!

CAUTION

Danger of injury from electrical shock and damage to the unit!

Put the System SLIO in a safe, powered down state before starting installation, disassembly or wiring of the System SLIO modules!

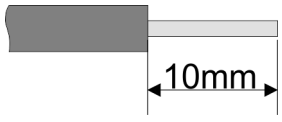
CAUTION

Consider temperature for external cables!

Cables may experience temperature increase due to system heat dissipation. Thus the cabling specification must be chosen 25°C above ambient temperature!

- With wiring the terminal modules, 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.

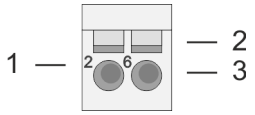
Data



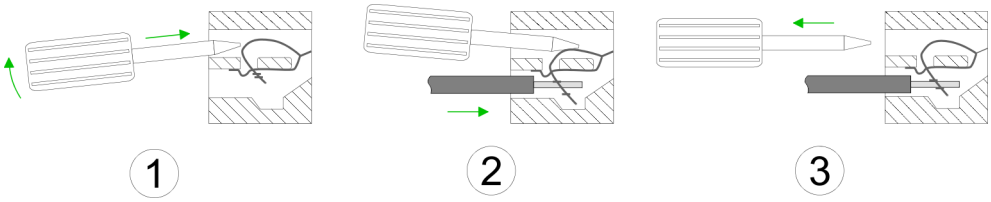
Please use copper wire only!

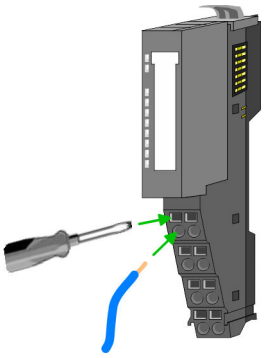
U_{max}	240V AC / 30V DC
I_{max}	10A
Cross section	0.08 ... 1.5mm² (AWG 28 ... 16)
Stripping length	10mm

Wiring procedure



1 Pin number at the connector
2 Opening for screwdriver
3 Connection hole for wire





1. Insert a suited screwdriver at an angel 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.

Shield attachment ➥ *'Shielding'...page 20*

2.8 Wiring 16x periphery modules

Terminal block connectors

CAUTION

Do not connect hazardous voltages!

If this is not explicitly stated in the corresponding module description, hazardous voltages are not allowed to be connected to the corresponding terminal block!

CAUTION

Danger of injury from electrical shock and damage to the unit!

Put the System SLIO in a safe, powered down state before starting installation, disassembly or wiring of the System SLIO modules!

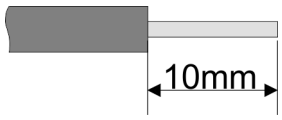
CAUTION

Consider temperature for external cables!

Cables may experience temperature increase due to system heat dissipation. Thus the cabling specification must be chosen 25°C above ambient temperature!

- The 16x periphery module has a removable terminal block for wiring.
- With the wiring of the terminal block a "push-in" spring-clip technique is used. This allows a quick and easy connection of your signal and supply lines.
- The clamping off takes place by means of a screwdriver.

Data



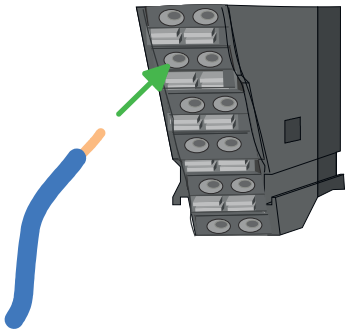
Please use copper wire only!

U_{max}	30V DC
I_{max}	10A
Cross section solid wire	0.25 ... 0.75mm²
Cross section with ferrule	0.14 ... 0.75mm²
AWG	24 ... 16
Stripping length	10mm

Wiring procedure

1 Release area
2 Connection hole for wire

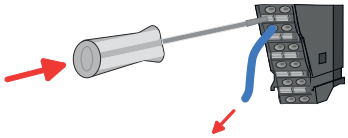
Insert wire



The wiring happens without a tool.

1. Determine according to the casing labelling the connection position.
2. Insert through the round connection hole of the according contact your prepared wire until it stops, so that it is fixed.
   ➥ By pushing the contact spring opens, thus ensuring the necessary contact pressure.

Remove wire



The wire is to be removed by means of a screwdriver with 2.5mm blade width.

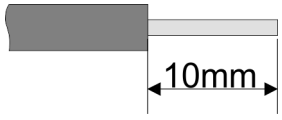
1. Press with your screwdriver vertically at the release button.
   ➥ The contact spring releases the wire.
2. Pull the wire from the round hole.

2.9 Wiring power modules

Terminal module terminals

Power modules are either integrated to the head module or may be installed between the periphery modules. With power modules, 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.

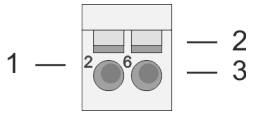
Data



Please use copper wire only!

U_{max}	30V DC
I_{max}	10A
Cross section	0.08 ... 1.5mm² (AWG 28 ... 16)
Stripping length	10mm

Wiring procedure



1 Pin number at the connector
2 Opening for screwdriver
3 Connection hole for wire

CAUTION

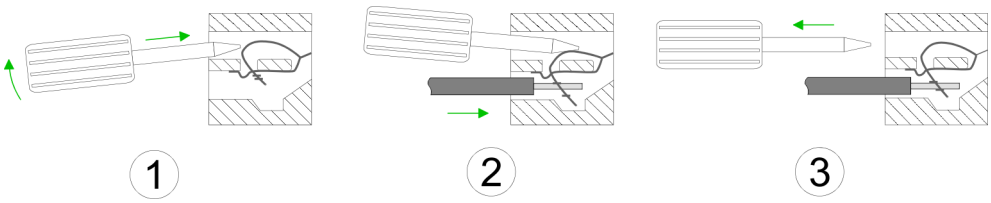
Danger of injury from electrical shock and damage to the unit!

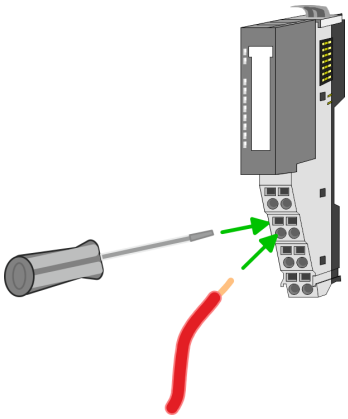
Put the System SLIO in a safe, powered down state before starting installation, disassembly or wiring of the System SLIO modules!

CAUTION

Consider temperature for external cables!

Cables may experience temperature increase due to system heat dissipation. Thus the cabling specification must be chosen 25°C above ambient temperature!

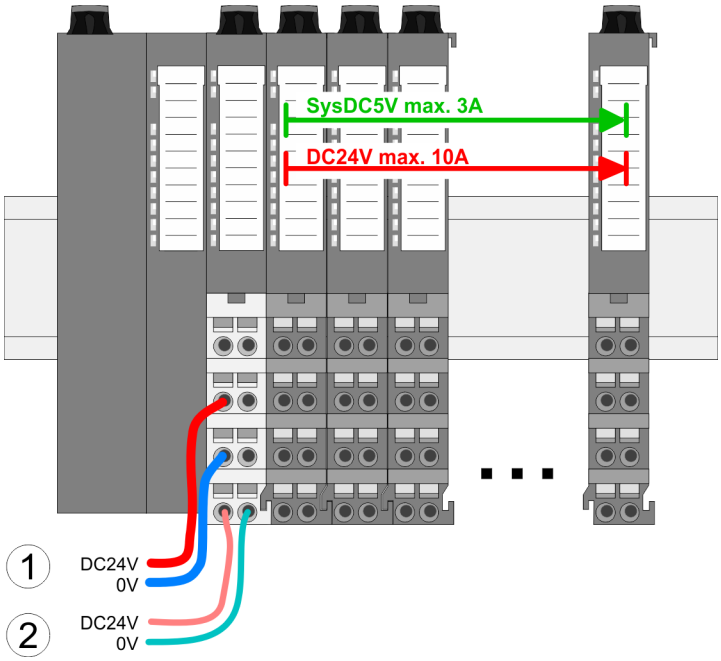




1. Insert a suited screwdriver at an angel into the square opening as shown. Press and hold the screwdriver in the opposite direction to open the contact spring.
2. Insert the stripped end of wire into the round opening. You can use wires with a cross section of 0.08mm² up to 1.5mm²
3. By removing the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

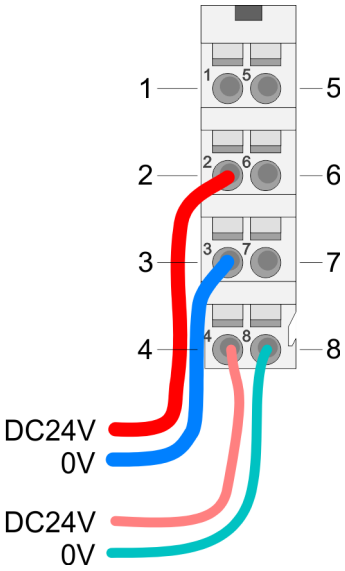
Shield attachment ➦ *'Shielding'...page 20*

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 power 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 power 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 and should be UL approved!

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 and should be UL approved.
  - For modules with positive logic (PNP), place the fuse on the positive connector.
  - For modules with negative logic (NPN), place the fuse on the negative connector.
  - For mixed logic, one fuse must be placed on the negative and one on the positive connector.
- It is recommended to externally protect the electronic power supply for head modules and I/O area with a 2A fuse (fast) respectively by a line circuit breaker 2A characteristics Z and should be UL approved.
- 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 and should be UL approved.

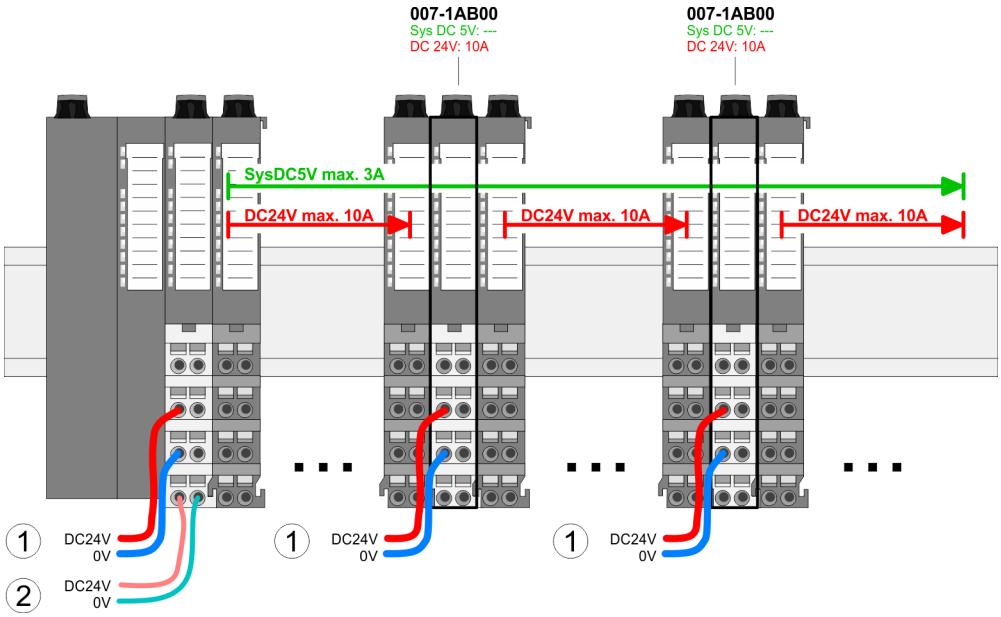
State of the electronic power supply via LEDs

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.

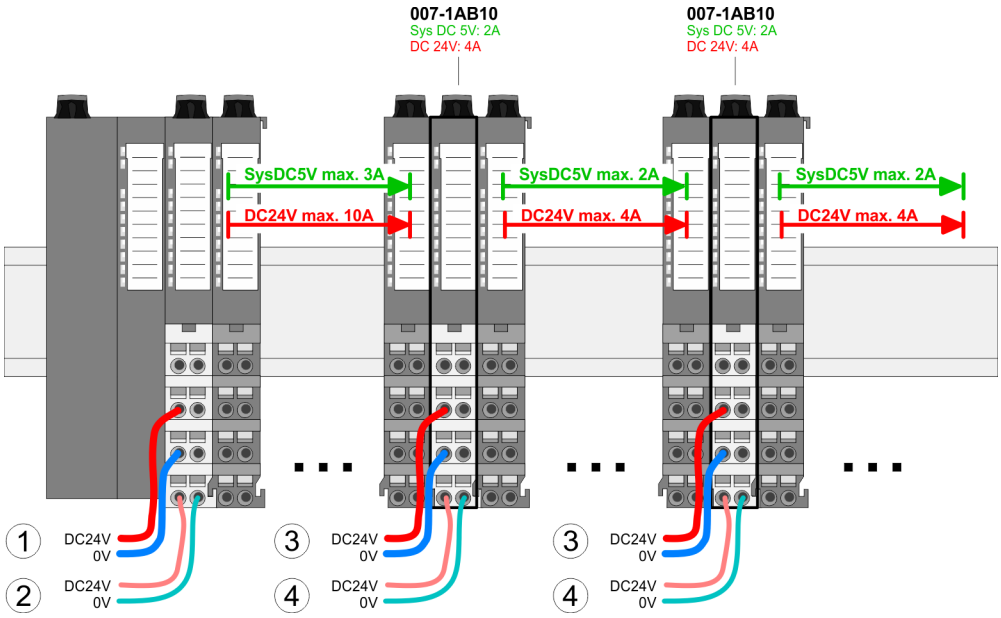
Deployment of the power modules

- If the 10A for the power section supply is no longer sufficient, you may use the power module 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 a power module 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

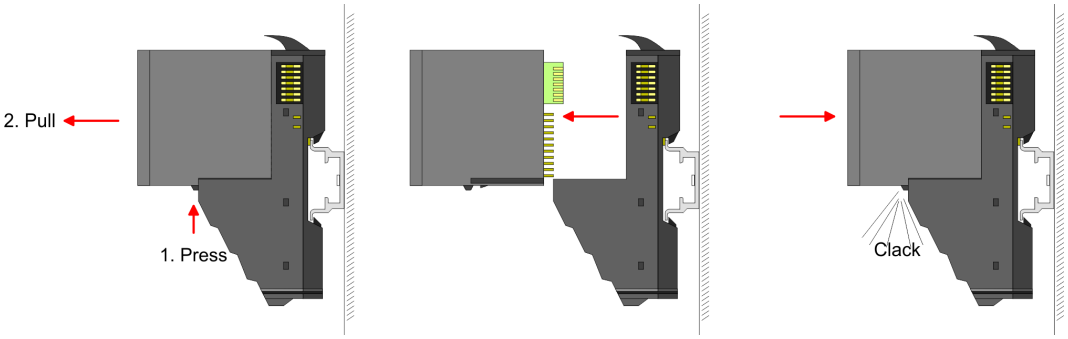
2.10 Demounting 8x periphery modules

Proceeding

Exchange of an electronic module

CAUTION
Put the System SLIO in a safe, powered down state before starting disassembly!

1. Power-off your system.



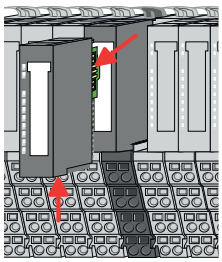
2. For the exchange of a electronic module, the electronic module may be pulled forward after pressing the unlocking lever at the lower side of the module.
3. For installation plug the new electronic module guided by the strips at the lower side until this engages to the terminal module.

➡ Now you can bring your system back into operation.

Easy Maintenance

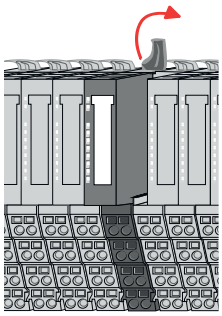
'Easy Maintenance' means the support for adding and removing electronic modules during operation without having to restart the system. If this is supported by your head module, you will find more detailed information on this in the "Deployment" chapter. ➥ *'Easy Maintenance'...page 40*

Exchange of a periphery module

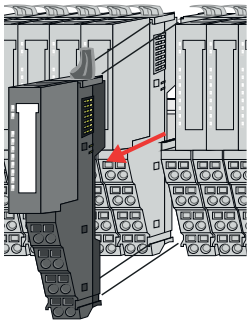


1. Power-off your system.
2. Remove if exists the wiring of the module.
3. *For demounting and exchange of a (head) module or a group of modules, due to mounting reasons you always have to remove the electronic module right beside. After mounting it may be plugged again.*

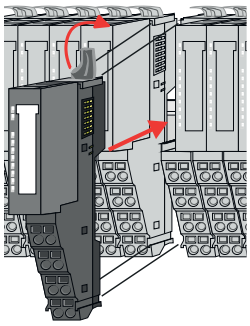
   Press the unlocking lever at the lower side of the just mounted right module and pull it forward.



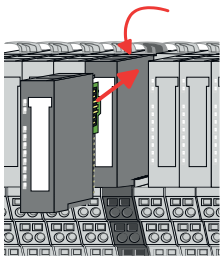
4. Turn the locking lever of the module to be exchanged upwards.



5. Pull the module.
6. For mounting turn the locking lever of the module to be mounted upwards.



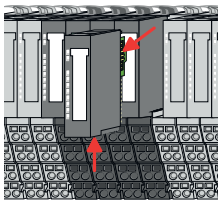
7. To mount the module put it to the gap between the both modules and push it, guided by the stripes at both sides, to the profile rail.
8. Turn the locking lever downward, again.



9. Plug again the electronic module, which you have removed before.
10. Wire your module.

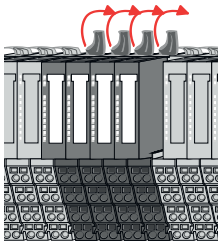
    ➡ Now you can bring your system back into operation.

Exchange of a module group

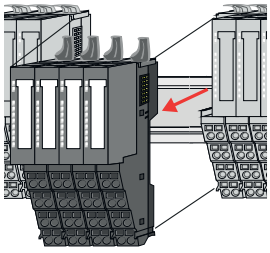


1. Power-off your system.
2. Remove if exists the wiring of the module group.
3. *For demounting and exchange of a (head) module or a group of modules, due to mounting reasons you always have to remove the electronic module right beside. After mounting it may be plugged again.*

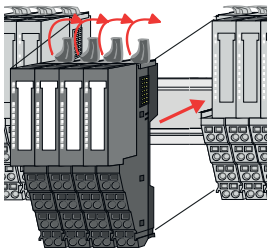
   Press the unlocking lever at the lower side of the just mounted right module near the module group and pull it forward.



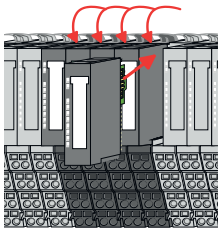
4. Turn all the locking lever of the module group to be exchanged upwards.



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



7. 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 profile rail.
8. Turn all the locking lever downward, again.



9. Plug again the electronic module, which you have removed before.
10. Wire your module group.

    ➡ Now you can bring your system back into operation.

2.11 Demounting 16x periphery modules

Proceeding

Exchange of an electronic unit

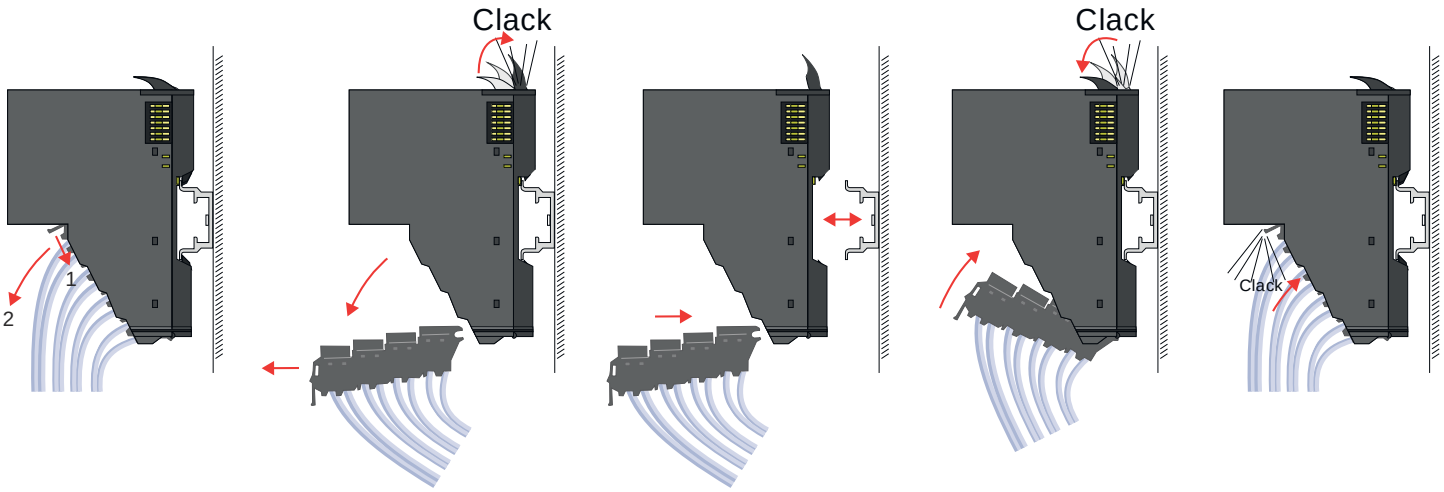
CAUTION

Put the System SLIO in a safe, powered down state before starting disassembly!

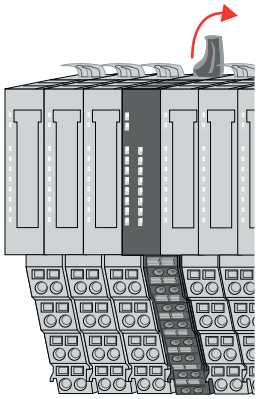
1. Power-off your system.
2. To replace an electronic unit, you can push down and pull off the terminal block after releasing the lock.

   To mount the terminal block, place it horizontally on the lower side of the electronic unit and push it towards the electronic unit until it clicks into place.

   ➡ Now you can bring your system back into operation.

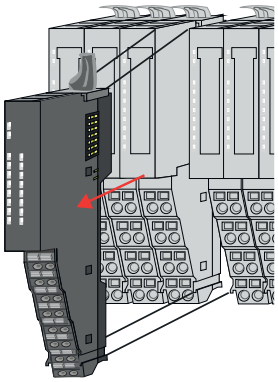


Exchange of a 16x periphery module

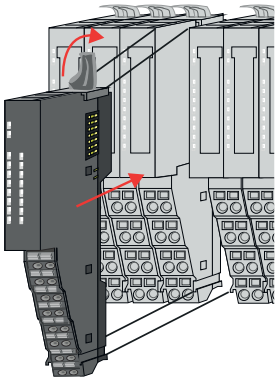


1. Power-off your system.
2. Remove if exists the wiring of the module respectively the wired terminal block.
3. *In contrast to 8x periphery modules, you can directly demount and mount 16x periphery modules.*

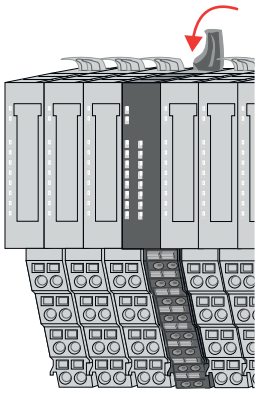
   Turn the locking lever of the module to be exchanged upwards.



4. Pull the module.
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 profile rail.

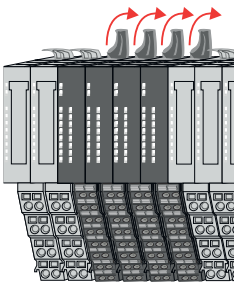


7. Turn the locking lever downward, again.
8. Wire your module respectively plug the wired terminal block again.

➡ Now you can bring your system back into operation.

Exchange of a module group

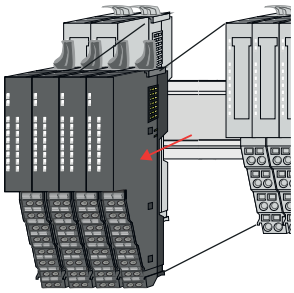
1. Power-off your system.
2. Remove if exists the wiring of the module group respectively the wired terminal blocks.



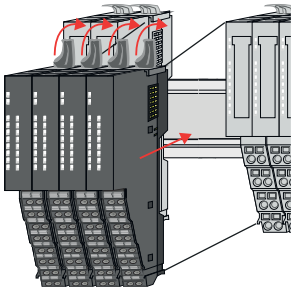
3.

In contrast to 8x periphery modules, you can directly demount and mount 16x periphery modules.

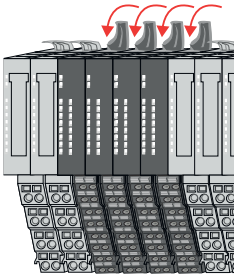
Turn all the locking lever of the module group to be exchanged upwards.



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 profile rail.

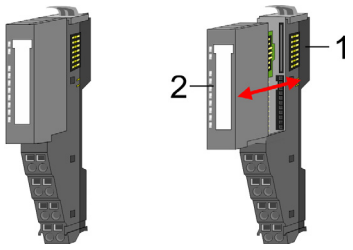


7. Turn all the locking lever downward, again.
8. Wire your module group respectively plug the wired terminal blocks again.

➡ Now you can bring your system back into operation.

2.12 Easy Maintenance

Overview



1 Terminal module
2 Electronic module

Easy Maintenance means the support for adding and removing an electronic module during operation without having to restart the system. Here the following behavior is shown by the example of a CPU:

- Electronic module is removed
  - The CPU detects a module failure on the backplane bus.
  - Diagnostic message *'System SLIO bus failure'* (0x39D0) is triggered.
  - OB 86 is called. If this is not available, the CPU switches to STOP otherwise it remains in RUN.
  - The SF LED of the CPU lights up.
  - The I/O data of all modules become invalid.
- Identical electronic module is plugged
  - The CPU detects the module return on the backplane bus.
  - The SF-LED of the CPU gets off.
  - All RUN LEDs on the modules get on and the MF LEDs get off.
  - Diagnostic message *'System SLIO bus recovery'* (0x38D0) is triggered.
  - OB 86 is called. If this is not available, the CPU switches to STOP otherwise it remains in RUN.
  - The I/O data of all modules become valid again.
- Wrong electronic module is plugged
  - The CPU detects the wrong module.
  - Diagnostic message *'System SLIO bus recovery, but expected configuration does not match actual configuration'* (0x38D1) is triggered.
  - The SF LED of the CPU remains on.
  - The MF LED of the wrong module flashes.
  - OB 86 is called. If this is not available, the CPU switches to STOP otherwise it remains in RUN.
  - With the exception of the wrong module, the I/O data of all modules become valid again.

CAUTION

Please note that only electronic modules may be exchanged during operation! Replacing an 8x or 16x periphery module during operation can damage the module and the system!

Please note that the CPU switches to STOP, if there is no OB 86 configured when adding or removing System SLIO modules!

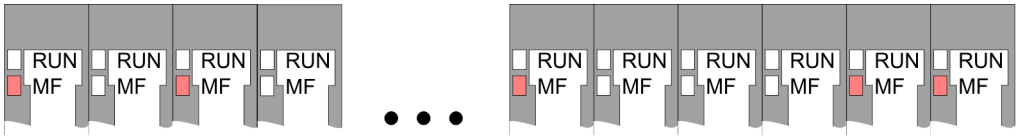
2.13 Trouble shooting - LEDs

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

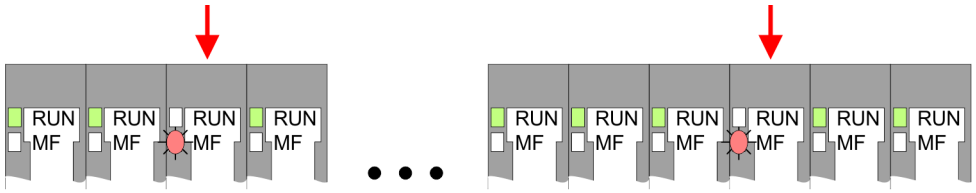


Behavior: After PowerON the RUN LED of each module is off and the MF LED of each module is sporadically on.

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. ➦ *'Wiring power modules'...page 30*

Error in configuration

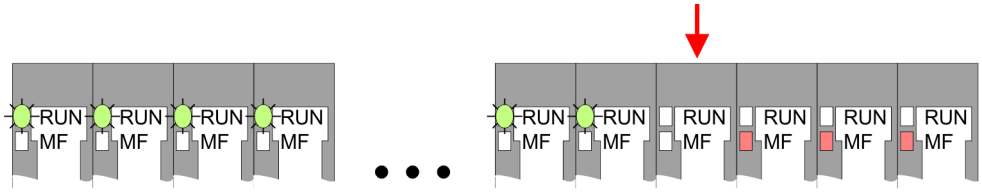


Behavior: After PowerON the MF LED of one module respectively more modules flashes. The RUN LED remains off.

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

Remedy: Match configuration and hardware structure.

Module failure



Behavior: 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.

2.14 Industrial security and installation guidelines

2.14.1 Industrial security in information technology

Latest version

This chapter can also be found as a guide *'Industrial IT Security'* in the *'Download Center'* of www.yaskawa.eu.com

Hazards

The topic of data security and access protection has become increasingly important in the industrial environment. The increased networking of entire industrial systems to the network levels within the company together with the functions of remote maintenance have all served to increase vulnerability. Hazards can arise from:

- Internal manipulation such as technical errors, operating and program errors and deliberate program or data manipulation.
- External manipulation such as software viruses, worms and trojans.
- Human carelessness such as password phishing.

Precautions

The most important precautions to prevent manipulation and loss of data security in the industrial environment are:

- Encrypting the data traffic by means of certificates.
- Filtering and inspection of the traffic by means of VPN - "Virtual Private Networks".
- Identification of the user by "Authentication" via save channels.
- Segmenting in protected automation cells, so that only devices in the same group can exchange data.
- Deactivation of unnecessary hardware and software.

Further Information

You can find more information about the measures on the following websites:

- Federal Office for Information Technology ➦ *www.bsi.bund.de*
- Cybersecurity & Infrastructure Security Agency ➦ *us-cert.cisa.gov*
- VDI / VDE Society for Measurement and Automation Technology ➦ *www.vdi.de*

2.14.1.1 Protection of hardware and applications

Precautions

- Do not integrate any components or systems into public networks.
  - Use VPN "Virtual Private Networks" for use in public networks. This allows you to control and filter the data traffic accordingly.
- Always keep your system up-to-date.
  - Always use the latest firmware version for all devices.
  - Update your user software regularly.
- Protect your systems with a firewall.
  - The firewall protects your infrastructure internally and externally.
  - This allows you to segment your network and isolate entire areas.
- Secure access to your plants via user accounts.
  - If possible, use a central user management system.
  - Create a user account for each user for whom authorization is essential.
  - Always keep user accounts up-to-date and deactivate unused user accounts.
- Secure access to your plants via secure passwords.
  - Change the password of a standard login after the first start.
  - Use strong passwords consisting of upper/lower case, numbers and special characters. The use of a password generator or manager is recommended.
  - Change the passwords according to the rules and guidelines that apply to your application.
- Deactivate inactive communication ports respectively protocols.
  - Only the communication ports that are used for communication should be activated.
  - Only the communication protocols that are used for communication should be activated.
- Consider possible defence strategies when planning and securing the system.
  - The isolation of components alone is not sufficient for comprehensive protection. An overall concept is to be drawn up here, which also provides defensive measures in the event of a cyber attack.
  - Periodically carry out threat assessments. Among others, a comparison is made here between the protective measures taken and those required.
- Limit the use of external storage media.
  - Via external storage media such as USB memory sticks or SD memory cards, malware can get directly into a system while bypassing a firewall.
  - External storage media or their slots must be protected against unauthorized physical access, e.g. by using a lockable control cabinet.
  - Make sure that only authorized persons have access.
  - When disposing of storage media, make sure that they are safely destroyed.
- Use secure access paths such as HTTPS or VPN for remote access to your plant.
- Enable security-related event logging in accordance with the applicable security policy and legal requirements for data protection.

2.14.1.2 Protection of PC-based software

Precautions

Since PC-based software is used for programming, configuration and monitoring, it can also be used to manipulate entire systems or individual components. Particular caution is required here!

- Use user accounts on your PC systems.
  - If possible, use a central user management system.
  - Create a user account for each user for whom authorization is essential.
  - Always keep user accounts up-to-date and deactivate unused user accounts.
- Protect your PC systems with secure passwords.
  - Change the password of a standard login after the first start.
  - Use strong passwords consisting of upper/lower case, numbers and special characters. The use of a password generator or manager is recommended.
  - Change the passwords according to the rules and guidelines that apply to your application.
- Enable security-related event logging in accordance with the applicable security policy and legal requirements for data protection.
- Protect your PC systems by security software.
  - Install virus scanners on your PC systems to identify viruses, trojans and other malware.
  - Install software that can detect phishing attacks and actively prevent them.
- Always keep your software up-to-date.
  - Update your operating system regularly.
  - Update your software regularly.
- Make regular backups and store the media at a safe place.
- Regularly restart your PC systems. Only boot from storage media that are protected against manipulation.
- Use encryption systems on your storage media.
- Perform security assessments regularly to reduce the risk of manipulation.
- Use only data and software from approved sources.
- Uninstall software which is not used.
- Disable unused services.
- Activate a password-protected screen lock on your PC systems.
- Always lock your PC systems as soon as you leave your PC workstation.
- Do not click any links that come from unknown sources. If necessary ask, e.g. on e-mails.
- Use secure access paths such as HTTPS or VPN for remote access to your PC system.

2.14.2 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 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 ground 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.
  - 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 shielded.
  - Analog lines must be shielded. When transmitting signals with small amplitudes the one sided laying of the isolation may be favourable.
  - Cables for frequency inverters, servo and stepper motors must be shielded.
  - Lay the line isolation extensively on an isolation/protected ground conductor rail directly after the cabinet entry and fix the isolation with cable clamps.
  - Make sure that the isolation/protected ground 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 ground 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 ground 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 ground 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.

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

2.15 General data for the System SLIO

Conformity and approval		
Conformity		
CE	2014/35/EU	Low Voltage Directive
	2014/30/EU	EMC Directive
RoHS (EU)	2011/65/EU	Restriction of the use of certain hazardous substances in electrical and electronic equipment
UKCA	2016 No. 1101	Electrical Equipment (Safety) Regulations
	2016 No. 1091	Electromagnetic Compatibility Regulations
RoHS (UK)	2012 No. 3032	Use of Certain Hazardous Substances
Approval		
Certifications	-	Refer to technical data

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 ground		
Inputs / outputs	-	AC / DC 50V, test voltage AC 500V
Protective measures	-	against short circuit

Environmental conditions to EN 61131-2		
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
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 ... 6GHz, 3V/m, 80% AM (1kHz)
		EN 61000-4-6	HF conducted 150kHz … 80MHz, 10V, 80% AM (1kHz)
		EN 61000-4-4	Burst
		EN 61000-4-5	Surge[1]

1) 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.

2.15.1 Use in difficult operating conditions

Without additional protective measures, the products must not be used in locations with difficult operating conditions; e.g. due to:

- *dust generation*
- *chemically active substances (corrosive vapors or gases)*
- *strong electric or magnetic fields*

3 Hardware description

3.1 Properties

Properties

- 1 Counter 32 bit (A, B) RS422 / TTL
- Counting frequency: max. 16 MHz (at 4-fold evaluation / RS422)
- Encoder connection: RS422 / TTL
- Encoder supply: DC 5V / 24V
- Encoder evaluation: 1-, 2-, 4-fold
- Counter modes: Encoder, Pulse/direction, Forwards/Backwards
- Additional functions: Gate, Latch, COIN, Filter, timestamp
- Measuring functions: Pulse frequency, pulse period, pulse duration
- Digital inputs and outputs with diagnostic function

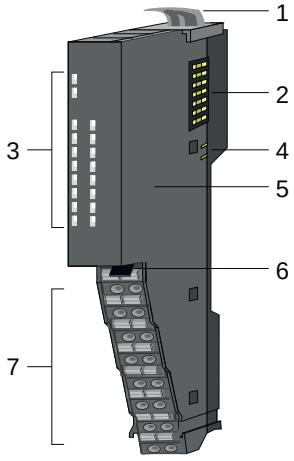
Ordering data

Type	Order number	Description
FM 050	050-1BA50	Counter module advanced RS422/TTL 1x32Bit DC 5V/24V 0.2A, DI 3xDC 24V, DO 3xDC 24V 0.25A

Please note that the module listed here is not supported by every head module. For more information, please refer to the compatibility list. These can be found in the 'Download Center' of www.yaskawa.eu.com at 'System SLIO - Compatibility list'

3.2 Structure

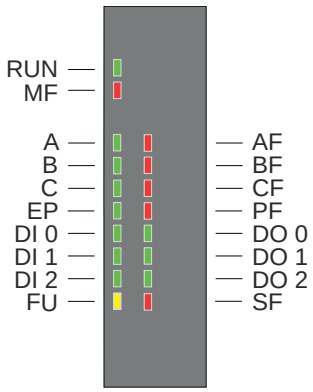
Structure



1 Locking lever module
2 Backplane bus
3 LED status indication
4 DC 24V power section supply
5 Electronic unit
6 Locking lever terminal block
7 Terminal block

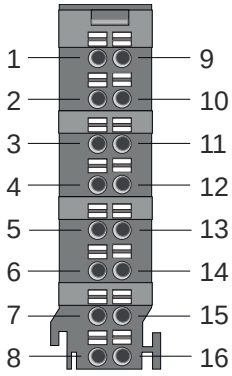
At an ambient temperature of 60°C and high load on the counter module and neighbouring modules with high power dissipation, small areas of the housing can reach temperatures higher than 85°C. This is compliant with DIN EN 61010-2-201:2019-04.

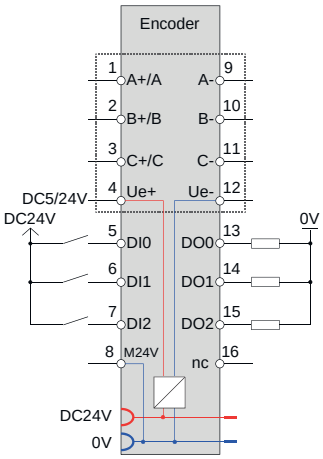
Status indication



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 ➦ *'Trouble shooting - LEDs'...page 41*
A	green	●	Input A active ■ LED always shows activity at input A. ■ When active, the LED lights up with a minimum duration of 50ms.
B	green	●	Input B active ■ LED shows activity at input B. ■ With ➦ *'PARAM - Counter - Mode'...page 110* *'1: Counter pulse /direction'* the signal level at Input B is shown.
C	green	●	Input C active ■ LED shows signal level at input C.
EP	green	●	Encoder supply enabled
DI0	green	●	Digital input DI 0 has "1" signal
DI1	green	●	Digital input DI 1 has "1" signal
DI2	green	●	Digital input DI 2 has "1" signal
FU	yellow	X	reserved
AF	red	●	Error Input A
BF	red	●	Error Input B
CF	red	●	Error Input C
PF	red	●	Encoder supply error
DO0	green	●	Digital output DO 0 has "1" signal
DO1	green	●	Digital output DO 1 has "1" signal
DO2	green	●	Digital output DO 2 has "1" signal
SF	red	●	Overload or short circuit at DO 0 ... DO 2 (Collective error)
on: ● | off: ○ | blinking (2Hz): B | not relevant: X			

Pin assignment





For wires with a core cross-section of 0.14mm² up to 0.75mm². With a core cross-section < 0.25mm² , ferrules must be used. ➦ *'Data'...page 30*

Pos.	Function	Type	Description
1	A+/A	I	RS422 differential, TTL single ended
2	B+/B	I	RS422 differential, TTL single ended
3	C+/C	I	RS422 differential, TTL single ended, trigger input
4	Ue+	PW	Encoder supply positive, parametrizable 0V (default), DC 5V or 24V
5	DI0	I	Digital input DI 0 DC 24V PNP, trigger input
6	DI1	I	Digital input DI 1 DC 24V PNP, trigger input
7	DI2	I	Digital input DI 2 DC 24V PNP, trigger input
8	M24V	PW	GND digital input / output
9	A-	I	RS422 differential
10	B-	I	RS422 differential
11	C-	I	RS422 differential
12	Ue- / GND	PW	Encoder supply negative, GND TTL single ended
13	DO 0	O	Digital output DO 0 DC 24V, output signal PNP push-pull/tristate
14	DO 1	O	Digital output DO 1 DC 24V, output signal PNP push-pull/tristate
15	DO 2	O	Digital output DO 2 DC 24V, output signal PNP push-pull/tristate
16	n.c.	-	reserved

I: Input, O: Output, PW: Power supply

The inputs DI0...DI2 can be used as inputs or trigger signals and the input C as a trigger signal for:

- ➦ *'PARAM - Counter - Set value source'...page 112*
- ➦ *'PARAM - Counter - Reset source'...page 111*
- ➦ *'PARAM - HW gate - Source'...page 117*
- ➦ *'OUT - Latch 1, 2 - Source'...page 105*
- ➦ *'PARAM - Timestamp 1…4 - Source'...page 117*

The outputs DO 0...2 can be used as outputs or as output signals for:

- ➦ *'PARAM - COIN 0…8 - Configuration'...page 119*

CAUTION

Behavior on failure of the DC 24V power section supply:

- The DC 5V/24V encoder power supply fails.
- Due to signal loss, the encoder count value stops.
- The digital outputs DO 0...2 are disabled.
- Bit 6 is set in ➦ *'Status word'...page 60*.
- Bit 4 is set in ERR_A diagnostics. ➦ *'Diagnostics and interrupt'...page 121*

3.3 Technical data

Order no.	050-1BA50
Type	FM 050 - Counter module
Module ID	08C8 3804
Current consumption/power loss	
Current consumption from backplane bus	100 mA
Power loss	1.9 W
Technical data digital inputs	
Number of inputs	3
Cable length, shielded	100 m
Cable length, unshielded	-
Rated load voltage	-
Reverse polarity protection of rated load voltage	-
Current consumption from load voltage L+ (without load)	-
Rated value	DC 24 V
Permitted range	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	-
Signal logic input	Sinking input
Frequency range	-
Input resistance	-
Input current for signal "1"	2.3 mA
Connection of Two-Wire-BEROs possible	✓
Max. permissible BERO quiescent current	0.5 mA
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	3
Number of simultaneously utilizable inputs vertical configuration	3
Input characteristic curve	IEC 61131-2, type 3
Initial data size	64 Byte
Technical data digital outputs	
Number of outputs	3
Cable length, shielded	100 m
Cable length, unshielded	100 m
Rated load voltage	DC 24 V
Permitted range	DC 20.4...28.8 V
Current consumption from load voltage L+ (without load)	20 mA
Output current at signal "1", rated value	-
Signal logic output	Sourcing output
Output delay of "0" to "1"	3 µs
Output delay of "1" to "0"	3 µs
Minimum load current	-
Lamp load	-
Parallel switching of outputs for redundant control of a load	-
Parallel switching of outputs for increased power	-
Actuation of digital input	✓

Order no.	050-1BA50
Switching frequency with resistive load	max. 10 kHz
Switching frequency with inductive load	max. 0.5 Hz
Switching frequency on lamp load	-
Internal limitation of inductive shut-off voltage	L+ (-55 V)
Short-circuit protection of output	yes, electronic
Trigger level	0.7 A
Number of operating cycle of relay outputs	-
Switching capacity of contacts	-
Output data size	16 Byte
Technical data counters	
Number of counters	1
Cable length, shielded	15 m
Cable length, unshielded	-
Counter width	32 Bit
Number of inputs	3 (A, B, C)
Input signals	RS422 (differential) / TTL single ended
Termination resistance (RS422)	150 Ω
Maximum input frequency	-
Maximum input frequency (TTL)	1 MHz
Maximum input frequency (RS422)	4 MHz
Maximum count frequency	-
Maximum count frequency (TTL)	4 MHz
Maximum count frequency (RS422)	16 MHz
Encoder supply (output)	0 / DC 5 V/ DC 24 V (max. 300 mA)
Mode incremental encoder	✓
Mode pulse / direction	✓
Mode forwards/backwards	✓
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	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 LED
Isolation	
Between channels	-
Between channels of groups to	-
Between channels and backplane bus	✓

Order no.	050-1BA50
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	64
Output bytes	16
Parameter bytes	110
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
Net weight	56 g
Weight including accessories	56 g
Gross weight	76 g
Environmental conditions	
Operating temperature	0 °C to 60 °C
Storage temperature	-25 °C to 70 °C
Certifications	
UL certification	yes (DC general use)
KC certification	yes
UKCA certification	-
ChinaRoHS certification	yes

The module is specified for an ambient temperature of 0...60°C, with a maximum DO current of 0.25A and an encoder supply current of 0.2A. If any of the following conditions are met, the module can be used with a DO current of 0.5A and an encoder supply current of 0.3A:

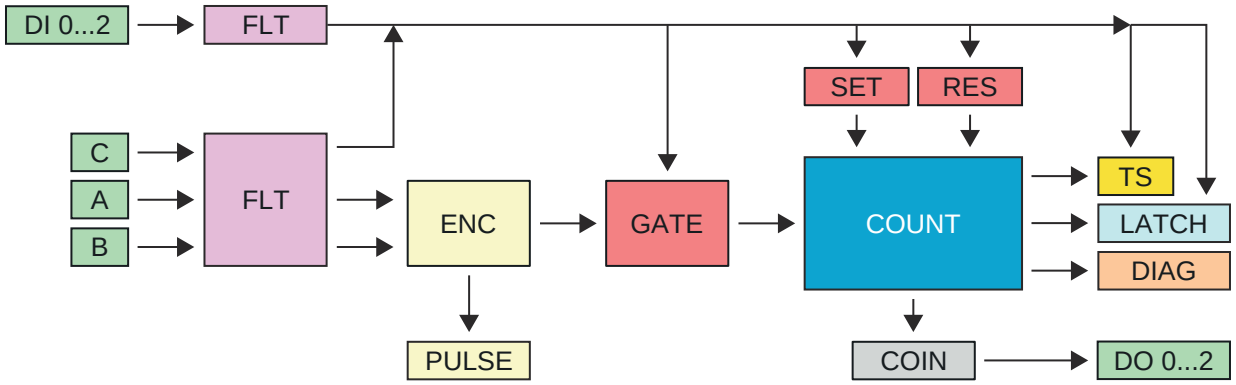
- TTL encoder input configuration

  or
- Ambient temperature below 50°C

4 Deployment

4.1 Functional Overview

Structure



- A, B, C: Encoder inputs A, B and C
- DI 0...2: Digital input DI 0...2
- DO 0...2: Digital output DO 0...2
- FLT: Filter function
- GATE: Gate function for counter release
- SET: Overwrite counter value with set value
- RES: Reset counter to reset value
- ENC: Encoder function
- COUNT: Counter value
- PULSE: Pulse frequency, pulse period, pulse duration
- LATCH: Stored counter values
- TS: Time stamp
- COIN: Counter value at threshold
- DIAG: Diagnostics

Functions

4.1.1 Process data overview

Inputs - 64 bytes

With CPU and PROFINET the input area is embedded to the corresponding address area. More can be found in the corresponding manual.

SX - Subindex for access via EtherCAT with index 6000h + EtherCAT-Slot

Offset	Name	SX	Bytes	Function
+0	CSTS	01	4	➦ *'IN - Status word'...page 102*
+4	CV_1...CV_4	02...05	16	➦ *'IN - Counter value 1...4'...page 102*
+20	CL_1, CL_2	06, 07	8	➦ *'IN - Latch 1, 2'...page 102*
+28	PF	08	4	➦ *'IN - Pulse frequency'...page 102*
+32	PP	09	4	➦ *'IN - Pulse period'...page 103*
+36	PD	10	4	➦ *'IN - Pulse duration'...page 103*
+40	TS_1...TS_4	11...14	16	➦ *'IN - Timestamp 1...4'...page 103*
+56	DI_STS	15	4	➦ *'IN - DI status'...page 103*
+60	DO_STS	16	4	➦ *'IN - DO status'...page 104*

Outputs - 16 bytes

With CPU and PROFINET the output area is embedded to the corresponding address area. More can be found in the corresponding manual.

SX - Subindex for access via EtherCAT with index 7000h + EtherCAT-Slot

Offset	Name	SX	Bytes	Function
+0	CTRL	01	4	➦ *'OUT - Control word'...page 104*
+4	CCOIN_TH_0	02	4	➦ *'OUT - Threshold COIN 0'...page 104*
+8	CSV	03	4	➦ *'OUT - Counter set value'...page 104*
+12	DOC	04	1	➦ *'OUT - DO control byte'...page 105*
+13		05	1	reserved
+14	CLS_1,CLS_2	06, 07	2	➦ *'OUT - Latch 1, 2 - Source'...page 105*

4.1.2 Parameter overview

Access

DS - Record set for access via CPU and PROFINET.

SX - Subindex for access via EtherCAT with index 3100h + EtherCAT-Slot.

More can be found in the according manual of your head module.

➦ *'Parameters - Basic functions'...page 108*

Name	DS	SX	Bytes	Default	Function
DIAG_EN	0	01	1	0	➦ *'PARAM - Diagnostic interrupt'...page 108*
FCYCLE	1	02	1	5	➦ *'PARAM - Module cycle time'...page 108*
-	2	03	1	-	reserved
CYCMULT	2	04	1	2	➦ *'PARAM - Isochronous cycle time factor'...page 109*

➦ *'Parameters - Counter'...page 109*

Name	DS	SX	Bytes	Default	Function
CE	128	05	1	0	➦ *'PARAM - Counter - Evaluation'...page 109*
CEL	128	06	1	0	➦ *'PARAM - Counter - Evaluation logic'...page 109*
CDR	128	07	1	0	➦ *'PARAM - Counter - Direction reversal'...page 110*
CM	128	08	1	0	➦ *'PARAM - Counter - Mode'...page 110*
CUL	128	09	4	2147483647	➦ *'PARAM - Counter - Upper limit'...page 110*
CLL	128	10	4	-2147483648	➦ *'PARAM - Counter - Lower limit'...page 110*
CLM	128	11	1	0	➦ *'PARAM - Counter - Limit mode'...page 110*
-	128	12	1	-	reserved
CRV	129	13	4	0	➦ *'PARAM - Counter - Reset value'...page 111*
CRS	129	14	1	0	➦ *'PARAM - Counter - Reset source'...page 111*
CSVS	129	15	1	0	➦ *'PARAM - Counter - Set value source'...page 112*
CI	129	16	1	0	➦ *'PARAM - Counter - Inputs'...page 113*

➦ *'Parameters - Encoder'...page 114*

Name	DS	SX	Bytes	Default	Function
CI	129	16	1	0	➦ *'PARAM - Counter - Inputs'...page 113*
ENC_PW	129	17	1	0	➦ *'PARAM - Encoder - Power supply'...page 114*
ENC_FLT	129	18	1	0	➦ *'PARAM - Encoder - Filter'...page 114*

➦ *'Parameters - DIO'...page 115*

Name	DS	SX	Bytes	Default	Function
DI_FLT_0 ... DI_FLT_2	130	19...21	3	0	➦ *'PARAM - DI 0…2 - Input filter'...page 115*
DO_SWC_0 ... DO_SWC_2	131	22...24	3	0	➦ *'PARAM - DO 0…2 - Switching characteristic'...page 115*
DO_CFG_0 ... DO_CFG_2	131	25...27	3	0	➦ *'PARAM - DO 0…2 - Configuration'...page 116*
DO_SV_0 ... DO_SV_2	131	28...30	3	0	➦ *'PARAM - DO 0…2 - Substitute value configuration'...page 116*

➦ *'Parameters - Latch'...page 116*

Name	DS	SX	Bytes	Default	Function
CLC_1 CLC_2	132	31, 32	2	0	➦ *'PARAM - Latch 1, 2 - Configuration'...page 116*
-	132	33, 34	2	-	reserved

➦ *'Parameters - HW gate'...page 117*

Name	DS	SX	Bytes	Default	Function
HWGS	132	35	1	0	➦ *'PARAM - HW gate - Source'...page 117*

➦ *'Parameters - Timestamp'...page 117*

Name	DS	SX	Bytes	Default	Function
TSS_1 ... TSS_4	133	36...39	8	0	➦ *'PARAM - Timestamp 1…4 - Source'...page 117*

➦ *'Parameters - Measuring functions'...page 118*

Name	DS	SX	Bytes	Default	Function
PFW	134	40	4	0	➦ *'PARAM - Pulse frequency window'...page 118*
-	134	41	4	-	reserved

➦ *'Parameters - COIN'...page 119*

Name	DS	SX	Bytes	Default	Function
CCOIN_TH_1 ... CCOIN_TH_8	135	42...49	32	0	➦ *'PARAM - COIN 1…8 - Threshold'...page 119*
CCOIN_CFG_0 ... CCOIN_CFG_8	136	50...58	9	0	➦ *'PARAM - COIN 0…8 - Configuration'...page 119*
CCOIN_DIR_0 ... CCOIN_DIR_8	136	59...67	9	0	➦ *'PARAM - COIN 0…8 - Direction'...page 120*
CCOIN_DOD_0	136	68	2	0	➦ *'PARAM - COIN 0 - DO hold time'...page 120*
-	136	69	1	-	reserved

4.2 Control word

➥ *'OUT - Control word'...page 104*

The *control word* serves as a command and enable word. The individual bits represent specific control commands. If these refer to a bit in ➥ *'Status word'...page 60*, the bit is specified.

Bit	Name	Function	Status word
0	CCTRL_ERRRES	Control word - Reset error bit 1...10 Edge 0-1: Resets bits 1...10 in the status word after the related fault has been cleared.	Bit 1...10
1	CCTRL_CRESE	Control word - Enable counter reset 1: Enables the counter reset.	-
2	CCTRL_CRES	Control word - Execute counter reset ➥ *'Reset counter to reset value'...page 69* Edge 0-1: Executes counter reset and sets the counter to the reset value. Precondition: Bit 1 in the control word must be set to 1 and ➥ *'PARAM - Counter - Reset source'...page 111* must be set to 2 ("Control word...").	-
3	CCTRL_CSVE	Control word - Enable counter set value 1: Enables setting the counter. Edge 1-0: Resets bit 17 in the status word.	Bit 17:
4	CCTRL_CSV	Control word - Execute counter set ➥ *'Overwrite counter value with set value'...page 68* Edge 0-1: Counter is set to set value and bit 17 is set in the status word. Precondition: Bit 3 in the control word must be set to 1, in ➥ *'OUT - Counter set value'...page 104* a set value must be set and ➥ *'PARAM - Counter - Set value source'...page 112* must be set to 1 ("Control word...").	Bit 17
10...5	reserved		
11	CCTRL_CLE_1	Control word - Enable counter latch 1 ➥ *'Latch function'...page 78* 1: Enables the latch function for latch 1.	-
12	CCTRL_CL_1	Control word - Execute counter latch 1 ➥ *'Latch function'...page 78* Edge 0-1: Executes the latch function for latch 1. Here, the latch ID 1 in the status word is incremented in bits 11 and 12. Precondition: Bit 11 in the control word must be set to 1 and in ➥ *'OUT - Latch 1, 2 - Source'...page 105* the source for Latch 1 must be set to 1 ("Control word...").	Bit 11,12
13	CCTRL_CLE_2	Control word - Enable counter latch 2 ➥ *'Latch function'...page 78* 1: Enables the latch function for latch 2.	-
14	CCTRL_CL_2	Control word - Execute counter latch 2 ➥ *'Latch function'...page 78* Edge 0-1: Executes the latch function for latch 2. Here, the latch ID 2 in the status word is incremented in bits 13 and 14. Precondition: Bit 13 in the control word must be set to 1 and in ➥ *'OUT - Latch 1, 2 - Source'...page 105* the source for Latch 2 must be set to 1 ("Control word...").	Bit 14,13
15	CCTRL_COFR	Control word - Reset counter overflow bit 15 ➥ *'Counter'...page 64* Edge 0-1: Resets bit 15 counter overflow in the status word.	Bit 15
16	CCTRL_CUFR	Control word - Reset counter underflow bit 16 ➥ *'Counter'...page 64* Edge 0-1: Resets bit 16 counter underflow in the status word.	Bit 16:
18,17	-	reserved	-
19	CCTRL_CSWG	Control word - Counter close SW gate ➥ *'HW gate function'...page 77* Edge 0-1: Closes the SW gate - counter blocked - SW gate active.	Bit 19:
20	CCTRL_COINE_0	Control word - Enable counter COIN 0 ➥ *'Coin function'...page 80* 1: Enables the COIN 0 function Edge 1-0: Resets bit 20 in the status word.	Bit 20:
20+x	CCTRL_COINE_1 ... CCTRL_COINE_8	Control word - Enable counter COIN x with x = 1...8 ➥ *'Coin function'...page 80* 1: Enables the COIN x function	-
31...29	-	reserved	-

4.3 Status word

➦ 'IN - Status word'...page 102

The *status word* serves as a feedback and diagnostic word. The individual bits represent specific status and diagnostic information. Status bits that do not reset automatically can be reset via the corresponding bit in*➦ 'Control word'...page 59*, as long as the corresponding error has been fixed.

Bit	Name	Function	Reset - Control word
0	CSTS_ERR	Counter status - Error Bit is set as soon as one of the error bits bit 1...10 is set.	Edge 0-1 in Bit 0
1	CSTS_ERRPAR	Counter status - Error - *➦ 'Parameters'...page 105* Reset: When the correct parameters are set.	-
2	-	reserved	-
3	CSTS_ERRCSV	Counter status - Error - Set value *➦ 'Overwrite counter value with set value'...page 68* outside the limit values.	Edge 0-1 in Bit 0
4	CSTS_ERRENC	Counter status - Error - Encoder plausiblity *➦ 'Encoder'...page 96*	Edge 0-1 in Bit 0
5	CSTS_ERRPF	Counter status - Error - Overflow pulse frequency measurement *➦ 'Measuring functions'...page 93*	Edge 0-1 in Bit 0
6	CSTS_ERRPW	Counter Status - Error - DC 24V power section supply *➦ 'Pin assignment'...page 66*	Edge 0-1 in Bit 0
7	CSTS_ERRENCPW	Counter status - Error - Encoder power supply *➦ 'Encoder'...page 96*	Edge 0-1 in Bit 0
8	CSTS_ERRCI	Counter status - Error - Counter input A…C *➦ 'Diagnostics and interrupt'...page 121*	Edge 0-1 in Bit 0
9	CSTS_ERRDO	Counter status - Error - Output DO *➦ 'Diagnostics and interrupt'...page 121*	Edge 0-1 in Bit 0
10	CSTS_ERRICM	Counter status - Error - Isochronous mode *➦ 'Data capture - isochronous mode'...page 61*	Edge 0-1 in Bit 0
12, 11	CSTS_CLID_1	Counter Status - Latch ID 1 *➦ 'Latch function'...page 78* Reset: no - increments with each latch 1 event	-
14, 13	CSTS_CLID_2	Counter Status - Latch ID 2 *➦ 'Latch function'...page 78* Reset: no - increments with each latch 2 event	-
15	CSTS_COF	Counter status - Counter overflow *➦ 'Counter'...page 64*	Edge 0-1 in Bit 15
16	CSTS_CUF	Counter status - Counter underflow *➦ 'Counter'...page 64*	Edge 0-1 in Bit 16
17	CSTS_CSVRDY	Counter Status - Counter setting completed *➦ 'Overwrite counter value with set value'...page 68*	Edge 1-0 in Bit 3
18	CSTS_CHWG	Counter status - HW gate active *➦ 'HW gate function'...page 77* Reset: Automatically as soon as the HW gate is deactivated	-
19	CSTS_CSWG	Counter status - SW gate active	Edge 1-0 in Bit 19
20	CSTS_CCOIN_0	Counter status - COIN 0 *➦ 'Coin function'...page 80*	Edge 1-0 in Bit 20
29...21		reserved	
30	CSTS_ICMINIT	Counter status - Isochronous mode initialization *➦ 'Data capture - isochronous mode'...page 61* Reset: Automatically, as soon as the initialization of the isochronous mode is completed.	-
31	CSTS_ICM	Counter status - Isochronous mode active *➦ 'Data capture - isochronous mode'...page 61* Reset: Automatically as soon as isochronous mode is deactivated.	-

4.4 Data capture - isochronous mode

Overview

During data capture, a distinction is made between the following modes, which are described below:

- Isochronous data capture
  - 4 counter values are registered per cycle and provided to the field bus for the head module in an isochronous manner.
- Data capture in free-running cycle
  - 1 counter values is registered per cycle and provided to the head module.

Isochronous data capture

Please note that some head modules do not support isochronous data capture due to the system. For more information, please refer to the compatibility list. This can be found in the 'Download Center' of www.yaskawa.eu.com under 'System SLIO Compatibility list'.

As of the specified firmware version, the following head modules support isochronous data capture:

- *053-1PN01 || HW: 01 | FW V1.2.1 (Px000312)*
- *053-1EC01 || HW: 01 | FW V2.3.1 (Px000314)*

When used in an isochronous manner together with a bus coupler as head module, the following delay times result:

- *Outputs are set after 200µs.*
- *Inputs are read after 230µs.*

- In isochronous operation, 4 counter values are always registered and supplied to the field bus for the head module at the end of the cycle in an isochronous manner. The subsequent cycle always represents the 4 counter values from the previous cycle.
- With activated isochronous mode, data capture is synchronised with the field bus. The *Module cycle time* parameter is ignored here.
- The ➦ *'PARAM - Isochronous cycle time factor'...page 109* parameter can be used to adjust the cycle time for the isochronous sampling to the cycle time of your isochronous head module via a factor.

  It is valid: Module cycle = *Isochronous cycle time factor* x field bus cycle

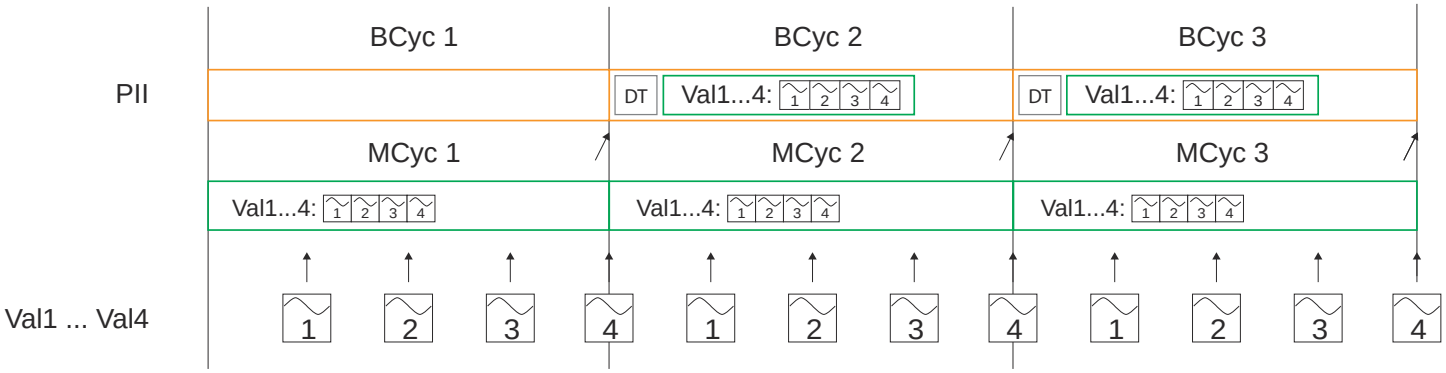
  Here the resulting *module cycle* must correspond to one of the following values: 62.5µs, 125µs, 250µs, 500µs, 1ms, 2ms, 4ms, 8ms, 16ms, 32ms
- Changing the parameter during isochronous operation causes the diagnostic error message *'Configuration error of isochronous operation'*. Here the parameter is accepted and activated during the next isochronous operation. ➦ *'Diagnostics and interrupt'...page 121*

The following options are available for the cycle time factor:

Value	Cycle time factor
0	0.25-fold
1	0.5-fold
2	1-fold (default)
3	2-fold
4	4-fold

Use of Isochronous cycle time factor: 1-fold (2) - default

In the following figure, the factor for isochronous data capture corresponds to the bus cycle time.

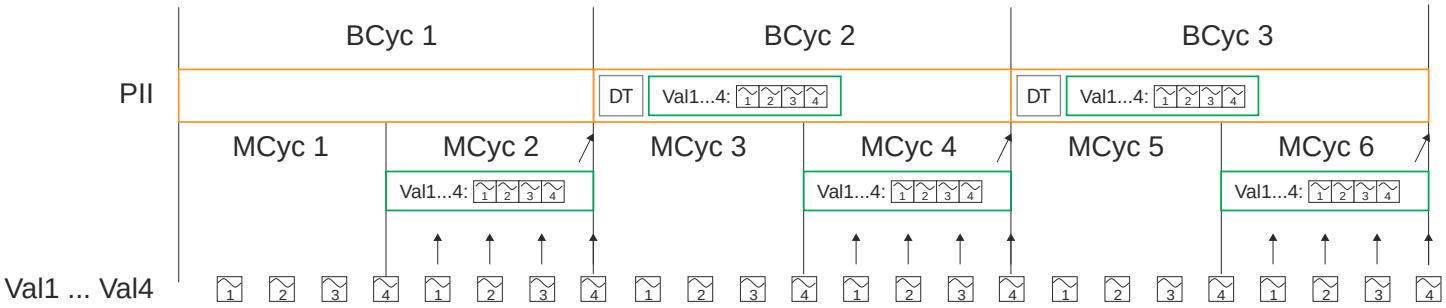


BCyc x Field bus cycle of the head module.
MCyc x Module cycle
DT Delay time until data are provided.
PII Input area in the header module with the 4 counter values.
Valx Captured counter values 1 to 4 within a module cycle.

Use of Isochronous cycle time factor: 0.5-fold (1)

In the following figure, the factor for isochronous data capture corresponds to half of the bus cycle time.

- Useful for time-critical counter registration, for example for fast control systems.
- Since the counter values are transmitted after 2 module cycles, the counter values of the 1. module cycle are overwritten by the counter values of the 2. module cycle during the bus cycle.

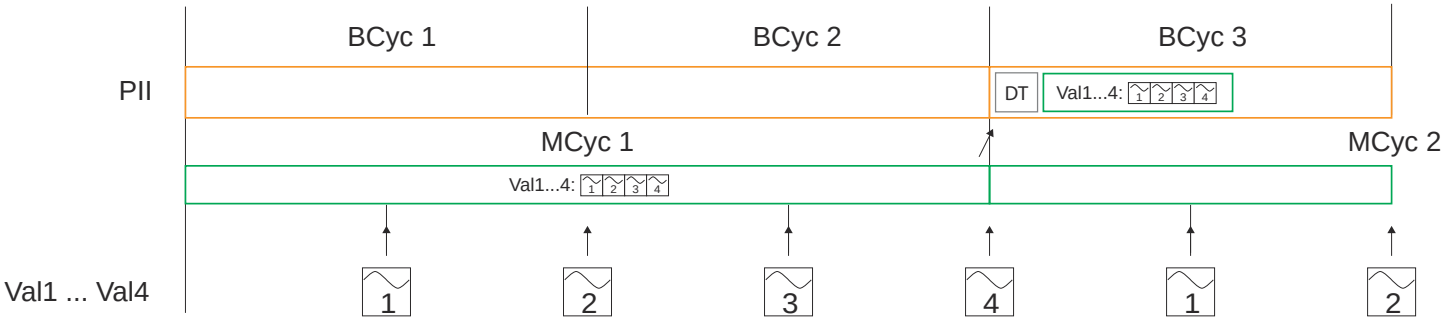


BCyc x Field bus cycle of the head module
MCyc x Module cycle
DT Delay time until data are provided
PII Input area in the header module with the 4 counter values
Valx Captured counter values 1 to 4 within a module cycle.

Use of Isochronous cycle time factor: 2-fold (3)

In the following figure, the factor for isochronous data capture corresponds to double of the bus cycle time.

- Useful for slowly changing counter values such as for adapting to longer cycle times with a large number of modules on the backplane bus or for compensating for frame drops.



BCyc x Field bus cycle of the head module
MCyc x Module cycle
DT Delay time until data are provided
PII Input area in the header module with the 4 counter values
Valx Captured counter values 1 to 4 within a module cycle.

Data capture in free-running cycle

- In contrast to isochronous data capture, data capture in the free-running cycle takes place not in the fieldbus cycle, but decoupled from it in the cycle of the head module.
- In the free-running cycle, 1 counter value is always registered and supplied to the head module at the end of the cycle as identical counter values via ➦ *'IN - Counter value 1...4'...page 102*. The subsequent cycle always represents the counter value from the previous cycle.
- The parameter ➦ *'PARAM - Module cycle time'...page 108* can be used to specify the cycle time for data capture for the module.
- In the free-running cycle, the parameter ➦ *'PARAM - Isochronous cycle time factor'...page 109* is directly applied.

The following options are available for the module cycle time:

Value	Module cycle time
1	62.5µs
2	125µs
3	250µs
4	500µs
5	1000µs (default)
6	2000µs
7	4000µs
8	8000µs
9	16000µs
10	32000µs

4.5 Counter

4.5.1 Overview

Counter functions

- You can count forwards and backwards and choose between the following counter functions:
  - ➦ *'Count continuously'...page 70* e.g. distance measurement with incremental encoder.
  - ➦ *'Count to the counter limit'...page 72* e.g. item tracking up to a maximum limit.
- The following operating modes are available for data capture:
  - In *isochronous operation*, 4 counter values are always registered and supplied to the fieldbus for the head module at the end of the cycle in an isochronous manner.
  - In the *free-running cycle*, 1 counter value is always registered and supplied to the header module at the end of the cycle.
- Via parametrization, additional functions can be activated, signal evaluation can be adjusted, and a counter set value can be specified via the output area.

➦ *'Parameters - Counter'...page 109*

Name	DS	SX	Bytes	Default	Function
CE	128	05	1	0	➦ *'PARAM - Counter - Evaluation'...page 109*
CEL	128	06	1	0	➦ *'PARAM - Counter - Evaluation logic'...page 109*
CDR	128	07	1	0	➦ *'PARAM - Counter - Direction reversal'...page 110*
CM	128	08	1	0	➦ *'PARAM - Counter - Mode'...page 110*
CUL	128	09	4	2147483647	➦ *'PARAM - Counter - Upper limit'...page 110*
CLL	128	10	4	-2147483648	➦ *'PARAM - Counter - Lower limit'...page 110*
CLM	128	11	1	0	➦ *'PARAM - Counter - Limit mode'...page 110*
-	128	12	1	-	reserved
CRV	129	13	4	0	➦ *'PARAM - Counter - Reset value'...page 111*
CRS	129	14	1	0	➦ *'PARAM - Counter - Reset source'...page 111*
CSVS	129	15	1	0	➦ *'PARAM - Counter - Set value source'...page 112*
CI	129	16	1	0	➦ *'PARAM - Counter - Inputs'...page 113*

➦ *'Data capture - isochronous mode'...page 61*

➦ *'Additional functions'...page 77*

➦ *'Signal evaluation'...page 75*

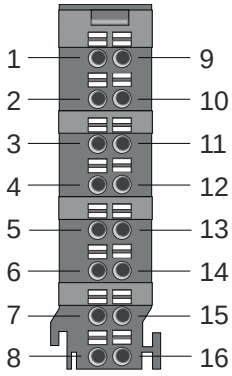
Counter inputs

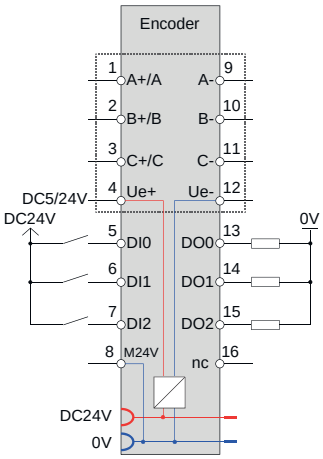
The counter can evaluate inputs A and B. Input C can be used as a trigger signal for the various functions such as set, reset, HW gate, latch and time stamp. In ➦ *'PARAM - Counter - Inputs'...page 113* is defined how the input pins of the counter are assigned or evaluated.

The following options are available for the counter inputs:

Value	Assignment of the counter inputs
0	RS422 differential (default) ■ Input A: Pin 1/A+ and pin 9/A- ■ Input B: Pin 2/B+ and pin 10/B- ■ Input C: Pin 3/C+ and Pin 11/C No wire break diagnostics at an input (default).
1	TTL single ended ■ Input A: Pin 1/A ■ Input B: Pin 2/B ■ Input C: Pin 3/C
2	RS422 with wire break monitoring ■ Input A: Pin 1/A+ and pin 9/A- ■ Input B: Pin 2/B+ and pin 10/B- ■ Input C: Pin 3/C+ and Pin 11/C Wire break diagnostics at input A, B, or C.
3	RS422 with wire break monitoring A/B ■ Input A: Pin 1/A+ and pin 9/A- ■ Input B: Pin 2/B+ and pin 10/B- Wire break diagnostics at input A or B. Input C is not monitored.

Pin assignment





For wires with a core cross-section of 0.14mm² up to 0.75mm². With a core cross-section < 0.25mm² , ferrules must be used. ➦ *'Data'...page 30*

Pos.	Function	Type	Description
1	A+/A	I	RS422 differential, TTL single ended
2	B+/B	I	RS422 differential, TTL single ended
3	C+/C	I	RS422 differential, TTL single ended, trigger input
4	Ue+	PW	Encoder supply positive, parametrizable 0V (default), DC 5V or 24V
5	DI0	I	Digital input DI 0 DC 24V PNP, trigger input
6	DI1	I	Digital input DI 1 DC 24V PNP, trigger input
7	DI2	I	Digital input DI 2 DC 24V PNP, trigger input
8	M24V	PW	GND digital input / output
9	A-	I	RS422 differential
10	B-	I	RS422 differential
11	C-	I	RS422 differential
12	Ue- / GND	PW	Encoder supply negative, GND TTL single ended
13	DO 0	O	Digital output DO 0 DC 24V, output signal PNP push-pull/tristate
14	DO 1	O	Digital output DO 1 DC 24V, output signal PNP push-pull/tristate
15	DO 2	O	Digital output DO 2 DC 24V, output signal PNP push-pull/tristate
16	n.c.	-	reserved

I: Input, O: Output, PW: Power supply

The inputs DI0...DI2 can be used as inputs or trigger signals and the input C as a trigger signal for:

- ➦ *'PARAM - Counter - Set value source'...page 112*
- ➦ *'PARAM - Counter - Reset source'...page 111*
- ➦ *'PARAM - HW gate - Source'...page 117*
- ➦ *'OUT - Latch 1, 2 - Source'...page 105*
- ➦ *'PARAM - Timestamp 1…4 - Source'...page 117*

The outputs DO 0...2 can be used as outputs or as output signals for:

- ➦ *'PARAM - COIN 0…8 - Configuration'...page 119*

CAUTION

Behavior on failure of the DC 24V power section supply:

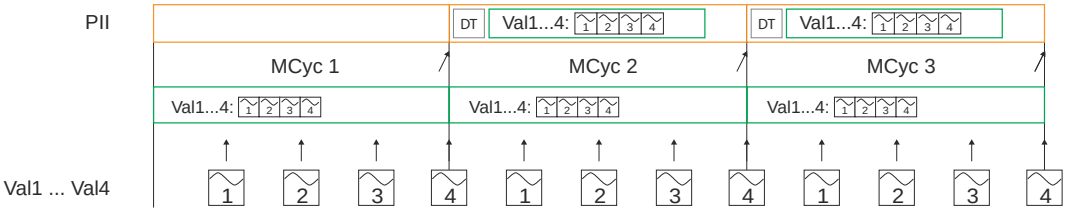
- The DC 5V/24V encoder power supply fails.
- Due to signal loss, the encoder count value stops.
- The digital outputs DO 0...2 are disabled.
- Bit 6 is set in ➦ *'Status word'...page 60*.
- Bit 4 is set in ERR_A diagnostics. ➦ *'Diagnostics and interrupt'...page 121*

Counter value

In the *free-running cycle*, 1 counter value is captured within a module cycle and stored as an identical value in ➦ *'IN - Counter value 1...4'...page 102*.

In *isochronous operation*, 3 additional counter values are captured within a module cycle in addition to the current counter value. This results in the following correlations:

- Counter value 1 in ➦ *'IN - Counter value 1...4'...page 102*
  - Counter value after ¼ of the module cycle time.
- Counter value 2 in ➦ *'IN - Counter value 1...4'...page 102*
  - Counter value after ½ of the module cycle time.
- Counter value 3 in ➦ *'IN - Counter value 1...4'...page 102*
  - Counter value after ¾ of the module cycle time.
- Counter value 4 in ➦ *'IN - Counter value 1...4'...page 102*
  - Counter value at the module cycle end.



MCyc x Module cycle
DT Delay time until data are provided.
PII Input area in the header module with the 4 counter values.
Valx Captured counter values 1 to 4 in the module.

Priority

If several events occur within a sampling period of 10ns, processing takes place in the following priority:

- 0 (lowest): Counter signal (tracks A, B)
- 1: Gate signal (HW/SW gate)
- 2: Set value signal
- 3: Reset signal
- 4 (highest): Latch signal

Examples: The following events occur within a sampling period of 10ns:

- Signal for counting and signal for setting value
  - Counter is set to the set value and then the signal for counting is evaluated.
- Signal for counting and signal for latch
  - The current counter value is stored (latch) and then the signal for counting is evaluated.
- Gate signal and reset signal
  - The counter is reset to the reset value and then the gate signal is evaluated.

Counter limits

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

Via parametrization, this range can be limited by specifying counting limits. If no limits are set, the entire counting range is available.

➦ *'PARAM - Counter - Upper limit'...page 110*

➦ *'PARAM - Counter - Lower limit'...page 110*

Please note that the upper limit must always be greater than the lower limit. Otherwise this leads to a diagnostic message. ➦ *'Diagnostics and interrupt'...page 121*

4.5.2 Overwrite counter value with set value

- After the start-up process, the counter starts at 0.
- The current counter value can be overwritten by specifying a counter set value.
- A new counter set value can only be accepted if bit 3 (enable counter set value) is set in ➦ *'Control word'...page 59*. This bit enables the function so that the stored setting value in ➦ *'OUT - Counter set value'...page 104* is loaded into the counter with the trigger event.
- To execute the setting process, the triggering signal must be parametrized in ➦ *'PARAM - Counter - Set value source'...page 112*. Here the signal that starts the setting process is defined.
- When the setting value is accepted, bit 17 (counter setting completed) is set in ➦ *'Status word'...page 60*.
- As long as bit 3 is set in ➦ *'Control word'...page 59*, further setting values are ignored. The function is only enabled again after resetting and setting bit 3 again (edge 1-0-1).

The following options are available for the setting value source:

Value	Counter set source
0	Disabled (default)
1	➦ *'Control word'...page 59* Bit 4 edge 0-1
2	C: Edge 0-1
3	C: Edge 1-0
4	C: both edges
5	DI 0: Edge 0-1
6	DI 0: Edge 1-0
7	DI 0: both edges
8	DI 1: Edge 0-1
9	DI 1: Edge 1-0
10	DI 1: both edges
11	DI 2: Edge 0-1
12	DI 2: Edge 1-0
13	DI 2: both edges

A closed HW/SW gate does not prevent the counter from being reset or set.

4.5.3 Reset counter to reset value

- The counter is only reset if bit 1 (enable counter reset) is set in ➦ *'Control word'...page 59*. This bit enables the function so that the counter can be reset to the value defined in ➦ *'PARAM - Counter - Reset value'...page 111*.
- To execute the reset, the triggering signal must be parametrized in ➦ *'PARAM - Counter - Reset source'...page 111*. Here the signal that starts the reset process is defined.
- In addition, in ➦ *'PARAM - Counter - Reset value'...page 111*, a value can be specified to which the counter is to be reset. This value replaces the previous counter value after the reset.
- There is no feedback via the status word about the successful completion of the reset process.

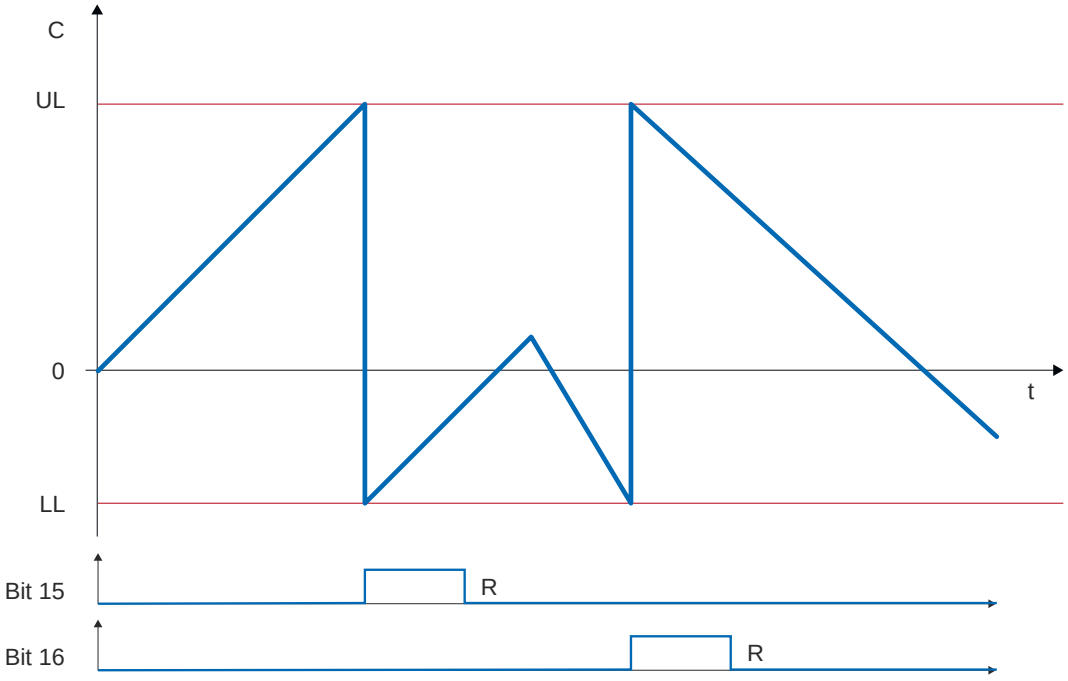
The following options are available for the Reset source:

Value	Counter reset source
0	Disabled (default)
1	➦ *'Control word'...page 59* Bit 2 edge 0-1
2	C: Edge 0-1
3	C: Edge 1-0
4	C: both edges
5	DI 0: Edge 0-1
6	DI 0: Edge 1-0
7	DI 0: both edges
8	DI 1: Edge 0-1
9	DI 1: Edge 1-0
10	DI 1: both edges
11	DI 2: Edge 0-1
12	DI 2: Edge 1-0
13	DI 2: both edges

A closed HW/SW gate does not prevent the counter from being reset or set.

4.5.4 Count continuously

- Presetting
  - Output area ➦ *'Control word'...page 59*
  - Parameter ➦ *'PARAM - Counter - Limit mode'...page 110*: Count continuously (0)
  - Parameter ➦ *'PARAM - Counter - Upper limit'...page 110*
  - Parameter ➦ *'PARAM - Counter - Lower limit'...page 110*
  - ➦ *'Signal evaluation'...page 75*
  - ➦ *'Additional functions'...page 77*
- Result
  - Input area ➦ *'Status word'...page 60*
  - Input area ➦ *'IN - Counter value 1...4'...page 102*
- Function
  - After the start-up process, the counter starts at 0.
  - When the counter counts forwards 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 counter limits are fix set to maximum range.
  - Bit 15 or bit 16 are set in ➦ *'Status word'...page 60* if the value exceeds or falls below the limit. These bits remain set until they are reset in ➦ *'Control word'...page 59* with the corresponding bit.



C Counter value
t Time
UL Upper counter limit
LL Lower counter limit
Bit 15 Counter overflow bit 15 ➦ *'Status word'...page 60*
Bit 16: Counter underflow bit 16 ➦ *'Status word'...page 60*
R Reset ➦ *'Control word'...page 59*

4.5.4.1 Behavior when setting values outside the limits

➦ 'OUT - Counter set value'...page 104

If a ➦ 'OUT - Counter set value'...page 104 is set that exceeds the upper limit value or drops below the lower limit value, the setting is ignored and the counter retains its value. Here bit 3 (error set value) is set in ➦ 'Status word'...page 60.

➦ 'PARAM - Counter - Reset value'...page 111

If a ➦ 'PARAM - Counter - Reset value'...page 111 is set that exceeds the upper limit value or drops below the lower limit value, the setting is ignored and the counter retains its value. Here bit 1 (error set value) is set in ➦ 'Status word'...page 60.

➦ 'PARAM - Counter - Upper limit'...page 110

If ➦ 'PARAM - Counter - Upper limit'...page 110 is used to set the upper limit to a value that is lower than the current counter value, the counter retains its value. At the next positive increment, the counter value is set to the lower limit. The counter value is incremented with a negative increment.

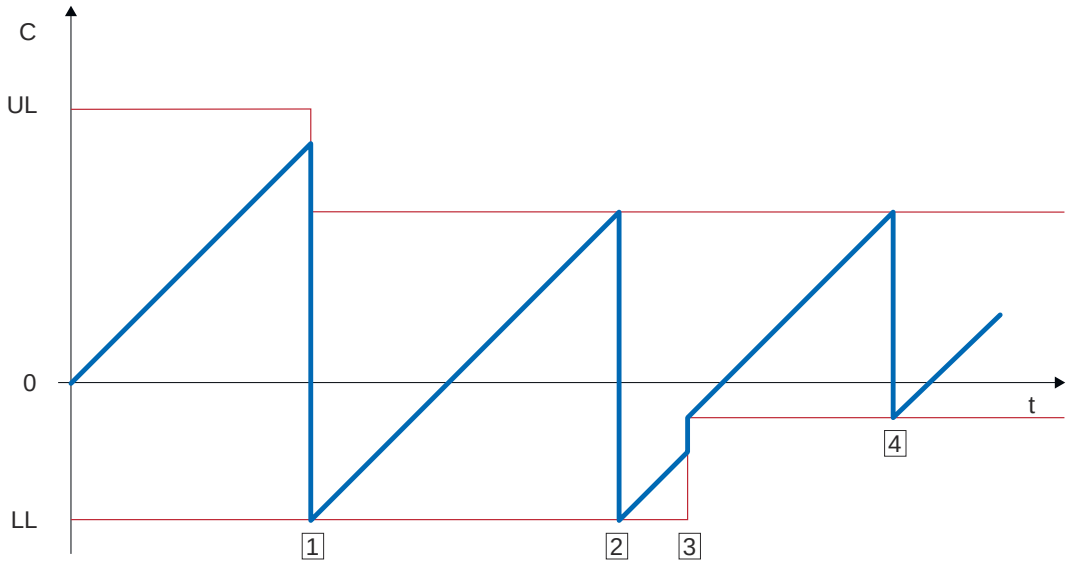
➦ 'PARAM - Counter - Lower limit'...page 110

If ➦ 'PARAM - Counter - Lower limit'...page 110 is used to set the lower limit to a value that is higher than the current counter value, the counter retains its value. At the next negative increment, the counter value is set to the upper limit. The counter value is incremented with a positive increment.

Example

The example of positive incrementing is used below to show how changes to the counter limits affect the result.

- After the start-up process, the counter starts at 0.
- During the counting process, the upper counter limit is changed.
  - Since the upper counter limit is below the current counter value, the counter value is set to the lower limit with the next positive increment. 1.
  - If the counter is incremented positively and the counter value reaches the new upper counting limit, the counter value is set to the lower limit with the next positive increment. 2.
- During the counting process, the lower counter limit is changed
  - Since the lower counter limit is above the current counter value, the counter value is set to the new lower limit with the next positive increment. 3.
  - If the counter is incremented positively and the counter value reaches the new upper counting limit, the counter value is set to the new lower limit with the next positive increment. 4.



C Counter value
t Time
UL Upper counter limit
LL Lower counter limit
1 Change: Upper counter limit < counter value
2 Counter value reaches changed upper counter limit
3 Change: Lower counter limit > counter value
4 Counter value jumps to changed lower counter limit

4.5.5 Count to the counter limit

- Presetting
  - Output area ➦ *'Control word'...page 59*
  - Parameter ➦ *'PARAM - Counter - Limit mode'...page 110*: Counter once (1)
  - Parameter ➦ *'PARAM - Counter - Upper limit'...page 110*
  - Parameter ➦ *'PARAM - Counter - Lower limit'...page 110*
  - ➦ *'Signal evaluation'...page 75*
  - ➦ *'Additional functions'...page 77*
- Result
  - Input area ➦ *'Status word'...page 60*
  - Input area ➦ *'IN - Counter value 1...4'...page 102*
- Function
  - After the start-up process, the counter starts at 0.
  - If the counter counts forwards and reaches the set upper limit, it will stop at this limit with the next positive counting pulse.

    Bit 15 for "counter overflow" is set ➦ *'Status word'...page 60*.

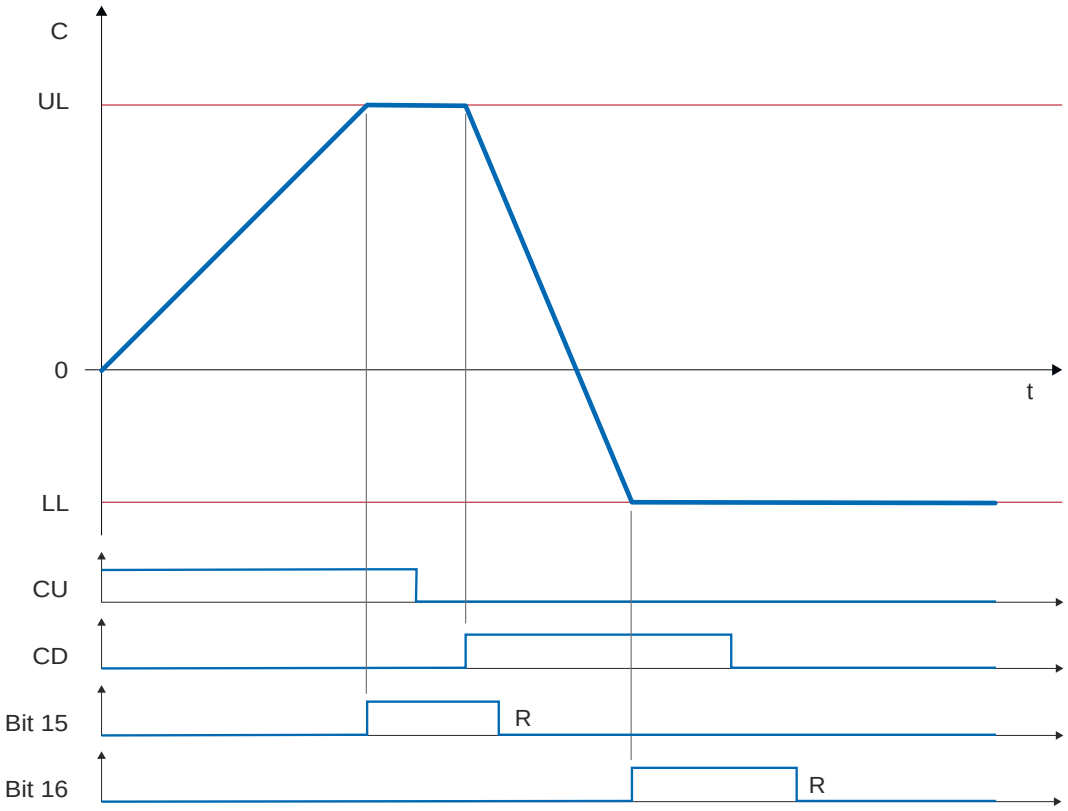
    Further counting pulses in positive direction are ignored; the counter value remains unchanged.

    The counter value is decreased with the first counting pulse in the negative direction.
  - If the counter counts backwards and reaches the set lower limit, it will stop at this limit with the next negative counting pulse.

    Bit 16 for "counter underflow"' is set ➦ *'Status word'...page 60*.

    Further counting pulses in negative direction are ignored; the counter value remains unchanged.

    The counter value is increased with the first counting pulse in the positive direction.



C Counter value
t Time
UL Upper counter limit
LL Lower counter limit
CU Counter pulse forwards (count up)
CD Counter pulse backwards (count down)
Bit 15 Counter overflow bit 15 ➦ *'Status word'...page 60*
Bit 16: Counter underflow bit 16 ➦ *'Status word'...page 60*
R Reset ➦ *'Control word'...page 59*

4.5.5.1 Behavior when setting values outside the limits

➦ 'OUT - Counter set value'...page 104

If a ➦ *'OUT - Counter set value'...page 104* is set that exceeds the upper limit value or drops below the lower limit value, the setting is ignored and the counter retains its value. Here bit 3 (error set value) is set in ➦ *'Status word'...page 60*.

➦ 'PARAM - Counter - Reset value'...page 111

If a ➦ *'PARAM - Counter - Reset value'...page 111* is set that exceeds the upper limit value or drops below the lower limit value, the setting is ignored and the counter retains its value. Here bit 1 (error set value) is set in ➦ *'Status word'...page 60*.

➦ 'PARAM - Counter - Upper limit'...page 110

If ➦ *'PARAM - Counter - Upper limit'...page 110* is used to set the upper limit to a value that is lower than the current counter value, the counter retains its value. It can still count forwards and backwards above the new upper limit. The new upper limit will only take effect once the counter value is less or equal to the new upper limit.

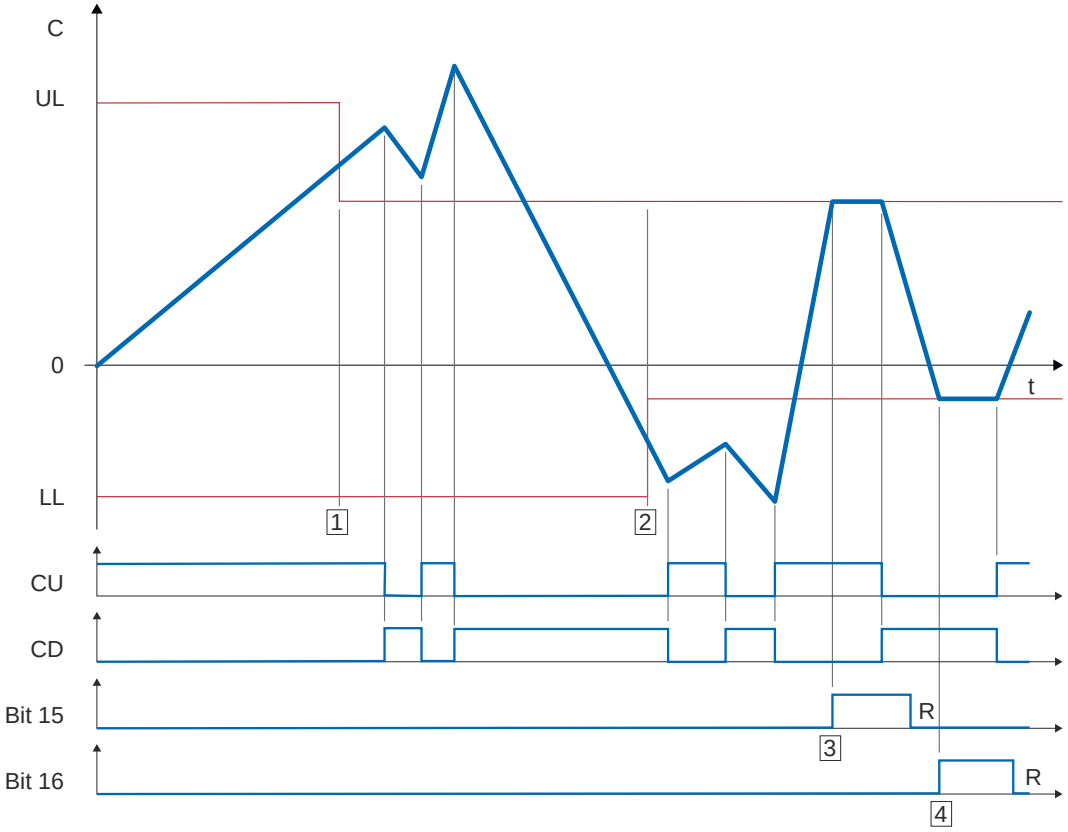
➦ 'PARAM - Counter - Lower limit'...page 110

If ➦ *'PARAM - Counter - Lower limit'...page 110* is used to set the lower limit to a value that is higher than the current counter value, the counter retains its value. It can still count forwards and backwards below the new lower limit. The new lower limit will only take effect once the counter value is greater or equal to the new lower limit.

Example

The following example shows the effect of changes to the counter limits.

- After the start-up process, the counter starts at 0.
- During the counting process, the upper counter limit is changed [1].
  - Since the upper counter limit is below the current counter value, the count value is not affected.
  - The counter can still count forwards and backwards above the new upper limit.
  - The new upper limit will only take effect once the counter value is less or equal to the new upper limit. [3].
- During the counting process, the lower counter limit is changed [2].
  - Since the lower counter limit is above the current counter value, the counter value is not affected.
  - The counter can still count forwards and backwards below the new lower limit.
  - The new lower limit will only take effect once the counter value is greater or equal to the new lower limit. [4].



C Counter value
t Time
UL Upper counter limit
LL Lower counter limit
CU Counter pulse forwards (count up)
CD Counter pulse backwards (count down)
[1] Change: Upper counter limit < counter value
[2] Change: Lower counter limit > counter value
[3] Counter value reaches changed upper counter limit
[4] Counter value reaches changed upper counter limit
Bit 15 Counter overflow bit 15 ➦ *'Status word'...page 60*
Bit 16: Counter underflow bit 16 ➦ *'Status word'...page 60*
R Reset ➦ *'Control word'...page 59*

4.5.6 Signal evaluation

Overview

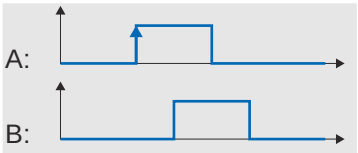
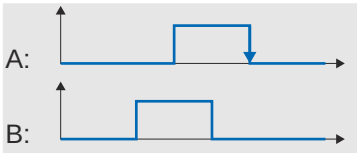
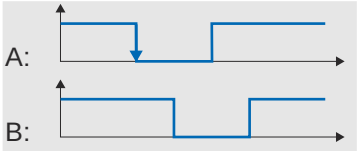
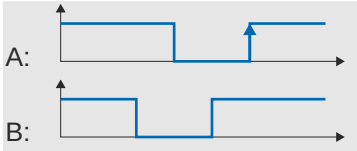
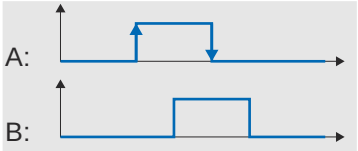
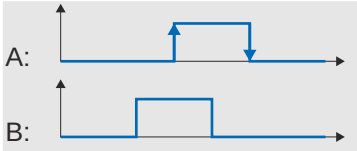
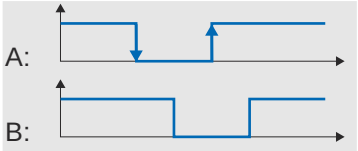
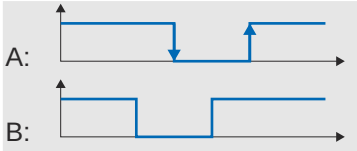
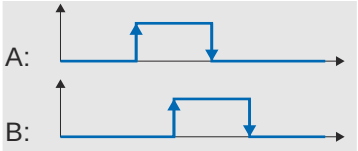
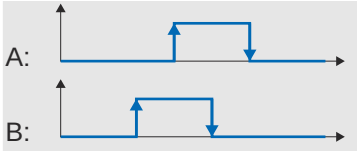
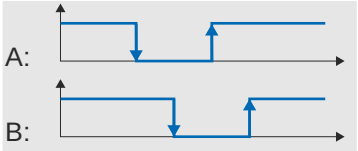
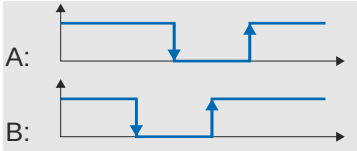
By specifying the following parameters, the signal evaluation and counting function for the corresponding input signal can be set:

- ➦ *'PARAM - Counter - Mode'...page 110*
  - 0: Encoder (default)
  - 1: Counter pulse/direction
  - 2: Counter forwards/backwards
- ➦ *'PARAM - Counter - Evaluation'...page 109*
  - 0: 4-fold - only for encoder (default)
  - 1: 2-fold
  - 2: 1-fold
- ➦ *'PARAM - Counter - Evaluation logic'...page 109*
  - 0: positive (default)
  - 1: negative

The possible combinations for the corresponding counter mode are listed below. The respective triggering edge is marked with an arrow.

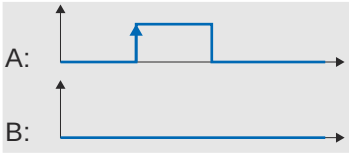
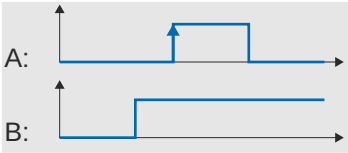
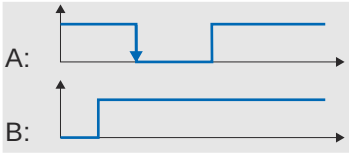
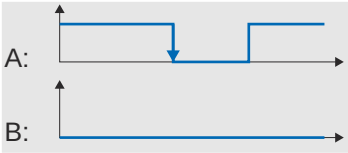
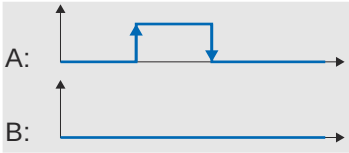
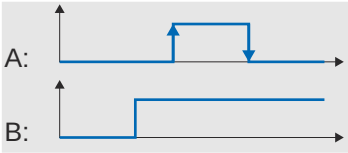
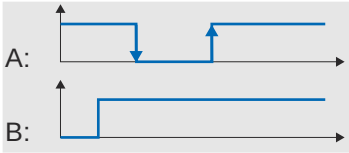
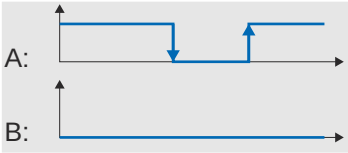
Encoder

➦ *'PARAM - Counter - Mode'...page 110*: Encoder (0)

Counting forwards	Counting backwards	Parameter
		➦ *'PARAM - Counter - Evaluation'...page 109*: 1-fold ➦ *'PARAM - Counter - Evaluation logic'...page 109*: positive
		➦ *'PARAM - Counter - Evaluation'...page 109*: 1-fold ➦ *'PARAM - Counter - Evaluation logic'...page 109*: negative
		➦ *'PARAM - Counter - Evaluation'...page 109*: 2-fold ➦ *'PARAM - Counter - Evaluation logic'...page 109*: positive
		➦ *'PARAM - Counter - Evaluation'...page 109*: 2-fold ➦ *'PARAM - Counter - Evaluation logic'...page 109*: negative
		➦ *'PARAM - Counter - Evaluation'...page 109*: 4-fold ➦ *'PARAM - Counter - Evaluation logic'...page 109*: positive
		➦ *'PARAM - Counter - Evaluation'...page 109*: 4-fold ➦ *'PARAM - Counter - Evaluation logic'...page 109*: negative

Counter pulse / direction

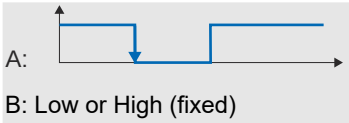
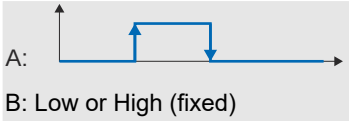
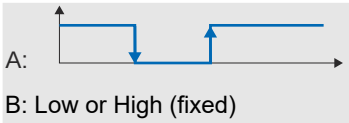
➦ *'PARAM - Counter - Mode'...page 110*: Counter pulse / direction (1)

Counting forwards	Counting backwards	Parameter
		➦ *'PARAM - Counter - Evaluation'...page 109*: 1-fold ➦ *'PARAM - Counter - Evaluation logic'...page 109*: positive
		➦ *'PARAM - Counter - Evaluation'...page 109*: 1-fold ➦ *'PARAM - Counter - Evaluation logic'...page 109*: negative
		➦ *'PARAM - Counter - Evaluation'...page 109*: 2-fold ➦ *'PARAM - Counter - Evaluation logic'...page 109*: positive
		➦ *'PARAM - Counter - Evaluation'...page 109*: 2-fold ➦ *'PARAM - Counter - Evaluation logic'...page 109*: negative

Counter forwards / backwards

➦ *'PARAM - Counter - Mode'...page 110*: Counter forwards/backwards (2)

Please note that the signal, which is not to be evaluated, must be in a defined state (High or Low). This status must not change during the counting process.

Counting forwards	Counting backwards	Parameter
	A: Low or High (fixed) 	➦ *'PARAM - Counter - Evaluation'...page 109*: 1-fold ➦ *'PARAM - Counter - Evaluation logic'...page 109*: positive
	A: Low or High (fixed) 	➦ *'PARAM - Counter - Evaluation'...page 109*: 1-fold ➦ *'PARAM - Counter - Evaluation logic'...page 109*: negative
	A: Low or High (fixed) 	➦ *'PARAM - Counter - Evaluation'...page 109*: 2-fold ➦ *'PARAM - Counter - Evaluation logic'...page 109*: positive
	A: Low or High (fixed) 	➦ *'PARAM - Counter - Evaluation'...page 109*: 2-fold ➦ *'PARAM - Counter - Evaluation logic'...page 109*: negative

4.6 Additional functions

Overview

The following additional functions can be configured for the counter via the parametrization of the 050-1BA50:

- ➦ *'HW gate function'...page 77*
  - The gate function is used to block a counting function.
- ➦ *'Latch function'...page 78*
  - As soon as during a count process at a latch input an edge 0-1 is detected, the current *counter value* is stored in the according latch register.
- ➦ *'Coin function'...page 80*
  - A *threshold* can be specified which activates a digital output depending on the *counter value*.
- ➦ *'Filter functions'...page 91*
  - To filter unwanted signals, a filter can be activated for the input signals DI 0...2 or encoder inputs A...C.
- ➦ *'Timestamp'...page 93*
  - Via parametrization, up to 4 events can be defined for which a time stamp of the internal nanosecond timer is stored.
- ➦ *'Measuring functions'...page 93*
  - Here the pulse frequency, pulse period and pulse duration of a signal connected to channel A can be determined.

4.6.1 HW gate function

Functionality

- After switching on, the counter starts counting immediately.
- The counting process can be blocked by means of the internal gate (I gate).
- The I gate is the logical OR operation of software gate (SW gate) and hardware gate (HW gate).

  As soon as the result is <> 0, the counting process is blocked.
- The source for the HW gate is parametrized in ➦ *'PARAM - HW gate - Source'...page 117*.
  - By disabling the HW gate in ➦ *'PARAM - HW gate - Source'...page 117*, the counting process can only be blocked by the SW gate.
- The SW gate is controlled via bit 19: 0 in ➦ *'Control word'...page 59*.
  - 0: The SW gate is opened (deactivated) and the counter is enabled for counting.
  - Flank 0-1: The SW gate is closed (activated) and the counter for the counting process is blocked.

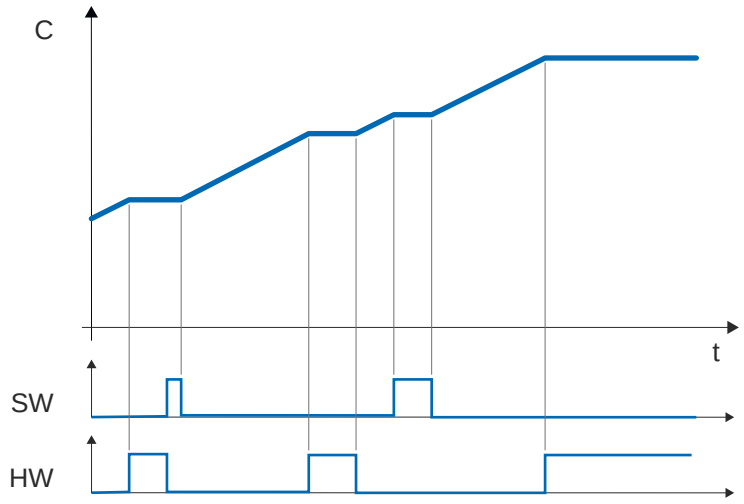
The following options are available for the HW gate source:

Value	HW-gate source
0	HW gate is disabled, counter lock takes place via SW gate (default)
1	C: "1" signal locks the counter
2	C: "0" signal locks the counter
3	DI 0: "1" signal locks the counter
4	DI 0: "0" signal locks the counter
5	DI 1: "1" signal locks the counter
6	DI 1: "0" signal locks the counter
7	DI 2: "1" signal locks the counter
8	DI 2: "0" signal locks the counter

The following states influence the I gate:

SW gate	HW gate	influences the I gate
0	0	0 >>> I gate is open - counter is counting
1	x	1 >>> I gate is closed - counter is blocked
x	1	1 >>> I gate is closed - counter is blocked
x: not relevant		

A closed HW/SW gate does not prevent the counter from being reset or set.



C Counter value
t Time
SW Software gate: Bit 19 ➦ *'Control word'...page 59*
HW Hardware gate ➦ *'PARAM - HW gate - Source'...page 117*

4.6.2 Latch function

➦ *'Parameters - Latch'...page 116*

Name	DS	SX	Bytes	Default	Function
CLC_1 CLC_2	132	31, 32	2	0	➦ *'PARAM - Latch 1, 2 - Configuration'...page 116*
-	132	33, 34	2	-	reserved

Functionality

- As soon as during a count process an edge 0-1 is recognized at a latch input, the current counter value is stored in the according latch register.
- Each time a latch value is entered, the corresponding latch ID is incremented in ➦ *'Status word'...page 60*.
- Latch values remain stored until they are overwritten.
- After a system reboot, the latch registers are set to 0.
- To use the latch function, you have to select a latch source, configure it, and enable the latch function. The *Configuration* determines whether Latch is to be executed once or continuously.

  ➦ *'OUT - Latch 1, 2 - Source'...page 105*
  ➦ *'PARAM - Latch 1, 2 - Configuration'...page 116*
  Enable Latch 1: Bit 11: 1 ➦ *'Control word'...page 59*
  Enable Latch 2: Bit 13: 1 ➦ *'Control word'...page 59*

The following options are available for Latch source:

Value	Latch source
0	Disabled
1	➦ *'Control word'...page 59* Latch 1: Bit 12 edge 0-1 Latch 2: Bit 14 edge 0-1
2	C: Edge 0-1
3	C: Edge 1-0
4	C: both edges
5	DI 0: edge 0-1
6	DI 0: edge 1-0
7	DI 0: both edges
8	DI 1: edge 0-1
9	DI 1: edge 1-0
10	DI 1: both edges
11	DI 2: edge 0-1
12	DI 2: edge 1-0
13	DI 2: both edges

Latch configuration

➦ *'PARAM - Latch 1, 2 - Configuration'...page 116* defines whether Latch 1 and Latch 2 are to be executed once or continuously.

- 0: Once (default)
  - A latch event executes the latch function once, as long as the latch function is not re-enabled via edge 1-0-1 of bit 11 or 13 in ➦ *'Control word'...page 59*.
- 1: Continuous
  - Each latch event executes a latch function.
  - For each latch event, the corresponding latch ID in ➦ *'Status word'...page 60* is incremented.

Example Latch 1 - once

1. Select the source for Latch 1.

   ➦ *'OUT - Latch 1, 2 - Source'...page 105*

2. In the configuration for Latch 1, specify the value 0 for "once".

   ➦ *'PARAM - Latch 1, 2 - Configuration'...page 116*

3. Enable latch 1 with bit 11: 1 in ➦ *'Control word'...page 59*

   ➡ Latch 1 is enabled.

4. With the first Latch 1 event, the current counter value is stored in the Latch register and the Latch 1 ID is incremented. If configured, the corresponding timestamp is also stored.

   ➡ After execution, the latch function is disabled and must be enabled via edge 1-0-1 of bit 11.

Example Latch 1 - continuous

1. Select the source for Latch 1.

   ➦ *'OUT - Latch 1, 2 - Source'...page 105*

2. In the configuration for Latch 1, specify the value 1 for "continuous".

   ➦ *'PARAM - Latch 1, 2 - Configuration'...page 116*

3. Enable latch 1 with bit 11: 1 in ➦ *'Control word'...page 59*

   ➡ Latch 1 is enabled.

4. With each Latch 1 event, the current counter value is stored in the latch register and the Latch 1 ID is incremented. If configured, the corresponding timestamp is also stored.

4.6.3 Coin function

COIN

- COIN is short for **coin**cidence.
- The COIN function is enabled in ➦ *'Control word'...page 59* via bit 20.
- When the COIN function is enabled, the assigned DO output is switched as soon as the count value reaches the previously defined *threshold value* from the corresponding *direction* due to a counting pulse. If the count value is set to a set or reset value during runtime, the output is not switched.
- 9 threshold values (COIN 0 to 8) can be defined. COIN 0 has the highest priority, COIN 8 the lowest.
- While the threshold value for COIN 0 is specified via the output range ➦ *'OUT - Threshold COIN 0'...page 104*, the threshold values for COIN 1 to 8 are set via the parameters. ➦ *'PARAM - COIN 1…8 - Threshold'...page 119*
- To enable the corresponding DO output to be switched, the COIN function must be configured in ➦ *'PARAM - DO 0…2 - Configuration'...page 116*.
- The behavior of the DOs for the corresponding COIN function is specified via the ➦ *'PARAM - COIN 0…8 - Configuration'...page 119*.
- A DO duration can only be specified for COIN 0 via parametrization in ➦ *'PARAM - COIN 0 - DO hold time'...page 120*. Once this duration has elapsed, the corresponding DO returns to its previous state. By specifying 0, the output remains in the required state until the COIN 0 function is re-enabled via edge 1-0-1 of bit 20 in ➦ *'Control word'...page 59*.
- For COIN 1 to 8 the DOs should always be controlled with a COIN pair (ON/OFF).

The following options are available for COIN 0...8:

Value	COIN - Configuration DO 0...2
0	Disabled (default)
1	Set DO 0 to 1.
2	Set DO 0 to 0.
3	Set DO 1 to 1.
4	Set DO 1 to 0.
5	Set DO 2 to 1.
6	Set DO 2 to 0.
7	Set DO 0 to 1 when counting forwards. Set DO 0 to 0 when counting backwards.
8	Set DO 0 to 0 when counting forwards. Set DO 0 to 1 when counting backwards.
9	Set DO 1 to 1 when counting forwards. Set DO 1 to 0 when counting backwards.
10	Set DO 1 to 0 when counting forwards. Set DO 1 to 1 when counting backwards.
11	Set DO 2 to 1 when counting forwards. Set DO 2 to 0 when counting backwards.
12	Set DO 2 to 0 when counting forwards. Set DO 2 to 1 when counting backwards.

➦ *'Parameters - COIN'...page 119*

Name	DS	SX	Bytes	Default	Function
CCOIN_TH_1 ... CCOIN_TH_8	135	42...49	32	0	➦ *'PARAM - COIN 1…8 - Threshold'...page 119*
CCOIN_CFG_0 ... CCOIN_CFG_8	136	50...58	9	0	➦ *'PARAM - COIN 0…8 - Configuration'...page 119*
CCOIN_DIR_0 ... CCOIN_DIR_8	136	59...67	9	0	➦ *'PARAM - COIN 0…8 - Direction'...page 120*
CCOIN_DOD_0	136	68	2	0	➦ *'PARAM - COIN 0 - DO hold time'...page 120*
-	136	69	1	-	reserved

COIN 0

- Threshold
  - The threshold value for COIN 0 takes place via the output area.
    ➦ *'OUT - Threshold COIN 0'...page 104*
- Direction
  - Specifies the counting direction in which the COIN function should be executed.
  - ➦ *'PARAM - COIN 0…8 - Direction'...page 120*
- Configuration
  - Behavior of outputs DO 0...2 for the corresponding COIN function.
  - ➦ *'PARAM - COIN 0…8 - Configuration'...page 119*
- Duration
  - A DO duration can only be specified for COIN 0 via parametrization. Once this duration has elapsed, the corresponding DO returns to its previous state.
  - ➦ *'PARAM - COIN 0 - DO hold time'...page 120*
- Priority
  - Coin 0 has the highest priority.
- Enable COIN 0 function
  - The COIN 0 function is enabled in ➦ *'Control word'...page 59* via bit 20.
    1: Enables COIN 0
    0: Disables COIN 0

COIN 1...8

- Threshold
  - The threshold value for COIN 1...8 takes place via the parametrization. The DOs should always be controlled with a COIN pair (ON/OFF).
    ➦ *'PARAM - COIN 1…8 - Threshold'...page 119*
- Direction
  - Specifies the counting direction in which the COIN function should be executed.
  - ➦ *'PARAM - COIN 0…8 - Direction'...page 120*
- Configuration
  - Behavior of the outputs.
  - ➦ *'PARAM - COIN 0…8 - Configuration'...page 119*
- Duration
  - The parametrization of a DO duration is not possible. The DOs should always be controlled with a COIN pair (ON/OFF).
- Priority
  - The priority decreases from COIN 0 to COIN 8
- Enable COIN functions 1 to 8
  - The COIN function 1 to 8 is enabled in ➦ *'Control word'...page 59* via bit 21 to 28.
    1: Enables the corresponding COIN function.
    0: Disables the corresponding COIN function.

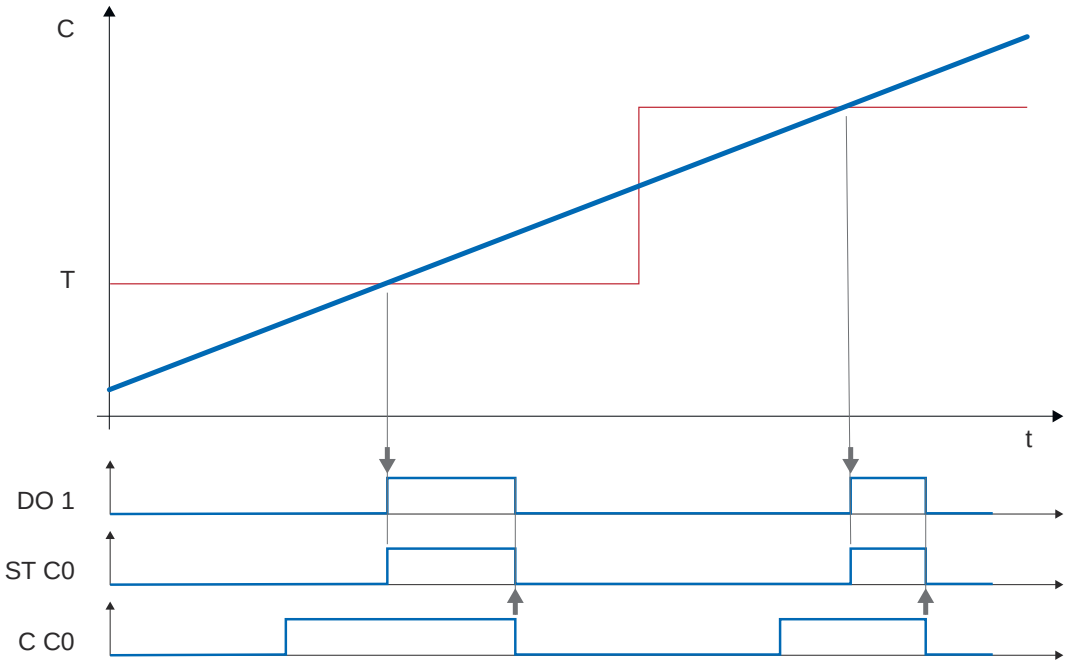
Example for priority

1. COIN 3 is configured to *'Set DO 1 to 0'*.
2. COIN 4 is configured to *'Set DO 1 to 1'*.

   ➧ When COIN 3 and COIN 4 have the same threshold and the same direction, the higher priority (COIN 3 before COIN 4) determines the output behavior. Due to the higher priority of COIN 3, DO 1 is set to 0 when the threshold is reached.

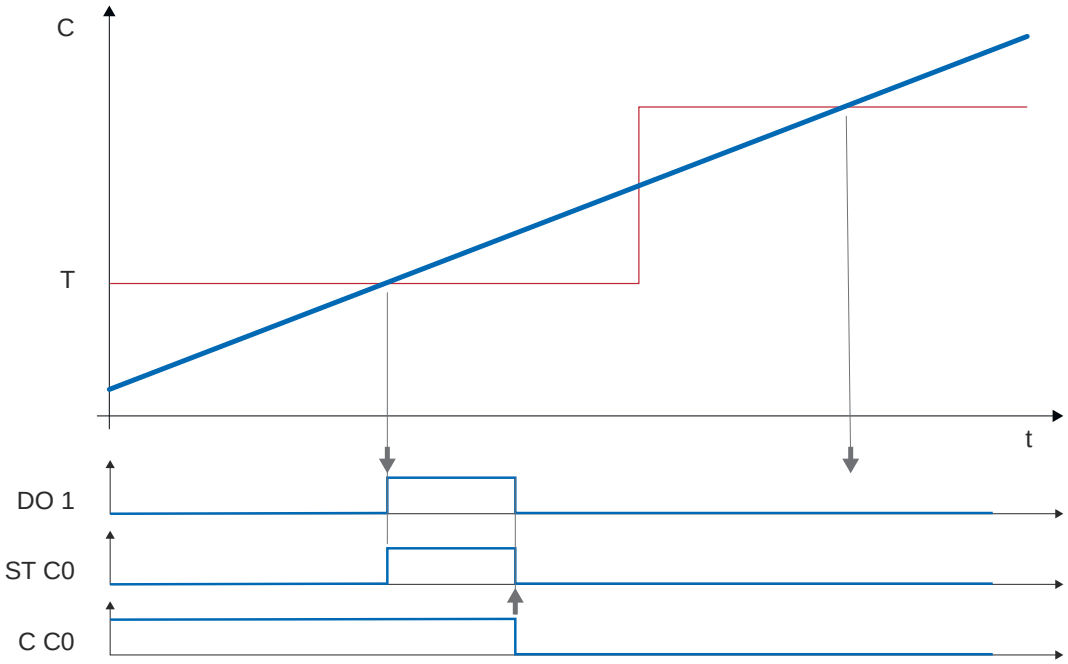
4.6.3.1 Examples COIN 0

COIN 0 with COIN 0 duration = 0 with reset and reactivation of the COIN 0 function



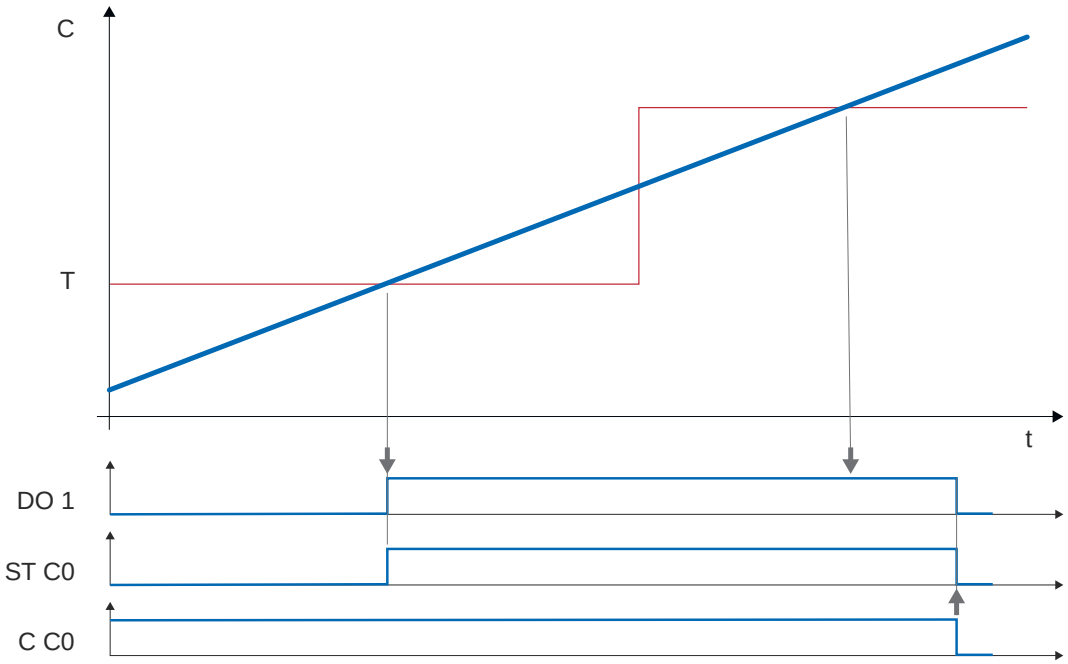
C Counter value
T Threshold
t Time
DO 1 Status DO 1
ST C0 Status COIN 0
C C0 Bit 20 in ➥ *'Control word'...page 59*

COIN 0 with duration = 0 and with reset of the COIN 0 function:



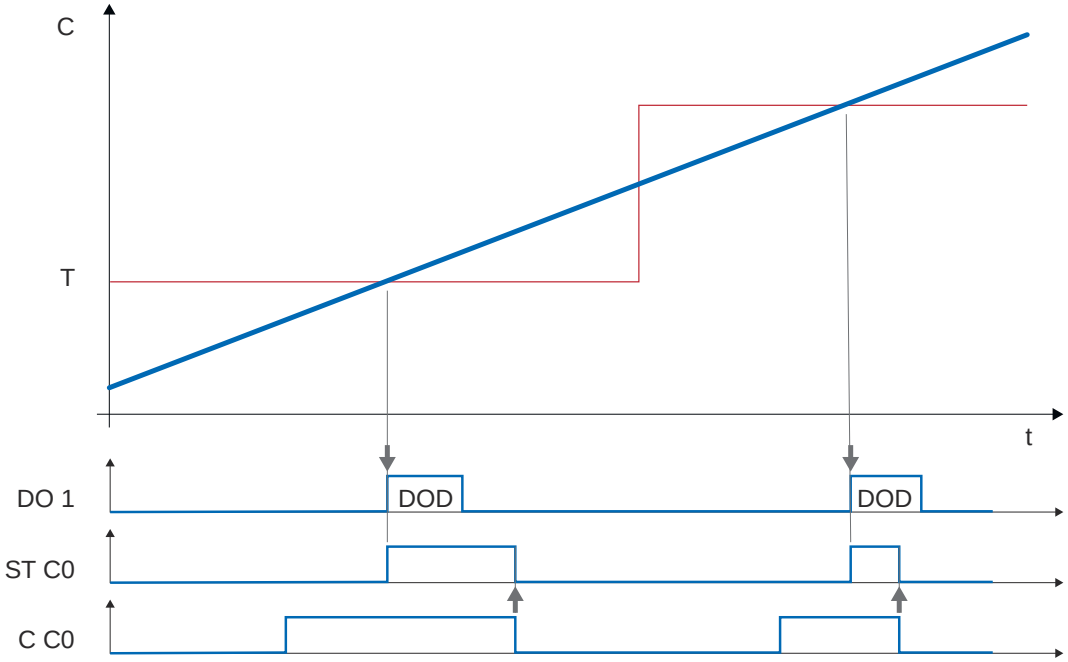
C Counter value
T Threshold
t Time
DO 1 Status DO 1
ST C0 Status COIN 0
C C0 Bit 20 in ➥ *'Control word'...page 59*

COIN 0 with duration = 0 without a reset of the COIN 0 function:



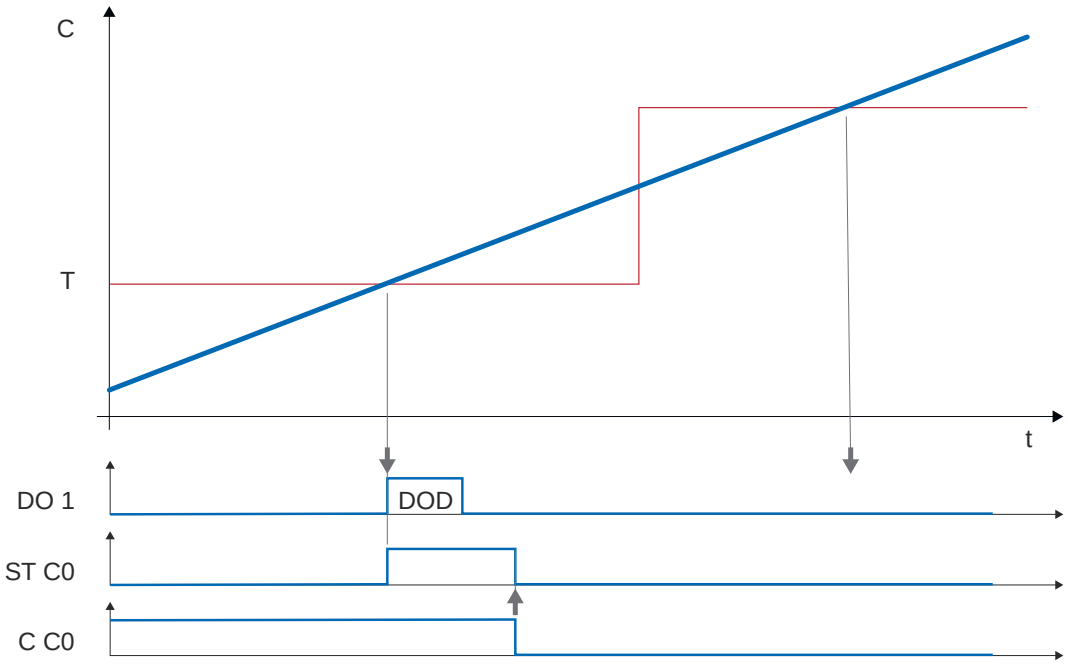
C Counter value
T Threshold
t Time
DO 1 Status DO 1
ST C0 Status COIN 0
C C0 Bit 20 in ➦ *'Control word'...page 59*

COIN 0 with duration > 0 with reset and reactivation of the COIN 0 function:



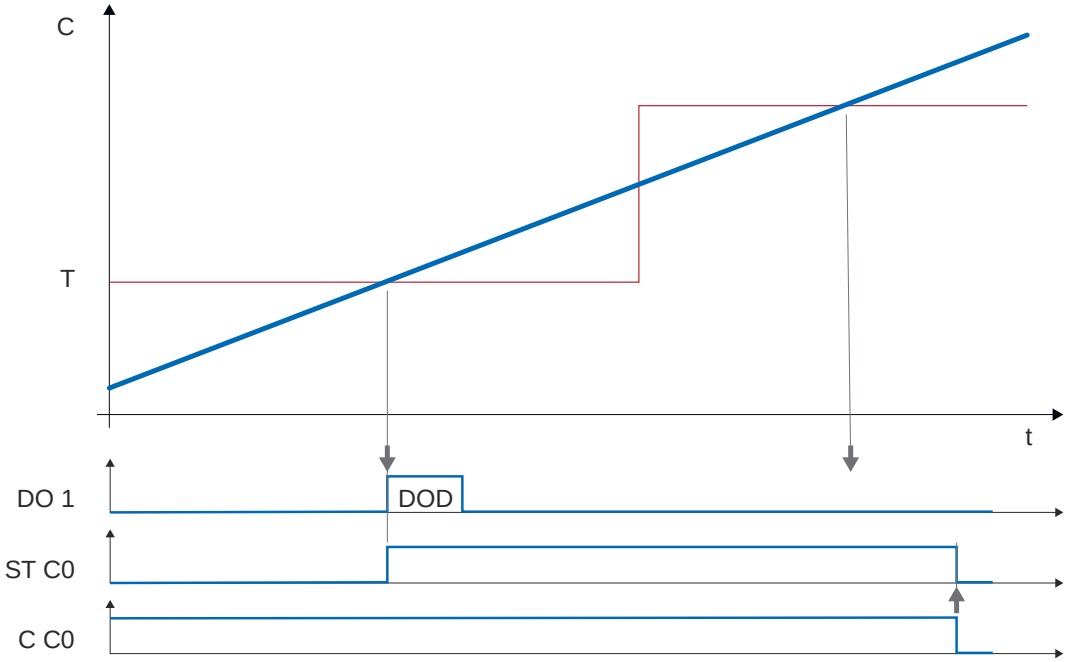
C Counter value
T Threshold
t Time
DOD DO 0 duration > 0
DO 1 Status DO 1
ST C0 Status COIN 0
C C0 Bit 20 in ➦ *'Control word'...page 59*

COIN 0 with duration > 0 and with reset of the COIN 0 function:



C Counter value
T Threshold
t Time
DOD DO 0 duration > 0
DO 1 Status DO 1
ST C0 Status COIN 0
C C0 Bit 20 in ➦ *'Control word'...page 59*

COIN 0 with duration > 0 without a reset of the COIN 0 function:

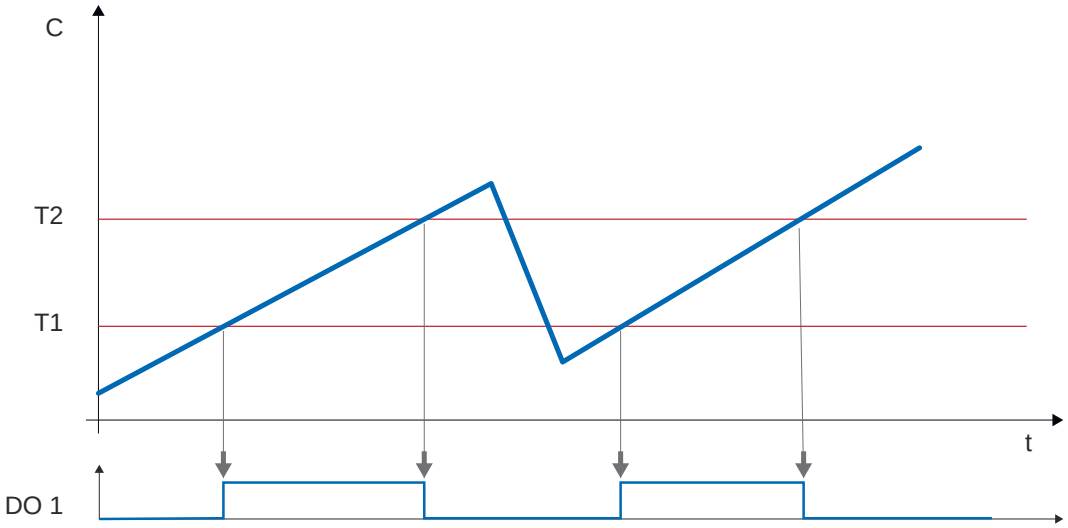


C Counter value
T Threshold
t Time
DOD DO 0 duration > 0
DO 1 Status DO 1
ST C0 Status COIN 0
C C0 Bit 20 in ➦ *'Control word'...page 59*

4.6.3.2 Examples COIN 1...8

COIN 1 and COIN 2 control DO 1 when counting forwards

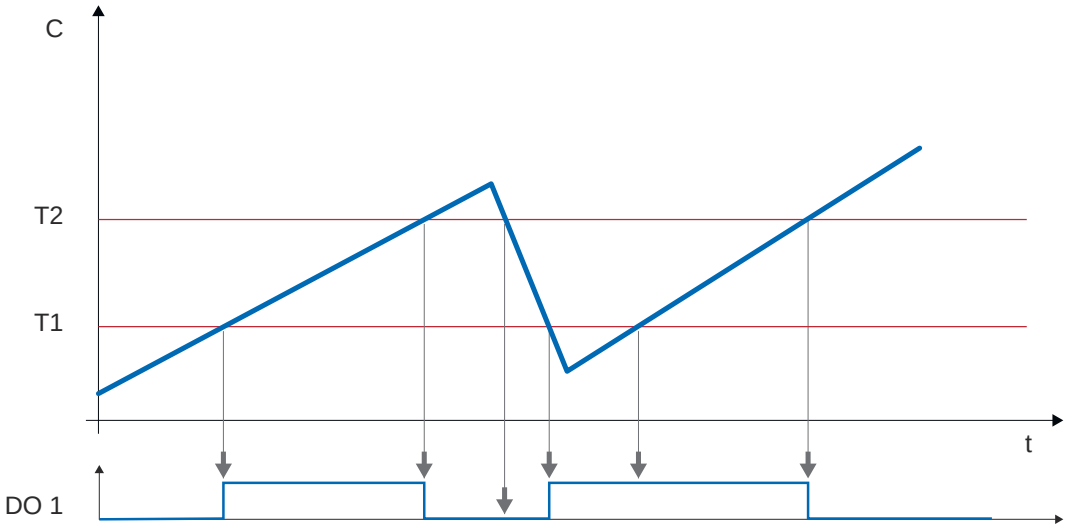
- Threshold
  - COIN 1: T1
  - COIN 2: T2
- Direction
  - COIN 1: When counting forwards
  - COIN 2: When counting forwards
- Configuration
  - COIN 1: Set DO 1 to 1
  - COIN 2: Set DO 1 to 0



C Counter value
T1 Threshold 1
T2 Threshold 2
t Time
DO 1 Status DO 1

COIN 1 and COIN 2 control DO 1 when counting forwards and backwards

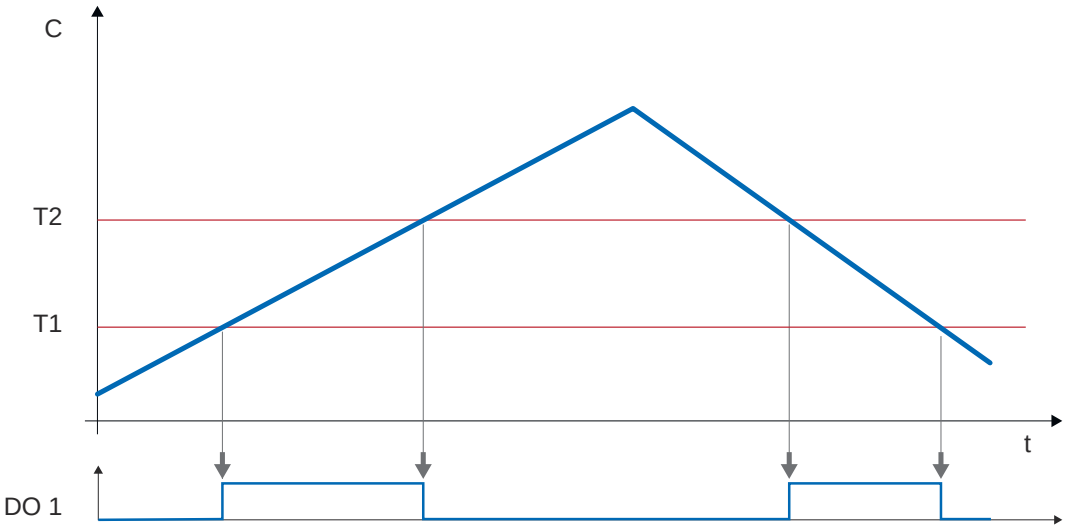
- Threshold
  - COIN 1: T1
  - COIN 2: T2
- Direction
  - COIN 1: Both counting directions
  - COIN 2: Both counting directions
- Configuration
  - COIN 1: Set DO 1 to 1
  - COIN 2: Set DO 1 to 0



C Counter value
T1 Threshold 1
T2 Threshold 2
t Time
DO 1 Status DO 1

COIN 1 and COIN 2 control DO 1 when counting forwards and backwards in combination

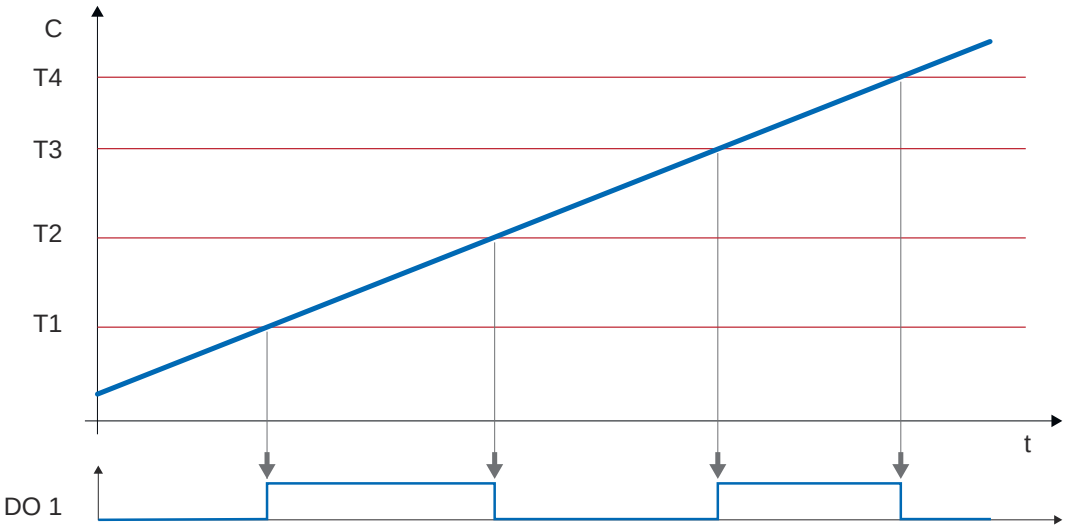
- Threshold
  - COIN 1: T1
  - COIN 2: T2
- Direction
  - COIN 1: Both counting directions
  - COIN 2: Both counting directions
- Configuration
  - COIN 1: Set DO 1 to 1 when counting forwards, set DO 1 to 0 when counting backwards
  - COIN 2: Set DO 1 to 0 when counting forwards, set DO 1 to 1 when counting backwards



C Counter value
T1 Threshold 1
T2 Threshold 2
t Time
DO 1 Status DO 1

COIN 1...4 control DO 1 when counting forwards

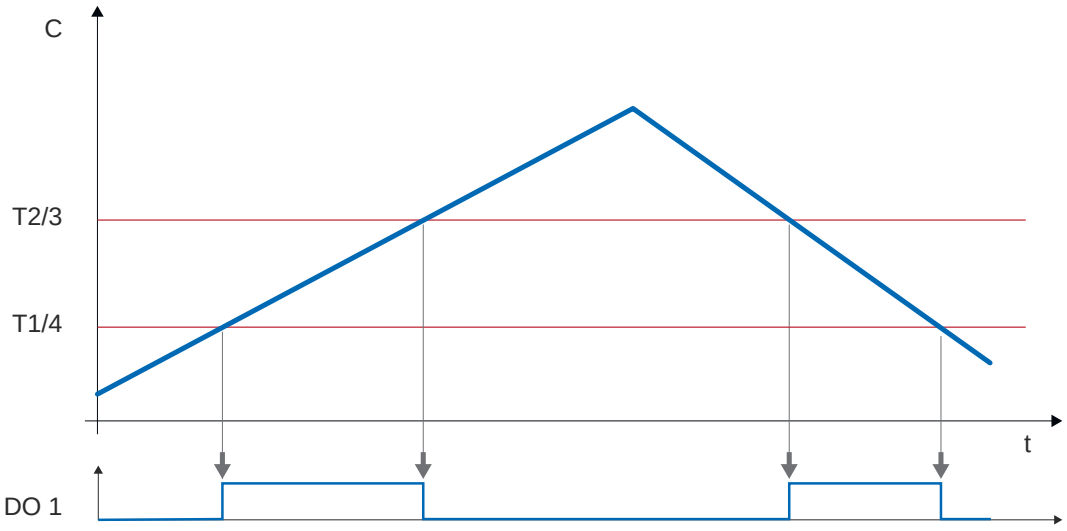
- Threshold
  - COIN 1: T1
  - COIN 2: T2
  - COIN 3: T3
  - COIN 4: T4
- Direction
  - COIN 1...4: When counting forwards
- Configuration
  - COIN 1: Set DO 1 to 1
  - COIN 2: Set DO 1 to 0
  - COIN 3: Set DO 1 to 1
  - COIN 4: Set DO 1 to 0



C Counter value
T1...4 Threshold 1...4
t Time
DO 1 Status DO 1

COIN 1...4 control DO 1 when counting forwards and backwards

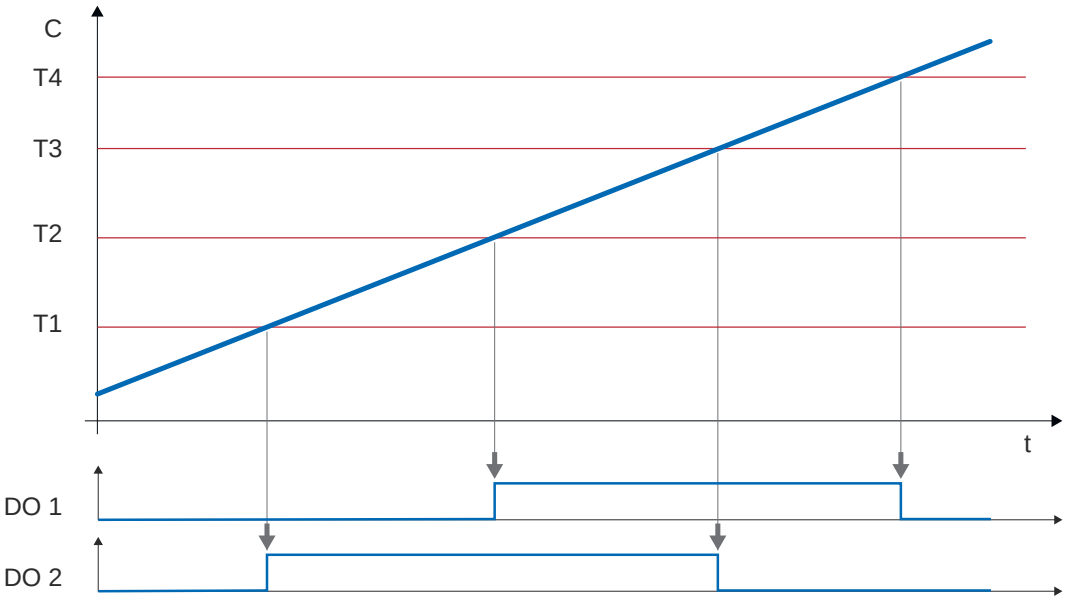
- Threshold
  - COIN 1: T1
  - COIN 2: T2
  - COIN 3: T3
  - COIN 2: T4
- Direction
  - COIN 1...4: Both counting directions
- Configuration
  - COIN 1: Set DO 1 to 1
  - COIN 2: Set DO 1 to 0
  - COIN 3: Set DO 1 to 1
  - COIN 4: Set DO 1 to 0



C Counter value
T1/4 Threshold 1
T2/3 Threshold 2
t Time
DO 1 Status DO 1

COIN 1...4 control DO 1 and DO 2 when counting forwards

- Threshold
  - COIN 1: T1
  - COIN 2: T2
  - COIN 3: T3
  - COIN 4: T4
- Direction
  - COIN 1...4: When counting forwards
- Configuration
  - COIN 1: Set DO 2 to 1
  - COIN 2: Set DO 1 to 1
  - COIN 3: Set DO 2 to 0
  - COIN 4: Set DO 1 to 0



C Counter value
T1...4 Threshold 1...4
t Time
DO 1 Status DO 1
DO 2 Status DO 2

4.6.4 Filter functions

Input filter

A filter can be activated for the digital inputs DI 0...2 via ➦ *'PARAM - DI 0…2 - Input filter'...page 115*.

The filter limit is defined by specifying a delay time for input DI 0...2. The input signal is monitored over the parametrized period, which is parametrized via the delay time. If the signal remains unchanged (high or low) during this entire time, the stable signal state is applied and stored in ➦ *'IN - DI status'...page 103*. Short-term signal changes (e.g. interference or bouncing) are thereby suppressed.

The following options are available for the filter:

Value	Delay time
0	Disabled (default)
1	1µs
2	5µs
3	10µs
4	100µs
5	500µs
6	1000µs
7	3000µs

Encoder filter

A filter can be activated via ➦ *'PARAM - Encoder - Filter'...page 114*. The filter limit is defined by specifying a limit frequency. Input signals with edge frequencies below this limit are evaluated, while higher-frequency signal parts or interferences are suppressed.

The following options are available for the limit frequency:

Value	Limit frequency
0	Disabled (default)
1	10kHz
2	25kHz
3	50kHz
4	100kHz
5	1MHz
6	2MHz (only for RS422)
7	4MHz (only for RS422)

➦ *'Counter inputs'...page 65*

Behavior when changing the filter value during operation:

- Filter condition not met and new filter value is greater
  - Filter counter is set to 0 (filter restart).
- Filter condition met and new filter value is greater
  - Filter counter is set to the new (larger) value.
- Filter condition not met and new filter value is smaller
  - Filter counter is set to 0 (filter restart).
- Filter condition met and new filter value is smaller
  - Filter counter is set to the new (smaller) value.

4.6.5 Timestamp

Functionality

- The module contains a 32-bit nanosecond timer (ns timer), which is started and synchronized via the head module and starts again at 0 after 2^{32}ns (ca. 4.3s).
- 4 timestamps are available in the input process image.
  ➦ *'Process data'...page 101*
  ➦ *'IN - Timestamp 1...4'...page 103*
- In ➦ *'PARAM - Timestamp 1…4 - Source'...page 117*, it is possible to configure the event at which the current value of the ns timer should be stored in the corresponding timestamp 1...4 .
- If a parametrized event occurs, the current value of the ns timer is automatically kept in ➦ *'IN - Timestamp 1...4'...page 103*.

The following options are available as source for timestamp:

Value	Timestamp source
0	Timestamp function is disabled (default)
1	Last change to the counter value
2	C: Last edge 0-1
3	C: Last edge 1-0
4	DI 0: Last edge 0-1
5	DI 0: Last edge 1-0
6	DI 1: Last edge 0-1
7	DI 1: Last edge 1-0
8	DI 2: Last edge 0-1
9	DI 2: Last edge 1-0
10	DO 0: Last edge 0-1
11	DO 0: Last edge 1-0
12	DO 1: Last edge 0-1
13	DO 1: Last edge 1-0
14	DO 2: Last edge 0-1
15	DO 2: Last edge 1-0

4.6.6 Measuring functions

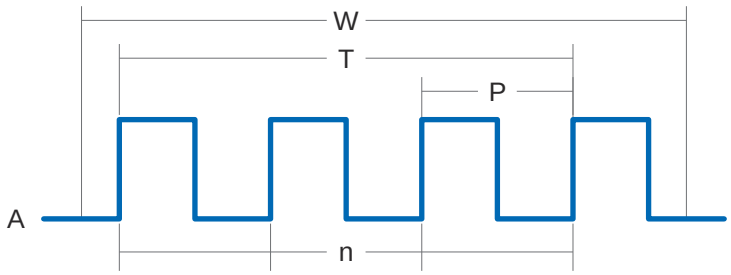
Measured values

The module provides the following measured values of a signal connected to A (track A):

- Pulse frequency
- Pulse period
- Pulse duration

Pulse frequency

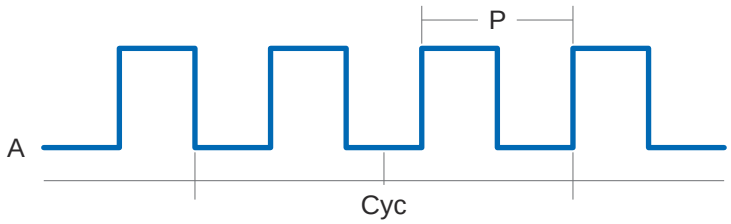
- By specifying a measurement window in ➦ *'PARAM - Pulse frequency window'...page 118*, the *pulse frequency* of a signal connected to A (track A) can be determined.
- Since the measurement accuracy depends on this, at least twice the period duration of the smallest frequency to be measured should be specified for the pulse frequency window.
- The time measurement for the *pulse frequency* begins with the first edge 0-1 of the signal that is detected within the measurement window (W).
- During the measurement, the number of periods (P) within the measured time (T) is determined.
- Time measurement ends with the last edge 0-1 within the measurement window, so that a complete period is always captured.
- RS422 and TTL signals are supported.
- The time resolution is 10ns.
- The *pulse frequency* is calculated by dividing the number of periods (n) by the measured time (T).
- The *pulse frequency* is shown in the process data in ➦ *'IN - Pulse frequency'...page 102* in 0.01Hz.



W Measuring window for pulse frequency
T Measured time
P Period
A Input A (track A)
n Number of periods within the measured time

Pulse period

- The *pulse period* is determined independently of the measuring window.
- Before the process data cycle, the last period is always measured.
- The *pulse period* results from the determined time between edge 0-1 until the next edge 0-1 of the last fully detected period.
- The *pulse period* is shown in the process data in ➦ *'IN - Pulse period'...page 103* in ns.

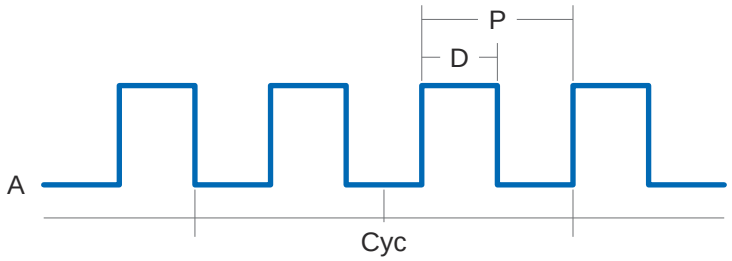


A Input A (track A)
P Pulse period
Cyc Process data cycle

On error, if the period duration exceeds 40 seconds, 4294967295 is returned and in ➦ *'Status word'...page 60* *bit 5 is set.*

Pulse duration

- The *pulse duration* is determined independently of the measuring window.
- Before the process data cycle, the last period is always measured.
- The *pulse duration* results from the determined time between edge 0-1 and edge 1-0 of the last fully detected period.
- The *pulse duration* is shown in the process data in ➦ *'IN - Pulse duration'...page 103* in ns.

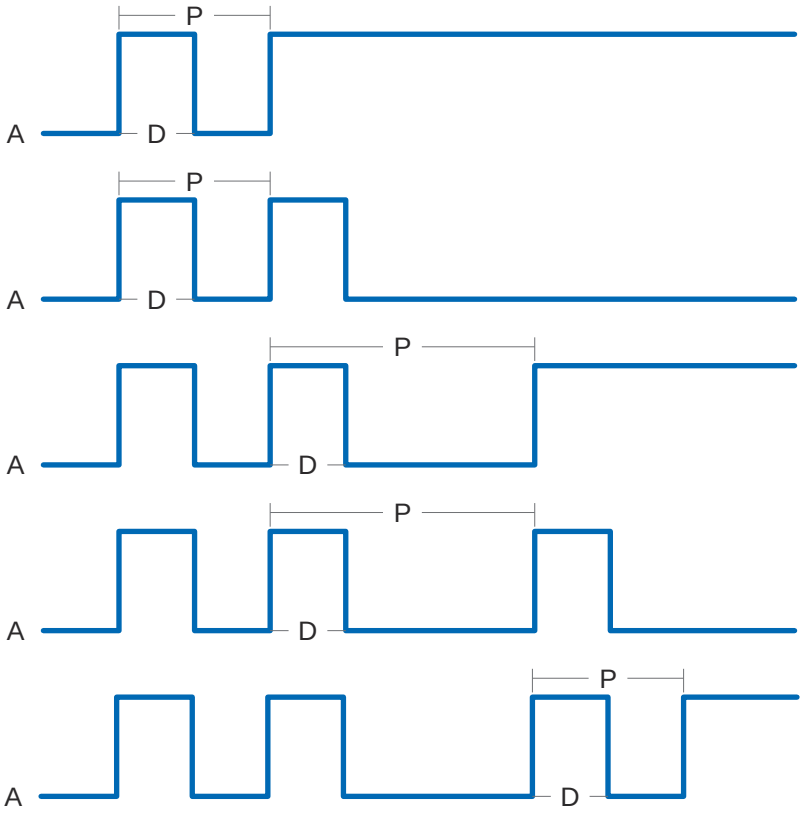


A Input A (track A)
P Pulse period
D Pulse duration
Cyc Process data cycle

On error, if the period duration exceeds 40 seconds, 4294967295 is returned and in ➦ 'Status word'...page 60 bit 5 is set.

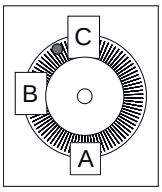
Example Pulse period Pulse duration

The following example shows the time sequence for *pulse duration (D)* and *pulse period (P)* at input A:

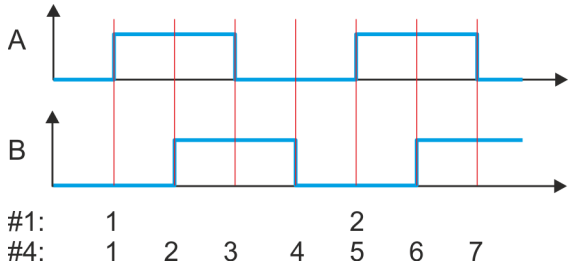


4.7 Encoder

Evaluation



- Encoder or incremental encoder are sensors for detecting angular or positional changes.
- Depending on the sensor type and the requested resolution, the scanning happens photo electrically or magnetically.
  - With the *optical scanning* a disk, which has a fine raster, is optically scanned.
  - With the magnetic scanning a pole wheel or magnetic band is scanned which has been written with a raster by a magnetization, before.
- The incremental encoder has two sensors *Track A* and *Track B* for scanning and one sensor *Track C*. The optional *Track C* emits exactly one pulse per revolution when passing the encoder zero position.
- The sensors are arranged at an angle of 90 degrees from each other on the system to be scanned.
- In a rotational movement of the system, the sensors *Track A* und *Track B* generate a specific number of pulses. These are a measure of the covered angel or way. With the electrical phase shift of the two signals the direction of rotation can be determined.
  - If the axis rotates to the right, then the signal of *Track A* is leading 90° towards the signal of *Track B*.
  - If the axis rotates to the left, then the signal of *Track A* is lagging 90° towards the signal of *Track B*.
- During the sensor evaluation from the difference between two counter values the velocity and direction can be determined.
- With *1-fold* evaluation one signal edge 0-1 of *Track A* corresponds to one counter pulse respectively one division of the system to be scanned corresponds to one counter pulse.
- With *4-fold* evaluation one signal edge of *Track A* and *Track B* corresponds to one counter pulse. The 4-fold evaluation is very often used.



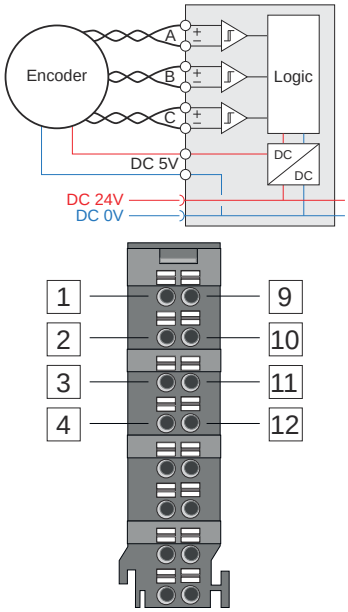
#1 1-fold evaluation
#4 4-fold evaluation

Plausibility test

The encoder signals *track A* and *track B* are monitored and checked for plausibility in order to detect interference signals and avoid miscounting. The encoder signals *track A* and *track B* are phase-shifted by 90°. Therefore, it is not possible for both signals to change their state simultaneously within one sampling interval (10ns). This condition is checked by the counter logic.

On error, bit 4 is set in ➦ *'Status word'...page 60* and an interrupt is triggered.

Connection



An encoder can be connected via the encoder inputs. Encoder values can be retrieved and processed accordingly in your user program.

Encoder: RS422 differentially or TTL single ended
Phase A, B and C
max. counting frequency 16MHz (RS422) / 4MHz (TTL)
4-fold evaluation

For wires with a core cross-section of 0.14mm² up to 0.75mm². With a core cross-section < 0.25mm² , ferrules must be used. ➦ *'Data'...page 30*

Pos.	Function	Type	Description
1	A+/A	I	RS422 differential, TTL single ended
2	B+/B	I	RS422 differential, TTL single ended
3	C+/C	I	RS422 differential, TTL single ended, trigger input
4	Ue+	PW	Encoder supply positive, parametrizable 0V (default), DC 5V or 24V

Pos.	Function	Type	Description
9	A-	I	RS422 differential
10	B-	I	RS422 differential
11	C-	I	RS422 differential
12	Ue- / GND	PW	Encoder supply negative, GND TTL single ended

I: Input, PW: Power supply

Input C can be used as a trigger signal for:

- ➦ *'PARAM - Counter - Set value source'...page 112*
- ➦ *'PARAM - Counter - Set value source'...page 112*
- ➦ *'PARAM - Counter - Reset source'...page 111*
- ➦ *'PARAM - HW gate - Source'...page 117*
- ➦ *'OUT - Latch 1, 2 - Source'...page 105*

➦ *'Parameters - Encoder'...page 114*

Name	DS	SX	Bytes	Default	Function
CI	129	16	1	0	➦ *'PARAM - Counter - Inputs'...page 113*
ENC_PW	129	17	1	0	➦ *'PARAM - Encoder - Power supply'...page 114*
ENC_FLT	129	18	1	0	➦ *'PARAM - Encoder - Filter'...page 114*

Encoder supply

The power supply for an encoder via pins 4 and 12 can be enabled via ➦ *'PARAM - Encoder - Power supply'...page 114*.

- 0: disabled (default)
- 1: DC 5V (4.75V … 5.25V), max 0.3A
- 2: DC 24V (20.4V … 28.8V), max 0.3A

The module is specified for an ambient temperature of 0...60°C, with a maximum DO current of 0.25A and an encoder supply current of 0.2A. If any of the following conditions are met, the module can be used with a DO current of 0.5A and an encoder supply current of 0.3A:

- TTL encoder input configuration

  or
- Ambient temperature below 50°C

Power is supplied via the internal DC 24V power section supply.

NOTICE

Make sure that the connected encoder supports the selected voltage range before switching to a higher voltage.

Encoder filter

A filter can be activated via ➦ *'PARAM - Encoder - Filter'...page 114*. The filter limit is defined by specifying a limit frequency. Input signals with edge frequencies below this limit are evaluated, while higher-frequency signal parts or interferences are suppressed.

The following options are available for the limit frequency:

Value	Limit frequency
0	Disabled (default)
1	10kHz
2	25kHz
3	50kHz
4	100kHz
5	1MHz
6	2MHz (only for RS422)
7	4MHz (only for RS422)

➦ *'Counter inputs'...page 65*

Behavior when changing the filter value during operation:

- Filter condition not met and new filter value is greater
  - Filter counter is set to 0 (filter restart).
- Filter condition met and new filter value is greater
  - Filter counter is set to the new (larger) value.
- Filter condition not met and new filter value is smaller
  - Filter counter is set to 0 (filter restart).
- Filter condition met and new filter value is smaller
  - Filter counter is set to the new (smaller) value.

4.8 Digital in-/output

➦ 'Parameters - DIO'...page 115

Name	DS	SX	Bytes	Default	Function
DI_FLT_0 ... DI_FLT_2	130	19...21	3	0	➦ 'PARAM - DI 0…2 - Input filter'...page 115
DO_SWC_0 ... DO_SWC_2	131	22...24	3	0	➦ 'PARAM - DO 0…2 - Switching characteristic'...page 115
DO_CFG_0 ... DO_CFG_2	131	25...27	3	0	➦ 'PARAM - DO 0…2 - Configuration'...page 116
DO_SV_0 ... DO_SV_2	131	28...30	3	0	➦ 'PARAM - DO 0…2 - Substitute value configuration'...page 116

➦ 'Status indication'...page 50

➦ 'Pin assignment'...page 66

4.8.1 Digital input

DI status

The inputs DI0...DI2 can be used as inputs or trigger signals for:

- ➦ 'PARAM - Counter - Set value source'...page 112
- ➦ 'PARAM - Counter - Reset source'...page 111
- ➦ 'PARAM - HW gate - Source'...page 117
- ➦ 'OUT - Latch 1, 2 - Source'...page 105
- ➦ 'PARAM - Timestamp 1…4 - Source'...page 117

The status of the digital inputs DI 0...2 can be accessed via ➦ 'IN - DI status'...page 103 in the process image.

Input filter

A filter can be activated for the digital inputs DI 0...2 via ➦ 'PARAM - DI 0…2 - Input filter'...page 115.

The filter limit is defined by specifying a delay time for input DI 0...2. The input signal is monitored over the parametrized period, which is parametrized via the delay time. If the signal remains unchanged (high or low) during this entire time, the stable signal state is applied and stored in ➦ 'IN - DI status'...page 103. Short-term signal changes (e.g. interference or bouncing) are thereby suppressed.

The following options are available for the filter:

Value	Delay time
0	Disabled (default)
1	1µs
2	5µs
3	10µs
4	100µs
5	500µs
6	1000µs
7	3000µs

4.8.2 Digital output

DO status

The outputs DO 0...2 can be used as outputs or as output signals for:

- ➦ *'PARAM - COIN 0…8 - Configuration'...page 119*
- The status of the digital outputs DO 0...2 can be accessed via ➦ *'IN - DO status'...page 104* in the process image.
- The corresponding outputs can be controlled via ➦ *'OUT - DO control byte'...page 105*.

The outputs D0 0...2 can be parametrized in:

- ➦ *'PARAM - DO 0…2 - Switching characteristic'...page 115*
- ➦ *'PARAM - DO 0…2 - Configuration'...page 116*
- ➦ *'PARAM - DO 0…2 - Substitute value configuration'...page 116*

In the event of a DO overload or a DO short circuit, the corresponding DO is switched off after 10ms and switched on again after 2000ms at the earliest, provided the status of the corresponding DO is still set (depending on ➦ 'PARAM - DO 0…2 - Configuration'...page 116).

The current status of the corresponding DO is mirrored in ➦ 'IN - DO status'...page 104.

DO switching characteristic

The electrical behavior of the outputs DO 0...2 is defined in ➦ *'PARAM - DO 0…2 - Switching characteristic'...page 115*:

- 0: Push-pull
  - The output can actively drive a "high" or a "low" signal.
  - No wire break detection.
  - Short circuits and overloads are detected.
- 1: Push-tristate
  - The output can actively drive a "high" or a "low" signal and be switched off with high impedance (tristate).
  - Wire break detection is possible.
  - Short circuit and overload are detected.
- 2: Push-tristate without wire break detection
  - The output can actively drive a "high" or a "low" signal and be switched off with high impedance (tristate).
  - No wire break detection.
  - Short circuit and overload are detected.

DO configuration

The signals that control the outputs DO 0...2 are defined in ➦ *'PARAM - DO 0…2 - Configuration'...page 116*:

- 0: ➦ *'OUT - DO control byte'...page 105* (default)
  - The corresponding output DO 0...2 can be controlled by setting or resetting the bits.
- 1: Counter overflow
  - The corresponding output DO 0...2 is activated in case of a counter overflow and in ➦ *'Status word'...page 60* bit 15 is set.

    ➦ *'Counter'...page 64*
- 2: Counter underflow
  - The corresponding output DO 0...2 is activated in case of a counter underflow and in ➦ *'Status word'...page 60* bit 16 is set.

    ➦ *'Counter'...page 64*
- 3: COIN function
  - The corresponding output DO 0...2 is activated in case of a COIN event. ➦ *'Coin function'...page 80*

Substitute value configuration

A substitute value for the corresponding digital output DO 0...2 can be parametrized in ➦ *'PARAM - DO 0…2 - Substitute value configuration'...page 116* for the BASP (**B**efehls**a**usgabe**sp**erre) status in the header module. As soon as BASP is active, the corresponding output is written with the substitute value. For more information about BASP, see the manual for your head module.

The following values can be entered:

- 0: Set DO x to 0 (default).
- 1: Set DO x to 1.
- 0: Retain the status of DO x.

NOTICE

Please note that the use of substitute values can lead to potentially dangerous operating states. This should only be used for test purposes respectively for troubleshooting.

4.9 Process data

4.9.1 Input area

Inputs - 64 bytes

With CPU and PROFINET the input area is embedded to the corresponding address area. More can be found in the corresponding manual.

SX - Subindex for access via EtherCAT with index 6000h + EtherCAT-Slot

Offset	Name	SX	Bytes	Function
+0	CSTS	01	4	➦ *'IN - Status word'...page 102*
+4	CV_1...CV_4	02...05	16	➦ *'IN - Counter value 1...4'...page 102*
+20	CL_1, CL_2	06, 07	8	➦ *'IN - Latch 1, 2'...page 102*
+28	PF	08	4	➦ *'IN - Pulse frequency'...page 102*
+32	PP	09	4	➦ *'IN - Pulse period'...page 103*
+36	PD	10	4	➦ *'IN - Pulse duration'...page 103*
+40	TS_1...TS_4	11...14	16	➦ *'IN - Timestamp 1...4'...page 103*
+56	DI_STS	15	4	➦ *'IN - DI status'...page 103*
+60	DO_STS	16	4	➦ *'IN - DO status'...page 104*

IN - Status word

Offset	Name	SX	Bytes	Type	RW	Default	Range of values	Description
+0	CTST	01	4	Bit array	R	0	Bit 31 ... 0	Status word

➦ 'Explanation of the elements'...page 105

➦ 'Status word'...page 60

IN - Counter value 1...4

Offset	Name	SX	Bytes	Type	RW	Default	Range of values	Description
+4	CV_1	02	4	I32	R	0	-2147483648 … 2147483647	Counter value 1
+8	CV_2	03	4	I32	R	0	-2147483648 … 2147483647	Counter value 2
+12	CV_3	04	4	I32	R	0	-2147483648 … 2147483647	Counter value 3
+16	CV_4	05	4	I32	R	0	-2147483648 … 2147483647	Counter value 4

Please note that the additional counter values 2...4 are only stored in Isochronous mode.

➦ 'Data capture - isochronous mode'...page 61

In the free-running cycle, 1 counter value is captured within a module cycle and stored as an identical value at counter value 1 ... 4.

➦ 'Explanation of the elements'...page 105

➦ 'Counter'...page 64

IN - Latch 1, 2

Offset	Name	SX	Bytes	Type	RW	Default	Range of values	Description
+20	CL_1	06	4	I32	R	0	-2147483648 … 2147483647	Latch 1: Counter value
+24	CL_2	07	4	I32	R	0	-2147483648 … 2147483647	Latch 2: Counter value

➦ 'Explanation of the elements'...page 105

➦ 'Latch function'...page 78

IN - Pulse frequency

Offset	Name	SX	Bytes	Type	RW	Default	Range of values	Description
+28	PF	08	4	U32	R	0	0 … 4294967295	Pulse frequency Unit: 0.01Hz

➦ 'Explanation of the elements'...page 105

➦ 'Measuring functions'...page 93

IN - Pulse period

Offset	Name	SX	Bytes	Type	RW	Default	Range of values	Description
+32	PP	09	4	U32	R	0	0 … 4294967295	Pulse period Unit: 10ns

➥ 'Explanation of the elements'...page 105
➥ 'Measuring functions'...page 93

IN - Pulse duration

Offset	Name	SX	Bytes	Type	RW	Default	Range of values	Description
+36	PD	10	4	U32	R	0	0 … 4294967295	Pulse duration Unit: 10ns

➥ 'Explanation of the elements'...page 105
➥ 'Measuring functions'...page 93

IN - Timestamp 1...4

Offset	Name	SX	Bytes	Type	RW	Default	Range of values	Description
+40	TS_1	11	4	U32	R	0	0 ... 140737488355327	Timestamp 1 Unit: ns
+44	TS_2	12	4	U32	R	0	0 ... 140737488355327	Timestamp 2 Unit: ns
+48	TS_3	13	4	U32	R	0	0 ... 140737488355327	Timestamp 3: Unit: ns
52	TS_4	14	4	U32	R	0	0 ... 140737488355327	Timestamp 4 Unit: ns

➥ 'Explanation of the elements'...page 105
➥ 'Timestamp'...page 93

IN - DI status

Offset	Name	SX	Bytes	Type	RW	Default	Range of values	Description
+56	DI_STS	15	4	Bit array	R	0	Bit 31 ... 0	DI status ■ Bit 0: Status DI 0 ■ Bit 1: Status DI 1 ■ Bit 2: Status DI 2 ■ Bit 31 ... 3: reserved

➥ 'Explanation of the elements'...page 105
➥ 'Digital input'...page 99

IN - DO status

Offset	Name	SX	Bytes	Type	RW	Default	Range of values	Description
+60	DO_STS	16	4	Bit array	R	0	Bit 31 ... 0	DO status ■ Bit 0: Status DO 0 ■ Bit 1: Status DO 1 ■ Bit 2: Status DO 2 ■ Bit 31 ... 3: reserved

➦ *'Explanation of the elements'...page 105*

➦ *'Digital output'...page 100*

4.9.2 Output area

Outputs - 16 bytes

With CPU and PROFINET the output area is embedded to the corresponding address area. More can be found in the corresponding manual.

SX - Subindex for access via EtherCAT with index 7000h + EtherCAT-Slot

Offset	Name	SX	Bytes	Function
+0	CTRL	01	4	➦ *'OUT - Control word'...page 104*
+4	CCOIN_TH_0	02	4	➦ *'OUT - Threshold COIN 0'...page 104*
+8	CSV	03	4	➦ *'OUT - Counter set value'...page 104*
+12	DOC	04	1	➦ *'OUT - DO control byte'...page 105*
+13		05	1	reserved
+14	CLS_1,CLS_2	06, 07	2	➦ *'OUT - Latch 1, 2 - Source'...page 105*

OUT - Control word

Offset	Name	SX	Bytes	Type	RW	Default	Range of values	Description
0	CCTRL	01	4	Bit array	R/W	0	Bit 31 ... 0	Control word

➦ *'Explanation of the elements'...page 105*

➦ *'Control word'...page 59*

OUT - Threshold COIN 0

Offset	Name	SX	Bytes	Type	RW	Default	Range of values	Description
+4	CCOIN_TH_0	02	4	I32	R/W	0	-2147483648 … 2147483647	Threshold COIN 0

➦ *'Explanation of the elements'...page 105*

➦ *'Coin function'...page 80*

OUT - Counter set value

Offset	Name	SX	Bytes	Type	RW	Default	Range of values	Description
+8	CSV	03	4	I32	R/W	0	-2147483648 … 2147483647	Counter set value

➦ *'Explanation of the elements'...page 105*

➦ *'Counter'...page 64*

OUT - DO control byte

Offset	Name	SX	Bytes	Type	RW	Default	Range of values	Description
+12	DOC	04	1	Bit array	R/W	0	Bit 7 ... 0	DO control byte ■ Bit 0: Control bit DO 0 ■ Bit 1: Control bit DO 1 ■ Bit 2: Control bit DO 2 ■ Bit 7 ... 3: reserved

➦ *'Explanation of the elements'...page 105*
➦ *'Digital output'...page 100*

OUT - Latch 1, 2 - Source

Offset	Name	SX	Bytes	Type	RW	Default	Range of values	Description
+14	CLS_1,	06	1	U08	R/W	0	0 ... 13	Latch 1 source
+15	CLS_2	07	1	U08	R/W	0	0 ... 13	Latch 2 source

➦ *'Explanation of the elements'...page 105*
➦ *'Latch function'...page 78*

The following options are available:

Value	Latch source
0	Disabled
1	➦ *'Control word'...page 59* Latch 1: Bit 12 edge 0-1 Latch 2: Bit 14 edge 0-1
2	C: Edge 0-1
3	C: Edge 1-0
4	C: both edges
5	DI 0: edge 0-1
6	DI 0: edge 1-0
7	DI 0: both edges
8	DI 1: edge 0-1
9	DI 1: edge 1-0
10	DI 1: both edges
11	DI 2: edge 0-1
12	DI 2: edge 1-0
13	DI 2: both edges

4.10 Parameters

Explanation of the elements

Offset	-	Address offset in the process image
DS	-	Record set for access via CPU and PROFINET
SX	-	Subindex for access via EtherCAT
Bit array	-	Data type Array [...] of BOOL
Ux	-	Data type UNSIGNEDx
I32	-	Data type INTEGER 32
RW	-	Read-, write access

4.10.1 Parameter overview

Access

DS - Record set for access via CPU and PROFINET.

SX - Subindex for access via EtherCAT with index 3100h + EtherCAT-Slot.

More can be found in the according manual of your head module.

➦ *'Parameters - Basic functions'...page 108*

Name	DS	SX	Bytes	Default	Function
DIAG_EN	0	01	1	0	➦ *'PARAM - Diagnostic interrupt'...page 108*
FCYCLE	1	02	1	5	➦ *'PARAM - Module cycle time'...page 108*
-	2	03	1	-	reserved
CYCMULT	2	04	1	2	➦ *'PARAM - Isochronous cycle time factor'...page 109*

➦ *'Parameters - Counter'...page 109*

Name	DS	SX	Bytes	Default	Function
CE	128	05	1	0	➦ *'PARAM - Counter - Evaluation'...page 109*
CEL	128	06	1	0	➦ *'PARAM - Counter - Evaluation logic'...page 109*
CDR	128	07	1	0	➦ *'PARAM - Counter - Direction reversal'...page 110*
CM	128	08	1	0	➦ *'PARAM - Counter - Mode'...page 110*
CUL	128	09	4	2147483647	➦ *'PARAM - Counter - Upper limit'...page 110*
CLL	128	10	4	-2147483648	➦ *'PARAM - Counter - Lower limit'...page 110*
CLM	128	11	1	0	➦ *'PARAM - Counter - Limit mode'...page 110*
-	128	12	1	-	reserved
CRV	129	13	4	0	➦ *'PARAM - Counter - Reset value'...page 111*
CRS	129	14	1	0	➦ *'PARAM - Counter - Reset source'...page 111*
CSVS	129	15	1	0	➦ *'PARAM - Counter - Set value source'...page 112*
CI	129	16	1	0	➦ *'PARAM - Counter - Inputs'...page 113*

➦ *'Parameters - Encoder'...page 114*

Name	DS	SX	Bytes	Default	Function
CI	129	16	1	0	➦ *'PARAM - Counter - Inputs'...page 113*
ENC_PW	129	17	1	0	➦ *'PARAM - Encoder - Power supply'...page 114*
ENC_FLT	129	18	1	0	➦ *'PARAM - Encoder - Filter'...page 114*

➦ *'Parameters - DIO'...page 115*

Name	DS	SX	Bytes	Default	Function
DI_FLT_0 ... DI_FLT_2	130	19...21	3	0	➦ *'PARAM - DI 0…2 - Input filter'...page 115*
DO_SWC_0 ... DO_SWC_2	131	22...24	3	0	➦ *'PARAM - DO 0…2 - Switching characteristic'...page 115*
DO_CFG_0 ... DO_CFG_2	131	25...27	3	0	➦ *'PARAM - DO 0…2 - Configuration'...page 116*
DO_SV_0 ... DO_SV_2	131	28...30	3	0	➦ *'PARAM - DO 0…2 - Substitute value configuration'...page 116*

➦ *'Parameters - Latch'...page 116*

Name	DS	SX	Bytes	Default	Function
CLC_1 CLC_2	132	31, 32	2	0	➦ *'PARAM - Latch 1, 2 - Configuration'...page 116*
-	132	33, 34	2	-	reserved

➦ *'Parameters - HW gate'...page 117*

Name	DS	SX	Bytes	Default	Function
HWGS	132	35	1	0	➦ *'PARAM - HW gate - Source'...page 117*

➦ *'Parameters - Timestamp'...page 117*

Name	DS	SX	Bytes	Default	Function
TSS_1 ... TSS_4	133	36...39	8	0	➦ *'PARAM - Timestamp 1…4 - Source'...page 117*

➦ *'Parameters - Measuring functions'...page 118*

Name	DS	SX	Bytes	Default	Function
PFW	134	40	4	0	➦ *'PARAM - Pulse frequency window'...page 118*
-	134	41	4	-	reserved

➦ *'Parameters - COIN'...page 119*

Name	DS	SX	Bytes	Default	Function
CCOIN_TH_1 ... CCOIN_TH_8	135	42...49	32	0	➦ *'PARAM - COIN 1…8 - Threshold'...page 119*
CCOIN_CFG_0 ... CCOIN_CFG_8	136	50...58	9	0	➦ *'PARAM - COIN 0…8 - Configuration'...page 119*
CCOIN_DIR_0 ... CCOIN_DIR_8	136	59...67	9	0	➦ *'PARAM - COIN 0…8 - Direction'...page 120*
CCOIN_DOD_0	136	68	2	0	➦ *'PARAM - COIN 0 - DO hold time'...page 120*
-	136	69	1	-	reserved

4.10.2 Parameters - Basic functions

PARAM - Diagnostic interrupt

Name	DS	SX	Bytes	Type	RW	Default	Range of values	Description
DIAG_EN	0	01	1	U08	R/W	0	Bit 7 ... 0	Diagnostics interrupt ■ 5 ... 0: reserved ■ 6: Enable diagnostic interrupt ■ 7: reserved

This record set may only be transferred at STOP state resp. at active command output disable (BASP). Further information can be found in the description of your head module.

➥ *'Explanation of the elements'...page 105*

➥ *'Diagnostics and interrupt'...page 121*

PARAM - Module cycle time

Name	DS	SX	Bytes	Type	RW	Default	Range of values	Description
FCYCLE	1	02	1	U08	R/W	5	1 ... 10	Module cycle time with free-running data capture

➥ *'Explanation of the elements'...page 105*

➥ *'Data capture in free-running cycle'...page 63*

The following options are available:

Value	Module cycle time
1	62.5µs
2	125µs
3	250µs
4	500µs
5	1000µs (default)
6	2000µs
7	4000µs
8	8000µs
9	16000µs
10	32000µs

PARAM - Isochronous cycle time factor

Name	DS	SX	Bytes	Type	RW	Default	Range of values	Description
CYCMULT	2	04	1	U08	R/W	2	0 ... 4	Cycle time factor for isochronous data capture.

This record set may only be transferred at STOP state resp. at active command output disable (BASP). Further information can be found in the description of your head module.

➦ *'Explanation of the elements'...page 105*

➦ *'Data capture - isochronous mode'...page 61*

The following options are available:

Value	Cycle time factor
0	0.25-fold
1	0.5-fold
2	1-fold (default)
3	2-fold
4	4-fold

4.10.3 Parameters - Counter

PARAM - Counter - Evaluation

Name	DS	SX	Bytes	Type	RW	Default	Range of values	Description
CE	128	05	1	U08	R/W	0	0 ... 2	Counter evaluation ■ 0: 4-fold[1] ■ 1: 2-fold ■ 2: 1-fold

1) only valid if in ➦ *'PARAM - Counter - Mode'...page 110* "Encoder" is set to (0).

➦ *'Explanation of the elements'...page 105*

➦ *'Counter'...page 64*

➦ *'Signal evaluation'...page 75*

PARAM - Counter - Evaluation logic

Name	DS	SX	Bytes	Type	RW	Default	Range of values	Description
CEL	128	06	1	U08	R/W	0	0 ... 1	Counter evaluation logic for inputs A, B and C: ■ 0: positive ■ 1: negative

➦ *'Explanation of the elements'...page 105*

➦ *'Signal evaluation'...page 75*

PARAM - Counter - Direction reversal

Name	DS	SX	Bytes	Type	RW	Default	Range of values	Description
CDR	128	07	1	U08	R/W	0	0 ... 1	Counter direction reversal ■ 0: no ■ 1: yes

➦ 'Explanation of the elements'...page 105

➦ 'Counter'...page 64

PARAM - Counter - Mode

Name	DS	SX	Bytes	Type	RW	Default	Range of values	Description
CM	128	08	1	U08	R/W	0	0 ... 2	Counter mode ■ 0: Encoder ■ 1: Counter pulse / direction ■ 2: Counter forwards / backwards

➦ 'Explanation of the elements'...page 105

➦ 'Counter'...page 64

➦ 'Signal evaluation'...page 75

PARAM - Counter - Upper limit

Name	DS	SX	Bytes	Type	RW	Default	Range of values	Description
CUL	128	09	4	I32	R/W	2147483647	-2147483648 … 2147483647	Upper counter limit

➦ 'Explanation of the elements'...page 105

➦ 'Counter'...page 64

PARAM - Counter - Lower limit

Name	DS	SX	Bytes	Type	RW	Default	Range of values	Description
CLL	128	10	4	I32	R/W	-2147483648	-2147483648 … 2147483647	Lower counter limit

➦ 'Explanation of the elements'...page 105

➦ 'Counter'...page 64

PARAM - Counter - Limit mode

Name	DS	SX	Bytes	Type	RW	Default	Range of values	Description
CLM	128	11	1	U08	R/W	0	0 ... 1	Counter limit mode ■ 0: Count continuously ■ 1: Count once

➦ 'Explanation of the elements'...page 105

➦ 'Counter'...page 64

PARAM - Counter - Reset value

Name	DS	SX	Bytes	Type	RW	Default	Range of values	Description
CRV	129	13	4	I32	R/W	0	-2147483648 … 2147483647	Counter reset value

➦ *'Explanation of the elements'...page 105*
➦ *'Counter'...page 64*
➦ *'Reset counter to reset value'...page 69*

PARAM - Counter - Reset source

Name	DS	SX	Bytes	Type	RW	Default	Range of values	Description
CRS	129	14	1	U08	R/W	0	0 ... 13	Source for resetting the counter to the reset value.

➦ *'Explanation of the elements'...page 105*
➦ *'Counter'...page 64*
➦ *'Reset counter to reset value'...page 69*

The following options are available:

Value	Counter reset source
0	Disabled (default)
1	➦ *'Control word'...page 59* Bit 2 edge 0-1
2	C: Edge 0-1
3	C: Edge 1-0
4	C: both edges
5	DI 0: Edge 0-1
6	DI 0: Edge 1-0
7	DI 0: both edges
8	DI 1: Edge 0-1
9	DI 1: Edge 1-0
10	DI 1: both edges
11	DI 2: Edge 0-1
12	DI 2: Edge 1-0
13	DI 2: both edges

PARAM - Counter - Set value source

Name	DS	SX	Bytes	Type	RW	Default	Range of values	Description
CSVS	129	15	1	U08	R/W	0	0 … 13	Source for setting the counter

➦ *'Explanation of the elements'...page 105*

➦ *'Overwrite counter value with set value'...page 68*

The following options are available:

Value	Counter set source
0	Disabled (default)
1	➦ *'Control word'...page 59* Bit 4 edge 0-1
2	C: Edge 0-1
3	C: Edge 1-0
4	C: both edges
5	DI 0: Edge 0-1
6	DI 0: Edge 1-0
7	DI 0: both edges
8	DI 1: Edge 0-1
9	DI 1: Edge 1-0
10	DI 1: both edges
11	DI 2: Edge 0-1
12	DI 2: Edge 1-0
13	DI 2: both edges

PARAM - Counter - Inputs

Name	DS	SX	Bytes	Type	RW	Default	Range of values	Description
CI	129	16	1	U08	R/W	0	0 ... 3	Assignment of the counter inputs

➦ *'Explanation of the elements'...page 105*
➦ *'Counter'...page 64*
➦ *'Counter inputs'...page 65*

The following options are available:

Value	Assignment of the counter inputs
0	RS422 differential (default) ■ Input A: Pin 1/A+ and pin 9/A- ■ Input B: Pin 2/B+ and pin 10/B- ■ Input C: Pin 3/C+ and Pin 11/C No wire break diagnostics at an input (default).
1	TTL single ended ■ Input A: Pin 1/A ■ Input B: Pin 2/B ■ Input C: Pin 3/C
2	RS422 with wire break monitoring ■ Input A: Pin 1/A+ and pin 9/A- ■ Input B: Pin 2/B+ and pin 10/B- ■ Input C: Pin 3/C+ and Pin 11/C Wire break diagnostics at input A, B, or C.
3	RS422 with wire break monitoring A/B ■ Input A: Pin 1/A+ and pin 9/A- ■ Input B: Pin 2/B+ and pin 10/B- Wire break diagnostics at input A or B. Input C is not monitored.

4.10.4 Parameters - Encoder

PARAM - Encoder - Power supply

Name	DS	SX	Bytes	Type	RW	Default	Range of values	Description
ENC_PW	129	17	1	U08	R/W	0	0 ... 2	Configuration output Encoder supply ■ 0: off (default) ■ 1: DC 5V (4.75…5.25V) max. 0.3A ■ 2: DC 24V (20.4… 28.8V) max. 0.3A

The module is specified for an ambient temperature of 0...60°C, with a maximum DO current of 0.25A and an encoder supply current of 0.2A. If any of the following conditions are met, the module can be used with a DO current of 0.5A and an encoder supply current of 0.3A:

- TTL encoder input configuration
  or
- Ambient temperature below 50°C

➦ *'Explanation of the elements'...page 105*

➦ *'Encoder'...page 96*

PARAM - Encoder - Filter

Name	DS	SX	Bytes	Type	RW	Default	Range of values	Description
ENC_FLT	128	18	1	U08	R/W	0	0 ... 7	Encoder filter

➦ *'Explanation of the elements'...page 105*

➦ *'Encoder'...page 96*

➦ *'Encoder filter'...page 98*

The following options are available:

Value	Limit frequency
0	Disabled (default)
1	10kHz
2	25kHz
3	50kHz
4	100kHz
5	1MHz
6	2MHz (only for RS422)
7	4MHz (only for RS422)

4.10.5 Parameters - DIO

PARAM - DI 0…2 - Input filter

Name	DS	SX	Bytes	Type	RW	Default	Range of values	Description
DI_FLT_0	130	19	1	U8	R/W	0	0 ... 7	DI 0 Input filter delay time
DI_FLT_1	130	20	1	U8	R/W	0	0 ... 7	DI 1: Input filter delay time
DI_FLT_2	130	21	1	U8	R/W	0	0 ... 7	DI 2: Input filter delay time

➦ *'Explanation of the elements'...page 105*
➦ *'Digital input'...page 99*
➦ *'Input filter'...page 99*

There are the following options:

Value	Delay time
0	Disabled (default)
1	1µs
2	5µs
3	10µs
4	100µs
5	500µs
6	1000µs
7	3000µs

PARAM - DO 0…2 - Switching characteristic

Name	DS	SX	Bytes	Type	RW	Default	Range of values	Description
DO_SWC_0	131	22	1	U08	R/W	0	0 ... 2	DO 0: electrical behavior
DO_SWC_1	131	23	1	U08	R/W	0	0 ... 1	DO 1: electrical behavior
DO_SWC_2	131	24	1	U08	R/W	0	0 ... 1	DO 2: electrical behavior

➦ *'Explanation of the elements'...page 105*
➦ *'Digital output'...page 100*
➦ *'DO switching characteristic'...page 100*

The following options are available:

Value	DO switching characteristic
0	Push-Pull (default)
1	Push-Tristate
2	Push-Tristate without wire break detection

PARAM - DO 0…2 - Configuration

Name	DS	SX	Bytes	Type	RW	Default	Range of values	Description
DO_CFG_0	131	25	1	U08	R/W	0	0 ... 3	DO 0: control signal
DO_CFG_1	131	26	1	U08	R/W	0	0 ... 3	DO 1: control signal
DO_CFG_2	131	27	1	U08	R/W	0	0 ... 3	DO 2: control signal

➦ *'Explanation of the elements'...page 105*

➦ *'DO configuration'...page 101*

The following options are available:

Value	DO configuration
0	➦ *'OUT - DO control byte'...page 105* (default)
1	Counter overflow
2	Counter underflow
3	COIN function

PARAM - DO 0…2 - Substitute value configuration

Name	DS	SX	Bytes	Type	RW	Default	Range of values	Description
DO_SV_0	131	28	1	U08	R/W	0	0 ... 2	DO 0: Substitute value configuration
DO_SV_1	131	29	1	U08	R/W	0	0 ... 2	DO 1: Substitute value configuration
DO_SV_2	131	30	1	U08	R/W	0	0 ... 2	DO 2: Substitute value configuration

➦ *'Explanation of the elements'...page 105*

➦ *'Digital output'...page 100*

➦ *'Substitute value configuration'...page 101*

The following options are available:

Value	DO substitute value configuration
0	Set DO x to 0 (default).
1	Set DO x to 1.
2	Retain the status of DO x.

4.10.6 Parameters - Latch

PARAM - Latch 1, 2 - Configuration

Name	DS	SX	Bytes	Type	RW	Default	Range of values	Description
CLC_1	132	31	1	U08	R/W	0	0 ... 1	Latch 1: Configuration
CLC_2	132	32	1	U08	R/W	0	0 ... 1	Latch 2: Configuration

➦ *'Explanation of the elements'...page 105*

➦ *'Latch function'...page 78*

➦ *'Latch configuration'...page 79*

The following options are available:

Value	Latch configuration
0	Once (default):
1	Continuous

4.10.7 Parameters - HW gate

PARAM - HW gate - Source

Name	DS	SX	Bytes	Type	RW	Default	Range of values	Description
HWGS	132	35	1	U08	R/W	0	0 ... 8	HW gate: Source for locking the counter

➦ *'Explanation of the elements'...page 105*
➦ *'HW gate function'...page 77*

The following options are available:

Value	HW-gate source
0	HW gate is disabled, counter lock takes place via SW gate (default)
1	C: "1" signal locks the counter
2	C: "0" signal locks the counter
3	DI 0: "1" signal locks the counter
4	DI 0: "0" signal locks the counter
5	DI 1: "1" signal locks the counter
6	DI 1: "0" signal locks the counter
7	DI 2: "1" signal locks the counter
8	DI 2: "0" signal locks the counter

4.10.8 Parameters - Timestamp

PARAM - Timestamp 1…4 - Source

Name	DS	SX	Bytes	Type	RW	Default	Range of values	Description
TSS_1	133	36	2	U16	R/W	0	0 ... 15	Timestamp 1: Source
TSS_2	133	37	2	U16	R/W	0	0 ... 15	Timestamp 2: Source
TSS_3	133	38	2	U16	R/W	0	0 ... 15	Timestamp 3: Source
TSS_4	133	39	2	U16	R/W	0	0 ... 15	Timestamp 4: Source

➦ *'Explanation of the elements'...page 105*
➦ *'Timestamp'...page 93*
➦ *'IN - Timestamp 1...4'...page 103*

The following options are available:

Value	Timestamp source
0	Timestamp function is disabled (default)
1	Last change to the counter value
2	C: Last edge 0-1
3	C: Last edge 1-0
4	DI 0: Last edge 0-1
5	DI 0: Last edge 1-0
6	DI 1: Last edge 0-1
7	DI 1: Last edge 1-0
8	DI 2: Last edge 0-1
9	DI 2: Last edge 1-0
10	DO 0: Last edge 0-1
11	DO 0: Last edge 1-0
12	DO 1: Last edge 0-1
13	DO 1: Last edge 1-0
14	DO 2: Last edge 0-1
15	DO 2: Last edge 1-0

4.10.9 Parameters - Measuring functions

PARAM - Pulse frequency window

Name	DS	SX	Bytes	Type	RW	Default	Range of values	Description
PFW	134	40	4	U32	R/W	0	0 ... 10000000	Measuring window for pulse frequency measurement Unit: µs

➦ *'Explanation of the elements'...page 105*
➦ *'Measuring functions'...page 93*

4.10.10 Parameters - COIN

PARAM - COIN 1…8 - Threshold

Name	DS	SX	Bytes	Type	RW	Default	Range of values	Description
CCOIN_TH_1	135	42	4	I32	R/W	0	-2147483648 ... 2147483647	COIN 1: Threshold
CCOIN_TH_2	135	43	4	I32	R/W	0	-2147483648 ... 2147483647	COIN 2: Threshold
CCOIN_TH_3	135	44	4	I32	R/W	0	-2147483648 ... 2147483647	COIN 3: Threshold
CCOIN_TH_4	135	45	4	I32	R/W	0	-2147483648 ... 2147483647	COIN 4: Threshold
CCOIN_TH_5	135	46	4	I32	R/W	0	-2147483648 ... 2147483647	COIN 5: Threshold
CCOIN_TH_6	135	47	4	I32	R/W	0	-2147483648 ... 2147483647	COIN 6: Threshold
CCOIN_TH_7	135	48	4	I32	R/W	0	-2147483648 ... 2147483647	COIN 7: Threshold
CCOIN_TH_8	135	49	4	I32	R/W	0	-2147483648 ... 2147483647	COIN 8: Threshold

➦ *'Explanation of the elements'...page 105*
➦ *'Coin function'...page 80*

PARAM - COIN 0…8 - Configuration

Name	DS	SX	Bytes	Type	RW	Default	Range of values	Description
CCOIN_CFG_0	136	50	1	U08	R/W	0	0 ... 12	COIN 0: Configuration DO 0...2
CCOIN_CFG_1	136	51	1	U08	R/W	0	0 ... 12	COIN 1: Configuration DO 0...2
CCOIN_CFG_2	136	52	1	U08	R/W	0	0 ... 12	COIN 2: Configuration DO 0...2
CCOIN_CFG_3	136	53	1	U08	R/W	0	0 ... 12	COIN 3: Configuration DO 0...2
CCOIN_CFG_4	136	54	1	U08	R/W	0	0 ... 12	COIN 4: Configuration DO 0...2
CCOIN_CFG_5	136	55	1	U08	R/W	0	0 ... 12	COIN 5: Configuration DO 0...2
CCOIN_CFG_6	136	56	1	U08	R/W	0	0 ... 12	COIN 6: Configuration DO 0...2
CCOIN_CFG_7	136	57	1	U08	R/W	0	0 ... 12	COIN 7: Configuration DO 0...2
CCOIN_CFG_8	136	58	1	U08	R/W	0	0 ... 12	COIN 8: Configuration DO 0...2

➦ *'Explanation of the elements'...page 105*
➦ *'Coin function'...page 80*

The following options are available:

Value	COIN - Configuration DO 0...2
0	Disabled (default)
1	Set DO 0 to 1.
2	Set DO 0 to 0.
3	Set DO 1 to 1.
4	Set DO 1 to 0.
5	Set DO 2 to 1.
6	Set DO 2 to 0.
7	Set DO 0 to 1 when counting forwards. Set DO 0 to 0 when counting backwards.
8	Set DO 0 to 0 when counting forwards. Set DO 0 to 1 when counting backwards.
9	Set DO 1 to 1 when counting forwards. Set DO 1 to 0 when counting backwards.
10	Set DO 1 to 0 when counting forwards. Set DO 1 to 1 when counting backwards.
11	Set DO 2 to 1 when counting forwards. Set DO 2 to 0 when counting backwards.
12	Set DO 2 to 0 when counting forwards. Set DO 2 to 1 when counting backwards.

PARAM - COIN 0…8 - Direction

Name	DS	SX	Bytes	Type	RW	Default	Range of values	Description
CCOIN_DIR_0	136	59	1	U08	R/W	0	0 ... 2	COIN 0: Direction
CCOIN_DIR_1	136	60	1	U08	R/W	0	0 ... 2	COIN 1: Direction
CCOIN_DIR_2	136	61	1	U08	R/W	0	0 ... 2	COIN 2: Direction
CCOIN_DIR_3	136	62	1	U08	R/W	0	0 ... 2	COIN 3: Direction
CCOIN_DIR_4	136	63	1	U08	R/W	0	0 ... 2	COIN 4: Direction
CCOIN_DIR_5	136	64	1	U08	R/W	0	0 ... 2	COIN 5: Direction
CCOIN_DIR_6	136	65	1	U08	R/W	0	0 ... 2	COIN 6: Direction
CCOIN_DIR_7	136	66	1	U08	R/W	0	0 ... 2	COIN 7: Direction
CCOIN_DIR_8	136	67	1	U08	R/W	0	0 ... 2	COIN 8: Direction

➦ *'Explanation of the elements'...page 105*
➦ *'Coin function'...page 80*

The following options are available:

Value	COIN - direction
0	Both counting directions (default)
1	When counting forwards
2	When counting backwards

PARAM - COIN 0 - DO hold time

Name	DS	SX	Bytes	Type	RW	Default	Range of values	Description
CCOIN_DOD_0	136	68	2	U16	R/W	0	0 ... 20000	COIN 0: DO 0 hold time Unit: µs

➦ *'Explanation of the elements'...page 105*
➦ *'Coin function'...page 80*

4.11 Diagnostics and interrupt

Diagnostic data

- 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.

The following events may release a diagnostics interrupt:

- Error in configuration or parametrization
- Short circuit or overload at DO 0...2
- Short circuit or wire break at input A, B or C
- Error in encoder power supply
- Error in configuration isochronous mode
- Error in synchronization isochronous mode
- Diagnostic buffer overflow
- Communication error

DS - Record set for access via CPU and PROFINET. Access is via DS 01h. Additionally the first 4 bytes may be accessed by record set DS 00h.

SX - Subindex for access via EtherCAT with index 5005h.

For details, can be found in the manual for your head module.

Name	Bytes	Function	Default	DS	SX
ERR_A	1	Diagnostic	0x00	01h	01
MODTYP	1	Module information	0x18:		02
ERR_C	1	Parametrization error subindex	0x00		03
ERR_D	1	Diagnostic	0x00		04
CHTYP	1	Channel type	0x77		05
NUMBIT	1	Number diagnostic bits per channel	0x08		06
NUMCH	1	Number channels of the module	0x08		07
CHERR	1	Channel error	0x00		08
CH0ERR	1	Error output DO 0	0x00		09
CH1ERR	1	Error output DO 1	0x00		10
CH2ERR	1	Error output DO 2	0x00		11
CH3ERR	1	Error Input A	0x00		12
CH4ERR	1	Error Input B	0x00		13
CH5ERR	1	Error Input C	0x00		14
CH6ERR	1	Error encoder power supply	0x00		15
CHERR7	1	Parametrization error code	0x00		16
DIAG_US	4	µs ticker	0x00		-

ERR_A Diagnostic

Byte	Bit 7 ... 0
0	■ 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 external auxiliary supply missing ■ Bit 6 ... 5: reserved ■ Bit 7: set at error in parametrization For more information see ERR_C and CH7ERR

MODTYP Module information

Byte	Bit 7 ... 0
0	■ Bit 3 ... 0: Module class – 1000b: Function module ■ Bit 4: set at channel information present ■ Bit 7 ... 5: reserved

ERR_C Diagnostic

Byte	Bit 7 ... 0
0	Subindex of the parameter that triggered the last parametrization error.

ERR_D Diagnostic

Byte	Bit 7 ... 0
0	■ Bit 2 ... 0: reserved ■ Bit 3: set at internal diagnostics buffer overflow ■ Bit 4: set at internal communication error ■ Bit 5: set at synchronization error during isochronous operation ■ Bit 6: reserved ■ Bit 7: set at configuration error of isochronous mode

CHTYP Channel type

Byte	Bit 7 ... 0
0	■ Bit 6 ... 0: Channel type – 77h: Counter (advanced) ■ 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 08h)

CHERR - Channel error

Byte	Bit 7 ... 0
0	■ Bit 0: set on error output DO 0 ■ Bit 1: set on error output DO 1 ■ Bit 2: set on error output DO 2 ■ Bit 3: set on error input A ■ Bit 4: set on error input B ■ Bit 5: set on error Input C ■ Bit 5: set on error encoder power supply ■ Bit 6: set on parametrization error

CH0ERR ... CH2ERR

Byte	Bit 7 ... 0
0	DO x error for the outputs DO 0...2: ■ Bit 2 ... 0: reserved ■ Bit 3: set at short circuit at DO x ■ Bit 4: set at wire break at DO x ■ Bit 5: reserved ■ Bit 6: set at overload at DO x ■ Bit 7: reserved

CH3ERR ... CH5ERR

Byte	Bit 7 ... 0
0	Input x error for inputs A, B and C: ■ Bit 2 ... 0: reserved ■ Bit 3: set at short circuit at input x ■ Bit 4: set at wire break at input x ■ Bit 7 ... 5: reserved

CH6ERR

Byte	Bit 7 ... 0
0	Encoder power supply: ■ Bit 0: set at error in the encoder power supply. ■ Bit 7 ... 1: reserved ➥ *'Encoder'...page 96*

CH7ERR

Byte	Bit 7 ... 0
0	Parametrization error code ■ Bit 4 ... 0: Code for parametrization error ■ Bit 7 ... 5: reserved

Code for parametrization error

Code	Description
0	No error
1	Index not valid
2	Subindex not valid
3	Value not valid
4	Value greater than maximum
5	Value less than minimum
6	Access to object not possible
7	Data type not valid
8	Internal error
9	Access is only possible in the BASP state of the header module. ➦ *'PARAM - Diagnostic interrupt'...page 108* ➦ *'PARAM - Isochronous cycle time factor'...page 109*
10	➦ *'PARAM - Counter - Upper limit'...page 110* is smaller than ➦ *'PARAM - Counter - Lower limit'...page 110*.
11	4-fold evaluation only possible in ➦ *'PARAM - Counter - Mode'...page 110* "Encoder" (0).
12 ... 31	reserved

DIAG_US µs ticker

Byte	Bit 7 ... 0
0...3	Value of the µs ticker at the moment of the diagnostic

µs ticker

In the System SLIO module there is a timer (µs ticker). With PowerON the timer starts counting with 0. After 2^{32}-1µs the timer starts with 0 again.