MURR ELEKTRONIK

stay connected

CUBE20S Expansion manual

Counter module 1x 32 bits, up to 400 kHz + 1xDO

This document is valid for the following products:

Name	Art. no.
CUBE20S system **Counter module 1x 32 bits, 400 kHz + 1DO** Counter modules incl. base	57160

Status
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Table of contents

1 Introduction

1.1 Service and support

Sales

Our sales staff in the company, field service and technicians will support you at all times.

CONNECTIVITY system consultants

Our system consultants are your competent contact persons when you want to develop CONNECTIVITY solutions. Together with you, they find the optimum solutions for your electrical installations.

Our CONNECTIVITY consultants find ways that help you to permanently improve the competitiveness of your machines and plants.

Customer Service Center (CSC)

Our staff of the Customer Service Center will help you with all questions concerning installation and set-up. They support you, for example, if you have problems when combining hardware and software products of different manufacturers.

There are numerous support tools and possibilities for measurements - both for fieldbus systems and electromagnetic interference.

Please do not hesitate to call us on +49 (0) 7191 47-2050 or send us an e-mail to: csc@murrelektronik.de.

Service addresses

Please see our website for your contact person:

www.murrelektronik.com

1.2 Introduction / about this document

Function of this document

This document describes the use of the module
Counter module 1x 32 bits, 400 kHz + 1DO
from the Cube20S system of Murrelektronik GmbH. It includes a description of the design, engineering and application.

1.3 Applicable documents

Applicable documents

Document	Location
Operating manual	Online shop of Murrelektronik GmbH

1.4 Symbols

This document includes information and notes that have to be observed for your own safety and to avoid personal and material damage. They are characterized as follows:

DANGER!

Immediate danger

➔ Failure to observe this warning involves an imminent risk of death or serious injuries!

WARNING!

Possible danger

➔ Failure to observe this warning may cause death or serious injuries.

CAUTION!

Low-risk danger

➔ Failure to observe this warning causes minor to moderate injuries.

NOTICE

Risk of material damage

➔ Failure to observe this warning causes material damage.

NOTE
Other technical information and notes of Murrelektronik GmbH.

RECOMMENDATION
Notes with this symbol are recommendations of Murrelektronik GmbH.

Products and Accessories
This symbol refers to accessories or product recommendations.

Instruction for use

➔ An arrow marks instructions for use.

➔ Read and observe the instructions for use.

1 | If they are numbered, it is absolutely necessary to follow them in the correct order.

2 | Read and observe the instructions for use.

Hexadecimal numbers

Hexadecimal numbers are written in the **0x** format usually used by programmers, e.g. : **0x**15AE = 15AEh

1.5 Trademarks

The trademarks of the following companies are used in this documentation:

Adobe Systems Corp.	Adobe Acrobat Reader
Microsoft Corp.	Microsoft Windows 7, Windows Vista, Windows 2000, Windows XE/XP and Microsoft Internet Explorer
PROFIBUS International (P.I.)	PROFIBUS, PROFIBUS DP
PROFIBUS / PROFINET International (P.I.)	PROFINET, PROFINET IO
ODVA Open DeviceNet Vendor Association	EtherNet/IP
Beckhoff Automation GmbH	EtherCAT
CAN in AUTOMATION - International Users and Manufacturers Group e.V.	CANopen
Gould Inc. Corporation	Modbus
Siemens AG	S5-200, S5-300, S5-400 S7-200, S7-300, S7-400

2 For your own safety

2.1 Target group

Users

This manual is intended for users who have knowledge of automation systems.

Documentation

Please give this manual to all employees involved in the following tasks:

- Planning
- Installation
- Set-up
- Operation

2.2 Intended purpose

Designated use

The Cube20S system has been designed and manufactured for:

- communication and process control
- general control and automation tasks
- industrial use
- operation under the ambient conditions specified under technical data
- installation in a switch cabinet

Foreseeable misuse

The device is not approved for being used:

- in potentially explosive atmospheres (EX Zone)
- outside of switch cabinets.

2.3 General safety instructions

Note:

- the relevant safety and accident prevention regulations;
- the EC Directives or other national regulations;
- generally recognized safety rules;
- the section 2.5 "EMC installation guidelines".

NOTICE

Defective device!

Improper use of the hardware and software can cause damage to the device.

➔ Only qualified personnel of Murrelektronik GmbH may manipulate the device.

➔ Only use the device to the extent described in the manual.

Avoid accidents caused by electrical voltage!

➔ Comply with the 5 safety rules of electrical engineering!

➔ Disconnect the device from the mains.

➔ Then carry out installation or repair work.

Avoid personal and material damage due to malfunctions!

➔ Provide external circuit breakers.

➔ The device may only be operated within the specified tolerances.

Avoid undefined states!

- ➔ Select and install connection lines so that capacitive and inductive interferences do not have adverse effects on the system.
- ➔ Protect the device against improper and unintended use.

2.4 Notes on electrostatically sensitive equipment

NOTICE

Overvoltage due to electrostatic discharge!

The assemblies might get damaged.

- ➔ Ensure sufficient grounding of persons and working material!

Handling

Murrelektronik assemblies include highly integrated MOS components. These components are extremely sensitive to overvoltages occurring, for example, due to electrostatic discharge. Assemblies at risk are marked by the adjacent symbol.

The symbol is fixed to assemblies, sub-racks or packaging and indicates electrostatically sensitive equipment. These assemblies may become irreparably damaged by voltage and energy levels which are far below the perception levels of human beings.

If a person who is not electrostatically discharged handles electrostatically sensitive equipment, voltages may be produced. They may damage components, impair the functioning of the assemblies or render the assembly inoperative. Frequently, assemblies damaged like this cannot directly be recognized as faulty. The fault may show only after longer operation.

Components damaged by electrostatic discharge may produce temporary faults in case of temperature changes, vibrations or load changes.

Only with a consistent use of protective devices and a responsible compliance of the instructions for use can you avoid malfunctions or failures of the electrostatically sensitive equipment.

Shipping

- ➔ For shipping electrostatically sensitive equipment, use **always** the original packaging.

Measurements

Observe the following notes for measurements on electrostatically sensitive equipment:

- ➔ Discharge potential-free measuring instrument briefly.
- ➔ Ground the measuring instruments used.

Modifications

Observe the following in case of modifications on electrostatically sensitive equipment:

- ➔ Use a grounded soldering iron.

2.5 EMC installation guidelines

Industrial use

The CUBE20S system is an electronic device manufactured according to the current state-of-the-art standards. Both the robust mechanical construction and the design of the electronic components make it ideal for industrial use.

To guarantee a trouble-free operation, observe the following rules when installing the device in systems. Otherwise, the high interference immunity and resistance to damage of the device may become partially ineffective.

The interference immunity of the entire system considerably depends on the correct installation, location and wiring.

1 | For safe operation, check the installation regulations stipulated by the manufacturer of the controller.

2 | Bring them in line with the recommendations for an EMC-compatible design.

3 | Then install CUBE20S system.

2.6 Notes on spare parts and accessories

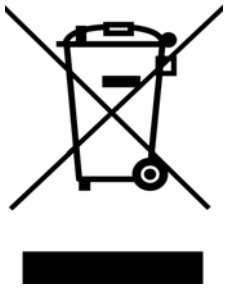
Spare parts

- Only use the original spare parts or spare parts by other manufacturers expressly authorized by Murrelektronik GmbH.
- Check the function of the device after having replaced a component.

Accessories

- The use of accessories may alter the device function. Use only accessories authorized by Murrelektronik GmbH.
- Observe the enclosed instructions of the accessories when installing them.

2.7 Environmentally friendly disposal



Disposal

Do not throw electrical devices, batteries or accumulators in the domestic waste!

If you want to dispose of the product, it may be returned free of charge to Murrelektronik GmbH. This is also valid for original packaging and batteries or accumulators.

Return

➔ Label the product and the packaging with ***"For disposal"***.

➔ Pack the product.

➔ Send the package to:

Murrelektronik GmbH

Falkenstraße 3

D-71570 Oppenweiler

We ensure that it is disposed of according to the German legislation. Transport to the place of destination is at the expense of the last owner.

2.8 EC Declaration of Conformity

CE

Murrelektronik GmbH herewith declares that the products and systems comply with the basic requirements and other relevant regulations of the following Directives:

- 2004/108/EC Electromagnetic compatibility
- 2011/65/EU RoHS

2.9 Warranty and liability

Warranty and liability claims

Warranty and liability claims shall be lost if

- the product is not used according to its designated use,
- damage is caused because the manual and the operating instructions have not been observed,
- the staff was/is not qualified.

3 System description

3.1 System

Overview

The Cube20S system is a modular automation system mounted on a 35 mm DIN rail. Using 2, 4 and 8-channel expansion modules, you may adapt this system perfectly to your automation tasks.

You do not need much wiring because the 24 V DC power supply is integrated in the backplane bus. Defective electronic modules can be replaced without having to replace the wiring.

Using power modules with different colors, you may define further voltage ranges for the 24 V DC power supply within the system or add 2 A to the electronic supply.

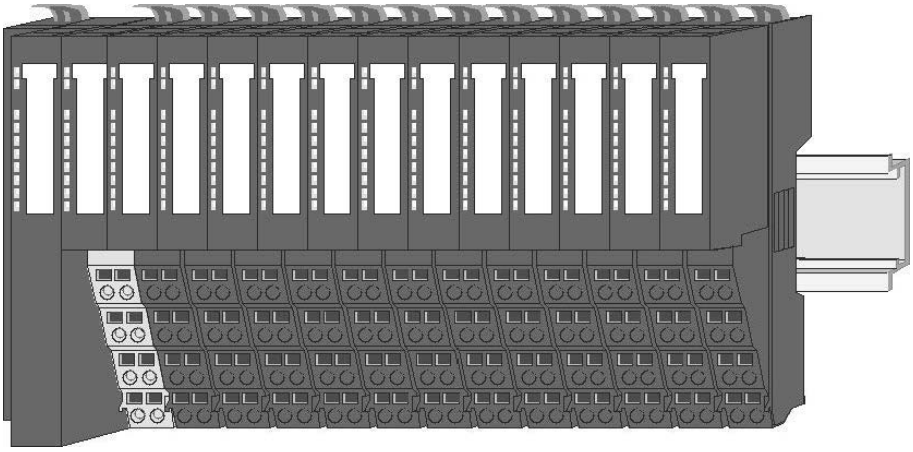


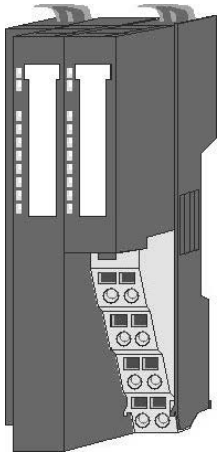
Fig. 3-1: Cube20S system

Components

The Cube20S system consists of the following components:

- Bus node
- Expansion modules
- Power modules
- Accessories

Bus node



Bus interface and power module of the bus node are incorporated in one housing. The bus interface is used to connect to a parent bus system.

Both bus interface and the electronics of the connected expansion modules are supplied with power over the power module.

There is another connection on the power module for the 24 V DC power supply of the connected expansion modules.

By installing up to 64 expansion modules on the bus node, they will be electrically connected, i.e.

- they are incorporated in the backplane bus,
- the electronic modules are supplied with power,
- each expansion module is connected to the 24 V DC power supply.

Bus cover

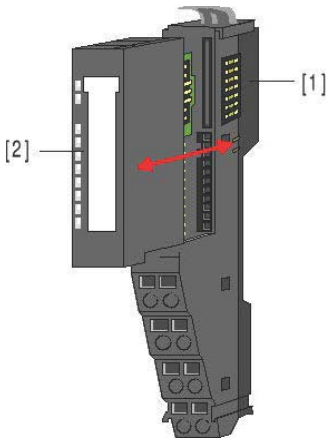
Each bus node has a cover to protect the contacts.

➔ Remove the cover on the bus node before installing CUBE20S modules.

➔ To protect the contacts, mount the bus cover on the outmost module.

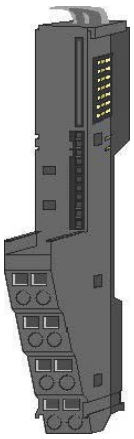
Expansion modules

Each expansion module consists of a terminal and an electronic module.



1 Terminal module
2 Electronic module

Terminal module

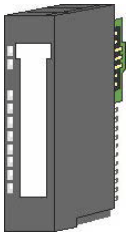


The terminal module consists of the following functional elements:

- a sliding mechanism to fasten the electronic module,
- the backplane bus with power supply for the electronics,
- the connection to the 24 V DC power supply,
- the staircase-shaped terminal block for wiring,
- a safe locking system for fastening on a mounting rail.

This locking mechanism allows you to mount your Cube20S system outside the switch cabinet and fix the complete system later in the switch cabinet.

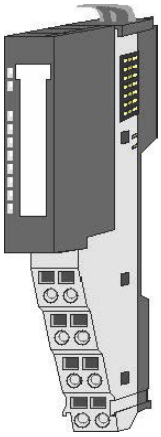
Electronic module



The functionality of an expansion module is defined over the electronic module.

- If the electronic module is defective, it can be replaced while wiring is kept.
- On its front, there are LEDs indicating the status.
- For an easier wiring, there are wiring diagrams on the front and side of each electronic module.

Power modules



Power modules provide the Cube20S system with power. The power modules are either integrated in the bus node or may be plugged between the expansion module.

Depending on the type of power module, groups of potential can be defined for the 24 V DC power supply, or the electronics supply may be extended by 2 A.

For a better recognition, the power modules have a different color than the expansion modules.

3.2 Dimensions

Dimensions of the bus node

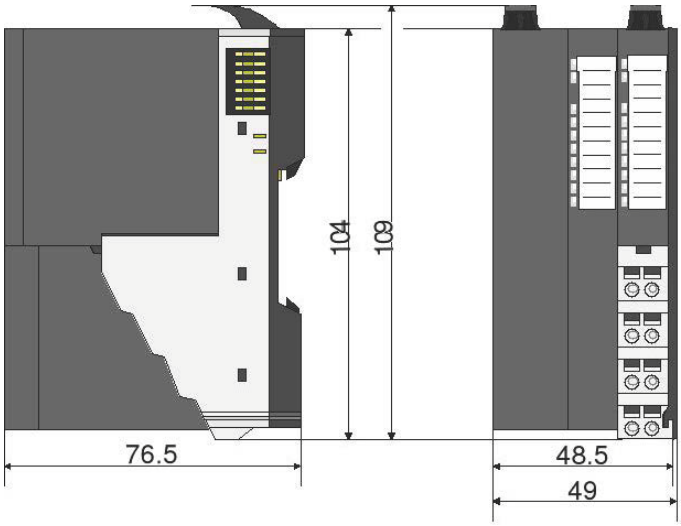


Fig. 3-2: Dimensions of the bus node

Dimensions of the expansion module

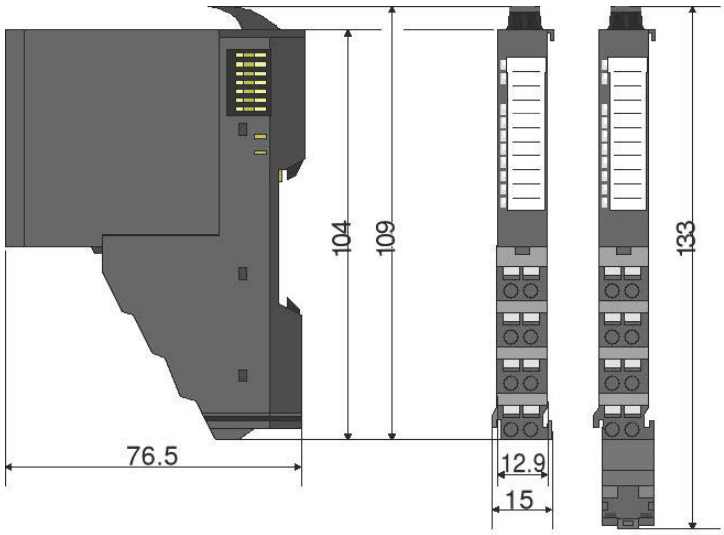


Fig. 3-3: Dimensions of the expansion module

Dimensions of the electronic module

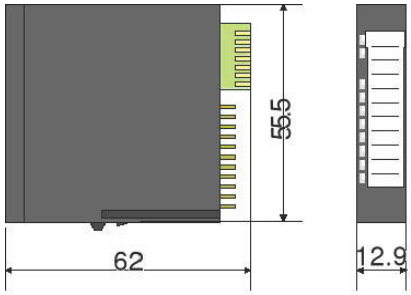


Fig. 3-4: Dimensions of the electronic module

3.3 Mounting

NOTE
You can mount the modules individually or as a whole block on the DIN rail. For block installation, please observe the following: **All** locking levers must be open.

3.3.1 General notes

The individual modules are mounted directly on a DIN rail. Electronics and power supply are connected over the backplane bus.

Conditions:

- Max. number of plug-in modules: 64
- Max. total current of the electronics supply: 3 A

A **power module sensor/actuator/bus art. no. 57131** extends the current for the electronics supply by 2 A. For details, refer to section 3.5 "Wiring".

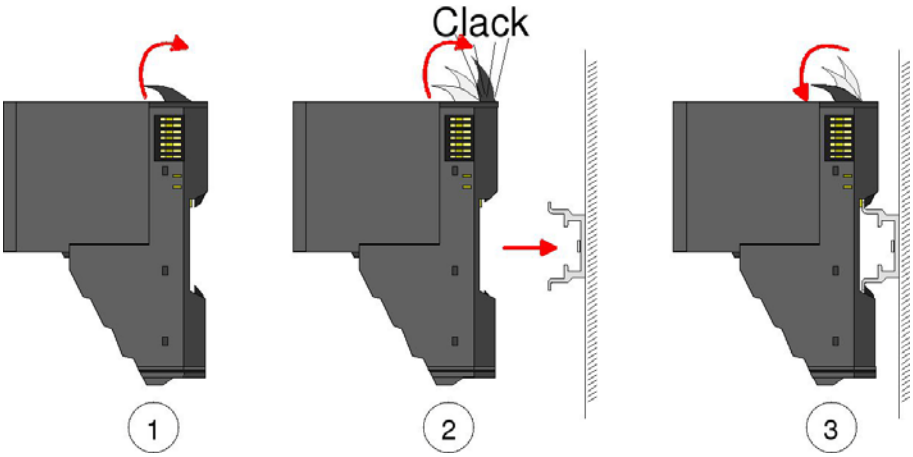


Fig. 3-5: Installing the module

3.3.2 Functional principle of the locking

Inserting and locking the module

- The terminal module has a locking lever at its top.

1 | For installation and disassembly, please press this lever upwards until it engages audibly.

2 | Plug the module to be mounted in the previously plugged-in module.

3 | Slide the module with the help of the guide strips at top and bottom onto the DIN rail.

4 | Flap the locking lever downwards.

The module is fastened to the DIN rail.

3.3.3 Replacing an electronic module

Disassembly

✓ The electronic module has a locking lever at the bottom.

1 | Press the locking lever upwards for disassembly.

2 | To remove the electronic module, pull it out towards the front.

The electronic module has been removed.

Installation

✓ The electronic module has a locking lever at the bottom.

➔ Slide the electronic module with the help of the guide strip into the terminal module.

The electronic module engages audibly at the bottom.

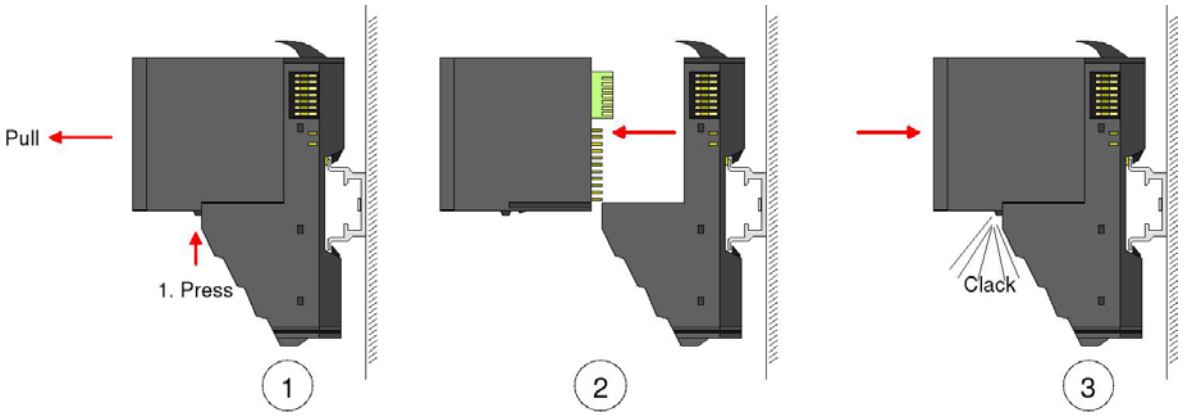


Fig. 3-6: Disassembling and installing the electronic module

3.3.4 Installing the DIN rail

➔ Install the DIN rail with the necessary distances (see Fig. 3-7: "Installation distances").

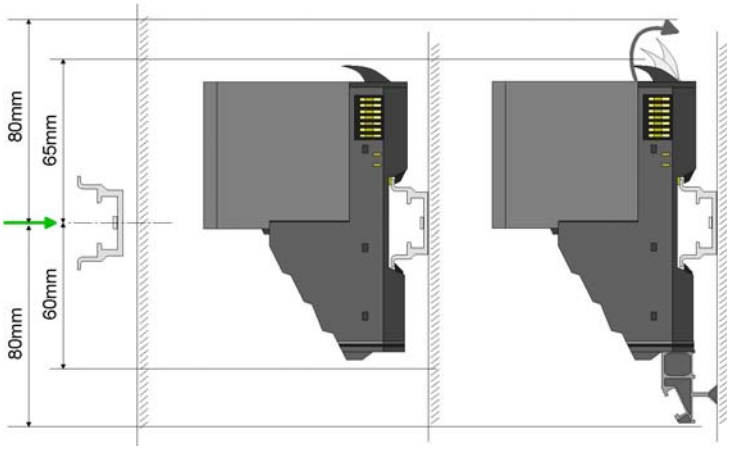


Fig. 3-7: Installation distances

3.3.5 Installing the bus node

✓ To mount the system, start on the left with the bus node.
1 | Flap the two locking levers of the bus node upwards.
2 | Plug the bus node in the DIN rail.
3 | Flap the two locking levers of the bus node downwards.
4 | To remove the right bus cover, pull it out towards the front.
5 | Store the bus cover to use it as termination of the system.

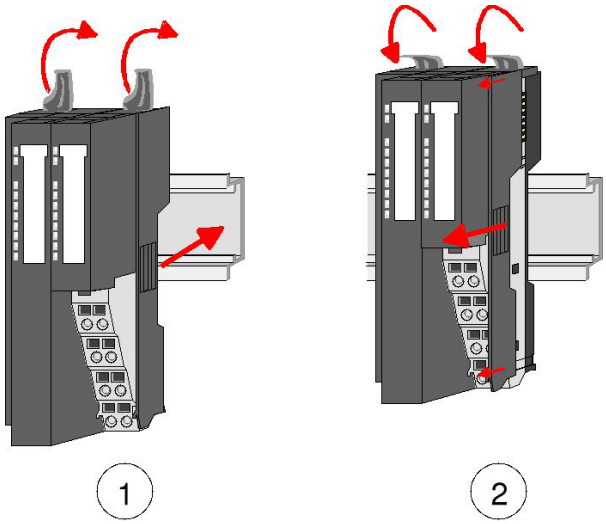


Fig. 3-8: Installing the bus node

3.3.6 Installing the expansion modules

1 | Flap the locking lever of the expansion module upwards.
2 | Plug the expansion module in the DIN rail.
3 | Push the expansion module towards the bus node or the last expansion module.
4 | Flap the locking lever of the expansion module downwards.
5 | Mount all expansion modules as described.

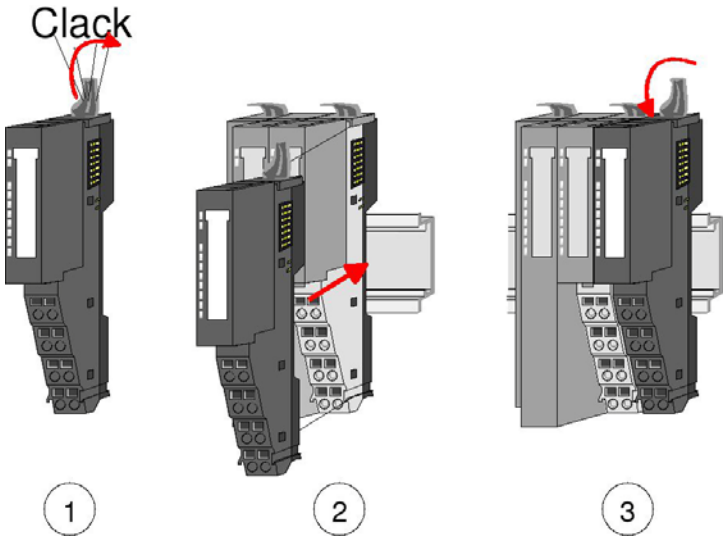


Fig. 3-9: Installing the expansion module

3.3.7 Installing the bus cover

✓ Prerequisite: The system has been completely mounted.
➔ Plug the bus cover in the outmost module as a protection of the bus contacts.

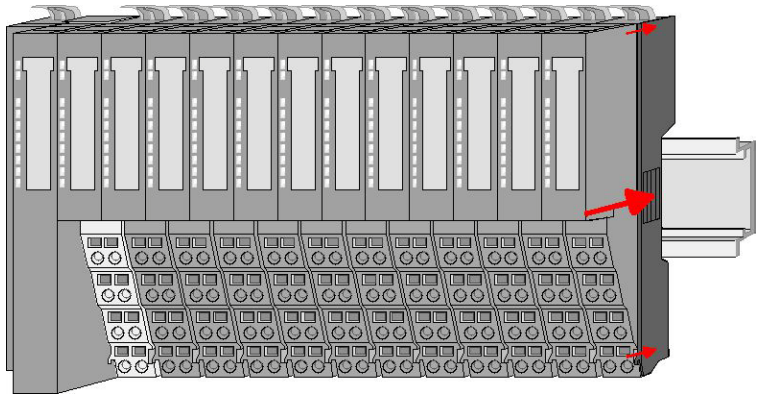


Fig. 3-10: Installing the bus cover

3.4 Disassembling and replacing modules

3.4.1 Procedure

During disassembly or when replacing a module or module group, please observe the following:

1 | Remove the electronic module to the right of the module or module group.
2 | Dismount/replace the module or module group.
3 | Plug in the electronic module.

3.4.2 Replacing an electronic module

Disassembly

✓ The electronic module has a locking lever at the bottom.
1 | Press the locking lever upwards for disassembly.
2 | To remove the electronic module, pull it out towards the front.

The electronic module has been removed.

Installation

✓ The electronic module has a locking lever at the bottom.
➔ Slide the electronic module with the help of the guide strip into the terminal module.

The electronic module engages audibly at the bottom.

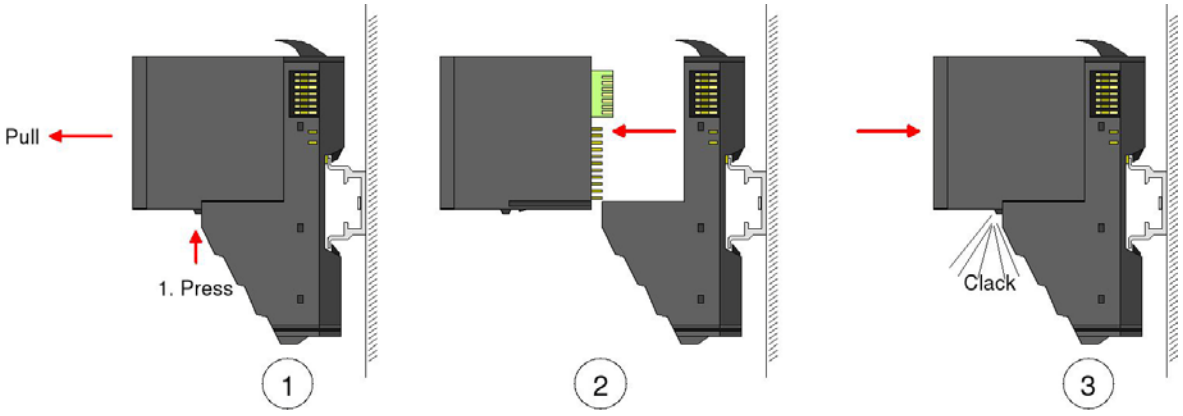


Fig. 3-11: Disassembling and installing the electronic module

3.4.3 Replacing a module

Dismounting

1 | Remove the wiring from the module, if any. For details refer to section ***Wiring***.
2 | Unlock the electronic module to its right at the bottom.
3 | To remove the electronic module, pull it out towards the front.
4 | Flap the locking lever of the module to be replaced upwards.
5 | To remove the module, pull it out towards the front.

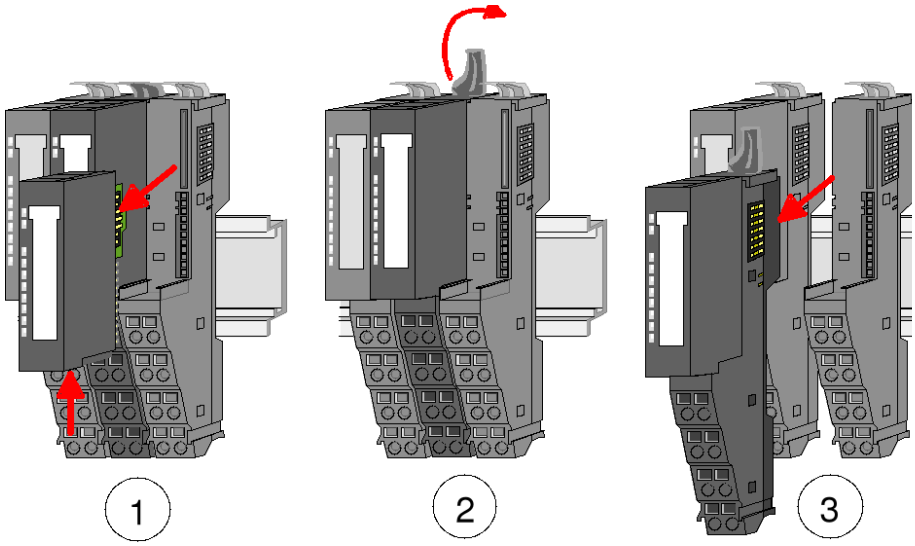


Fig. 3-12: Disassembling a module

Installing the new module

1 | Flap the locking lever of the module upwards.
2 | Plug the module in the gap between the modules.
3 | Slide the module with the help of the guide strips at both sides onto the DIN rail.
4 | Flap the locking lever of the module downwards.
5 | Plug in the electronic module.

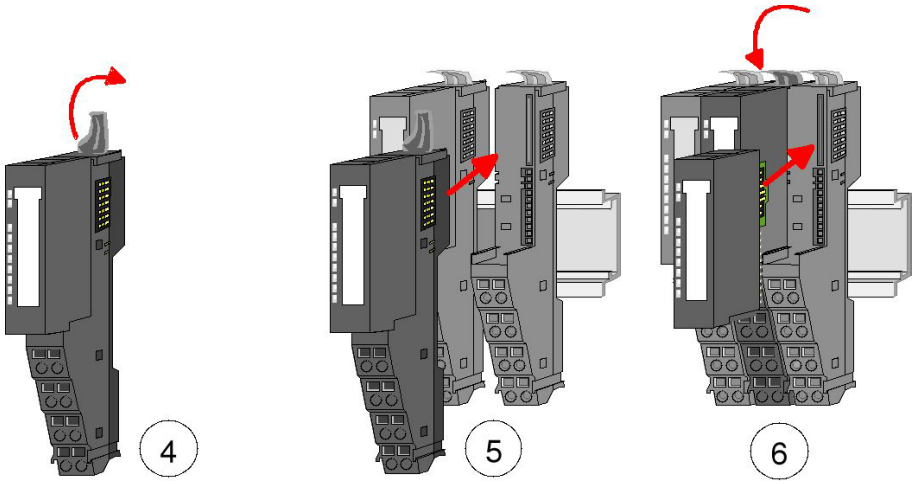


Fig. 3-13: Installing the new module

3.4.4 Replacing a bus node

Disassembly

CAUTION!

Power module and bus interface belong together!

If separated, the modules get destroyed.

➔ Do not separate power module and bus interface!

1 | Remove the wiring from the bus node, if any. For details, please see section ***Wiring***.

2 | Unlock the electronic module to its right at the bottom.

3 | To remove the electronic module, pull it out towards the front.

4 | Flap the locking lever of the bus node upwards.

5 | To remove the bus node, pull it out towards the front.

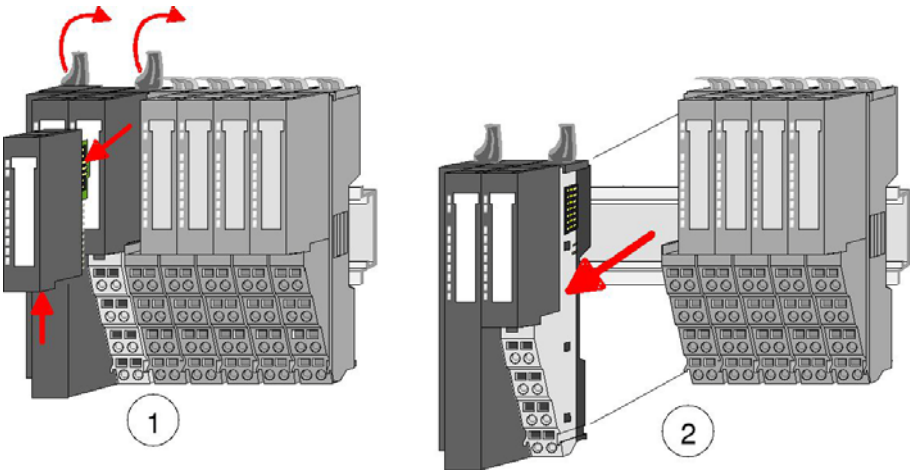


Fig. 3-14: Disassembling the bus node

Installing the new bus node

1 | Flap the locking levers of the bus node upwards.
2 | Plug the bus node in the left module.
3 | Slide the bus node with the help of the guide strips onto the DIN rail.
4 | Flap the locking levers downwards.
5 | Plug in the electronic module.

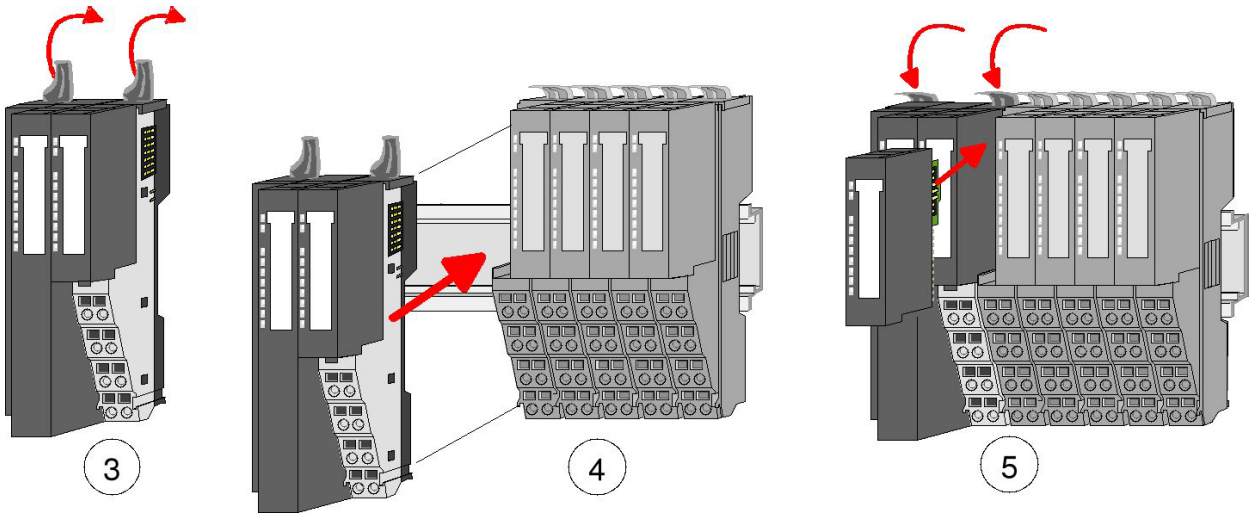


Fig. 3-15: Installing the new bus node

3.4.5 Replacing a module group

Disassembly

1 | Remove the wiring from the module group, if any. For details, please see section ***Wiring***.
2 | Unlock the electronic module to its right at the bottom.
3 | To remove the electronic module, pull it out towards the front.
4 | Flap the locking levers of the module group upwards.
5 | To remove the module group, pull it out towards the front.

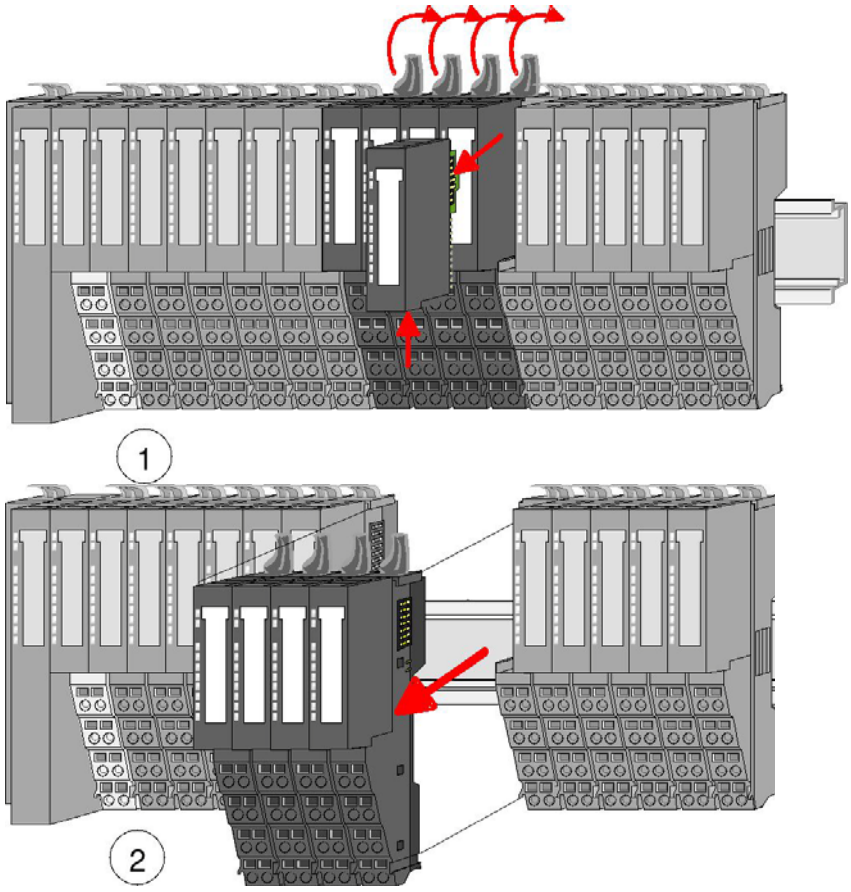


Fig. 3-16: Disassembling the module group

Installing the new module group

1 | Flap the locking levers of the module group upwards.
2 | Plug the module group in the gap between the modules.
3 | Slide the module group with the help of the guide strips at both sides onto the DIN rail.
4 | Flap the locking levers of the module group downwards.
5 | Plug in the electronic module.

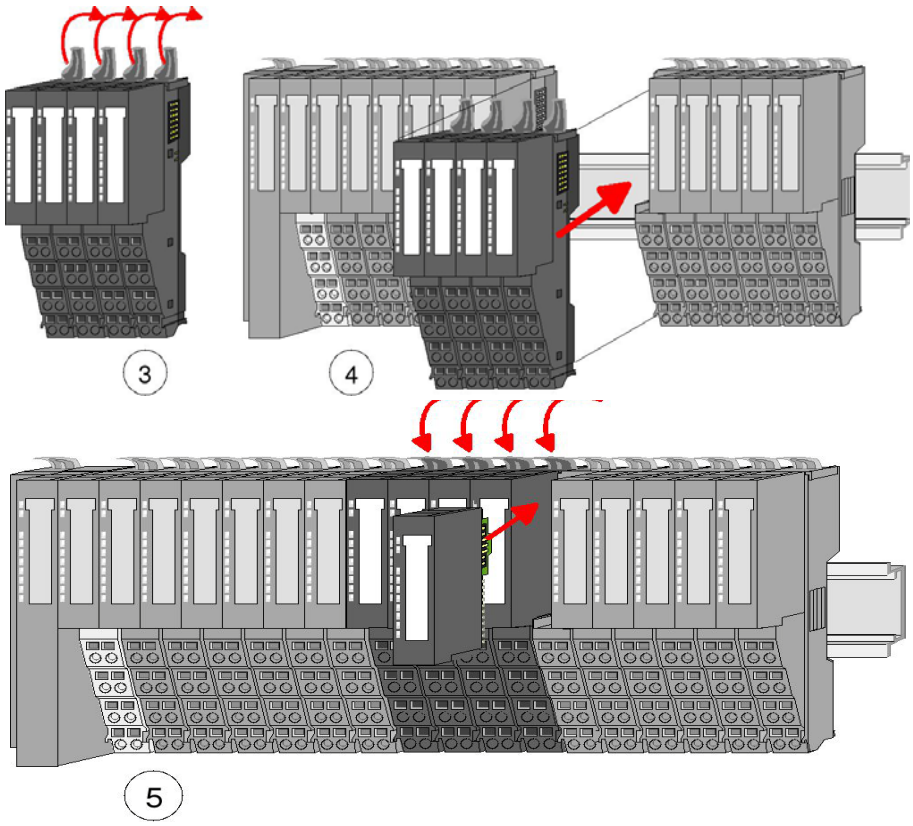


Fig. 3-17: Mounting of the module group

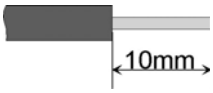
3.5 Wiring

3.5.1 Spring terminals

Terminals

Spring terminals are used for wiring. Spring terminals allow you to connect the signaling lines and power cables fast and easily. This type of connection is resistent to vibrations.

Cable data

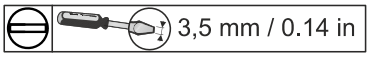


$U_{max.}$: 240 V AC / 30 V DC
$I_{max.}$: 10 A
Cross section: 0.08 ... 1.5 mm^2 (AWG 28 ... 16)
Stripping length: 10 mm

3.5.2 Procedure

Wiring

Tools: suitable screwdriver



Wire cross-section: 0.08 mm^2 ... 1.5 mm^2 (AWG 28 ... 16)

1 | Put the screwdriver slightly inclined in the rectangular opening (Fig. 3-18: 1).

2 | Press and hold the screwdriver away from the round opening. The contact spring is open (Fig. 3-18: 2).

3 | Put the stripped wire in the round opening (Fig. 3-18: 2).

4 | Remove the screwdriver (Fig. 3-18: 3).

The wire is securely connected with the terminal by means of a spring contact.

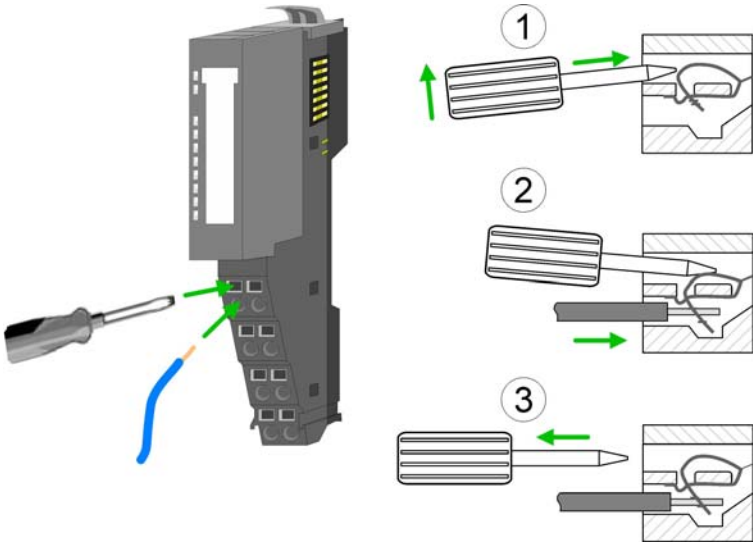


Fig. 3-18: Spring terminals

3.5.3 Standard wiring

Standard wiring

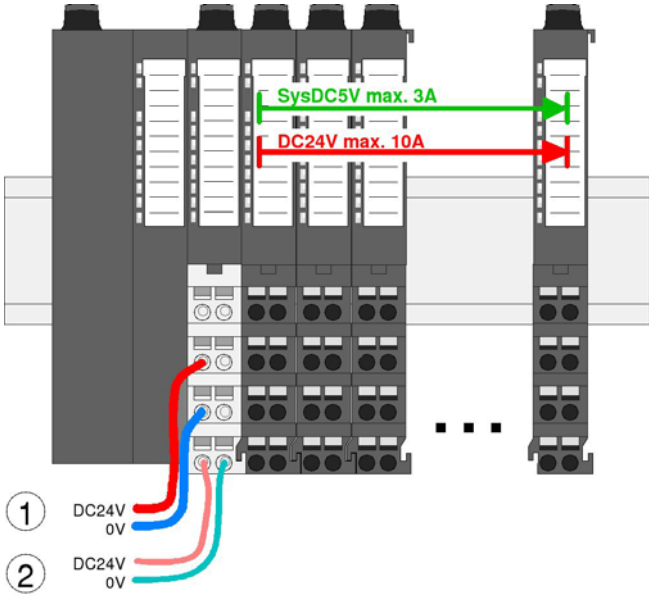


Fig. 3-19: Standard wiring

1 24 V DC for power supply of I/O level (max. 10 A)

2 24 V DC for electronics supply, bus node and I/O level

3.5.4 Fuse protection

WARNING!

The power supply is not protected internally.

It can get destroyed by too high currents.

➔ Protect the power supply externally using a fuse or line circuit breaker!

NOTE

The electronics supply is internally protected against too high voltages by means of a fuse. The fuse is located inside the power module. After the fuse has tripped, the electronic module has to be replaced!

External fuse

	External Fuse	Circuit breaker (optional)	Comment
Power supply	10 A (fast)	10 A characteristic Z	up to max. current 10 A
Electronics supply, bus node and I/O level	2 A (fast)	2 A characteristic Z	Recommendation!
Electronics supply, I/O level, power module art. no. 57131	1 A (fast)	1 A characteristic Z	Recommendation!

Tab. 3-1: Fuse protection of power supplies

3.5.5 Using power modules

Status of the electronics power supply

After switching on Cube20S, the RUN or MF LED lights up at every module.

If the total current for the electronics supply exceeds 3 A, the LEDs are not activated. In this case, plug in the power module, art. no. 57130, between the expansion modules.

NOTE
To guarantee power supply, the power modules can be used in any combination.

Power module art. no. 57130

Use this power module if

- 10 A are not longer enough for power supply
- you want to have groups of different potentials

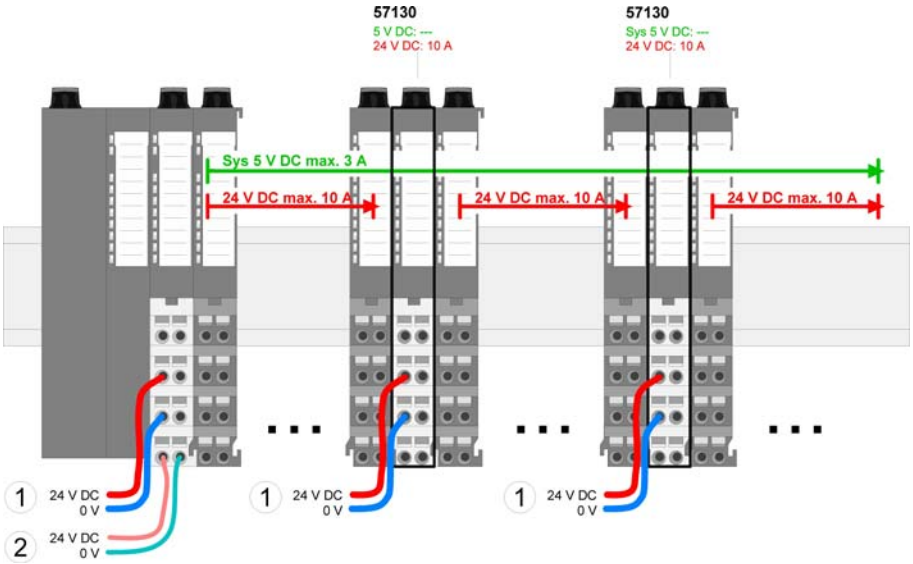


Fig. 3-20: Power module art. no. 57130

1 24 V DC for power supply of I/O level (max. 10 A)

2 24 V DC for electronics supply, bus node and I/O level

Power module art. no. 57131

Use this power module if 3 A are not enough for electronics supply on backplane bus.

In addition, you will have a new group of potential for 24 V DC power supply with max. 4 A.

Using a power module, you can plug in modules with a maximum total current of 2 A in the following backplane bus. Then you have to plug in another power module.

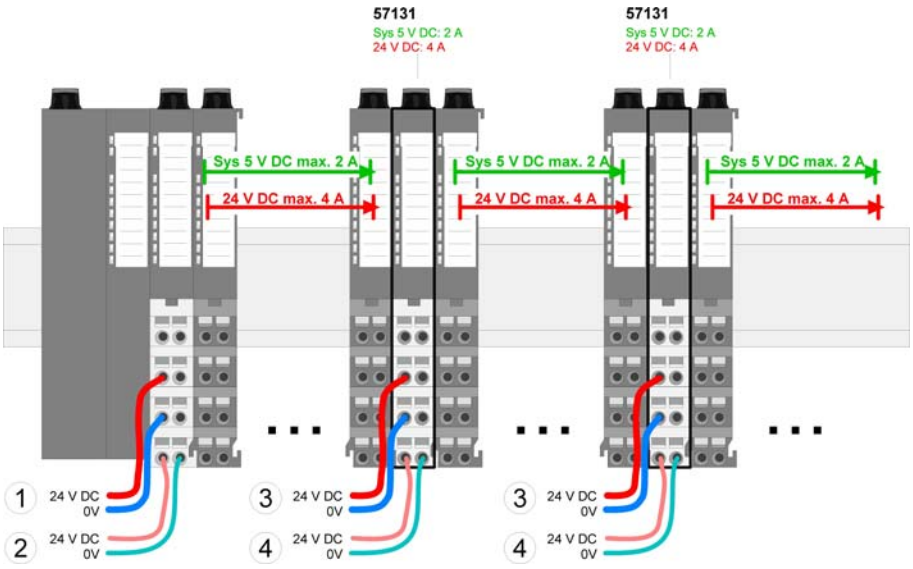


Fig. 3-21: Power module art. no. 57131

1 24 V DC for power supply of I/O level (max. 10 A)
2 24 V DC for electronics supply, bus node and I/O level
3 24 V DC for power supply of I/O level (max. 4 A)
4 24 V DC for electronics supply, I/O level

3.5.6 Fixing the shield

Fixing the shield

NOTE
Shield bus carriers are required for installing a shield (see **Accessories**).

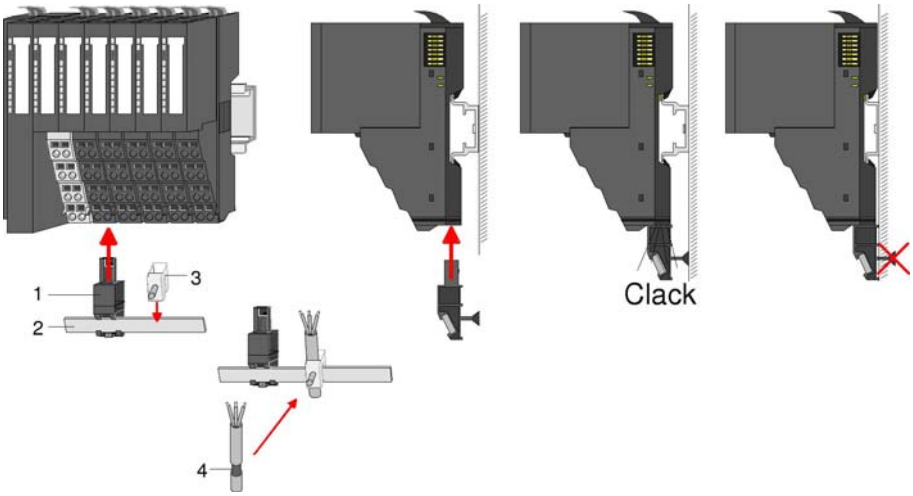


Fig. 3-22: Fixing the shield

1 Shield bus carrier
2 Shield bus (10 mm x 3 mm)
3 Shield terminal block
4 Shielding

Fixing the shielding

✓ The shield bus carrier and the shield bus have been plugged in.
➔ Fasten the lines with the stripped shield.
➔ Connect the shield terminal blocks to the shield bus.

3.6 Troubleshooting - LEDs

General information

Each module has two LEDs on the front: **RUN** and **MF**. These LEDs allow you to detect errors in your system or faulty modules.

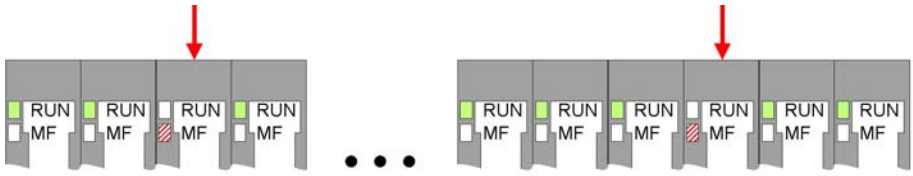
Designation	Indication	LED status
RUN LED		off
		green
		flashing green
MF LED		off
		red
		flashing red

Tab. 3-2: Status indications of the LEDs

Total current of electronics supply exceeded

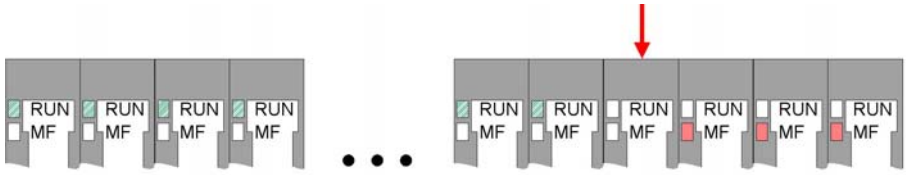
Reaction of the LEDs after switching on:	The **RUN LEDs** of all modules are off. The **MF LEDs** are only lighted on some modules.
Cause:	The total current for electronics supply exceeds the maximum current.
Remedy:	Plug in the power module art. no. 57131. For details, please see section ***Wiring***.

Configuration error



Reaction of the LEDs after switching on:	The **RUN LEDs** are off on one or several modules. The **MF LEDs** are flashing on these modules.
Cause:	The module on which the **MF LED** is flashing, does not match the current configuration.
Remedy:	Match configuration and hardware structure.

Module failure



Reaction of the LEDs after switching on:	The **RUN LEDs** are flashing up to the module to the left of the defective module. On the following modules, the **RUN LED** is off. The **MF LEDs** are off up to the module to the left of the defective module. On the following modules, the **MF LED**is lit.
Cause:	The module to the right of the flashing modules is defective.
Remedy:	Replace the defective module.

4 Counter module 57160 1x32 bits 400 kHz+1 DO

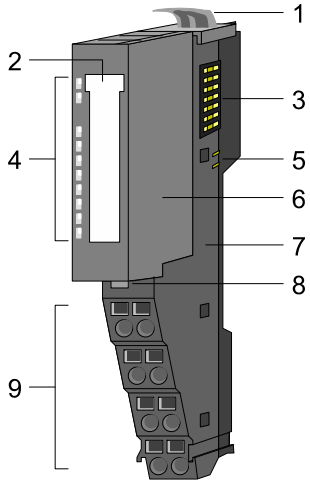
4.1 Features

Features

- 1 counters 32 bits (AB) invertible, 24 V DC
- Counting frequency max. 400 kHz (AB 1/2/4-fold evaluation or pulse and direction)
- Latch value, comparison value, set value, input filter (programmable)
- Hardware gate, reset, digital output for comparison
- Alarm and diagnostic function with µs time stamp
- µs time stamp for the counter value (e.g. for speed measurement)

4.2 Design

57160



1 Spring latch Terminal module
2 Labelling strips
3 Backplane bus
4 LED status indication
5 24 V DC power supply
6 Electronic module
7 Terminal module
8 Locking lever of electronic module
9 Terminals

Status indication

RUN	MF	Description
		Bus communication is OK Module status is OK
		Bus communication is OK Module status reports error
		Bus communication is not possible Module status reports error
		Error Bus supply voltage
		Configuration error (see 3.6 Troubleshooting - LEDs, Seite 31)

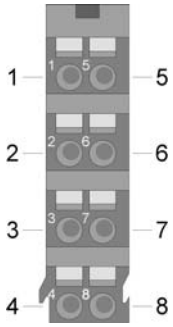
Tab. 4-1: Status indications of RUN and MF LED

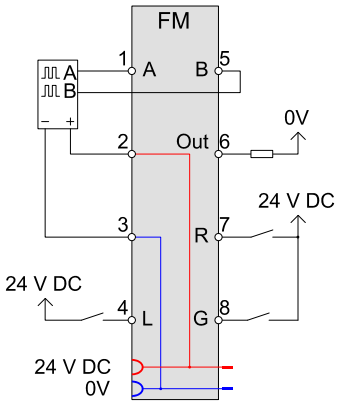
LED	Color	Description
A		Digital input 1 A / pulse is set
B		Digital input 5 B / direction is set
Latch		Digital input 4, Latch actuated
Gate		Digital input 8 Hardware gate controlled
Reset		Digital input 7 Reset controlled
OUT		Digital output 6 controlled

Tab. 4-2: Status of the inputs and outputs

Terminal

➔ Connect the wires with a cross section from 0.08 mm^2 to 1.5 mm^2.





Pos.	Function	Type	Description
1	A	Input	A / pulse Pulse input for count signal or track A of an encoder for 1-, 2- or 4-fold evaluation
2	24 V DC	Output	24 V DC for encoder
3	0 V	Output	GND
4	L	Input	Latch Input for saving the current counter value as latch value in the input range Triggering: with a 0-1 edge or with a level-triggered signal
5	B	Input	B / Direction Direction signal or track B of an encoder (can be inverted using parameterization)
6	OUT	Output	Digital output for control using comparison function
7	R	Input	Reset Input for resetting the counter Activation: in the parameterization
8	G	Input	Hardware gate Input for control of HW gate Control: with high level

Tab. 4-3: Terminal assignment

4.3 Quick start

Counting range
Max. counting frequency:
400 kHz

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

Tab. 4-4: Counting range

Address ranges

In CPU, PROFIBUS and PROFINET the input and output range is displayed in the corresponding address range.

IX Index for access using CANopen

SX Subindex for access via EtherCAT

Input range
12 bytes

Addr.	Name	Bytes	Function	IX	SX
+0	CV_I	4	Counter value	0x5400	0x01
+4	CL_I	4	Latch value	0x5401	0x02
+8	CSTS_I	2	Counter status	0x5402	0x03
+10	C_US	2	16 bits µs value	0x5403	0x04

Tab. 4-5: Input range 12 bytes

Output range
10 bytes

Addr.	Name	Bytes	Function	IX	SX
+0	CC_I	4	comparison value	0x5600	0x01
+4	CS_I	4	Set value	0x5601	0x02
+8	CCTRL_I	2	Control word	0x5602	0x03

Tab. 4-6: Output range 10 bytes

CSTS_I
Counter status

Bit	Name	Function
0	STS_SYNC	Reset was active
1	STS_CTRL_DO	Is set if the digital output is enabled
2	STS_SW-GATE	Status Software gate (set if ***SW gate*** active)
3	STS_RST	Status of the Reset input
4	STS_STRT	Status hardware gate (set if ***HW gate*** active)
5	STS_GATE	Status Internal gate (set if ***Internal gate*** active)
6	STS_DO	Status of digital counter output (DO)
7	STS_C_DN	Status set if counter direction backwards
8	STS_C_UP	Status set if counter direction forwards
9	STS_CMP*	Status Comparator is set if the comparison condition is fulfilled. If ***Comparison never*** is set, the bit is never set.
10	STS_END*	Status set if ***end value*** has been reached
11	STS_OFLW*	Status set for overflow
12	STS_UFLW*	Status set for underflow
13	STS_ZP*	Status set for zero crossing
14	STS_LTCH	Status of the latch input
15	-	reserved

Tab. 4-7: Counter status

* The bits remain set, until they are reset with RES_SET (Bit 6 Control word).

CCTRL_I
Control word

Bit	Name	Function
0	CTRL_SYNC_SET	Activates the Reset mode
1	CTRL_DO_SET	Enable of the digital output
2	SW_GATE_SET	Sets the software gate
3 ... 4	-	reserved
5	COUNTERVAL_SET	Sets the counter temporarily to the value in ***Set value***
6	RES_SET	Resetting with 0-1 edge of bits: STS_CMP STS_END STS_OFLW STS_UFLW STS_ZP
7	-	reserved
8	CTRL_SYNC_RESET	Disables the Reset mode
9	CTRL_DO_RESET	Disable of the digital output
10	SW_GATE_RESET	Resets the software gate
11 ... 15	-	reserved

Tab. 4-8: Control word

Parameterization data

DS	Data record for access using CPU, PROFIBUS and PROFINET
IX	Index for access using CANopen
SX	Subindex for access via EtherCAT

Name	Bytes	Function	Default	DS	IX	SX
DIAG_EN	1	Diagnostic interrupt*	0x00	0x00	0x3100	0x01
CH0A	1	Input frequency Track A	0x02	0x01	0x3101	0x02
CH1B	1	Input frequency Track B	0x02	0x01	0x3102	0x03
CH2L	1	Input frequency Latch	0x02	0x01	0x3103	0x04
CH3G	1	Input frequency Gate	0x02	0x01	0x3104	0x05
CH4R	1	Input frequency Reset	0x02	0x01	0x3105	0x06
CH5	1	0 (fixed)	0x00	0x01	0x3106	0x07
INT_I	1	Alarm behavior*	0x80	0x80	0x3107	0x08
FCT_I	1	Counter function*	0x40	0x80	0x3108	0x09
MODE2_I	1	Counter mode 2*	0x00	0x80	0x3109	0x0A
MODE3_I	1	Counter mode 3*	0x00	0x80	0x310A	0x0B
END_I	4	End value	0x00	0x81	0x310B ... 0x310E	0x0C
LOAD_I	4	Load value	0x00	0x81	0x310F ... 0x3112	0x0D
HYST_I	1	Hysteresis	0x00	0x81	0x3113	0x0E
PULSE_I	1	Pulse	0x00	0x81	0x3114	0x0F

Tab. 4-9: Parameters

* The parameters DIAG_EN, INT_I, FCT_I, MODE2_I and MODE3_I may only be transmitted in the STOP state.

Controlling the counter

The counter is controlled using the internal gate (I gate).

The I gate is the result of logic operation of hardware gate (HW) and software gate (SW), whereas the HW gate evaluation can be disabled using parameterization.

HW gate	Opening (enable):	0-1 edge at the hardware gate input on the module
	Closing (disable):	1-0 edge at the hardware gate input on the module

Tab. 4-10: HW gate

SW gate	Opening (enable):	In the user program using 0-1 edge of SW_GATE_SET in the ***Control word***
	Closing (disable):	In the user program using 0-1 edge of SW_GATE_RESET in the ***control word***

Tab. 4-11: SW gate

Counter output

The following behavior can be set for the output channel using parameterization:

- No comparison: Output is not controlled
- Counter value ≥ comparison value: Output is set
- Counter value ≤ comparison value: Output is set
- Counter value = comparison value: Output is set

Note that the output can only be controlled if the STS_CTRL_DO bit is set in the counter status.

4.4 Input/output range

Overview

The following ranges in the input/output range are reserved for the module:

Address ranges

In CPU, PROFIBUS and PROFINET the input and output range is displayed in the corresponding address range.

IX	Index for access using CANopen
SX	Subindex for access via EtherCAT

Input range 12 bytes

Addr.	Name	Bytes	Function	IX	SX
+0	CV_I	4	Counter value	0x5400	0x01
+4	CL_I	4	Latch value	0x5401	0x02
+8	CSTS_I	2	Counter status	0x5402	0x03
+10	C_US	2	16 bits µs value	0x5403	0x04

Tab. 4-12: Input range 12 bytes

CV_I
Counter value

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

CL_I
Latch value

Once a 0-1 edge occurs at the latch input, the current ***counter value*** is saved under ***CL_I latch value***.

CSTS_I
Counter status

Bit	Name	Function
0	STS_SYNC	Reset was active
1	STS_CTRL_DO	Is set if the digital output is enabled
2	STS_SW-GATE	Status Software gate (set if ***SW gate*** active)
3	STS_RST	Status of the Reset input
4	STS_STRT	Status hardware gate (set if ***HW gate*** active)
5	STS_GATE	Status Internal gate (set if ***Internal gate*** active)
6	STS_DO	Status of digital counter output (DO)
7	STS_C_DN	Status set if counter direction backwards
8	STS_C_UP	Status set if counter direction forwards
9	STS_CMP*	Status Comparator is set if the comparison condition is fulfilled. If ***Comparison never*** is set, the bit is never set.
10	STS_END*	Status set if ***end value*** has been reached
11	STS_OFLW*	Status set for overflow
12	STS_UFLW*	Status set for underflow
13	STS_ZP*	Status set for zero crossing
14	STS_LTCH	Status of the latch input
15	-	reserved

Tab. 4-13: Counter status

* The bits remain set, until they are reset with RES_SET (Bit 6 Control word).

C_US
µs ticker

A timer (µs ticker) is located in the Cube20S module. It is started with Power-ON and starts with 0 after 65535 µs.

After every change of the counter value, the time value of the timer is saved as a 16-bit value in µs together with the counter value in the input range.

Output range 10 bytes

Addr.	Name	Bytes	Function	IX	SX
+0	CC_I	4	comparison value	0x5600	0x01
+4	CS_I	4	Set value	0x5601	0x02
+8	CCTRL_I	2	Control word	0x5602	0x03

Tab. 4-14: Output range 10 bytes

CC_I
Comparison value

Defining comparison value

➔ The behavior of the output is specified by means of the MODE2_I parameter.

➔ The behavior of the process interrupt is defined by means of the INT_I parameter.

The comparison value is compared to the current counter value and affects the counter output or triggers a process interrupt.

CS_I
Set value

Loading counter with set value:

➔ Specify a set value.

*The set value is accepted in the counter with a 0-1 edge of COUNTERVAL_SET in the **control word**.*

CCTRL_I
Control word

Bit	Name	Function
0	CTRL_SYNC_SET	Activates the Reset mode
1	CTRL_DO_SET	Enable of the digital output
2	SW_GATE_SET	Sets the software gate
3 ... 4	-	reserved
5	COUNTERVAL_SET	Sets the counter temporarily to the value in ***Set value***
6	RES_SET	Resetting with 0-1 edge of bits: STS_CMP STS_END STS_OFLW STS_UFLW STS_ZP
7	-	reserved
8	CTRL_SYNC_RESET	Disables the Reset mode
9	CTRL_DO_RESET	Disable of the digital output
10	SW_GATE_RESET	Resets the software gate
11 ... 15	-	reserved

Tab. 4-15: Control word

4.5 Parameterization

Overview

Using the parameters, define among other things:

- Alarm behavior
- Input filter
- Counter operating mode or behavior

Parameterization data

DS	Data record for access using CPU, PROFIBUS and PROFINET
IX	Index for access using CANopen
SX	Subindex for access via EtherCAT

Name	Bytes	Function	Default	DS	IX	SX
DIAG_EN	1	Diagnostic interrupt*	0x00	0x00	0x3100	0x01
CH0A	1	Input frequency Track A	0x02	0x01	0x3101	0x02
CH1B	1	Input frequency Track B	0x02	0x01	0x3102	0x03
CH2L	1	Input frequency Latch	0x02	0x01	0x3103	0x04
CH3G	1	Input frequency Gate	0x02	0x01	0x3104	0x05
CH4R	1	Input frequency Reset	0x02	0x01	0x3105	0x06
CH5	1	0 (fixed)	0x00	0x01	0x3106	0x07
INT_I	1	Alarm behavior*	0x80	0x80	0x3107	0x08
FCT_I	1	Counter function*	0x40	0x80	0x3108	0x09
MODE2_I	1	Counter mode 2*	0x00	0x80	0x3109	0x0A
MODE3_I	1	Counter mode 3*	0x00	0x80	0x310A	0x0B
END_I	4	End value	0x00	0x81	0x310B ... 0x310E	0x0C
LOAD_I	4	Load value	0x00	0x81	0x310F ... 0x3112	0x0D
HYST_I	1	Hysteresis	0x00	0x81	0x3113	0x0E
PULSE_I	1	Pulse	0x00	0x81	0x3114	0x0F

Tab. 4-16: Parameters

* The parameters DIAG_EN, INT_I, FCT_I, MODE2_I and MODE3_I may only be transmitted in the STOP state.

DIAG_EN
Diagnostic interrupt

Byte	Bit 7 ... 0	Description	
0	7 ... 0	Diagnostic interrupt	
		0x00	disable
		0x40	enabled

Tab. 4-17: Diagnostic interrupt

➔ Enable or disable the diagnostic function here.

CHxx
Input frequency

Byte	Function	Possible values
0	Input frequency Track A	
1	Input frequency Track B	0x02: 100 kHz 0x07: 5 kHz
2	Input frequency Latch	0x03: 60 kHz 0x08: 2 kHz
3	Input frequency Gate	0x04: 30 kHz 0x09: 1 kHz
4	Input frequency Reset	0x06: 10 kHz
5	0 (fixed)	Other values are not permitted!

Tab. 4-18: CHxx Input frequency

Defining filters for the inputs E1, E4, E5, E7 and E8

➔ Specify the ***input frequency***.

The filter filters out, for example signal peaks for unclear signal.

INT_I
Alarm behavior

Byte	Bit 7 ... 0	Description
0	6 ... 0	Alarm behavior
	0	Proc. interrupt ***HW gate*** open
	1	Proc. interrupt ***HW gate*** closed
	2	Process interrupt ***Overflow***
	3	Process interrupt ***Underflow***
	4	Process interrupt ***Comparison value***
	5	Process interrupt ***End value***
	6	Proc. interrupt ***Latch value***
	7	1 (fixed)

Tab. 4-19: INT_I Alarm behavior

Activating process interrupt

➔ Set the corresponding bit.

FCT_I
Counter function

Byte	Bit 7 ... 0	Description	
0	5 ... 0		Counter function
		000000b	Count continuously
		000001b	Once: forwards
		000010b	Once: backwards
		000100b	Once: no main direction
		001000b	Periodic: forwards
		010000b	Periodic: backwards
		100000b	Periodic: no main direction
	6		1 (fixed)
	7		0 (fixed)

Tab. 4-20: FCT_I counter function

MODE2_I
Counter mode 2

Byte	Bit 7 ... 0	Description	
0	2 ... 0		Output switches (... under the following condition)
		000b	Never
		001b	Counter value ≥ comparison value
		010b	Counter value £ comparison value
		100b	Counter value = comparison value
	3		Invert counter direction track B
		0	No (do not invert)
		1	Yes (invert)
	6 ... 4		Reset
		000b	disabled
		001b	High level
		010b	Edge 0-1
		100b	0-1 edge once
	7		0 (fixed)

Tab. 4-21: MODE2_I counter mode 2

Control of the output: In the ***Control word***, ***CTRL_DO_SET*** (Bit 1) must be set!
Control of the reset: In the ***Control word***, ***CTRL_DO_SET*** (Bit 0) must be set!

MODE3_I
Counter mode 3

Byte	Bit 7 ... 0	Description	
0	2 ... 0		***Signal evaluation***
		000b	Counter disabled
		001b	Rotary encoder 1-fold (to A and B)
		010b	Rotary encoder 2-fold (to A and B)
		011b	Rotary encoder 4-fold (to A and B)
		100b	Direction (pulse to A and direction to B)
	6 ... 3		***HW gate***
		0000b	disabled
		0001b	enabled
	7		***Gate function (internal gate)***
		0	Cancel
		1	Interrupt

Tab. 4-22: MODE3_I counter mode 3

Counter disabled:Further parameter specifications for the counter are ignored.

HW gate disabled: The counter starts by setting the ***SW gate***.
HW gate enabled: A high level at gate enables the ***HW gate***. The counter starts only if the ***HW gate*** and ***SW gate*** are set.

Cancel gate function: The counting process is continued again starting from the load value.
Interrupt gate function: The counting process is continued from the counter value.

END_I, LOAD_I
End value, load value

Limiting the lower counting range:

➔ Enter a ***load value*** LOAD_I.

Limiting the upper counting range:

➔ Enter an ***end value*** END_I.

HYST_I
Hysteresis

If the counter value is within the range of the comparison value, the ***hysteresis*** avoids frequent switching of the output and/or triggering of the alarm.

Defining hysteresis between 0 and 255

➔ 0 or 1: Switching off the ***hysteresis***

➔ Value between 2 and 255: Activate hysteresis range

*The **Hysteresis** influences the zero crossing, comparison, overflow and underflow.*

PULSE_I
Pulse duration

The ***pulse duration*** specifies how long the output is set if the parameterized comparison criterion is reached.

Defining pulse duration

✓ Step length: 2.048 ms, range: between 0 and 522.24 ms

➔ Enter the value 0 for the pulse duration.
The output remains set until the comparison condition is no longer fulfilled.

➔ Enter for the pulse duration a value between 2.048 ms and 522.24 ms.
The output remains set until the entered value is reached.

4.6 Counter functions

Overview

The counter counts forwards and backwards. You can select from the following counter functions:

- Count continuously, for example for distance measurement with incremental encoders
- Count once, for example for unit decoding up to a maximum limit
- Periodical count, for example for applications with repeated counting operations

In the operation modes ***Count once*** and ***Periodical count*** define a counter range as the start or end value using parameterization.

Programmable additional functions are available for the counter, for example gate function, comparison, hysteresis and process interrupt.

Main counting direction

Define the main counting direction for the counter using parameterization.

If **no** main counting direction has been selected, the entire counting range is available:

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

Tab. 4-23: Counting range

Main counting direction
Sets the upper limit of the counting range.

The counter counts from 0 or ***load value*** in the positive direction up to the configured ***end value*** -1 and then jumps with the subsequent encoder pulse again to the ***load value***.

Main counting direction backwards
Sets the lower limit of the counting range.

The counter counts from the configured start value or ***load value*** in the negative direction up to the configured ***end value*** +1 and then jumps with the subsequent encoder pulse again to the start value.

Gate function
Abort/Interrupt

If the HW gate is enabled, the gate functions affect only the HW gate. Opening and closing of the SW gate affects only in an interrupting manner.

Aborting counting
The counting process starts with the ***load value*** after closing and restarting the gate.

Interrupting counting
The counting is continued with the last current counter value after closing and restarting the gate.

Counting continuously

In this operating mode the counter counts starting with the ***load value***.

If the counter reaches the upper count limit during up-counting and another counting pulse in the positive direction is received, it jumps to the lower count limit and continues counting from there.

If the counter reaches the lower count limit during down-counting and another counting pulse in the negative direction is received, it jumps to the upper count limit and continues counting from there.

The count limits are set fixedly to the maximum counting range.

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

Tab. 4-24: Counting range

If the count limit is exceeded or not reached, the status bits STS_OFLW or STS_UFLW are set.
The bits remain set until they are reset again using the RES_SET in the ***control word***.
If enabled, a process interrupt is triggered additionally.

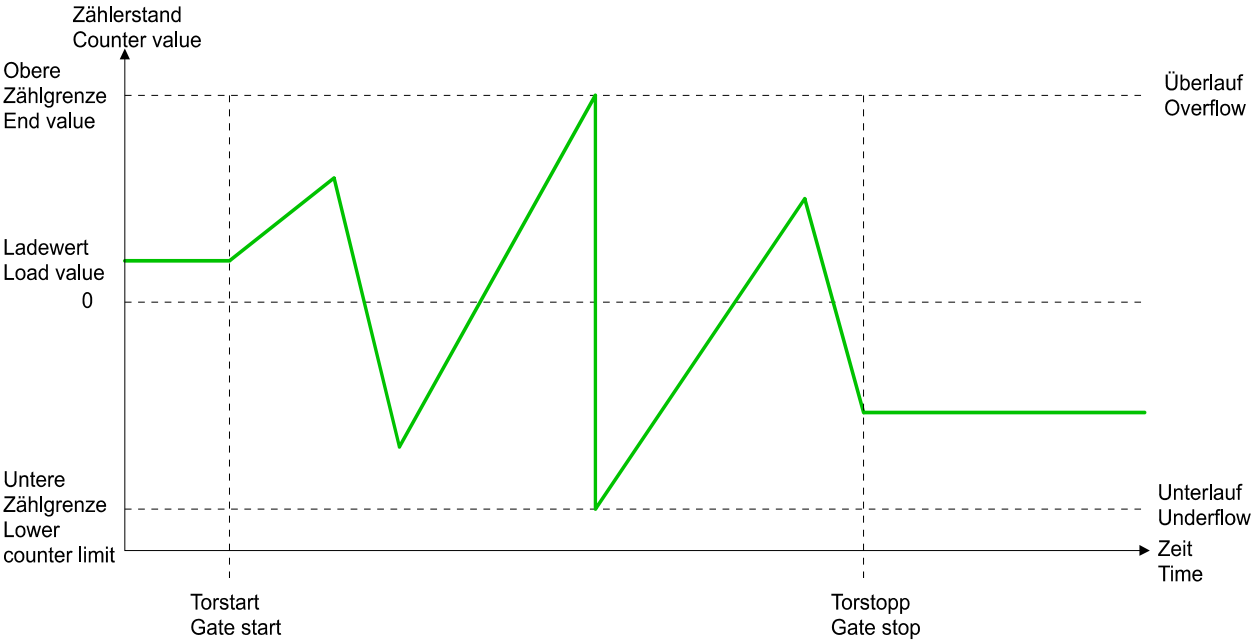


*Fig. 4-1: Operating mode **Count continuously***

Counting once

No main counting direction

- The counter counts once starting with the ***load value***.
- The counter counts forwards or backwards.
- The count limits are set fixedly to the maximum counting range.
- In case of overflow or underflow at the count limits, the counter jumps to the opposite count limit correspondingly, the internal gate is closed automatically and the status bits STS_OFLW or STS_UFLW are set. If enabled, a process interrupt is triggered additionally.
- To restart counting you have to open the internal gate again.
- With the interrupting gate control, the counting process is continued starting from the current ***counter value***.
- In case of aborting gate control, the counter starts with the ***load value***.

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

Tab. 4-25: Counting range

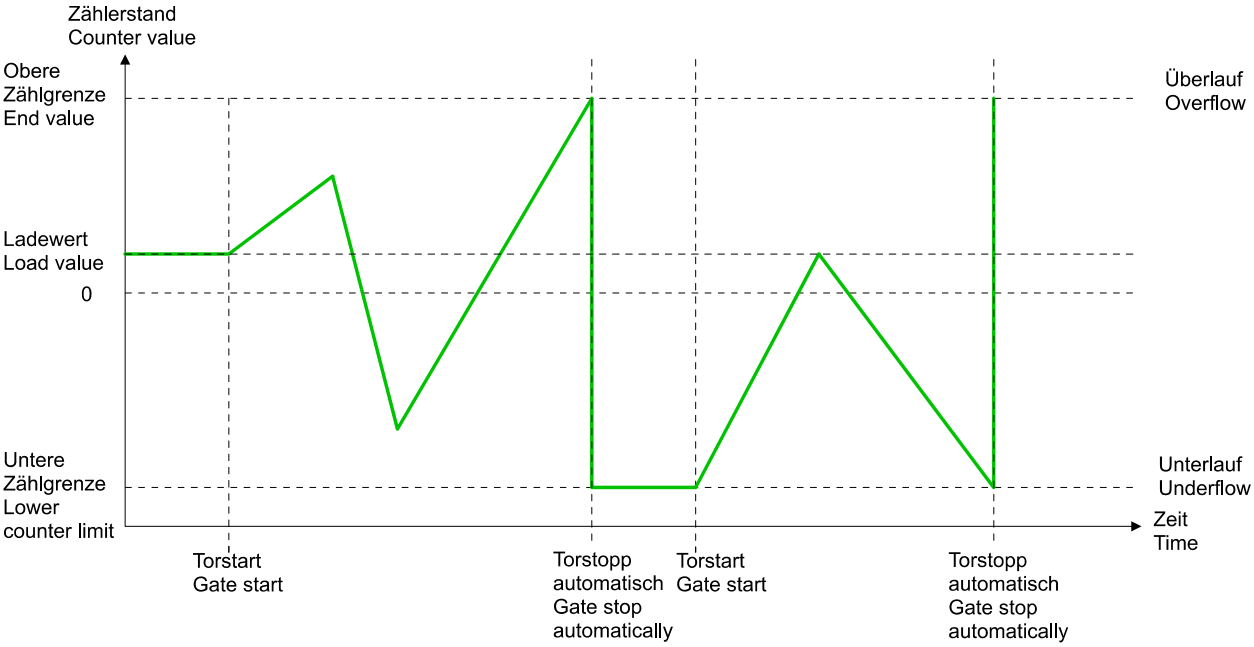


*Fig. 4-2: Operating mode **Count once (interrupting gate control)***

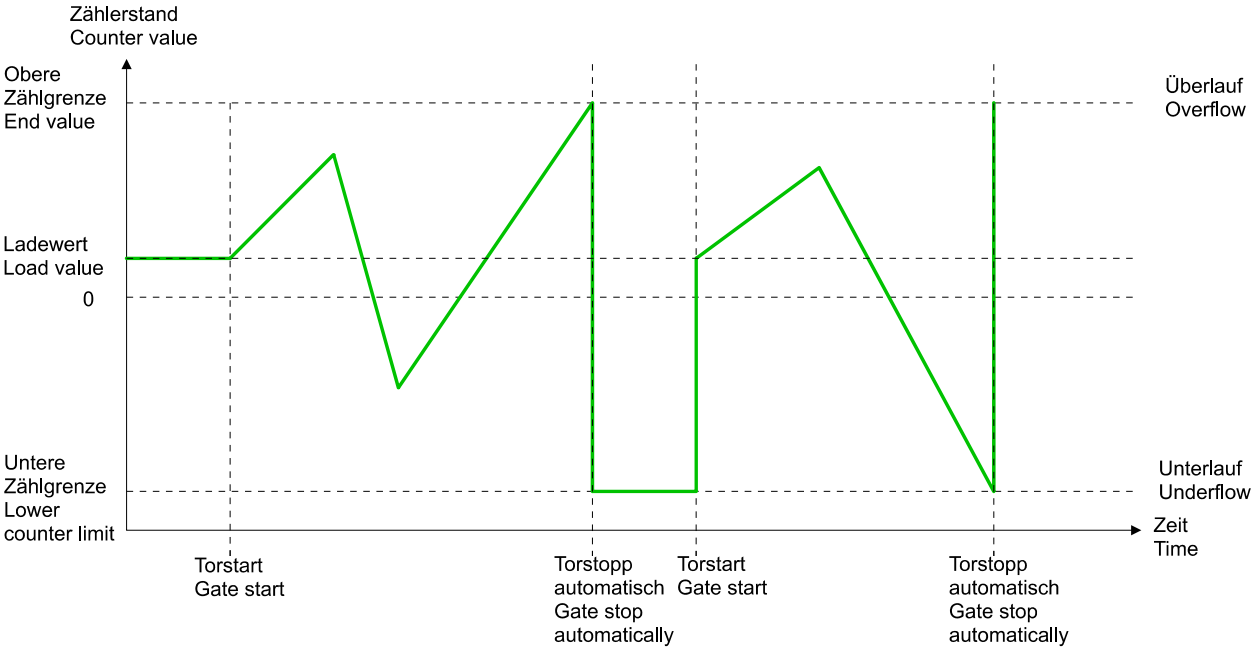


*Fig. 4-3: Operating mode **Count once (aborting gate control**)*

Main counting direction

- The counter counts forwards starting with the ***load value***.
- If the counter reaches the ***end value*** -1 in the positive direction, it jumps after the next counter pulse to the ***load value*** and the internal gate is closed automatically. If enabled, a process interrupt is triggered additionally.
- To restart counting you have to open the internal gate again. The counter starts with the ***load value***.
- The counter counts beyond the lower count limit.

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

Tab. 4-26: Counting range

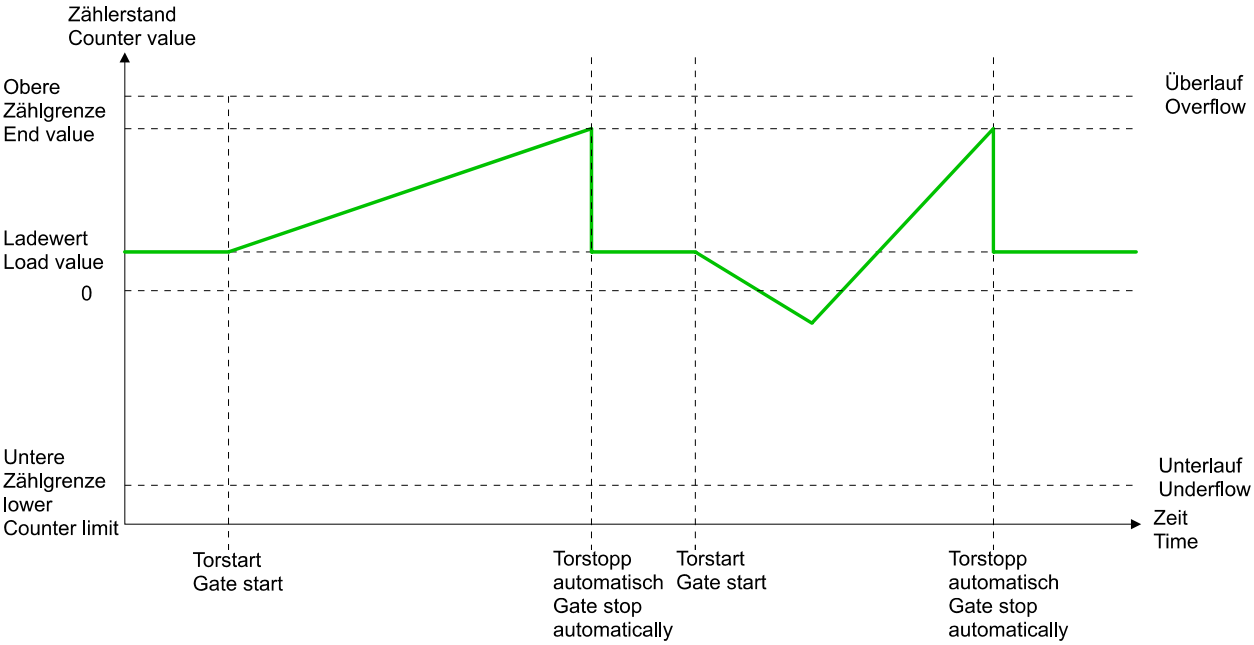


*Fig. 4-4: Operating mode **Count once (main counting direction forwards)***

Main counting direction backwards

- The counter counts backwards starting from the ***load value***.
- If the counter reaches the ***end value*** +1 in the negative direction, it jumps after the next counter pulse to the ***load value*** and the internal gate is closed automatically. If enabled, a process interrupt is triggered additionally.
- To restart counting you have to open the internal gate again. The counter starts with the ***load value***.
- The counter counts beyond the upper count limit.

Limits	Valid value range
End value	-2 147 483 648 (-2^{31}) ... +2 147 483 646 (2^{31}-2)
Upper count limit	2 147 483 647 (2^{31}-1)

Tab. 4-27: Counting range

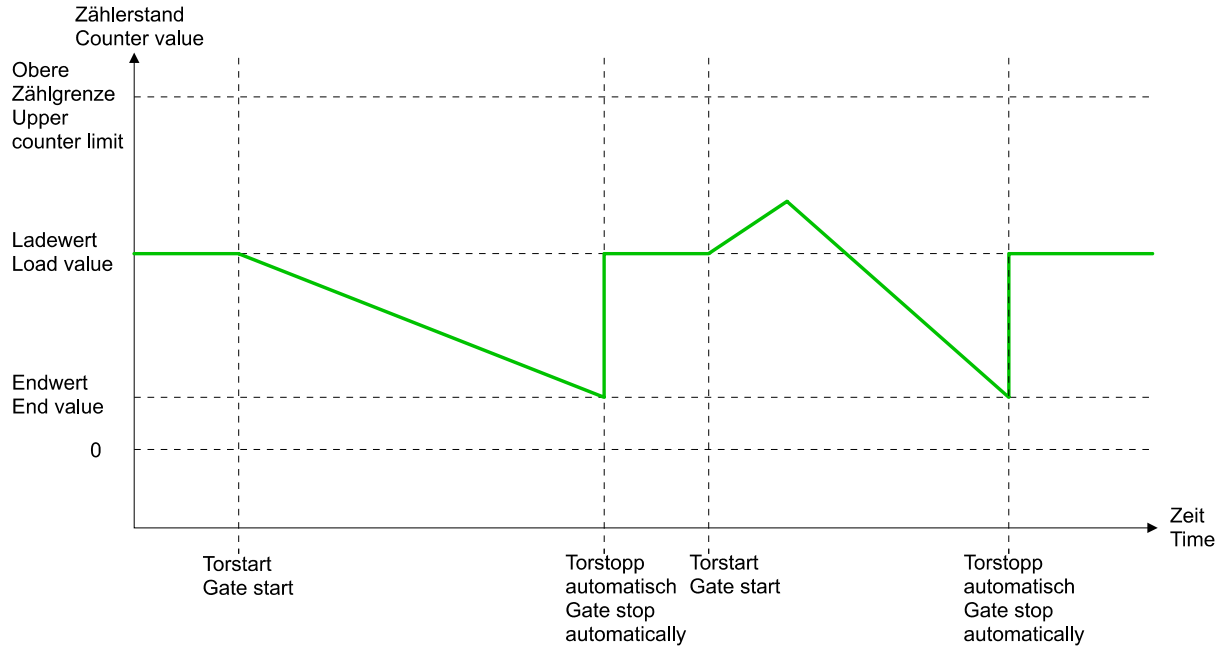


*Fig. 4-5: Operating mode **Count once (main counting direction backwards)***

Periodical count

No main counting direction

- The counter counts from the ***load value*** forwards or backwards.
- In case of overflow or underflow at the corresponding count limit, the counter jumps to the ***load value*** and continues counting from there. If enabled, a process interrupt is triggered additionally.
- The count limits are set fixedly to the maximum counting range.

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

Tab. 4-28: Counting range

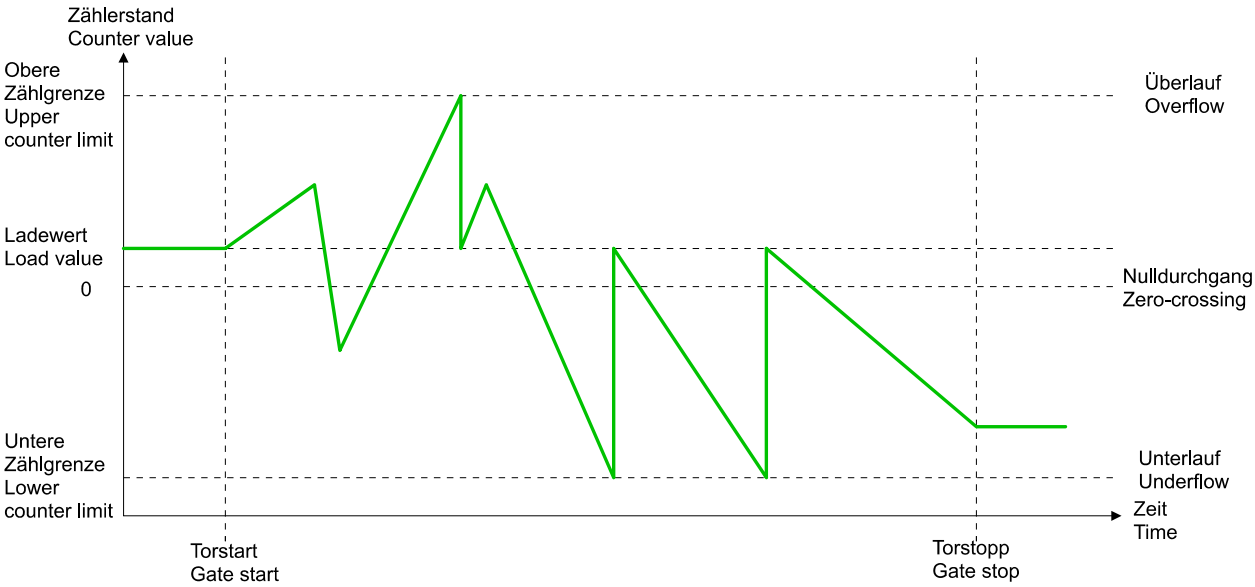


*Fig. 4-6: Operating mode **Periodical count (no main counting direction**)*

Main counting direction

- The counter counts forwards starting with the ***load value***.
- If the counter reaches the ***end value*** -1 in the positive direction, it jumps after the next counter pulse to the ***load value*** and the internal gate is closed automatically. If enabled, a process interrupt is triggered additionally.
- The counter counts beyond the lower count limit.

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

Tab. 4-29: Counting range

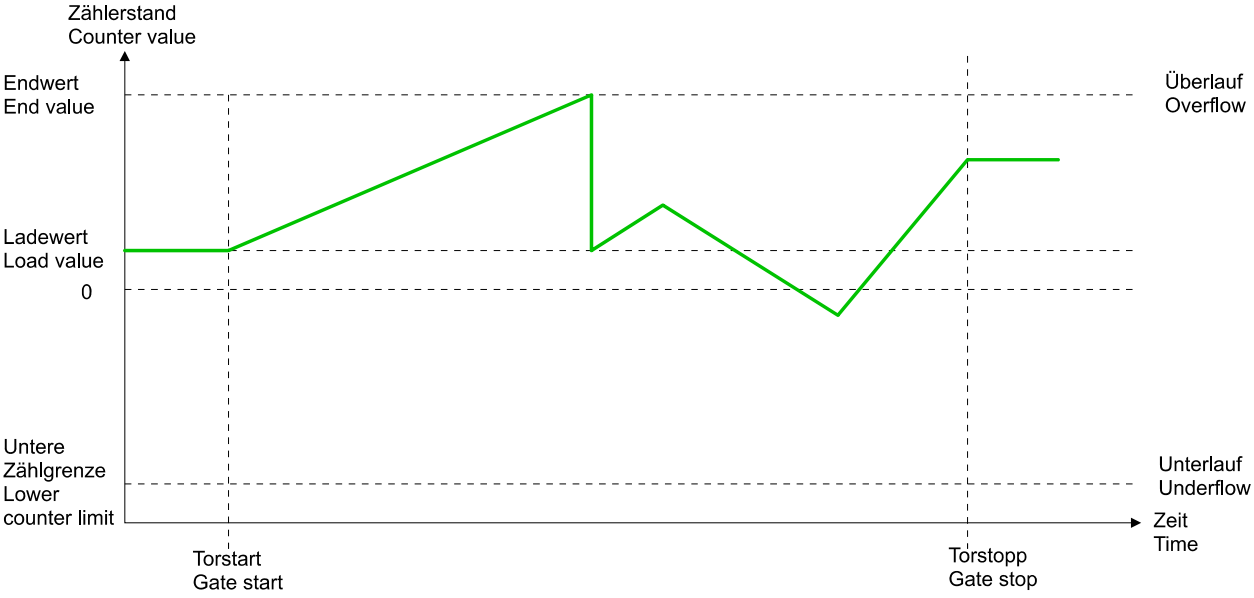


*Fig. 4-7: Operating mode **Periodical count (main counting direction forwards**)*

Main counting direction backwards

- The counter counts backwards starting from the ***load value***.
- If the counter reaches the ***end value*** +1 in the negative direction, it jumps after the next counter pulse to the ***load value*** and the internal gate is closed automatically. If enabled, a process interrupt is triggered additionally.
- The counter counts beyond the upper count limit.

Limits	Valid value range
End value	-2 147 483 648 (-2^{31}) ... +2 147 483 646 (2^{31}-2)
Upper count limit	2 147 483 647 (2^{31}-1)

Tab. 4-30: Counting range

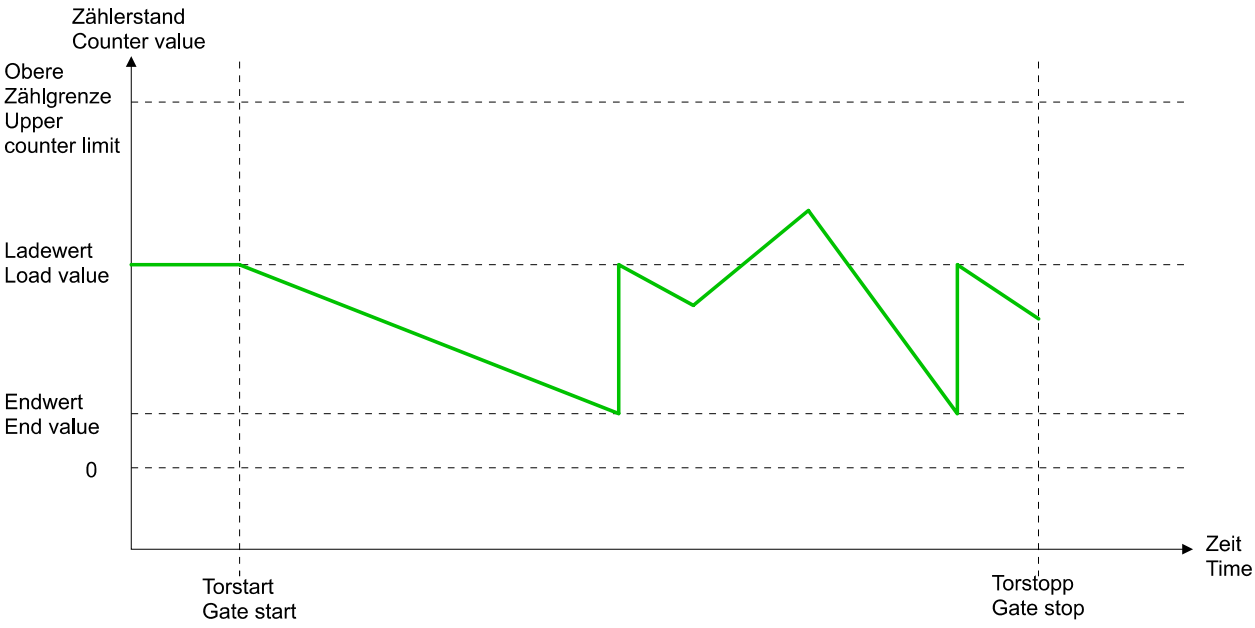


*Fig. 4-8: Operating mode **Periodical count (main counting direction backwards**)*

4.7 Additional functions Counter

Overview

The additional functions can be set using parameterization.

- ***Gate function***
  The gate function starts, stops and interrupts a counting function.
- ***Latch function***
  Once a 0-1 edge is available at the latch input, the current counter value is saved in the Latch register.
- ***Comparator***
  Here you enter a ***comparison value*** which enables the digital output depending on the ***counter value*** or triggers a process interrupt.
- ***Hysteresis***
  Specification of a ***hysteresis*** prevents, for example frequent switching operations of the output and/or triggering of the interrupts if the value of an encoder signal fluctuates around the ***comparison value***.

Schematic view

The figure shows how the additional functions affect the counting behavior. These additional functions are explained in detail on the following pages:

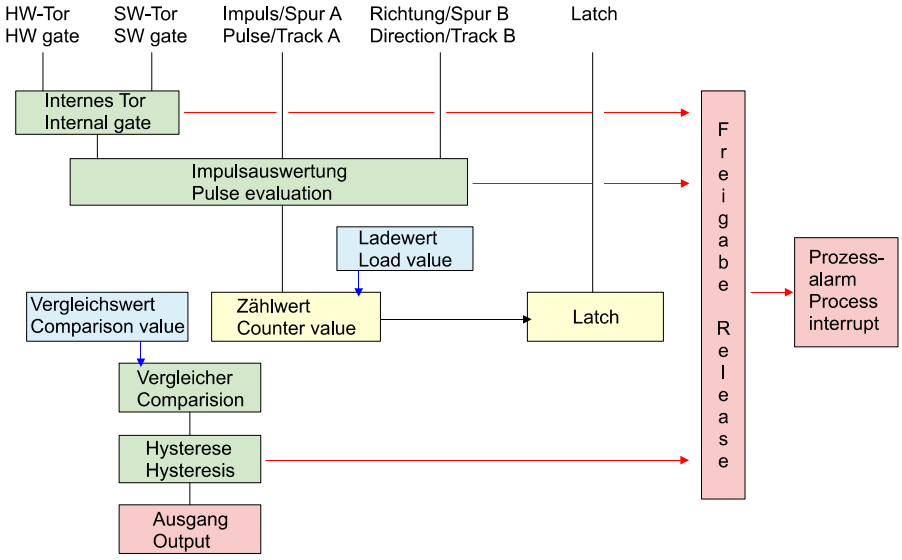


Fig. 4-9: Schematic view

Gate function

- ➔ You enable or disable the counter by means of an internal gate (***I gate***). The ***I gate*** is the logical AND linking of software gate (***SW gate***) and hardware gate (***HW gate***).
- ➔ The ***SW gate*** is opened (activated) in the user program using a 0-1 edge at SW_GATE_SET bit in the output range in CCTRL_I.
- ➔ Use a 0-1 edge at bit SW_GATE_RESET to close (deactivate) the ***SW gate*** again.
- ➔ The ***HW gate*** is controlled by means of the digital gate input.
- ➔ Use the parameterization to disable consideration of the ***HW gate*** so that the counter is enabled only by means of the ***SW gate***.

The following conditions influence the ***I gate***.

SW gate	HW gate	influences the I gate
0	with 0-1 edge	0
1	with 0-1 edge	1
with 0-1 edge	1	1
with 0-1 edge	0	0
with 0-1 edge	disabled	1

Tab. 4-31: Gate function

Aborting and interrupting gate functions

Using the parameterization, define whether the gate aborts or interrupts the counting process.

- With the ***aborting gate function***, the counting process starts with the ***load value*** after the gate restart.

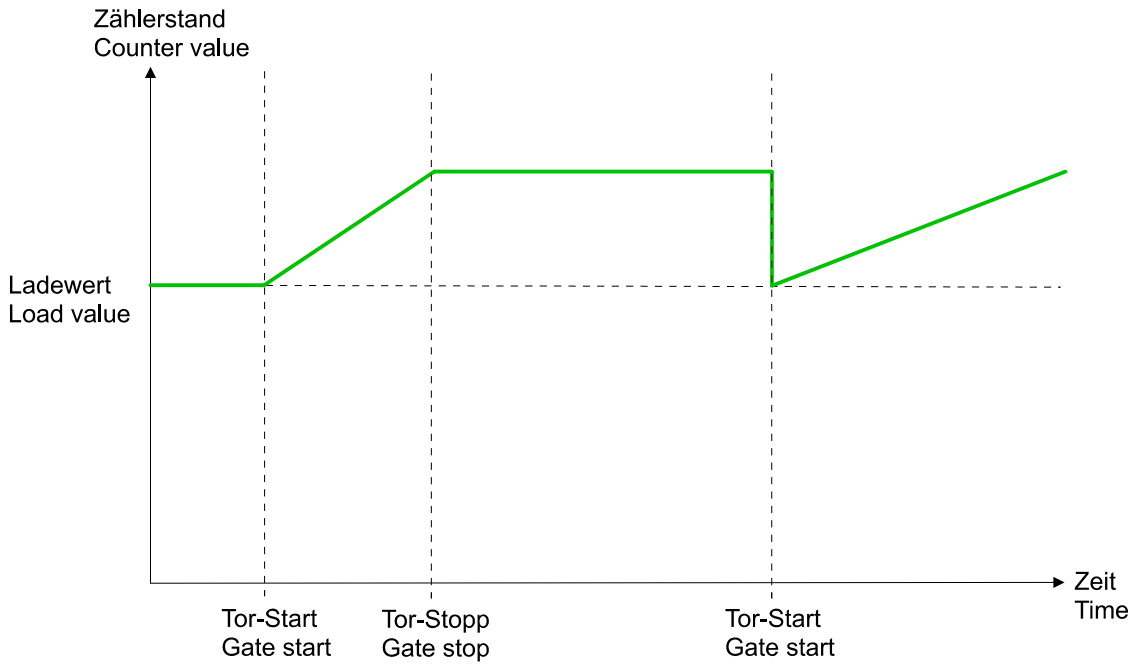


Fig. 4-10: Aborting gate function

- With the ***interrupting gate function***, the counting is continued after the gate start at the current ***counter value***.

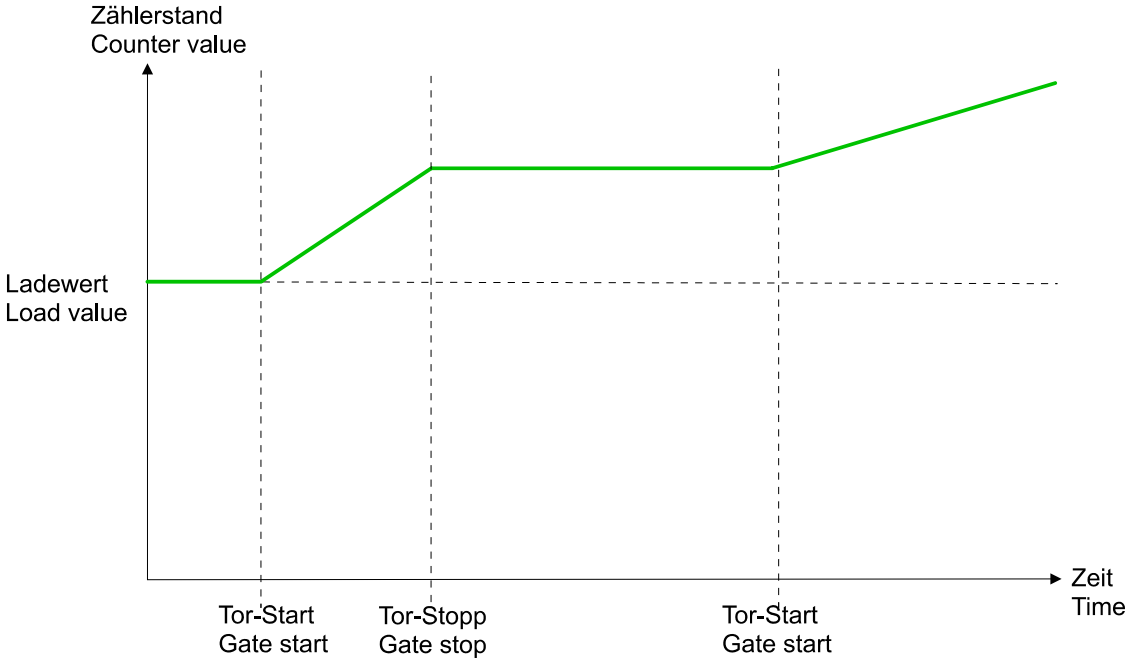


Fig. 4-11: Interrupting gate function

Gate control aborting, interrupting

SW gate	HW gate	Reaction of counter
Edge 0-1	disabled	Restart with ***load value***

*Tab. 4-32: Gate control: using **SW gate**, aborting*

SW gate	HW gate	Reaction of counter
Edge 0-1	disabled	Continuation

*Tab. 4-33: Gate control: using **SW gate**, interrupting*

SW gate	HW gate	Reaction of counter
Edge 0-1	1	Continuation
1	Edge 0-1	Restart with ***load value***

*Tab. 4-34: Gate control: using **SW/HW gate**, aborting*

SW gate	HW gate	Reaction of counter
Edge 0-1	1	Continuation
1	Edge 0-1	Continuation

*Tab. 4-35: Gate control: using **SW/HW gate**, interrupting*

Gate control Counting once

If the internal gate has been closed automatically, it can be opened only under the following conditions:

SW gate	HW gate	Reaction I gate
1	Edge 0-1	1
Edge 0-1 (after 0-1 edge at ***HW gate***)	1	1

*Tab. 4-36: Gate control by means of **SW/HW gate**, operating mode **Count once***

Latch function

If a 0-1 edge occurs during counting at the ***latch*** input, the current ***counter value*** is saved in the latch register.
In the input range you have access to the latch register.
After a STOP-RUN transition, latch is always 0.

Comparator

Define the comparison value using CC_I. If a comparison condition is fulfilled, the STS_DO bit is set in the counter status.

Note that the STS_DO bit can only be controlled if the STS_CTRL_DO bit is set in the counter status.

Using parameterization (MODE2_I), you specify the behavior of the counter output:

- Output does not switch
- Output switches if counter value ≥ comparison value
- Output switches if counter value ≤ comparison value
- Output switches if comparison value

Output does not switch

The output does not switch.

Output switches if counter value ≥ comparison value

As long as the counter value is higher or equal to the comparison value, the output remains set.

Output switches if counter value ≤ comparison value

As long as the counter value is smaller or equal to the comparison value, the output remains set.

Pulse with ***comparison value***

If the counter reaches the comparison value, the output for the parameterized pulse duration is set.

If the pulse duration = 0, the output is set until the comparison condition is no longer fulfilled.

If you have set the main counting direction, the output is switched only after the comparison value from the main counting direction has been reached.

Pulse duration

The ***pulse duration*** specifies how long the output has to be set. It can be pre-selected in steps of 2.048 ms between 0 and 522.24 ms.

The ***pulse duration*** starts with setting the corresponding digital output. The inaccuracy of the ***pulse duration*** is less than 2.048 ms.

The ***pulse duration*** is not retriggered if the ***comparison value*** is complied with and then it is reached again during pulse output.

NOTE
With the STS_DO bit, the STS_CMP bit is set in the counter status. Unlike the STS_DO bit, the STS_CMP bit remains set until it is reset using RES_SET in the ***control word***.

Hysteresis

If the counter value is within the range of the comparison value, the ***hysteresis*** avoids frequent switching of the output and/or triggering of the alarm.

Defining hysteresis between 0 and 255

➔ 0 or 1: Switching off hysteresis

➔ Value between 2 and 255: Activate hysteresis range

*The **Hysteresis** influences the zero crossing, comparison, overflow and underflow.*

An active hysteresis remains active after changing. The new hysteresis range is activated during the next hysteresis event.

The following figures show the behavior of the output with hysteresis 0 and hysteresis 3 for the corresponding conditions.

Mode of action with counter value ≥ comparison value

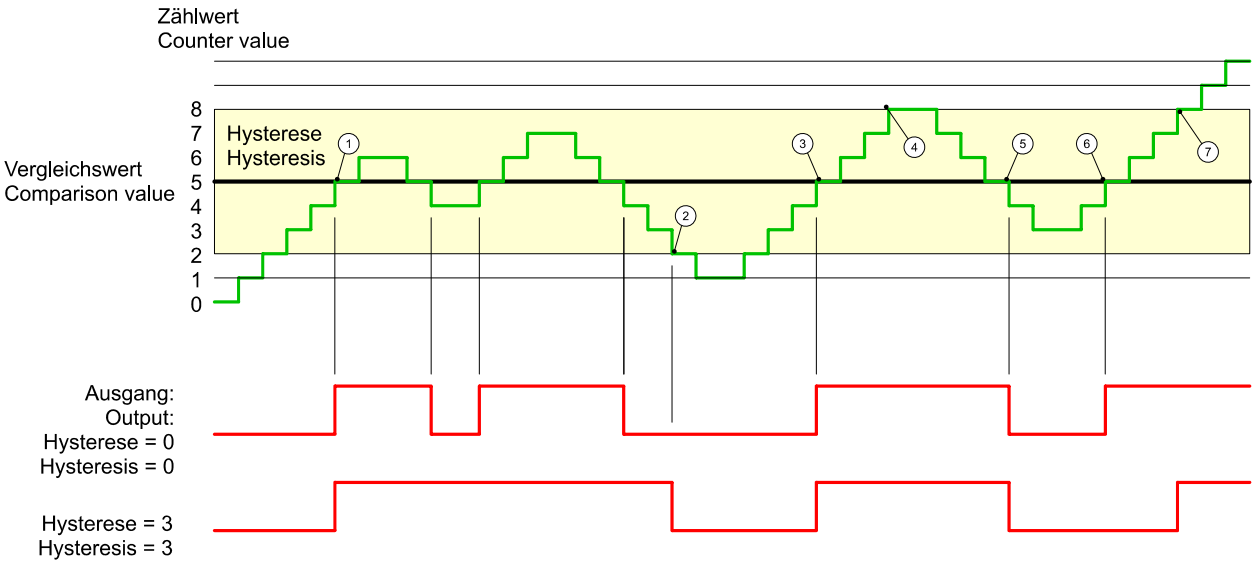


Fig. 4-12: Mode of action

1	Counter value ≥ comparison value	Output is reset and hysteresis is activated
2	Leaving the hysteresis range	Output is reset
3	Counter value ≥ comparison value	Output is reset and hysteresis is activated
4	Leaving the hysteresis range **and** counter value ≥ comparison value	Output remains set
5	Counter value < comparison value **and** hysteresis active	Output is reset
6	Counter value ≥ Comparison value **and** hysteresis activated	Output is not set
7	Leaving the hysteresis range **and** counter value ≥ comparison value	Output is set

Once the comparison condition has been reached, the ***hysteresis*** is activated. With the activated ***hysteresis***, the comparison result remains unchanged until the ***counter value*** leaves the set hysteresis range.
After leaving the hysteresis range, the ***hysteresis*** is activated again only if the comparison conditions are reached.

Mode of action with pulse duration zero

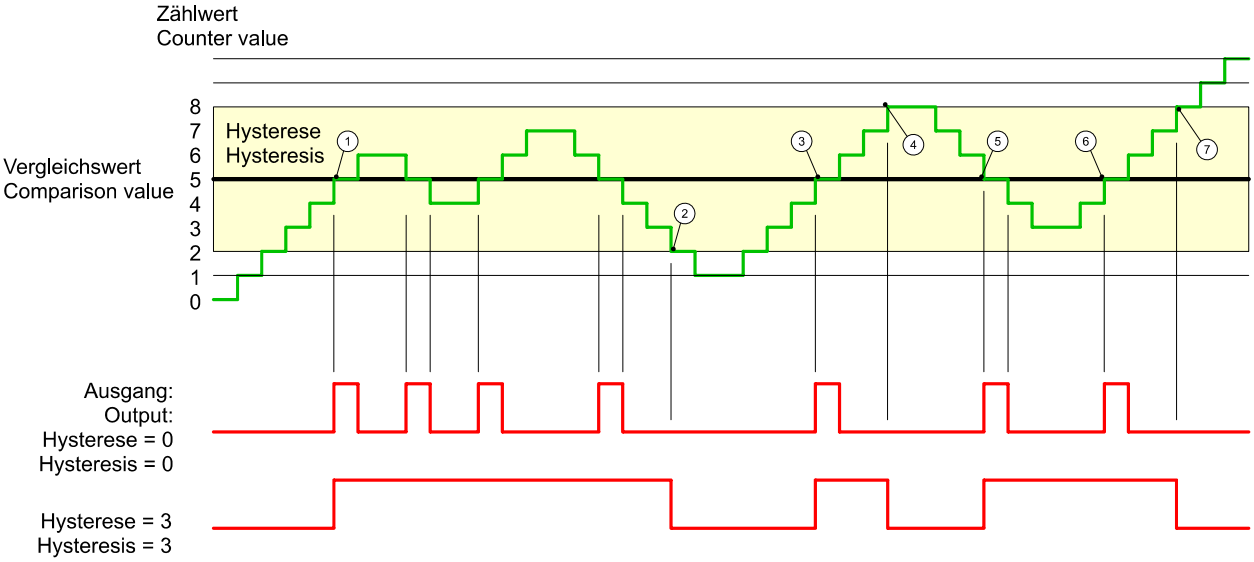


Fig. 4-13: Mode of action

1	Counter value = comparison value	Output is reset and hysteresis is activated
2	Leaving the hysteresis range	Output is reset and counter < comparison value
3	Counter value = comparison value	Output is reset and hysteresis is activated
4	Leaving the hysteresis range **and** counter value > comparison value	Output is reset
5	Counter value = comparison value	Output is reset and hysteresis is activated
6	Counter value = comparison value **and** hysteresis enabled	Output remains set
7	Leaving the hysteresis range **and** counter value > comparison value	Output is reset

Once the comparison condition has been reached, the ***hysteresis*** is activated. With the activated ***hysteresis***, the comparison result remains unchanged until the ***counter value*** leaves the set hysteresis range.
After leaving the hysteresis range, the ***hysteresis*** is activated again only if the comparison conditions are reached.

Mode of action with pulse duration unequal zero

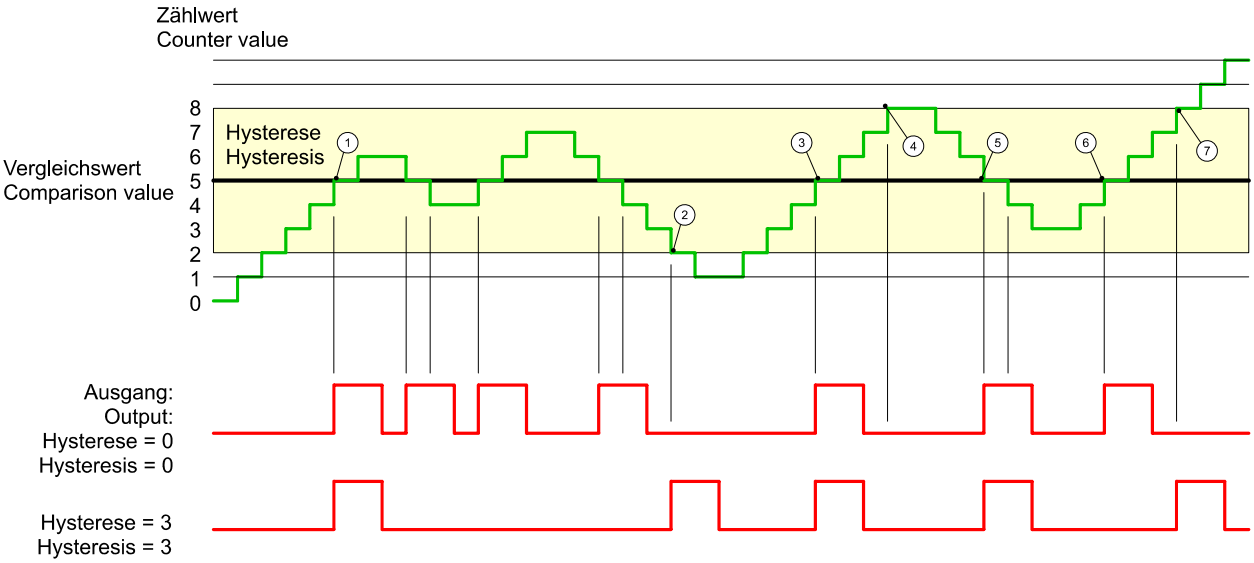


Fig. 4-14: Mode of action

1	Counter value = comparison value	Pulse of the parameterized duration is output, the hysteresis activated and the counting direction is saved.
2	Leaving the hysteresis range against the saved counting direction.	Pulse of the parameterized pulse duration is output and the hysteresis is deactivated.
3	Counter value = comparison value	Pulse of the parameterized pulse duration is output, the hysteresis activated and the counting direction is saved.
4	Hysteresis range is left without changing the counting direction.	Hysteresis is deactivated.
5	Counter value = comparison value	Pulse of the parameterized pulse duration is output, the hysteresis activated and the counting direction is saved.
6	Counter value = comparison value **and** hysteresis active	No pulse
7	Leaving the hysteresis range against the saved counting direction.	Pulse of the parameterized pulse duration is output and the hysteresis is deactivated.

Once the comparison condition has been reached, the ***hysteresis*** is activated and a pulse of the parameterized duration is output.

As long as the counter value is within the hysteresis range, no further pulse is output. Activation of the hysteresis defines the counting direction in the module.

If the counter value leaves the hysteresis range against the saved counting direction, a pulse of the parameterized duration is output.

If the hysteresis range is left without changing the direction, no pulse is output.

4.8 Diagnosis and interrupt

Overview

Trigger	Process interrupt	Diagnostic interrupt	programmable
HW gate open	x	-	x
HW gate closed	x	-	x
Overflow	x	-	x
Underflow	x	-	x
Comparison value	x	-	x
End value	x	-	x
Latch value	x	-	x
Diagnostic buffer overflow	-	x	-
Process interrupt lost	-	x	x
Overload at output	-	x	x

Tab. 4-37: Overview Alarms

Process interrupt data

Activate the process interrupts in order to respond to asynchronous events. A process interrupt stops the linear program sequence and branches depending on the master system into a certain interrupt routine. Here you can respond to the process interrupt.

CANopen transmits the process interrupt data in an Emergency telegram.

If CPU, PROFIBUS and PROFINET are used for access, they transmit this process interrupt data in a diagnosis telegram.

SX = Subindex for access via EtherCAT.

Name	Bytes	Function	Default	SX
PRIT_A	1	Process interrupt data	0x00	0x02
PRIT_B	1	Status of the inputs	0x00	0x03
PRIT_US	2	µs ticker	0x00	0x04 ... 0x05

Tab. 4-38: Process interrupts

PRIT_A
Process interrupt data

Byte	Bit 7 ... 0	Description
0		Process interrupt data
	0	HW gate open
	1	HW gate closed
	2	Overflow, underflow or end value reached
	3	Comparison value reached
	4	Latch value reached
	7 ... 5	reserved

Tab. 4-39: Process interrupt data

PRIT_B
Status of the inputs

Byte	Bit 7 ... 0	Description
0		Status of the inputs at the moment of process interrupt
	0	Input value channel 0 (trackA)
	1	Input value channel 1 (trackB)
	2	Input value channel 2 (latch)
	3	Input value channel 3 (HW gate)
	4	Input value channel 4 (reset)
	7 ... 5	reserved

Tab. 4-40: Status of the inputs

PRIT_US
µs ticker

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

Tab. 4-41: µs ticker

Diagnostic data

Using Parameterization activate a diagnostic interrupt for the module.

Function

- Upon triggering of a diagnostic interrupt, the module provides $_{incoming}$ diagnosis data for diagnosis.
- As soon as the reasons for triggering of a diagnosis interrupt are no longer present, you receive an $_{outgoing}$ diagnostic interrupt automatically.
- If an $_{incoming}$ diagnostic interrupt has been triggered for a channel due to Process interrupt lost, all events up to a certain $_{outgoing}$ diagnostic interrupt will be lost.
- The MF-LED of the module is lit during this period (from the 1st $_{incoming}$ diagnostic interrupt until the last $_{outgoing}$ diagnostic interrupt).

DS Data record for access using CPU, PROFIBUS and PROFINET
Access using DS 0x01
Besides, you can access the first 4 bytes using DS 0x00.

IX Index for access using CANopen
Access using IX 0x2F01.
Besides, you can access the first 4 Bytes using IX 0x2F00

SX Subindex for access via EtherCAT

Name	Bytes	Function	Default	DS	IX	SX
ERR_A	1	Diagnostics	0x00	0x01	0x2F01	0x02
MODTYP	1	Module information	0x18			0x03
ERR_C	1	reserved	0x00			0x04
ERR_D	1	Diagnostics	0x00			0x05
CHTYP	1	Channel type	0x76			0x06
NUMBIT	1	No. of diagnostic bits per channel	0x08			0x07
NUMCH	1	Number of channels of the module	0x01			0x08
CHERR	1	Channel error	0x00			0x09
CH0ERR	1	Channel-specific error	0x00			0x0A
CH1ERR ... CH7ERR	7	reserved	0x00			0x0B ... 0x11
DIAG_US	4	µs ticker	0x00			0x12

Tab. 4-42: Diagnostic data

ERR_A
Diagnostics

Byte	Bit 7 ... 0	Description
0	0	set in case of ***Assembly fault***
	1	reserved
	2	set in case of ***External error***
	3	set in case of ***Channel error available***
	4	set in case of ***Overload at output***
	7 ... 5	reserved

Tab. 4-43: Diagnostics

MODTYP
Module information

Byte	Bit 7 ... 0	Description
0	3 ... 0	Module class 1000b Function module
	4	set if ***Channel information available***
	7 ... 5	reserved

Tab. 4-44: Module information

ERR_C
reserved

Byte	Bit 7 ... 0	Description
0		reserved

Tab. 4-45: ERR_C

ERR_D
Diagnosis

Byte	Bit 7 ... 0	Description
0	2 ... 0	reserved
	3	set in case of ***Internal diagnosis buffer overflow***
	5 ... 4	reserved
	6	Process interrupt lost
	7	reserved

Tab. 4-46: Diagnosis

CHTYP
Channel type

Byte	Bit 7 ... 0	Description
0	6 ... 0	Channel type
		0x76 Counter module
	7	reserved

Tab. 4-47: Channel type

NUMBIT
Diagnostic bits

Byte	Bit 7 ... 0	Description
0	7 ... 0	Number of diagnostic bits of the module per channel (here 0x08)

Tab. 4-48: Diagnostic bits

NUMCH
Channels

Byte	Bit 7 ... 0	Description
0	7 ... 0	Number of channels of a module (here 0x01)

Tab. 4-49: Channels

CHERR
Channel error

Byte	Bit 7 ... 0	Description
0	0	set in case of error of channel group 0
	7 ... 1	reserved

Tab. 4-50: Channel error

CH0ERR
Channel-specific diagnostics

Byte	Bit 7 ... 0	Description
0		Diagnostic interrupt due to process interrupt lost at ...
	0	HW gate open
	1	HW gate closed
	2	Overflow, underflow or end value
	3	Comparison value reached
	4	Latch value saved
	7 ... 5	reserved

Tab. 4-51: Channel-specific diagnostics

CH1ERR ...
CH7ERR
reserved

Byte	Bit 7 ... 0	Description
0		reserved

Tab. 4-52: CH1ERR ... CH7ERR

DIAG_US
µs ticker

Byte	Bit 7 ... 0	Description
0 ... 3	7 ... 0	Value of the µs ticker when generating diagnostic data

Tab. 4-53: µs ticker

5 General data

Conformity			
	CE	2004/108/EC	EMC Directive
		2011/65/EU	RoHS
Personal and device protection			
	Ingress protection	EN 60529	IP20
	Electric isolation		
	To fieldbus	-	DC-isolated
	To process level	-	DC-isolated
	Dielectric strength	EN 61131-2	-
	Insulation voltage to ground		
	Inputs / outputs	-	50 V AC/DC, with test voltage 500 V AC
	Protective measures	-	against short-circuit
Ambient conditions			
	Climatic		
	Storage / transport	EN 60068-2-14	-25 … +70 °C
	Operation		
	Horizontal installation	EN 61131-2	0 … +60 °C
	Vertical installation	EN 61131-2	0 … +60 °C
	Humidity	EN 60068-2-30	RH1 (without condensation, relative humidity 10 … 95 %)
	Pollution	EN 61131-2	Pollution degree 2
	Mechanical		
	Vibration	EN 60068-2-6	1 g, 9 Hz ... 150 Hz
	Shock	EN 60068-2-27	15 g, 11 ms
Installation conditions			
	Place of installation	-	Inside the switch cabinet
	Installation position	-	Horizontal and vertical
	Fastening	-	35 mm DIN rail

Mechanical data	**Housing**	
	Material	PPE / PPE GF10
	Dimensions (W x H x D)	12.9 x 109 x 76.5 mm
	Weight	60 g
Ambient conditions		
	Operating temperature	0 °C to 60 °C
	Storage temperature	-25 °C to 70 °C
Certifications		
	Certification according to UL 508	yes

EMC / Standard			Notes
	Emitted interference	EN 61000-6-4	Class A (industrial environments)
	Immunity Zone B	EN 61000-6-2	Industrial environments
		EN 61000-4-2	ESD 8 kV with air discharge (severity grade 3), 4 kV with contact discharge (severity grade 2)
		EN 61000-4-3	HF irradiation (housing) 80 MHz ... 1000 MHz, 10 V/m, 80 % AM (1 kHz) 1.4 GHz ... 2.0 GHz, 3 V/m, 80 % AM (1 kHz) 2 GHz ... 2.7 GHz, 1 V/m, 80 % AM (1 kHz)
		EN 61000-4-6	conducted 150 kHz … 80 MHz, 10 V, 80 % AM (1 kHz)
		EN 61000-4-4	Burst, severity grade 3
		EN 61000-4-5	Surge, installation class 3 *)

*) Due to single high-energy impulses, a suitable external wiring with lightning protection elements is required for surge, e.g. lightning arresters and surge arrester.

6 Technical data

Power consumption / power dissipation		
	Power consumption from the backplane bus	75 mA
	Power dissipation	1 W

Digital inputs		
	Number of inputs	5
	Cable length shielded	100 m
	Cable length unshielded	-
	Nominal load voltage	20.4...28.8 V DC
	Reverse polarity protection of the nominal load voltage	-
	Power consumption from load voltage L+ (without load)	20 mA
	Nominal value	20.4...28.8 V DC
	Input voltage for signal "0"	0...5 V DC
	Input voltage for signal "1"	15...28.8 V DC
	Input voltage hysteresis	-
	Frequency range	-
	Input resistance	-
	Input current for signal "1"	3 mA
	Connection of 2-wire BEROs possible	yes
	max. permitted BERO quiescent current	0.5 mA
	Input delay of "0" after "1"	0.8 µs
	Input delay of "1" after "0"	0.8 µs
	Number of inputs in horizontal installation that can be used simultaneously	5
	Number of inputs in vertical installation that can be used simultaneously	5
	Input characteristic	IEC 61131, type 1
	Input data size	12 bytes

Digital outputs		
	Number of outputs	1
	Cable length shielded	100 m
	Cable length unshielded	100 m
	Nominal load voltage	20.4...28.8 V DC
	Power consumption from load voltage L+ (without load)	-
	Output current at signal "1", nominal value	0.5 A
	Output delay from "0" to "1"	30 µs
	Output delay from "1" to "0"	30 µs
	Minimum load current	-
	Lamp load	10 W
	Parallel connection of outputs for the redundant actuation	not possible
	Parallel connection of outputs for the redundant actuation to increase the output capacity	not possible
	Actuation of a digital input	yes
	Switching frequency with resistive load	max. 10 Hz
	Switching frequency with inductive load	max. 0.5 Hz
	Switching frequency with lamp load	max. 10 Hz
	Limiting (internal) of inductive interrupt voltage	L+ (-52 V)
	Short-circuit protection of the output	yes, electronically
	Response threshold of the protection	1 A
	Number of operating cycles of the relay outputs	-
	Switching capacity of the relay contacts	-
	Output data size	10 bytes

Counter		
	Number of counters	1
	Counter width	32 bits
	Maximum input frequency	100 kHz
	Maximum counting frequency	400 kHz
	Operating mode Incremental encoder	yes
	Operating mode Pulse/Direction	yes
	Operating mode Pulse	-
	Operating mode Frequency measurement	-
	Operating mode Period duration measurement	-
	Gate connection possible	yes
	Latch connection possible	yes
	Reset connection possible	yes
	Counter output possible	yes
Status, alarm, diagnosis		
	Status indication	yes
	Alarms	yes, programmable
	Process alarm	yes, programmable
	Diagnostic interrupt	yes, programmable
	Diagnostic function	yes, programmable
	Diagnosis information readable	possible
	Module status	Green LED
	Module error	Red LED
	Channel error	none
Electrical isolation		
	between the channels	-
	between the channels in groups of	-
	between the channels and backplane bus	yes
	between the channels and power supply	-
	max. potential difference between the circuits	-
	max. potential difference between the inputs (Ucm)	-
	max. potential difference between Mana and Mintern (Uiso)	-
	max. potential difference between the inputs and Mana (Ucm)	-
	max. potential difference between the inputs and Mintern (Uiso)	-
	max. potential difference between Mintern and outputs	-
	Insulation tested with	500 V DC
Data sizes		
	Input bytes	12
	Output bytes	10
	Parameter bytes	25
	Diagnostic bytes	20

7 Annex

7.1 Accessories

Bus cover
Art. no. 57190

Fig. 7-1: Bus cover

Carrier for shield busses

The shield busses (10 mm x 3 mm) to connect cable shields are fastened on the carrier.

NOTE
Carriers for shield busses, shield busses and cable shield fasteners are not included in the delivery.

Installing the carrier

✓ Prerequisite: The Cube20S system has been completely mounted.

➔ If the DIN rail is flat, break the spacer off the carrier.

➔ Plug the carrier in the terminal module below the terminal block until it engages.

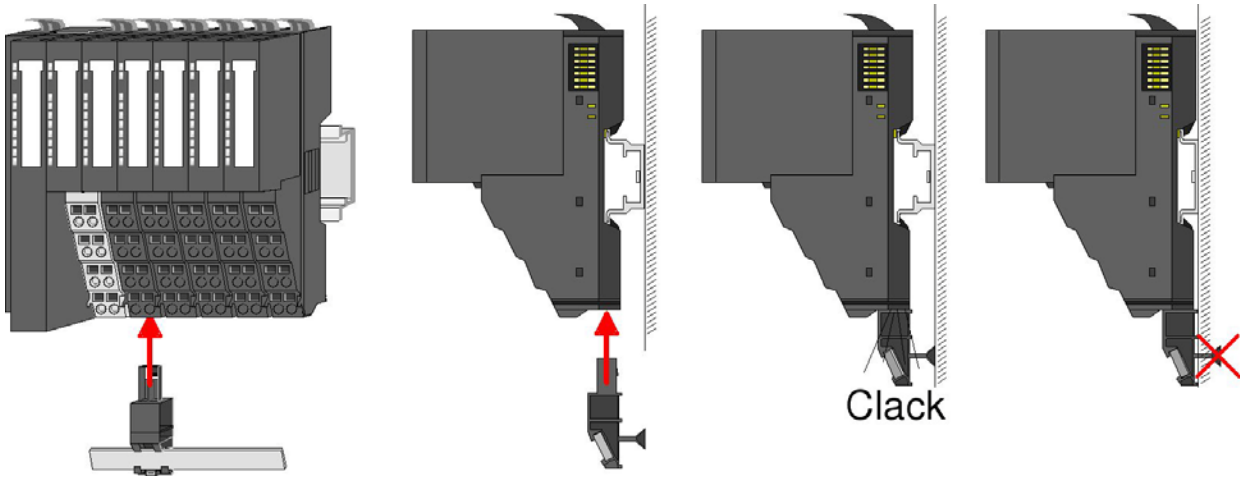


Fig. 7-2: Installing the carriers for shield busses

7.2 Glossary

General terms:

Term	Meaning
Intended purpose	Use of a product, process, or feature according to the specifications, instructions, and information supplied by the MANUFACTURER.
Bit	Binary digit
Byte	1 byte corresponds to 8 bit
DI	Digital inputs
DIN	Deutsches Institut für Normung (German Institute for Standardization)
I/O	Input/Output
Directive 2004/108/CE	EMC Directive
EMC	Electromagnetic compatibility
EN	European standard
ESD	Electrostatic discharges
FE	Functional earth
I	Current
IEC	International Electrotechnical Commission, international standardization institute
IN	Input
IP20	Ingress Protection, protection class according to DIN EN 60529 1st code digit = Protection against accidental contact and solid foreign objects 2nd code digit = Protection against ingress of water 2: protected against: solid foreign objects with diameter starting from 12.5 mm and contact with a finger. 0: No protection
IP67	6: Dustproof, protection against contact with a wire 7: Protection against the effects of temporary submersion in water
ISO	International Standard Organization
LED	Light Emitting Diode
n. c.	not connected
OUT	Output
PELV	Protective Extra Low Voltage
SELV	Safety Extra Low Voltage
U	Voltage
U/I	Voltage / current

7.3 Legal information

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