Operating Instructions Edition 02/2007

Expansion components

Central PC I/O expansion

industrial pc

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Industrial PC

Expansion components
Central PC I/O expansion

Operating Instructions

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2/2007
J31069-D0319-U001-A1-7618

Safety Guidelines

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

Danger

indicates that death or severe personal injury **will** result if proper precautions are not taken.

Warning

indicates that death or severe personal injury **may** result if proper precautions are not taken.

Caution

with a safety alert symbol, indicates that minor personal injury can result if proper precautions are not taken.

Caution

without a safety alert symbol, indicates that property damage can result if proper precautions are not taken.

Notice

indicates that an unintended result or situation can occur if the corresponding information is not taken into account.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The device/system may only be set up and used in conjunction with this documentation. Commissioning and operation of a device/system may only be performed by **qualified personnel**. Within the context of the safety notes in this documentation qualified persons are defined as persons who are authorized to commission, ground and label devices, systems and circuits in accordance with established safety practices and standards.

Prescribed Usage

Note the following:

Warning

This device may only be used for the applications described in the catalog or the technical description and only in connection with devices or components from other manufacturers which have been approved or recommended by Siemens. Correct, reliable operation of the product requires proper transport, storage, positioning and assembly as well as careful operation and maintenance.

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1 About this document

1.1 Overview

The central input/output (CIO) expansion can be used to add encoder inputs and associated counters, digital and analog inputs and outputs to a SIMATIC Microbox PC 42x or a SICOMP IMC CPCI system.

Overview

Section		Content
3	Description	Overview of the structure and function of the CIO expansion and its components
4	Application planning	Possible hardware configurations Brief overview of the functions
5	Installation in SIMATIC Microbox PC 42x	Installation of the CIO expansion
6	Installation in the SICOMP IMC system	
7	Configuration and operation	Configuration and operation of CIO Basic information about the associated registers is provided in the corresponding location where possible. Additional information can be found in the "Technical data" and "Examples/Applications" sections.
8	Examples/Applications	Flowcharts showing the structure of the programs for applications
9	Alarm, error, and system messages	Error messages which can be evaluated in the application software.
10	Troubleshooting	If something is not working
11	Technical data	General technical data Interfaces and pin assignments Setup of the available registers, their location in the memory area, and their mode of operation
12	Ordering units	Order numbers of the components
A	Service and support	Service and support addresses
B	ESD guidelines	ESD guidelines and ESD protective measures

1.2 Target group

This document contains information for the following target groups:

- Planners
- Programmers
- Users

1.3 Required background

A general knowledge of the following areas is needed in order to understand this documentation:

- Digital and analog circuitry
- Programming
- Measuring system

1.4 History

The following versions of this documentation have been released to date. The changes apply to the previous version:

Edition	
12/2006	First edition

2 Product-specific information

Notice

CE

The CE marking only applies to use according to the intended purpose in a SIMATIC Microbox PC 420 or in a SICOMP IMC system. The components must be in the defined, unchanged condition as delivered.

Notice

Use of filters

Details of the filters to be used can be found in the "Technical data" section.

See also

Ambient conditions (Page 136)

Description 3

3.1 Product overview

CIO expansion

- CIO stands for central input/output.
- The CIO expansion can be used to add encoder inputs and associated counters as well as analog and digital inputs and outputs to a SIMATIC Microbox PC 42x or a SICOMP IMC CPCI system. The functions of the CIO expansion are identical for both systems but the mechanical structure differs.
- The CIO expansion consists of
  – basic modules with encoder/counter functions and interfaces to the host system
  – I/O modules
  – Mechanical installation components
- The basic module forms the central interface to the host computer and manages the other modules.
- Connection and communication with the host is via a PCI-104 interface or a CPCI interface.

Table 3-1 Functional overview of the CIO components

Module	Description
Basic module (PC IO Base 400 or CPCI-SFT200)	• PCI-104 interface or CPCI interface to host • 4 encoder inputs, can also be used as counters if required • 4 digital inputs • Management of encoder inputs and associated counters and up to 4 I/O modules • Power supply distribution for 4 encoders
Digital I/O module 0 (PC IO MOD Digital 010 or CPCI-EAM220)	• 24 binary inputs • 16 binary outputs
Analog I/O module 0 (PC IO MOD Analog 020 or CPCI-EAM230)	• 8 analog inputs • 8 analog outputs • 4 Pt100 terminals
Encoder expansion rack (PC IO KIT 040)	For expanding a SIMATIC Microbox PC 42x. Connection unit for • 4 encoder inputs • 4 digital inputs • Encoder voltage supply
I/O expansion rack (PC IO KIT 030)	For expanding a SIMATIC Microbox PC 42x. Expansion rack to hold • 2 I/O modules in the Microbox PC 42x system

Expanding a SIMATIC Microbox PC 42x

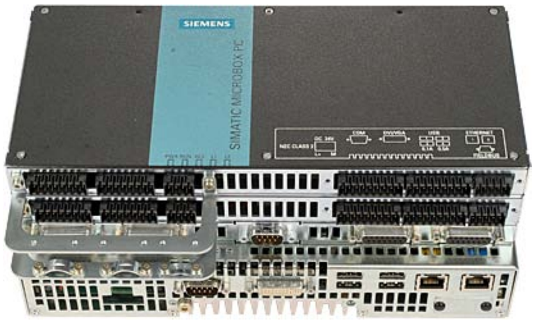


Figure 3-1 Example: Expansion with 1 basic module, 1 encoder expansion rack and 4 I/O modules

Expansion is by means of the following CIO components

- Basic module:
  Installed directly in the SIMATIC Microbox PC 42x
  Connected to the PCI-104 bus
- Encoder expansion rack:
  An encoder expansion rack comprises 4 encoder inputs and 4 digital inputs
- I/O modules:
  Using I/O expansion racks
  An I/O expansion rack can hold two I/O modules

Due to their different overall heights, a maximum of two basic modules is possible. A third basic module can only be used as a pure counter module.

Installation is described in "Installation in SIMATIC Microbox PC 42x".

Expanding a SICOMP IMC CPCI system

Expansion is by means of slide-in modules.

A slide-in module comprises one of the following components:

- Basic module with 4 encoder inputs and 4 digital inputs
- Digital or analog I/O module.

In the full expansion level you can install one basic module with 4 I/O modules.

Installation is described in "Installation in the SICOMP IMC system".

Program examples

Program examples for Windows XP and RMOS3 are available to download from the Internet.

See also

Service and support (Page 205)

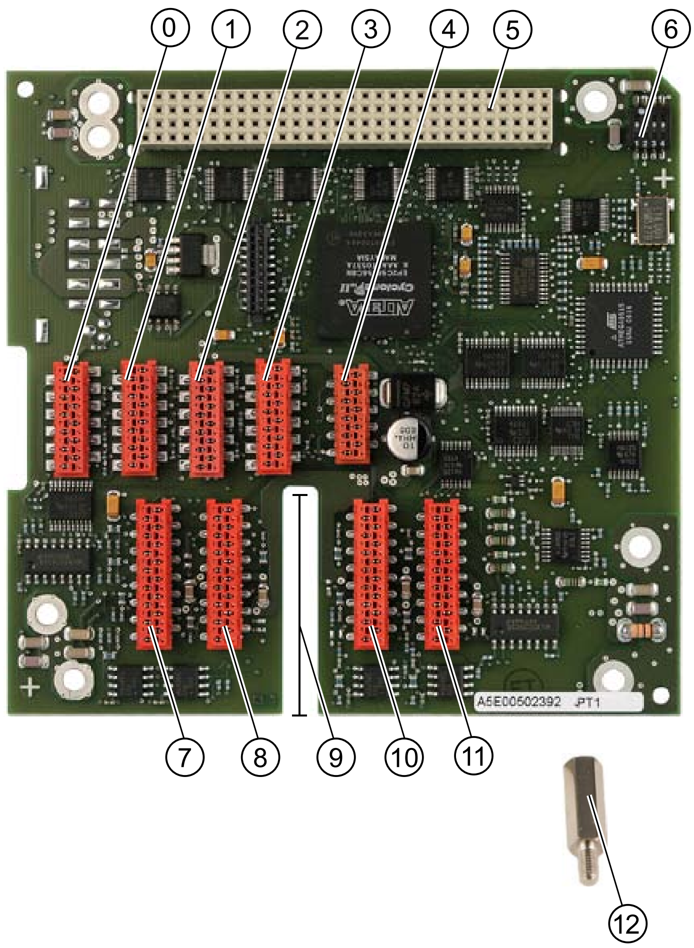
3.2 Structure

3.2.1 Structure of the CIO modules for the SIMATIC Microbox PC 42x

This section describes the modules. Their component interfaces and elements are described in brief.

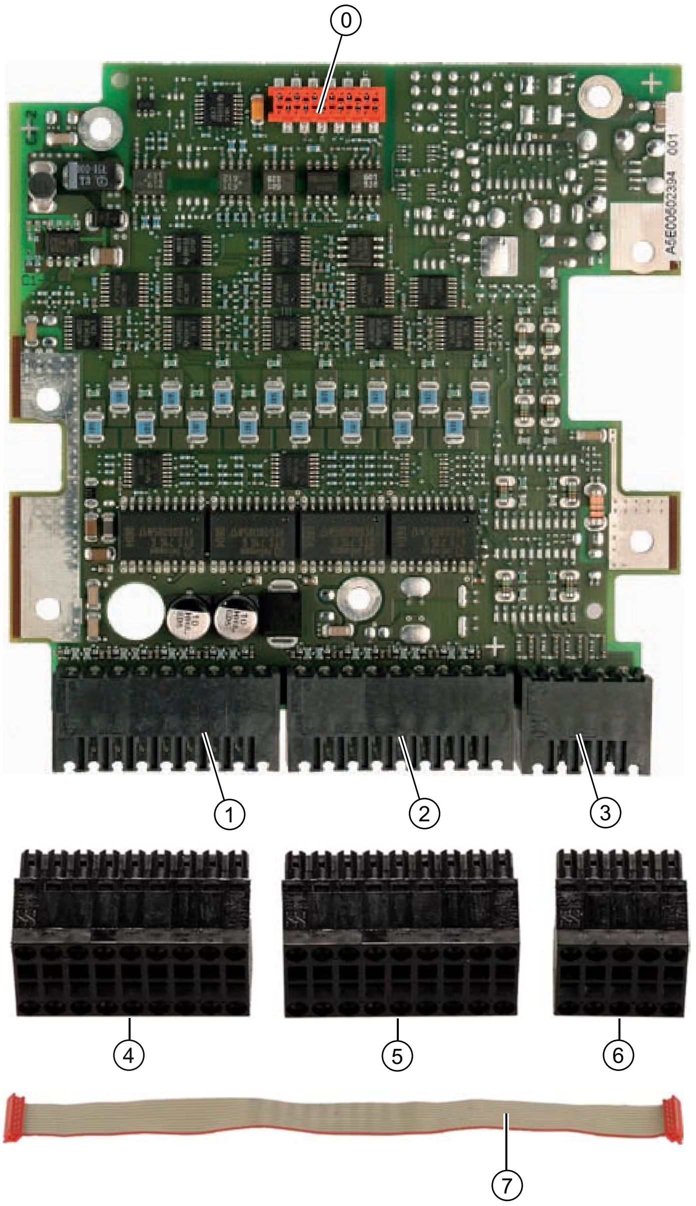
Basic module

Table 3-2 PC IO Base 400: basic module with accessories

Figure	Item	Description
	⓪	Communication to I/O module S0
	①	Communication to I/O module S1
	②	Communication to I/O module S2
	③	Communication to I/O module S3
	④	Encoder power supply interface for • Infeed of encoder supply voltage • Infeed of digital inputs from the encoder expansion rack
	⑤	PCI-104 interface
	⑥	Switch for slot selection on the PCI-104 interface
	⑦	Encoder interface 0
	⑧	Encoder interface 1
	⑨	Cutout for lead-in of flat ribbon cables
	⑩	Encoder interface 2
	⑪	Encoder interface 3
	⑫	M3 stud bolt, 15 mm, width across flats 5 (4)

Digital I/O module 0

Table 3-3 PC IO MOD Digital 010: digital I/O module 0 with accessories

Figure	Item	Description
	⓪	Communication with basic module
	①	Connector DX1: digital inputs 0 to 7 digital outputs 0 to 7
	②	Connector DX2: digital inputs 8 to 15 digital outputs 8 to 15
	③	Connector DX3: digital inputs 16 to 23
	④, ⑤	Mating connector (18-pin) to DX1 and DX2
	⑥	Mating connector (10-pin) to DX3
	⑦	Flat ribbon cable for communication with basic module
	-	Label with pin assignment (not shown)

Analog I/O module 0

Table 3-4 PC IO MOD Analog 020: analog I/O module 0

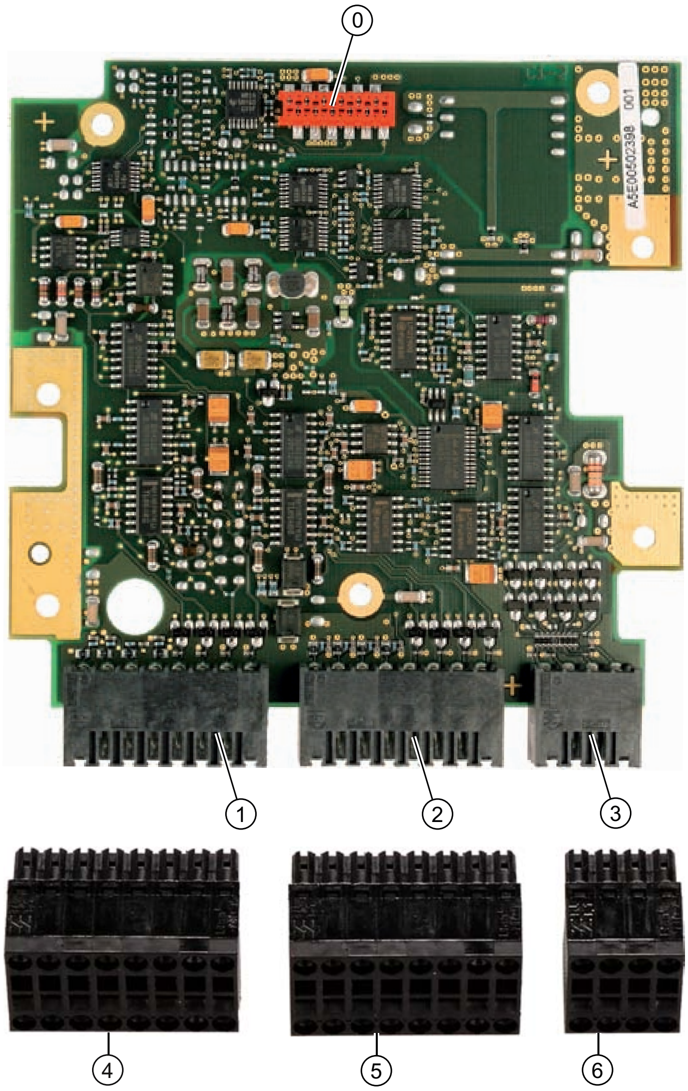
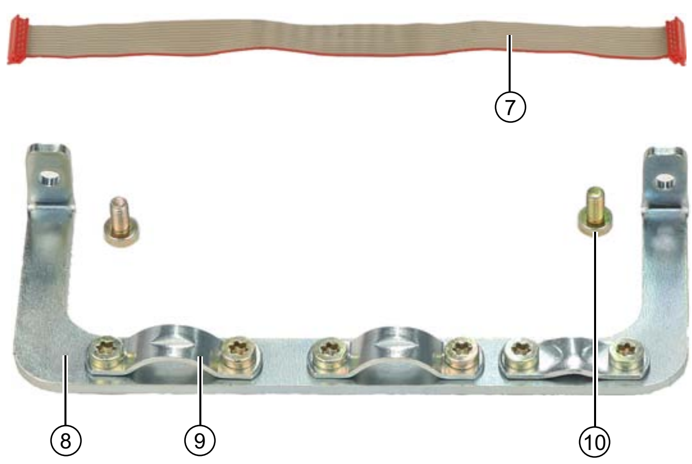
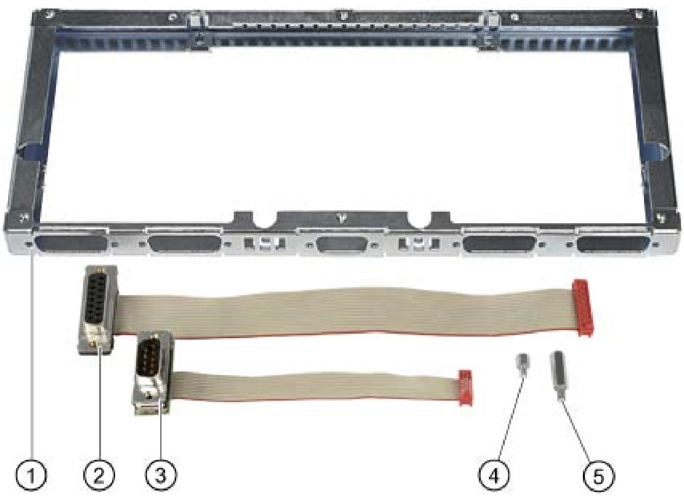
Figure	Item	Description
	⓪	Communication with basic module
	①	Connector AX1: analog inputs 0 to 3 analog outputs 0 to 3
	②	Connector AX2: analog inputs 4 to 7 analog outputs 4 to 7
	③	Connector AX3: Pt100 inputs 0 to 3
	④, ⑤	Mating connector (16-pin) to AX1 and AX2
	⑥	Mating connector (8-pin) to AX3

Table 3-5 PC IO MOD Analog 020: accessories for analog I/O module 0

Figure	Item	Description
	⑦	Flat ribbon cable for communication with basic module
	⑧	Shield clamp
	⑨	Strain-relief assembly for shield connection (3) with associated screws (6)
	⑩	Screw for fitting shield clamp (2)
	-	Label with pin assignment (not shown)

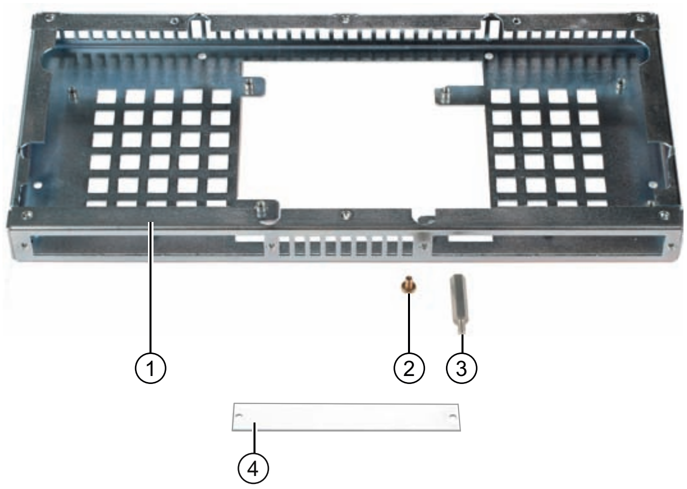
Encoder expansion rack

Table 3-6 PC IO KIT 040: encoder expansion rack with accessories

Figure	Item	Quantity	Description
	①	1	Encoder expansion rack
	②	4	15-pin sub D connector with flat ribbon cable for connecting an encoder
	③	1	9-pin sub D connector with 10-pin flat ribbon cable and adapter board for connecting an encoder power supply interface
	④	10	UNC 4/40 stud bolt for mounting the sub D connector
	⑤	6	15 mm M3 stud bolt (width across flats 5) for mounting the expansion rack
	-	1	Label with pin assignment (not shown)

I/O expansion rack

Table 3-7 PC IO KIT 030: I/O expansion rack accessories

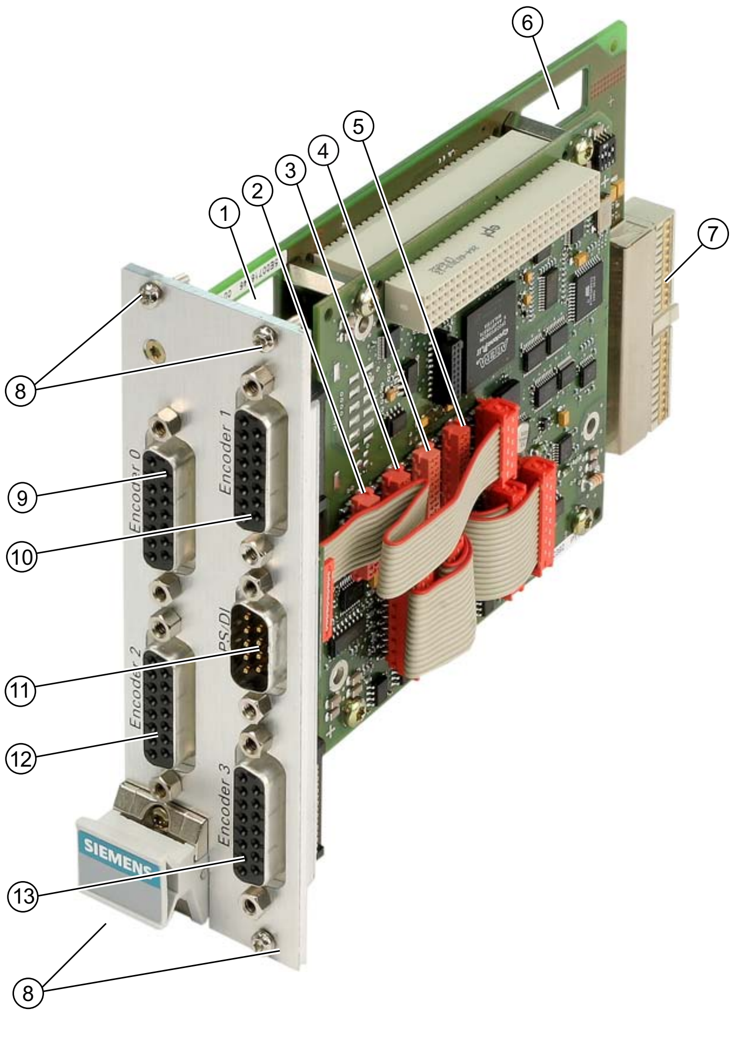
Figure	Item	Quantity	Description
	①	1	I/O expansion rack
	②	10	Screws for mounting the I/O modules
	③	6	21 mm M3 stud bolt (width across flats 5) for mounting the expansion rack
	④	1	Cover plate

3.2.2 Structure of the CIO modules for the SICOMP IMC CPCI system

This section shows the CIO modules for the SICOMP IMC CPCI system. Their component interfaces and elements are described in brief.

Basic module

Table 3-8 CPCI-SFT 200: Basic module

Figure	Item	Description
	①	Front cable duct for flat ribbon cable
	②	Communication to I/O module S0
	③	Communication to I/O module S1
	④	Communication to I/O module S2
	⑤	Communication to I/O module S3
	⑥	Rear cable duct for flat ribbon cable
	⑦	CPCI interface
	⑧	Captive fixing screws (4)
	⑨	Encoder interface 0
	⑩	Encoder interface 1
	⑪	Encoder power supply interface • Infeed of encoder supply voltage • Digital inputs for basic module
	⑫	Encoder interface 2
	⑬	Encoder interface 3

Digital I/O module 0

Table 3-9 CPCI-EAM 220: digital I/O module 0 without accessories

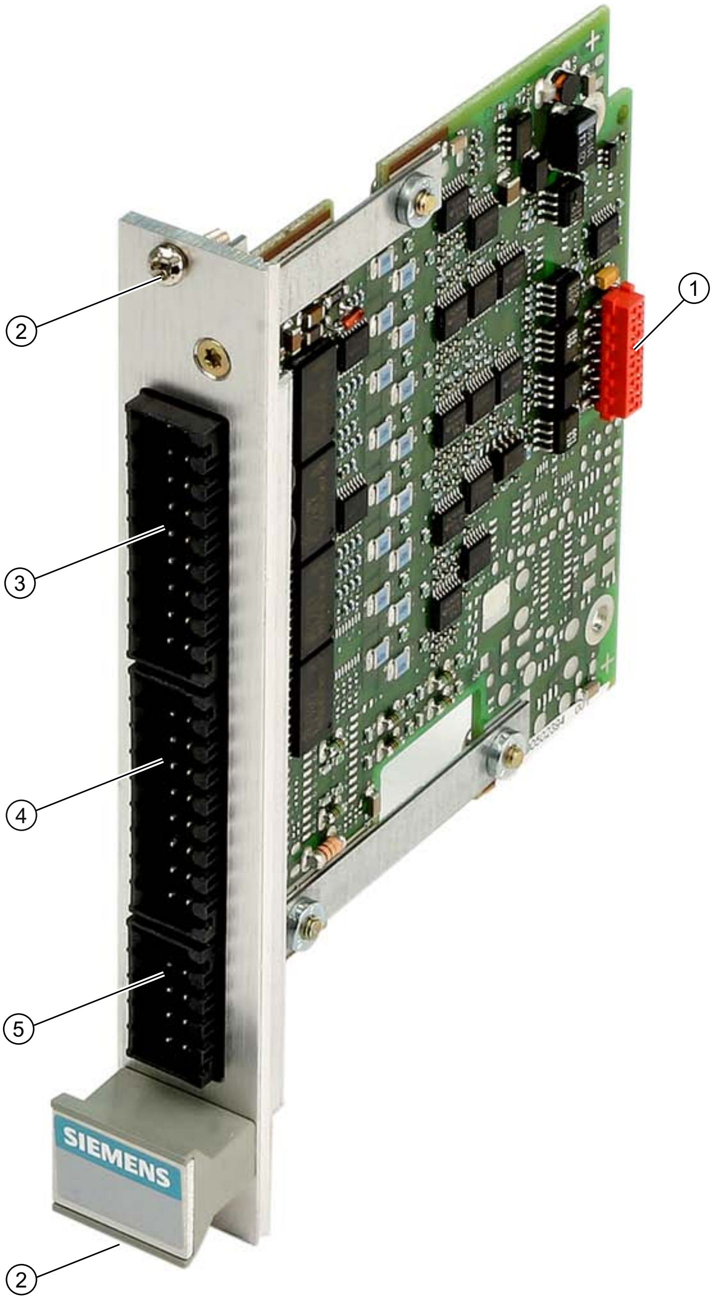
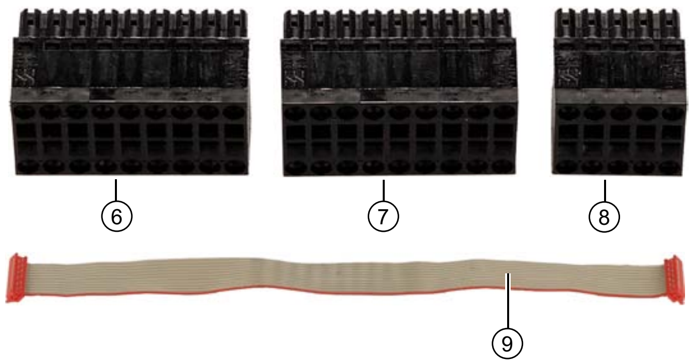
Figure	Item	Description
	①	Communication with basic module
	②	Captive fixing screws (2)
	③	Connector DX1: digital inputs 0 to 7 digital outputs 0 to 7
	④	Connector DX2: digital inputs 8 to 15 digital outputs 8 to 15
	⑤	Connector DX3: digital inputs 16 to 23

Table 3-10 CPCI-EAM 220: accessories for digital I/O module 0

Figure	Item	Description
	⑥, ⑦	Mating connector (18-pin) for DX1 and DX2
	⑧	Mating connector (10-pin) for DX3
	⑨	Flat ribbon cable for communication with basic module

Analog I/O module 0

Table 3-11 CPCI-EAM 230: analog I/O module 0 without accessories

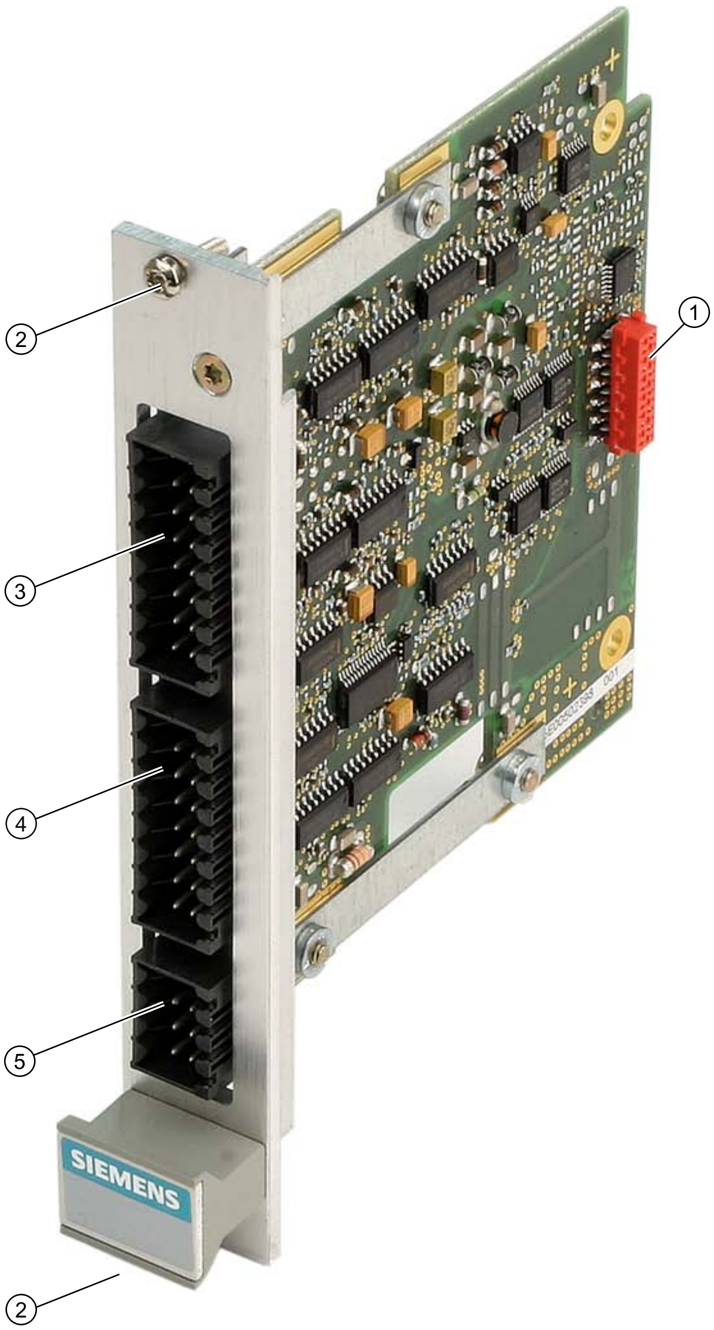
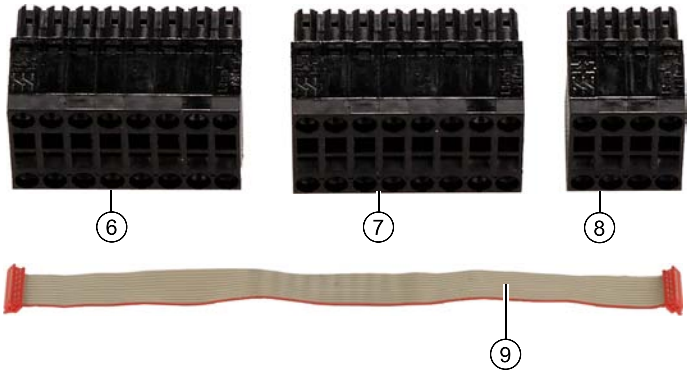
Figure	Item	Description
	①	Communication with basic module
	②	Captive fixing screws (2)
	③	Connector AX1: analog inputs 0 to 3 analog outputs 0 to 3
	④	Connector AX2: analog inputs 4 to 7 analog outputs 4 to 7
	⑤	Connector AX3: Pt100 inputs 0 to 3

Table 3-12 CPCI-EAM 230: accessories for analog I/O module 0

Figure	Item	Description
	⑥, ⑦	Mating connector (16-pin) for AX1 and AX2
	⑧	Mating connector (8-pin) for AX3
	⑨	Flat ribbon cable for communication with basic module

3.3 Properties of the basic module

3.3.1 Function blocks of the basic module

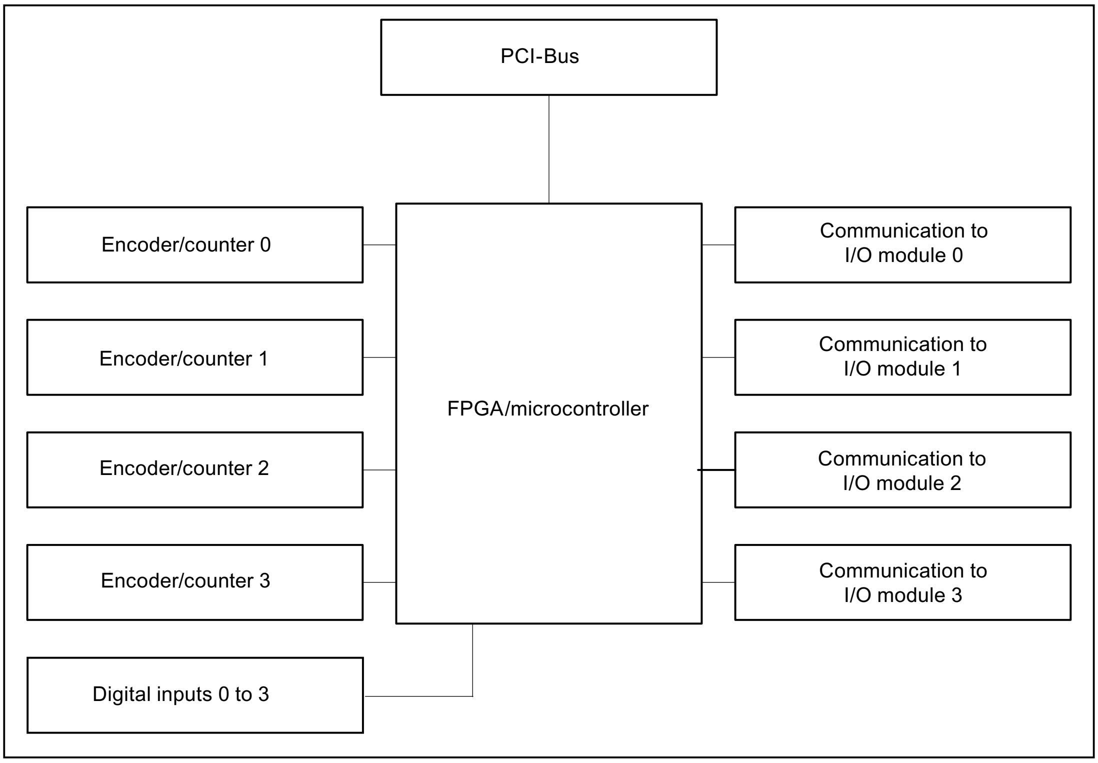


Figure 3-2 Function blocks of the basic module

3.3.2 FPGA

Tasks

The FPGA (field programmable gate array) is a programmable logic circuit. It acts as an interface and is responsible for data preparation between the PCI bus and the function blocks of the basic module:

- Encoder inputs, counters and digital inputs
- Communication to the I/O modules
- Microcontroller

  Communication via registers

3.3.3 Microcontroller

The firmware on the microcontroller is responsible for the following functions:

- Detection of connected I/O modules
- Initialization of I/O modules
- Support for the control of I/O modules
  - Interrupt triggering in the event of changes to the monitorable digital inputs on the digital I/O modules
- Monitoring of I/O modules
- System monitoring (watchdog)
- Communication interface to the analog I/O modules
  - Read analog input data from an analog I/O module
  - Output analog output data to the outputs of an analog I/O module, including data refresh cycles

---

Note

Programming the microcontroller

Experienced users can choose to program the microcontroller directly. Please contact service and support.

See also

Service and support (Page 205)

3.3.4 Encoder inputs and counters

Encoder inputs, counters and their assignment

The CIO basic module includes four encoder inputs, each with its own counter unit. Each of these counters can be used as

- an internal counter, e.g., for frequency measurement or pulse width measurement
- a counter for an external incremental encoder connected to the associated encoder input (encoder)

Depending on the usage, the label encoder input or counter is used.

Caution

Note the encoder connection voltage.

Encoders with a 24 V or 5 V power supply can be connected. When making the connections, be sure to apply the correct power supply to the encoder power supply interface. This voltage is supplied to all four encoders.

The encoder output signal must be a differential signal in accordance with RS422.

Notice

The encoder should only be connected to a 24 V DC or 5 V DC power supply which satisfies the requirements of safe extra low voltage (SELV).

When the device is operated on a wall, in an open rack or other similar locations, an NEC Class 2 current source is required for the compliance of the UL requirements (in accordance with UL 60950-1). In all other cases (in accordance with IEC / EN / DIN EN 60950-1) either a power source of limited performance (LPS = Low Power Source), or a line-side fuse or a line-side power switch is necessary. The fuse size must not exceed 2 A DC.

One of the following inputs can be assigned to each counter:

- Encoder input
- Digital input on the basic module
- Digital input on a digital I/O module
- Rapid digital input on a digital I/O module (10 μs input)

The exact assignment matrix can be found in "Encoder interface switching registers" in the "Technical data" / "Registers" section.

The principal functions of the counters and encoder inputs are "position evaluation by means of shaft encoder edge evaluation" and "frequency and pulse-width measurement". You can choose between these two functions for each counter in the control register. Frequency measurement and pulse-width measurement differ in terms of the choice of certain parameters, the mode of connection and the calculation formula.

This section also provides an overview of the individual functions available to you for configuring the counters and encoder inputs.

Physics of incremental encoders

Incremental encoders deliver a defined number of electrical pulses per rotation, which represent the measurement of the traveled distance or angle.

Incremental encoders operate on the principle of optoelectronic scanning of dividing disks with the transmitted light principle. The light source is a light emitting diode (LED). As the transmission shaft rotates, photocouples measures the light/dark modulation that arises.

The RS422 incremental encoder offers RS422 difference signals.

The resolution can be quadrupled by means of edge evaluation.

You can connect either a 5 V or a 24 V encoder. The corresponding voltage must be supplied to the encoder power supply interface. This voltage is looped through all four encoders.

Reading the counter value

The counter values can be read directly from the counter registers. However, these values are not synchronized to a trigger event.

With the appropriate parameter settings, the counter value is stored temporarily in the zero-mark register or in one of the universal registers when a trigger event occurs. The stored value can be read there.

Loading a preload value

You can pre-assign a preload value to the counters which is not equal to zero using the preload value register for the counter in question.

Position evaluation by means of shaft encoder edge evaluation

You can connect a two-track incremental rotary transducer with a zero-mark track to each encoder input. The count pulses and count direction are calculated from the A- and B-track signals. This is done by evaluating the pulse edges of both tracks.

Frequency measurement

A gate is applied at input B. The gate is open for a defined time t_B. During this time, count pulses at input A are measured. The frequency at input A is calculated by

f_A = counter value / t_B

Pulse-width measurement

The pulse to be measured is applied to input B. While the pulse is logical 1, the counter is active and is clocked with a known frequency f. This frequency can be an internal counting frequency or a known frequency at input A. The pulse width is calculated from the formula:

t_B = counter value / f_A

Clear functions

The counter on a channel can be set by various trigger events to 0 H or to a value stored in the preload value register.

Hysteresis functions

If the shaft encoder is exposed to vibration, count pulses can be generated even at rest. To prevent these pulses from being counted, three different hysteresis functions can be enabled.

Hysteresis with direction of rotation reversal

With this function the first pulse is ignored whenever the direction of rotation is reversed.

Zero-mark hysteresis

This function is useful if the zero-mark signal from an encoder is used to trigger interrupts.

The zero-mark logic is only enabled again after reaching a zero mark if the counter value moves two count pulses in one direction.

Comparator hysteresis

This function is useful if a comparator is used to trigger interrupts.

The comparator logic is only enabled again after reaching the comparator value if the counter value moves two count pulses in one direction.

See also

Encoder interface switching register: Counter 0 (Page 171)

Overview (Page 170)

3.3.5 Digital inputs

There are 4 digital inputs available on the basic module:

- Typical filter time 10 µs (same as for the rapid inputs on the I/O modules)
- These inputs can be used as function lines.
- You can also assign these digital inputs to counters.

3.4 Properties of the I/O modules

3.4.1 I/O module identifiers

A number of different identifiers are used for the numbering of I/O modules, which must be kept separate:

- Numbering without a letter

  Example: Digital I/O module 0 or analog I/O module 0

  Identifies the hardware variant:

Identifier in this manual	Ordering unit for SIMATIC Microbox PC 420	Ordering unit for SICOMP IMC system
Digital I/O module 0	PC IO MOD Digital 010	CPCI-EAM220
Analog I/O module 0	PC IO MOD Analog 020	CPCI-EAM230

- Numbering prefixed with S

  Sn (n = 0 to 3)

  Example: Digital I/O module S0 or analog I/O module S0

  Identifies the slot

  S0 to S3 corresponds to slots 0 to 3 on the basic module

- Numbering prefixed with A (analog I/O module only)

  Example: Analog I/O module A0

  An (n = 0 to 1)

  Identifies the analog I/O modules found by the firmware on booting and the assigned memory areas. The firmware starts the search for analog I/O modules at slot 0 (order: S0, S1, S2, S3).

3.4.2 Communication with the I/O modules

Communication with the I/O modules depends on which I/O modules were found on initialization.

There is a serial connection between the basic module and the I/O modules. This results in a delay between writing the data and the time at which the associated signals reach the outputs.

3.4.3 Properties of digital I/O module 0

More details about digital I/O module 0 can be found in the "Technical data/General equipment data" section.

Notice

The device should only be connected to a 24 V DC power supply which satisfies the requirements of safe extra low voltage (SELV).

When the device is operated on a wall, in an open rack or other similar locations, an NEC Class 2 current source is required for the compliance of the UL requirements (in accordance with UL 60950-1). In all other cases (in accordance with IEC / EN / DIN EN 60950-1) either a power source of limited performance (LPS = Low Power Source), or a line-side fuse or a line-side power switch is necessary. The fuse size must not exceed 4 A DC.

Digital inputs

Digital I/O module 0 has 24 digital inputs with various properties:

- Digital inputs 0 to 7: 0.1 ms, 24 V DC
- Digital inputs 8 to 23: 1 ms, 24 V DC
- Two sets of inputs 8 and 9 are provided: in parallel to the 1 ms inputs, the signal is also processed by means of rapid inputs at around 10 µs. These rapid inputs can be used as function lines. You can also assign these rapid digital inputs to counters.
- For digital inputs 0 to 7 you can specify whether an interrupt should be triggered when the input data is changed.
- All inputs are optically isolated through optocouplers.

Digital outputs

Digital I/O module 0 has 16 digital outputs. They are grouped into two groups of eight (0 to 7, 8 to 15) for monitoring purposes. The outputs of digital I/O module 0 have the following properties:

- Operating frequency: max. 2 kHz
- Output voltage: 24 V DC, optically isolated through optocouplers
- Rated current: 0.5 A
  Max. load per group of eight: 2 A (regardless of the distribution to the individual outputs)
- Current sourcing
- Short-circuit-proof
- External arc-suppression diode can be connected in parallel
- Status after POWER ON and after RESET: High resistance

Caution

Limitation of the output load

The maximum permissible output load per group of eight outputs is 2 A. Higher loads are not permissible. There is no integral current limitation for higher loads. The output current is only limited if the current limitation or the temperature monitoring system on the output drivers is tripped.

See also

I/O module interfaces (Page 145)

Mechanical and electrical data (Page 129)

3.4.4 Properties of analog I/O module 0

More details about analog I/O module 0 can be found in the "Technical data" section.

Analog inputs

- Number: 8
- Type: single-ended
- Voltage ranges: 0 to 5 V, 0 to 10 V, ± 5 V, ± 10 V
- Resolution: 12 bits including sign
- Conversion time: max. 100 µs per channel without Pt100
- Conversion time: max. 200 µs per channel with Pt100

  Therefore a maximum of n x 200 µs is needed to read n channels
- Impedance: > 10 kilohms

Pt100 inputs

Number: 4

Design: Two-wire measurement

Analog outputs

- Number: 8
- Type: single-ended
- Voltage range: ± 10 V
- Load current: max. 2 mA
- Resolution: 16 bits including sign
- Conversion time: max. 200 µs per channel

  Therefore a maximum of n x 200 µs is needed to change n channels
- After POWER ON and after RESET the voltage at the analog outputs is 0 V.

See also

I/O module interfaces (Page 145)
Mechanical and electrical data (Page 129)

3.5 Interfaces

This section provides a brief overview of the interfaces on the CIO expansion. Pin assignments for the individual interfaces are described in the "Technical data" section.

Overview

The CIO expansion has the following interfaces:

- PCI interface
- Encoder interface
- Encoder power supply interface
- I/O interfaces for digital I/O module 0
- I/O interfaces for analog I/O module 0
- Digital inputs on the basic module

3.5.1 Interfaces on the basic module

PCI interface

The CIO expansion is connected to the SIMATIC Microbox PC 42x or the SICOMP IMC CPCI system via a PCI interface.

The BIOS reserves a memory area of 64 KB for central inputs/outputs.

Encoder input interfaces

There are two different interfaces for the encoder function:

- The encoder interface: 15-pin sub D socket
- The encoder power supply interface for feeding the power supply to the encoders and for contacting the digital inputs on the basic module: 9-pin sub D socket (via adapter board)
- The power supply requirements for the encoders can be found in the description of "Encoder inputs and counters".

Interface between the basic module and the I/O modules

Serial connection via flat ribbon cable between the basic module and the I/O modules.

See also

PCI interface (Page 140)

Encoder input interfaces (Page 142)

Encoder inputs and counters (Page 30)

3.5.2 External interfaces on the I/O modules

Interfaces on digital I/O module 0

3 plug connectors for connecting the input and output signals:

- DX1: 18-pin plug connector (digital inputs and outputs 0 to 7)
- DX2: 18-pin plug connector (digital inputs and outputs 8 to 15)
- DX3: 10-pin plug connector (digital inputs 16 to 23)

Interfaces on analog I/O module 0

3 plug connectors for connecting the input and output signals:

- AX1: 16-pin plug connector (analog inputs and outputs 0 to 3)
- AX2: 16-pin plug connector (analog inputs and outputs 4 to 7)
- AX3: 8-pin plug connector (Pt100 terminals 0 to 3)

See also

I/O module interfaces (Page 145)

3.6 Shield connection

Shield connections on the SIMATIC Microbox PC 42x

The ground connections must be made as follows:

Interface	Type	Shield connection via
Encoder	shielded	Sub D connector
Encoder power supply	shielded	Sub D connector
Digital inputs/outputs	unshielded is possible	
Analog inputs/outputs	shielded	Bracket on I/O expansion rack

Shield connections on the SICOMP IMC system

The ground connections must be made as follows:

Interface	Type	Shield connection via
Encoder	shielded	Sub D connector
Encoder power supply	shielded	Sub D connector
Digital inputs/outputs	unshielded is possible	
Analog inputs/outputs	shielded	Ground the shield by means of the mounting cabinet

Application planning 4

4.1 System requirements

Hardware requirements

The following platforms are supported:

- SIMATIC Microbox PC 42x
  - Only modules with PCI-104 or PCI-104-Plus can be combined with the basic module in SIMATIC Microbox PC 42x
- SICOMP IMC CPCI system
  There must be enough free installation and CPCI slots available.
  - Basic modules require two CPCI slots
  - I/O modules require one slot: a CPCI terminal is not needed for these expansion boards.

Software requirements

CIO is independent of the operating system.

Program examples and drivers where necessary are available on the Internet for the following operating systems:

- RMOS V3.30 / V3.40
- Windows XP
- Windows XPe (Windows XP embedded)

Please contact customer support for the examples.

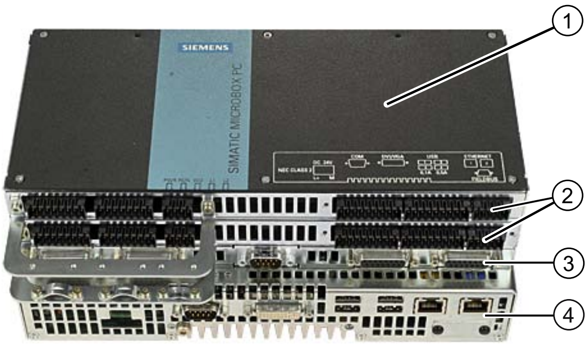
See also

Service and support (Page 205)

4.2 Available configurations

4.2.1 Available configurations for SIMATIC Microbox PC 42x

Example

Figure	Item	Meaning
	①	Cover plate
	②	I/O expansion rack
	③	Encoder expansion rack
	④	SIMATIC Microbox PC 420
	-	Basic module: not visible in SIMATIC Microbox PC

Supplementary conditions

The following supplementary conditions must be taken into account when planning an expansion with central inputs/outputs.

- For each basic module, a maximum of
  - 1 encoder rack with 4 encoder inputs and 4 digital inputs can be connected
  - 4 I/O modules, including 2 analog I/O modules, is permissible
- Only modules for PC-104-Plus and PCI-104 can be combined with CIO.
  PC-104-Plus modules must be installed in the lower slots.
- A maximum of 3 basic modules
- A maximum of 4 expansion racks
  For vibrational stability reasons, no more than 4 expansion racks can be used on the SIMATIC Microbox PC.

Example: Configuration with one basic module

The example shows the maximum configuration using one basic module.

- 1 basic module
- 1 encoder expansion rack with a total of 4 encoder inputs and 4 digital inputs
- 2 I/O expansion racks with a total of 4 I/O modules
  - The I/O modules can be a combination of digital and analog I/O modules.
  - One basic module can manage a maximum of 2 analog I/O modules.

The mounting hardware is included in the scope of delivery of the racks and the basic module.

Installation for the example above is described in "Installation in SIMATIC Microbox PC 42x".

Example: Configuration with two basic modules

The configuration below comprises two basic modules using the maximum permissible number of 4 expansion racks.

- 2 basic modules
- 1 encoder expansion rack with 4 encoders and 4 digital inputs
- 3 I/O expansion racks with 6 I/O modules
  - The I/O modules can be a combination of digital and analog I/O modules.
  - Each basic module can manage a maximum of 2 analog I/O modules.

The mounting hardware is included in the scope of delivery of the racks and the basic module.

Installation for the example above is described in "Installation in SIMATIC Microbox PC 42x".

Available configurations: Overview

The table below shows the maximum number of inputs and outputs that are possible with a SIMATIC Microbox PC 42x configuration with one basic module.

Table 4-1 Maximum available inputs and outputs with one basic module

Encoder expansion rack		I/O modules		Inputs			Outputs	
Encoder inputs	Digital inputs	digital	analog	digital	analog	Pt100	digital	analog
4	4	4	0	96	0	0	64	0
4	4	3	1	72	8	4	48	8
4	4	2	2	48	16	8	32	16

The table below shows the maximum available configurations for the SIMATIC Microbox PC 42x using 1 to 3 basic modules.

Table 4-2 Maximum configuration for SIMATIC Microbox PC 42x

Basic modules	Encoder expansions		I/O expansions		
	Expansion rack	Encoder inputs	Expansion rack	I/O modules	of which max. analog I/O modules
1	1	4	2	4	2
2	2	8	2	4	4
2	1	4	3	6	4
2	0	0	4	8	4
3	3	12	1	2	2
3	1	4	3	6	6

4.2.2 Available configurations for SICOMP IMC CPCI system

Configuration constraints

The following supplementary conditions must be taken into account when planning an expansion with central inputs/outputs.

- A maximum of two analog I/O modules per basic module
- If more than 4 I/O modules are used with multiple basic modules, one CPCI slot is required for each additional I/O module, otherwise relatively long flat ribbon cables will have to be sued

Available configurations: Overview

The table below shows the maximum number of inputs and outputs that are possible with a SICOMP IMC CPCI system configuration with one basic module.

Table 4-3 Maximum available inputs and outputs with one basic module

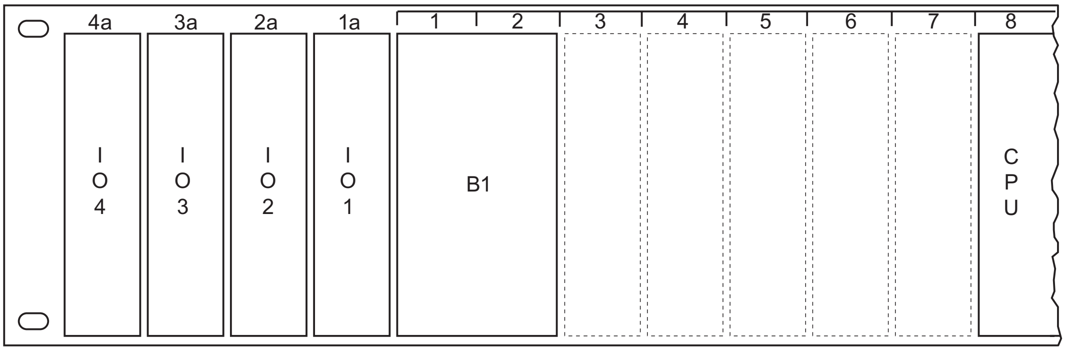
Encoder inputs	Digital inputs	I/O modules		Inputs			Outputs	
		digital	analog	digital	analog	Pt100	digital	analog
4	4	4	0	96	0	0	64	0
4	4	3	1	72	8	4	48	8
4	4	2	2	48	16	8	32	16

The following overview shows the maximum configuration for 1, 2 and 3 basic modules. This requires a CPCI rear panel with 8 CPCI slots.

Table 4-4 Maximum configuration for a SICOMP IMC CPCI system (rear panel with 8 CPCI slots)

Basic modules	Encoder inputs	I/O modules		Slots	
		Total	of which analog max.	Total	of which CPCI
1	4	4	2	6	2
2	8	7	4	11	7
3	12	5	5	11	7

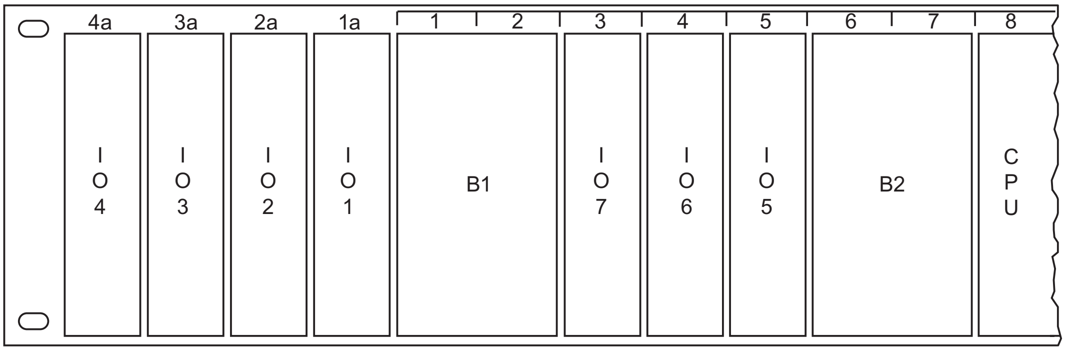
Example: Maximum configuration with one basic module



IO1, IO2, IO3, IO4	I/O modules
B1	Basic module
CPU	CPU of the SICOMP system
1a to 4a	Slots without CPCI interface
1 ... 8	CPCI slots

- 1 basic module with 4 encoder inputs and 4 digital inputs
- 4 I/O expansion boards
  - The I/O expansion boards can be a combination of digital and analog I/O expansion boards.
  - One basic module can manage a maximum of 2 analog I/O modules.

Example: Maximum configuration with two basic modules



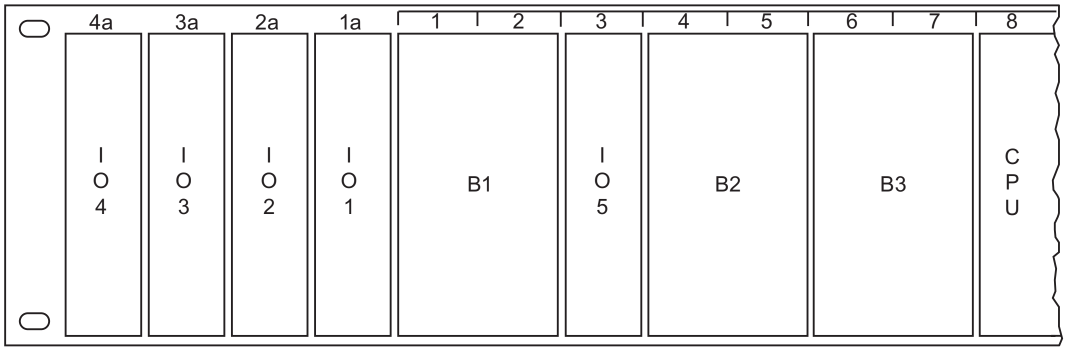
IO1 to IO7	I/O modules I/O modules 1 to 4 belong to basic module B1 I/O modules 5 to 7 belong to basic module B2
B1, B2	Basic modules
CPU	CPU of the SICOMP system
1a to 4a	Slots without CPCI interface
1 ... 8	CPCI slots

The example shows the maximum configuration using two basic modules

- 2 basic modules with a total of 8 encoder inputs and 8 digital inputs
- 7 I/O expansion boards
  The I/O expansion boards can be a combination of digital and analog I/O expansion boards.

  One basic module can manage a maximum of 2 analog I/O modules.

Example showing the maximum configuration with three basic modules



IO1 to IO5	I/O modules I/O modules 1 to 4 belong to basic module B1 I/O module 5 belongs to basic module B2
B1, B2, B3	Basic modules 1 to 3
CPU	CPU of the SICOMP system
1a to 4a	Slots without CPCI interface
1 ... 8	CPCI slots

The example shows the maximum configuration using three basic modules

- 3 basic modules with a total of 12 encoder inputs and 12 digital inputs
- 5 I/O expansion boards
  - The I/O expansion boards can be a combination of digital and analog I/O expansion boards.
  - One basic module can manage a maximum of 2 analog I/O modules.

5 Installation in SIMATIC Microbox PC 42x

Warning

Work should only be carried out by qualified personnel

Work on the SIMATIC Microbox PC 42x should only be carried out by qualified personnel in compliance with applicable safety regulations.

Warning

Isolate the machine from all voltage sources before starting work

The SIMATIC Microbox PC 42x must be voltage-free before it is opened.

Notice

Observe the safety measures for ESD

Ground yourself before touching and installing the modules and opening the SIMATIC Microbox PC 42x. The safety measures for ESD must be observed.

Notice

Do not kink flat ribbon cables

When folding flat ribbon cables, always ensure that a small bending radius is retained. To avoid damaging the cables, do not kink or fold them too tightly.

Notice

Be careful of reverse polarity protection

When connecting the ribbon cable connectors, be careful of the reverse polarity protection. Do not force the connectors into the sockets.

Note

Pin assignment of connectors

Details of the pin assignments of the connectors can be found in the "Technical data/Interfaces" section.

Tools required

The following tools are needed to expand the SIMATIC Microbox PC 42x with CIO

- Torx T10 and T8 screwdrivers
- Set of 5 wrenches

5.1 Preparatory work

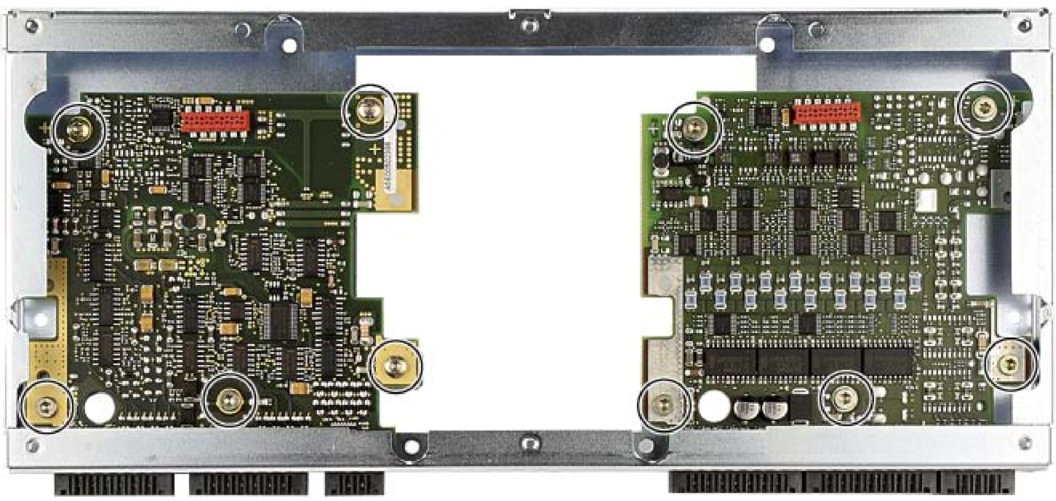
5.1.1 Setting up the I/O expansion rack

You can install up to two I/O modules in the I/O expansion rack. The following configurations are possible:

- One to two digital I/O modules
- One analog and one digital I/O module
- One to two analog I/O modules

The figure shows

- an analog I/O module 0 installed on the left
- a digital I/O module 0 installed on the right



Procedure:

1. Place the I/O module in the desired location on the expansion rack.
2. Screw the I/O module to the expansion rack using the five enclosed screws. The screws are marked in the figure.
   – The installation examples describe how to connect the flat ribbon cables and install the shield clamp for analog I/O module 0.
3. If you are only installing one I/O module:
   screw the enclosed cover plate to the vacant opening using the screws enclosed with the I/O expansion rack.

5.1.2 Slot setting

Slot setting equalizes the different propagation delays for the 33 MHz signal on the PCI-104 bus to the individual slots.

One of the four interrupt lines A, B, C, and D of the PCI-104 interface is assigned to each slot.

The pin assignment of the PCI-104 interface can be found in "PCI interface" in the "Technical data" section.

The assignment to the selected slot must be set by means of a four-way switch on the basic module.

Notice

Set the slot selection switches before installing the basic module.

Since the slot selection switch is located on the basic module, you must define the switch setting before installing the basic module.

Setting the slot selection switch on the basic module

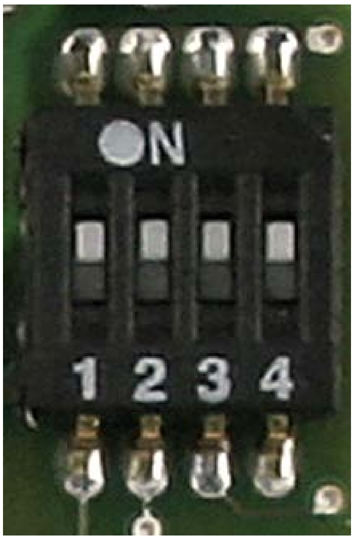


Figure 5-1 Slot selection switch

When the switch is pushed up it is ON (0), when it is pushed down it is OFF (1).

Table 5-1 Setting the interrupt

Slot (counting from the bottom)	Switch position		Switch position [1] (reserved)		Signal cable		
	1	2	3	4	Interrupt [2]	CS	Sampling time
0	ON (0)	ON (0)	ON	ON	A	0	0
1	OFF (1)	ON (0)	ON	ON	B	1	1
2	ON (0)	OFF (1)	ON	ON	C	2	2
3 (not permissible)	OFF (1)	OFF (1)	ON	ON	D	3	3

1) Switches 3 and 4 are currently not assigned and are intended for future applications.

2) The specified interrupt label (A, B, C, D) relates to the PCI-104 interrupt of the selected slot (see interrupt assignment in the documentation for the Microbox PC 42x that is used).

- Set the appropriate slot number on the switch.
  - When generating software you must use the associated interrupt.
  - A maximum of three PCI plug-in modules are permitted on the SIMATIC Microbox PC 42x. That is why slot number 3 is not permissible.
- On delivery all four switches are set to ON, i.e., slot 0 is preset.

See also

PCI interface (Page 140)

5.2 Installation example: Basic module and two I/O modules

Note

Encoder connection assignment

The connection of the plug connectors to the basic module determines the assignment of the encoder connections to encoders/counters 0 to 3 used by the software.

Note

I/O terminal assignment

The connection of the plug connectors to the basic module determines the assignment of the I/O modules (hardware) to I/O modules 0 to 3 used by the software.

Overview

Figure	Item	Description
	①	Case cover
	②	I/O expansion rack with analog I/O module 0 and digital I/O module 0
	③	SIMATIC Microbox PC 420 basic unit
	-	Basic module (installed in the SIMATIC Microbox PC, not visible)

This example shows the expansion of a SIMATIC Microbox PC 420 with

- one CIO basic module
- one digital I/O module 0
- one analog I/O module 0

You need the following:

Quantity	Description	Name
1	Basic module	PC IO Base 400
1	I/O expansion rack	PC IO KIT 030
1	Digital I/O module 0	PC IO MOD Digital 010
1	Analog I/O module 0	PC IO MOD Analog 020

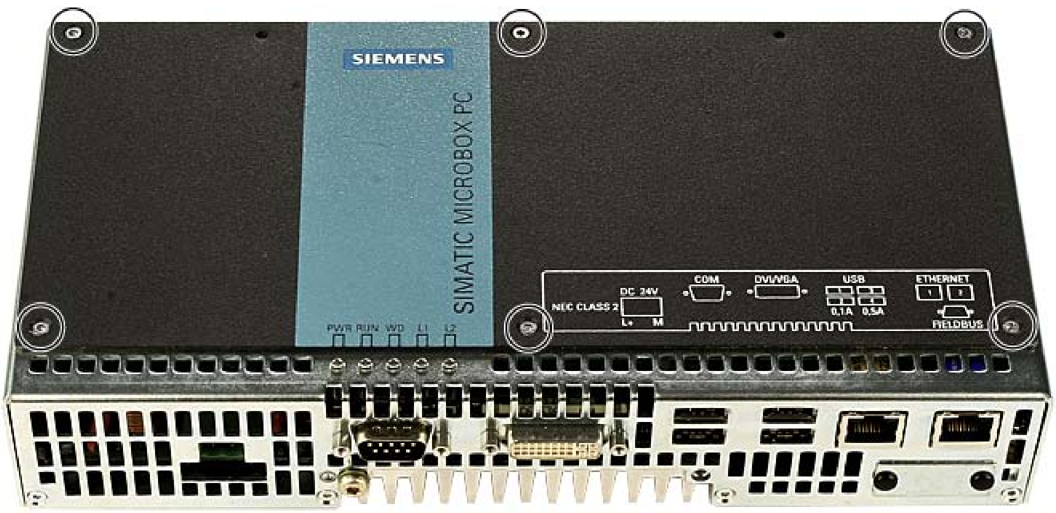
Setting up the I/O rack

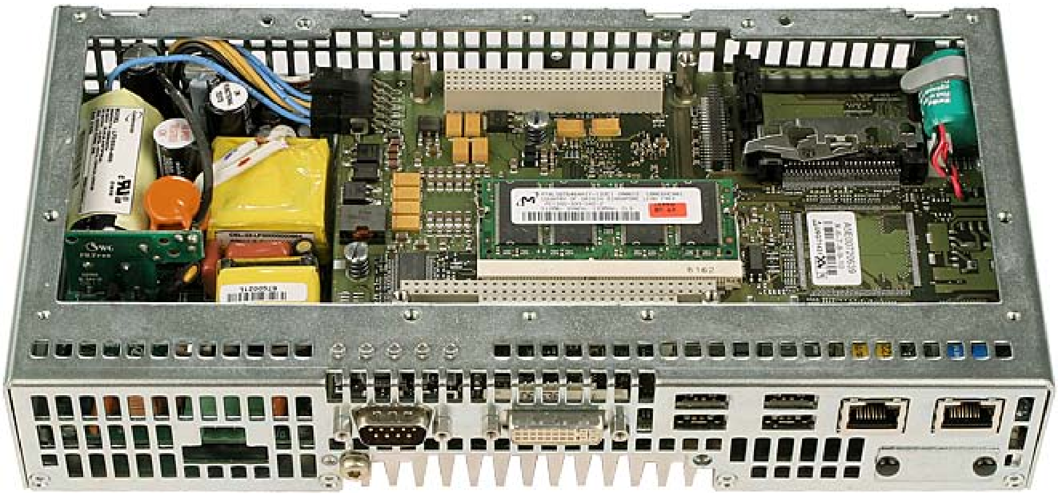
Set up an I/O expansion rack with an analog I/O module 0 and a digital I/O module 0 as described in "Preparatory work".

Procedure

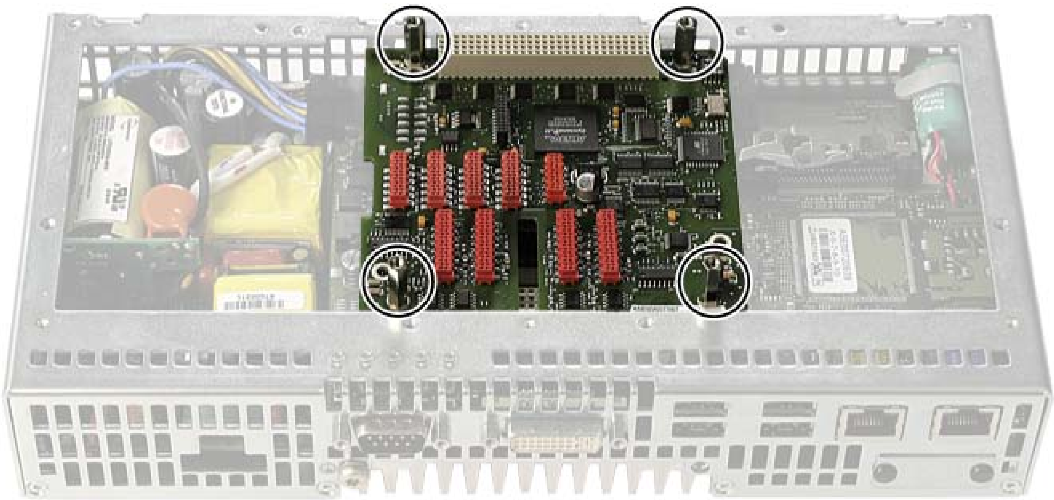
Figure: Open the Microbox PC

1. Observe the safety instructions at the start of the chapter.
2. Open the cover of the SIMATIC Microbox PC 420
   by releasing the six screws marked in the figure using a T8 screwdriver

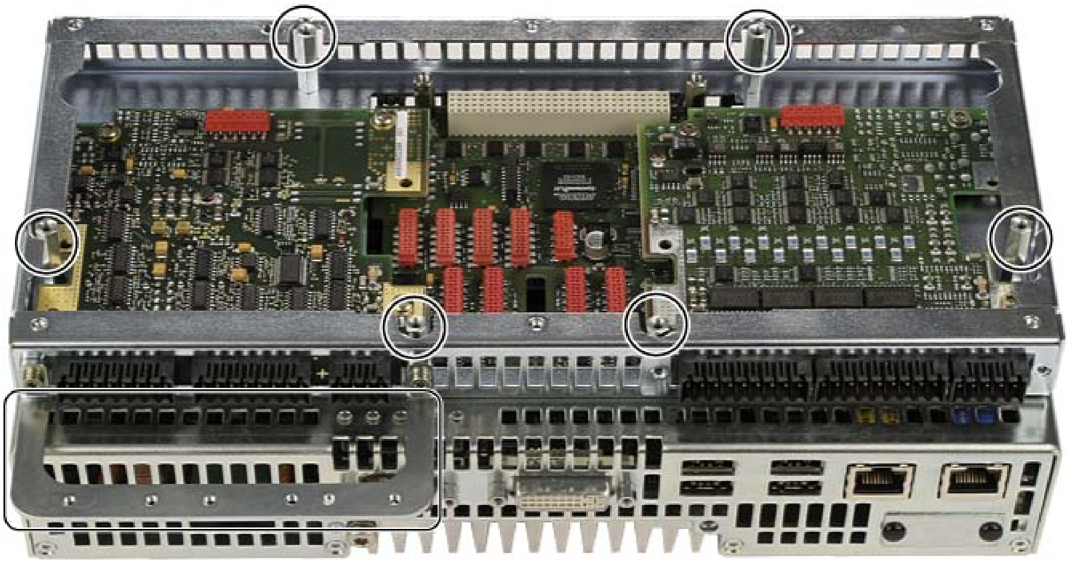




3. To set the slot, set the switch on the basic module to slot 0 (lowest slot). The procedure is described in "Preparatory work".
4. Plug the basic module into the PCI-104 interface and fix the basic module using the four enclosed 15 mm M3 stud bolts (width across flats 5).

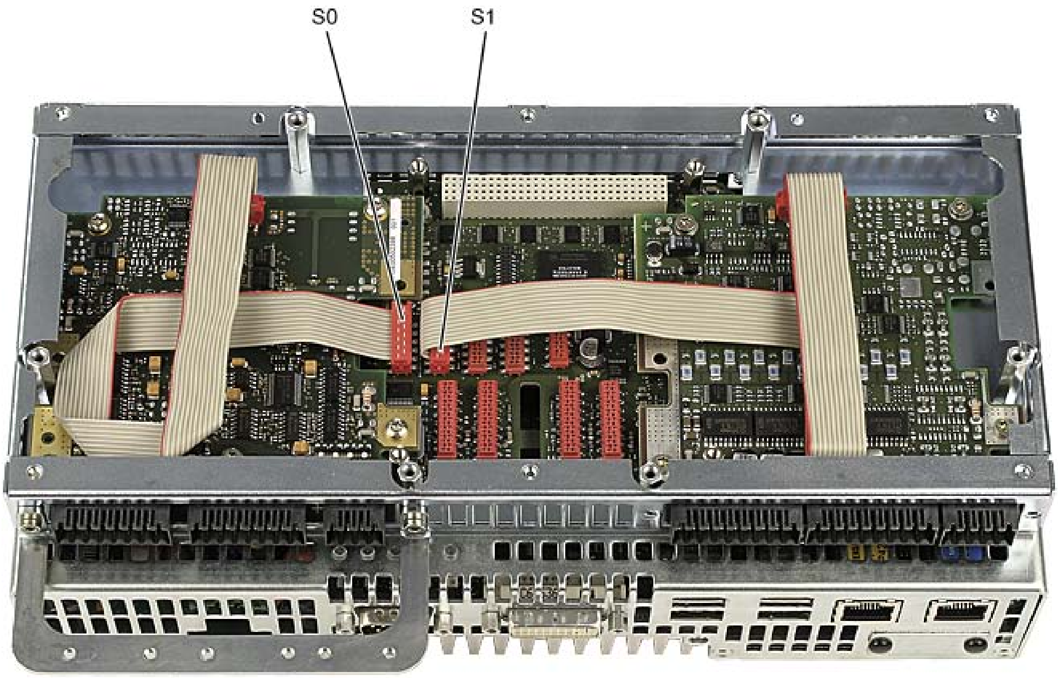


5. Install the set-up I/O expansion rack. Tighten the six 21 mm M3 stud bolts (width across flats 5).



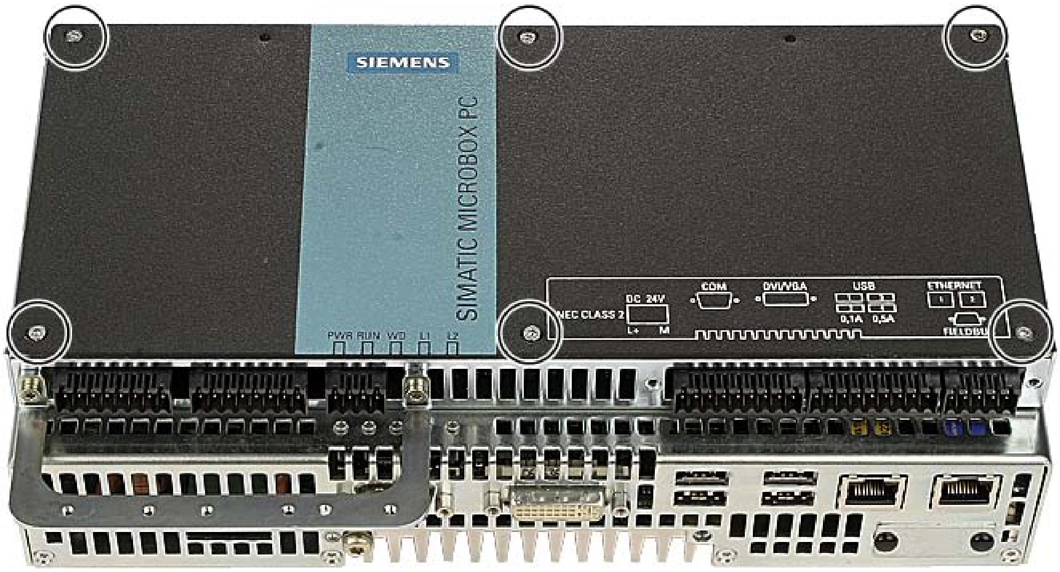
6. Tighten the shield clamp as shown in the diagram above. The shield clamp must be on the same side as the analog I/O module 0.

7. Attach the flat ribbon cables used by the I/O modules to communicate with the basic module.
   – The figure shows how you can fold the flat ribbon cables.
     The marking on the sockets on the basic module must be at the top.
     On the sockets on the I/O modules the red marking on the flat ribbon cable must be on the left
   – Do not use force to connect the ribbon cable connectors.
   – Make sure that the ribbon cable connectors are not loose.
   – Connect the analog I/O module 0 (left) to slot S0 on the basic module.
   – Connect the digital I/O module 0 (right) to slot S1 on the basic module.



8. Check that all ribbon cable connectors are correctly seated

9. Close the cover of the Microbox PC 420 and tighten the six screws using a T8 screwdriver.



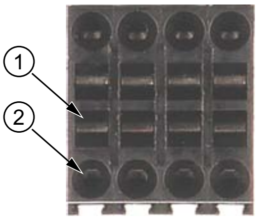
10. Stick the enclosed adhesive label showing the pin assignment of the I/O modules on the plug connections to the cover of the Microbox PC.

11. Connect the mating connectors on the analog and digital I/O module

   – The pin assignments of the connectors can be found in the "Technical data/Interfaces" section.

   – Open the springs by pushing a small slotted screwdriver, for example, into the square opening ①.

   – Push the bared wire into the matching round opening ②. After releasing the springs, check that the cable is securely seated.



12. Connect the desired analog and digital inputs and outputs.

13. The shield clamp is used to connect the shield for the analog signal lines.
    Use the enclosed strain-relief assemblies.

14. Connect the external 24 V power supply for the digital I/O module 0. The digital I/O module 0 will not work without this power supply.
15. Start up the Microbox PC 420 and the CIO expansion.

Note

First function test

On booting, the firmware detects all connected I/O modules. The result is stored in the I/O module status register. The module ID indicates whether the I/O modules are correctly connected.

The following overview shows the position of the I/O module status register. Bits 0 to 3 contain the module ID: "0001" for a digital I/O module 0 and "0010" for an analog I/O module 0.

I/O module in slot	Address	Byte
S0	BA + 1BC H	0
S1	BA + 1BC H	1
S2	BA + 1BC H	2
S3	BA + 1BC H	3

Access mode	R (read-only) DW: doubleword access only

See also

Module detection by the firmware during booting (Page 111)

5.3 Installation example: Basic module, encoder rack and four I/O modules

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Note

Encoder connection assignment

The connection of the plug connectors to the basic module determines the assignment of the encoder connections to encoders/counters 0 to 3 used by the software.

Note

I/O terminal assignment

The connection of the plug connectors to the basic module determines the assignment of the I/O modules (hardware) to I/O modules 0 to 3 used by the software.

Overview

Figure	Item	Description
	①	Case cover
	②	I/O expansion rack 2 with I/O modules S2 and S3
	③	I/O expansion rack 1 with I/O modules S0 and S1
	④	Encoder expansion rack
	⑤	SIMATIC Microbox PC 420 basic unit
	-	Basic module (installed in the Microbox PC, not visible)

This example shows a more extensive expansion of a SIMATIC Microbox PC 420 with

- one CIO basic module
- four encoders
- two analog I/O modules 0 and
- two digital I/O modules 0

You need the following:

Quantity	Description	Name
1	Basic module	PC IO Base 400
1	Encoder expansion rack	PC IO KIT 040
2	I/O expansion rack	PC IO KIT 030
2	Digital I/O module 0	PC IO MOD Digital 010
2	Analog I/O module 0	PC IO MOD Analog 020

Setting up the I/O rack

Set up two I/O expansion racks, each with an analog I/O module 0 and a digital I/O module 0 as described in "Preparatory work".

Installation

Note

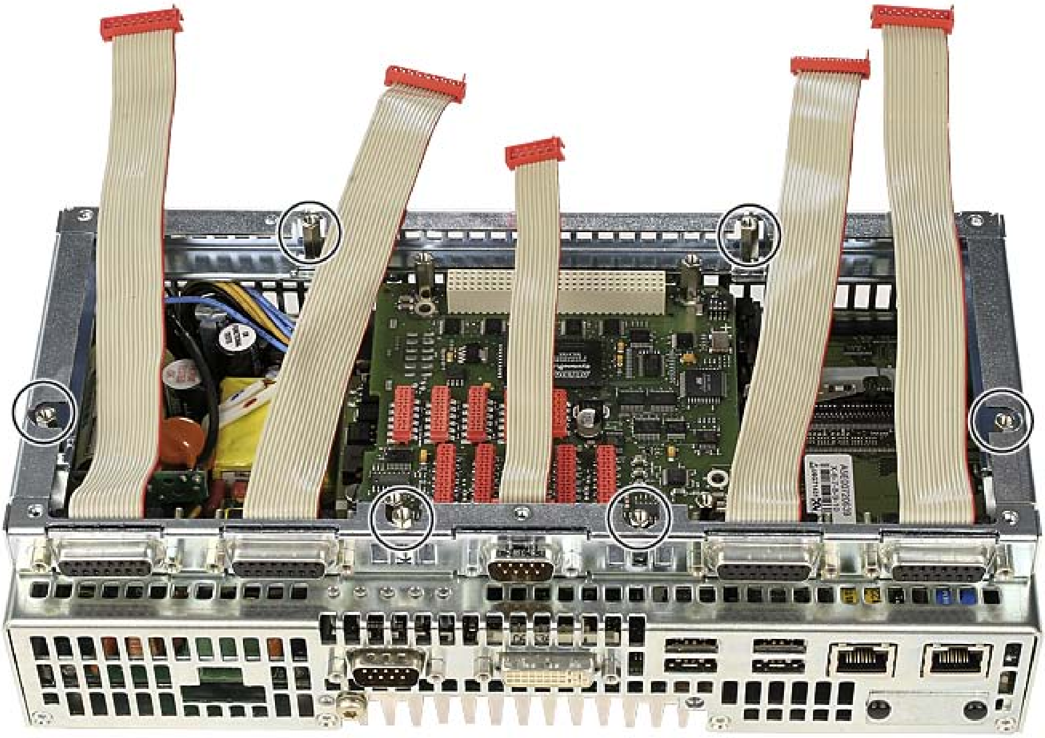
The steps illustrated with figures in the previous installation example are described here without illustrations.

1. Observe the safety instructions at the start of this chapter.

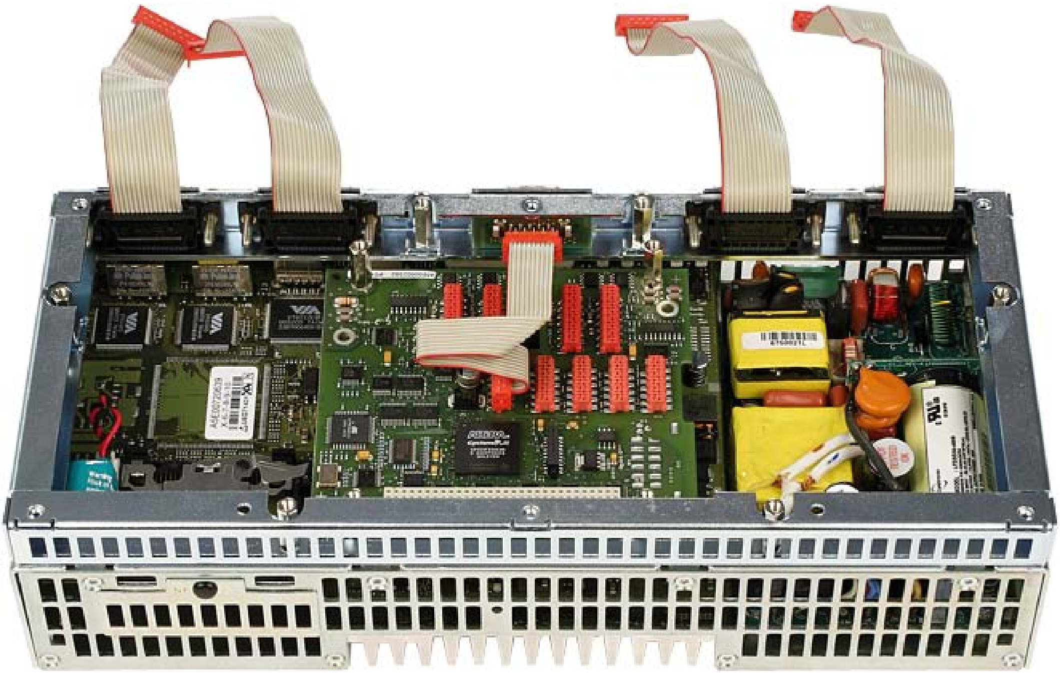
2. Set up the encoder rack:
   Screw the four enclosed 15-pin sub D sockets and the 9-pin sub D connector to the encoder expansion rack using the enclosed UNC 4/40 stud bolts.

3. Open the cover of the SIMATIC Microbox PC 420
   by releasing the six screws on the cover using a T8 screwdriver.
4. To set the slot, set the switch on the basic module to slot 0 (lowest slot). The procedure is described in "Preparatory work".
5. Plug the basic module into the PCI-104 interface and fix the basic module using the four enclosed 15 mm M3 threaded bolts (width across flats 5).

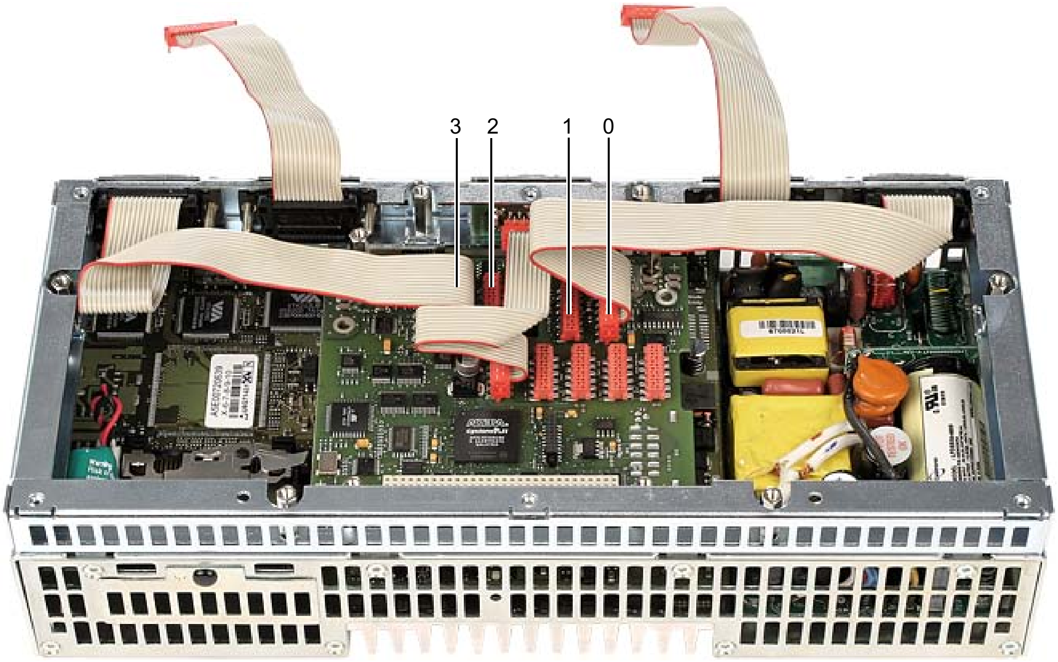
6. Install the set-up encoder expansion rack. Tighten the six 15 mm M3 stud bolts (width across flats 5).
   – In the next three figures the Microbox PC has been turned round to give a better view.



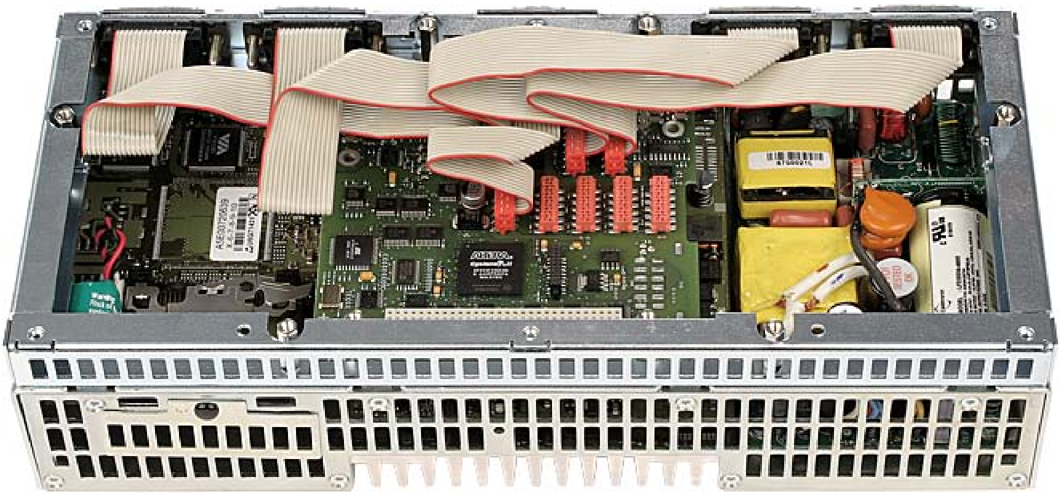
7. Connect the encoder power supply cable to the basic module
   – Make sure that the polarity is correct: in the position shown in the figure below, the red marking must be underneath in the socket on the basic module.



8. Connect the encoder interfaces to the basic module in the desired order.
   – Ensure that they are correctly assigned to the slots. The figure shows the connection of encoders 0 and 3.
   – Fold the flat ribbon cables as shown.
   – Make sure that the polarity is correct. In the position shown in the figure below, the red markings must be underneath in the sockets on the basic module.



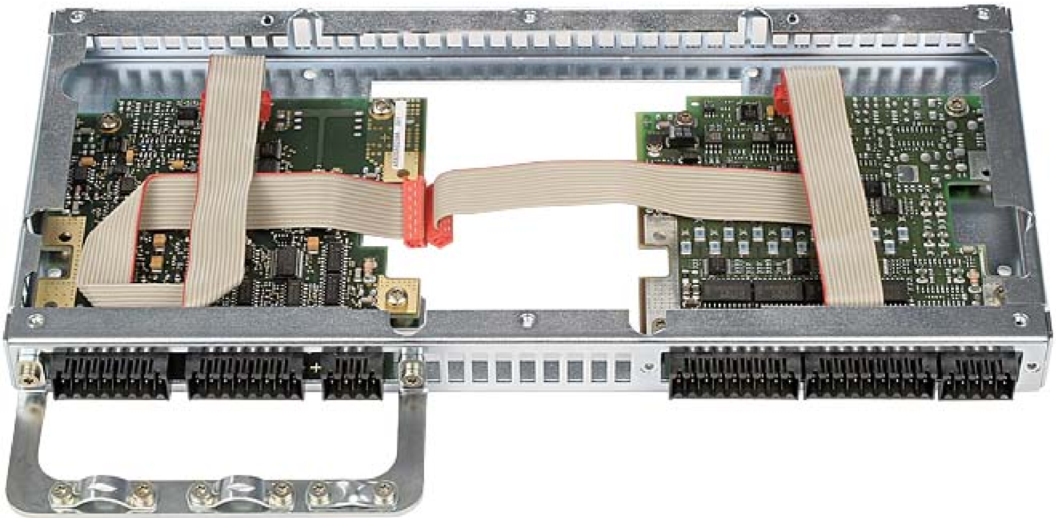
   – The figure below shows the connection of encoders 1 and 2.



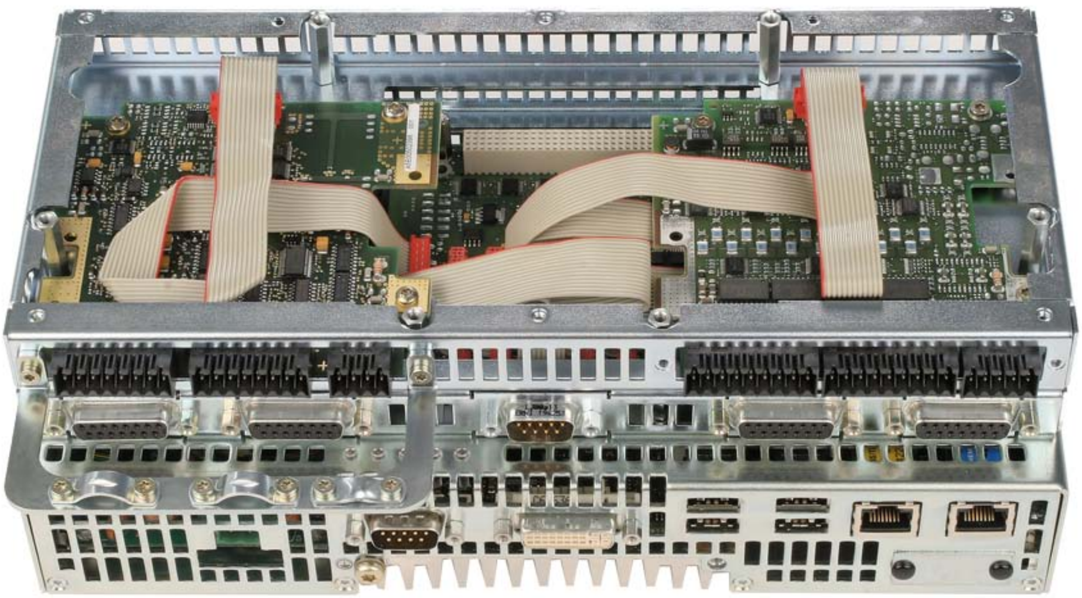
9. Set up the I/O expansion racks as shown in the figure.
   - Connect and lay the flat ribbon cables.

     Ensure that they are correctly assigned to the slots.

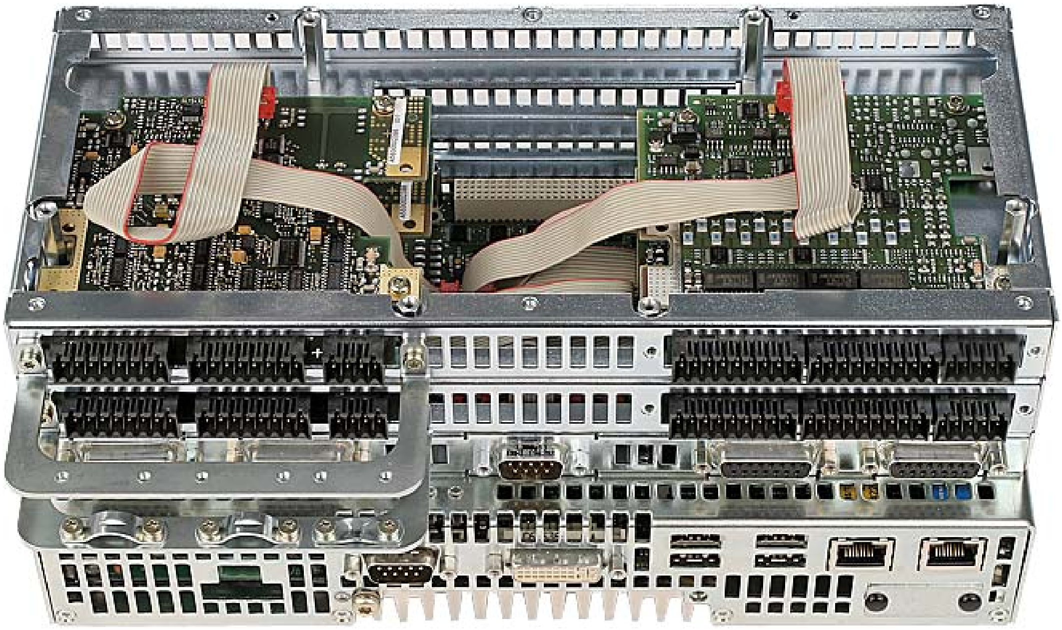
     Make sure that the polarity is correct. In the position shown in the figure below, the red markings on the flat ribbon cables must be on the left in the sockets on the I/O modules.
   - Mount the shield clamp in the analog I/O module 0.



10. Install the set-up I/O expansion rack. Tighten the six 21 mm M3 threaded bolts (width across flats 5).
    - In the figures below the Microbox PC has been turned round again.

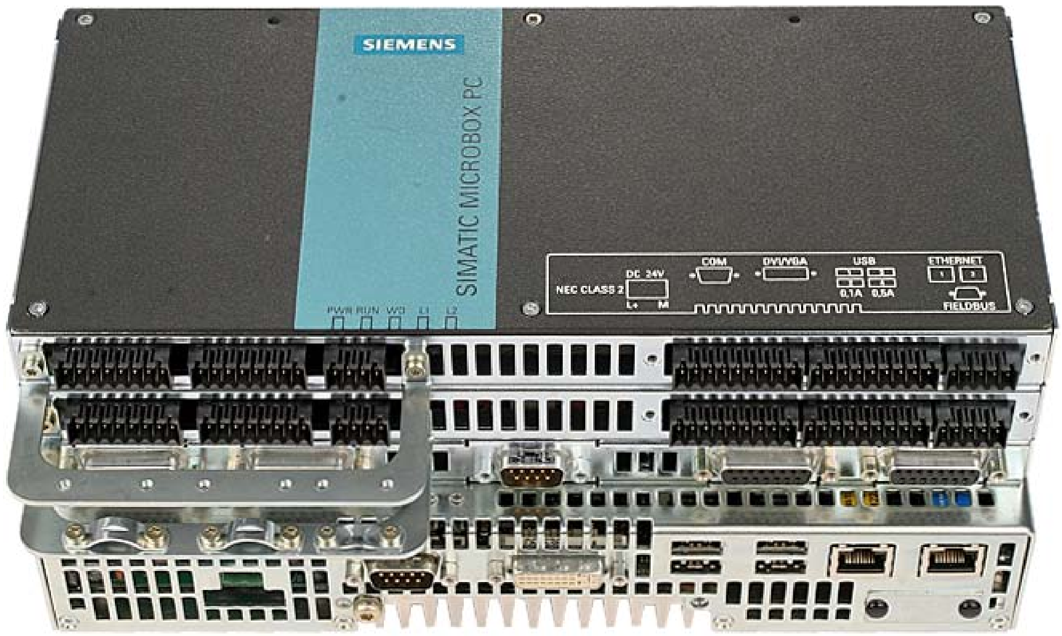


11. Attach the flat ribbon cables used by the I/O modules to communicate with the basic module.
    - Be sure to attach them in the desired order.
    - In the position shown in the diagram, socket S0 is on the left.
12. Second I/O expansion rack:
    - Set up the second I/O expansion racks in the same way
    - Install the second I/O expansion rack
    - Connect the flat ribbon cables.

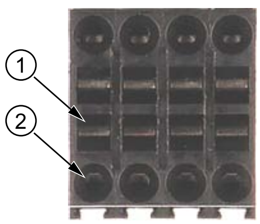


13. Check that all ribbon cable connectors are correctly seated

14. Close the cover of the Microbox PC 420 and tighten the six screws using a T8 screwdriver.



15. Stick the enclosed adhesive label showing the pin assignment of the I/O modules and the adhesive label with the encoder input labeling to the cover of the Microbox PC.
16. Connect the encoders.
17. Connect the external 5 V or 24 V power supply for the encoders.
18. Connect the mating connectors on the analog and digital I/O modules
    - The pin assignments of the connectors can be found in the "Technical data/Interfaces" section.
    - Open the springs by pushing a small slotted screwdriver, for example, into the square opening ①.
    - Push the bared wire into the matching round opening ②. After releasing the springs, check that the cable is securely seated.



19. Connect the desired analog and digital inputs and outputs.
20. The shield clamp is used to ground the shield for the analog signals.
    Use the enclosed strain-relief assemblies.
21. Connect the external 24 V power supply for the digital I/O modules 0. The digital I/O module 0 will not work without this power supply.

22. Start up the Microbox PC 420 and the CIO expansion.

Note

First function test

On booting, the firmware detects all connected I/O modules. The result is stored in the I/O module status register. The module ID indicates whether the I/O modules are correctly connected.

See also

Module detection by the firmware during booting (Page 111)

5.4 Installation example: 2 basic modules with 6 I/O modules and 4 encoders

Notice

A maximum of four expansion racks are permissible

For vibrational stability reasons, no more than four expansion racks (encoder racks and I/O racks) can be installed on a SIMATIC Microbox PC 42x.

Note

Encoder connection assignment

The connection of the plug connectors to the basic module determines the assignment of the encoder connections to encoders/counters 0 to 3 used by the software.

Note

I/O terminal assignment

The connection of the plug connectors to the basic module determines the assignment of the I/O modules (hardware) to I/O modules 0 to 3 used by the software.

Overview

Figure	Item	Description
	①	Case cover
	②	I/O expansion rack 3 with I/O modules S0 and S1 of basic module 2
	③	I/O expansion rack 2 with I/O modules S2 and S3 of basic module 1
	④	I/O expansion rack 1 with I/O modules S0 and S1 of basic module 1
	⑤	Encoder expansion rack for 4 encoders
	⑥	SIMATIC Microbox PC 420 basic unit
	-	Basic module 2 (installed in the Microbox PC, not visible)
	-	Basic module 1 (installed in the Microbox PC, not visible)

This example shows the expansion of a SIMATIC Microbox PC 420 with

- two CIO basic modules
- one encoder frame with 4 encoders
- 3 I/O racks with three digital I/O modules 0 and three analog I/O modules 0.

That accounts for the maximum permissible 4 expansion racks.

You need the following:

Quantity	Description	Name
2	Basic module	PC IO Base 400
1	Encoder expansion rack	PC IO KIT 040
3	I/O expansion rack	PC IO KIT 030
3	Digital I/O module 0	PC IO MOD Digital 010
3	Analog I/O module 0	PC IO MOD Analog 020

Setting up the I/O rack

1. Set up three I/O expansion racks, each with an analog I/O module 0 and a digital I/O module 0 as described in "Preparatory work".

Procedure

Note

Steps illustrated with figures in the previous installation examples are described without illustrations.

Note

In this installation example four I/O modules and 4 encoders are connected to the first (lower) basic module. Only two I/O modules are connected to the second (upper) basic module. A different assignment is also possible.

---

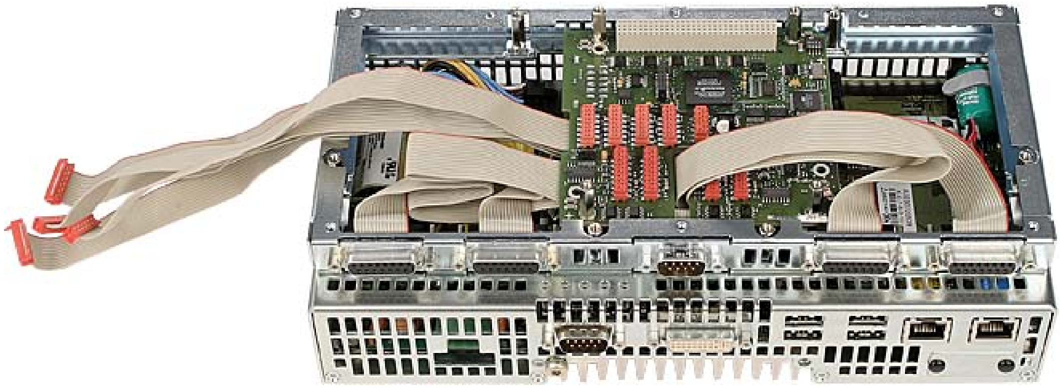
1. Observe the safety instructions at the start of this chapter.
2. Open the cover of the SIMATIC Microbox PC 420
   by releasing the six screws on the cover using a T8 screwdriver
3. To set the slot, set the switch on the basic module to slot 0 (lowest slot). The procedure is described in "Preparatory work".
4. Plug the first basic module into the PCI-104 interface and fix the basic module using the four enclosed 15 mm M3 stud bolts (width across flats 5).
5. Install the encoder expansion rack without its cables. Fasten the rack using the six 15 mm M3 stud bolts (width across flats 5).

6. Attach the connectors for all flat ribbon cables that you wish to connect to this basic module to the matching sockets on the basic module:
   – Four flat ribbon cables for communication with the desired I/O modules
   – Four cables for the encoders
   – One cable for the encoder power supply interface

   Make sure that the connector polarity is correct: In the position shown in the figure below, the red marking on the flat ribbon cable is on top in the sockets on the basic module

7. Fasten the 9-pin sub D connector for the encoder power supply interface to the encoder expansion rack as shown in the figure above.
8. Mark the flat ribbon cable so that you can assign it correctly later.
9. Check that all ribbon cable connectors are correctly seated
10. To set the slot, set the switch on the basic module to slot 1 (second slot from the bottom). The procedure is described in "Preparatory work".
11. Plug the second basic module into the PCI-104 interface and fix the basic module using the four enclosed 15 mm M3 threaded bolts (width across flats 5).
    You can pass the flat ribbon cables for the first basic module
    – to the left and right of the second basic module
    – through the cutout in the middle of the second basic module.

12. Fold the flat ribbon cables and fasten the sub D connectors for the encoders to the encoder expansion rack.

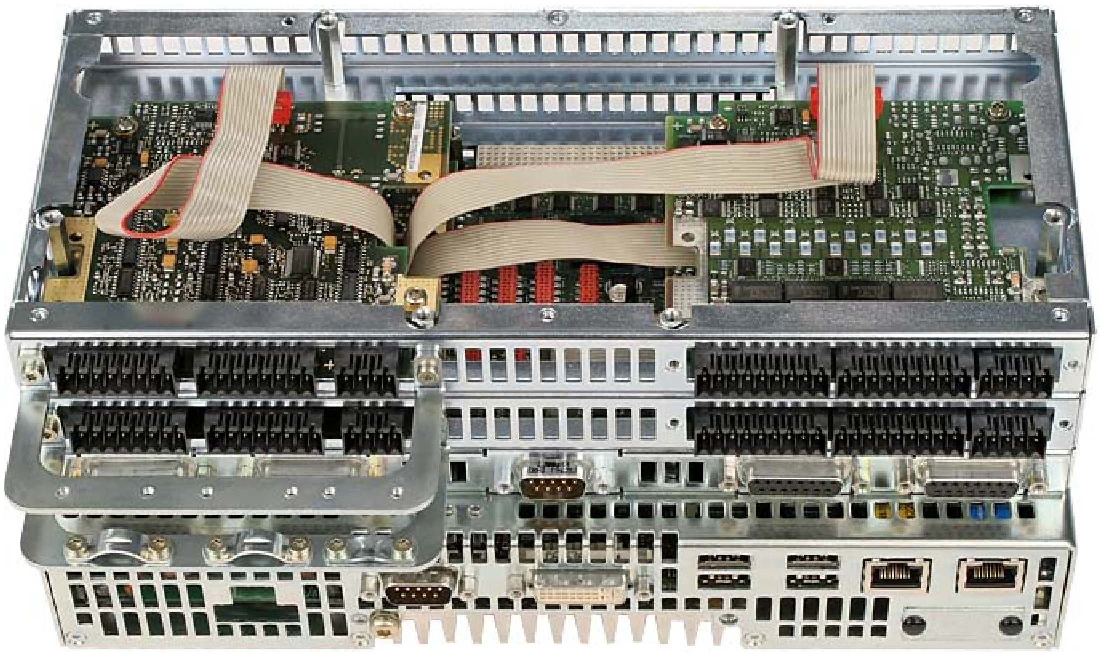


13. Install the first I/O expansion rack. Tighten the six 21 mm M3 stud bolts (width across flats 5).

14. Attach the connectors of the flat ribbon cables used to communicate with the first (lower) basic module to the sockets on the I/O modules.
    – Check the polarity and assignment to the slots.

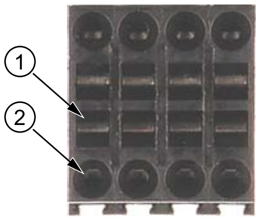
15. Install the second I/O expansion rack. Tighten the six 21 mm M3 stud bolts (width across flats 5).

16. Attach the connectors for the flat ribbon cables used to communicate with the first, lower basic module to the sockets on the I/O modules.



17. Install the third I/O expansion rack. Tighten the six 21 mm M3 stud bolts (width across flats 5).

18. Attach the flat ribbon cable connectors to the I/O modules and to the second (upper) basic module.
    – Make sure that the connector polarity and assignment is correct:
19. Check that all accessible ribbon cable connectors are correctly seated
20. This is the maximum permissible expansion with four expansion racks.
    Close the cover of the Microbox PC 420 and tighten the six screws using a T8 screwdriver.
21. Connect the encoders.
22. Connect the external 5 V or 24 V power supply for the encoders.
23. Connect the mating connectors on the analog and digital I/O module
    – The pin assignments of the connectors can be found in the "Technical data/Interfaces" section.
    – Open the springs by pushing a small slotted screwdriver, for example, into the square opening ①.
    – Push the bared wire into the matching round opening ②. After releasing the springs, check that the cable is securely seated.



24. Connect the desired analog and digital inputs and outputs.
25. Connect the external 24 V power supply for the digital I/O modules 0. The digital I/O modules 0 will not work without this power supply.
26. Start up the Microbox PC 420 and the CIO expansion.

Note

First function test

On booting, the firmware detects all connected I/O modules. The result is stored in the I/O module status register. The module ID indicates whether the I/O modules are correctly connected.

See also

Module detection by the firmware during booting (Page 111)

Installation in the SICOMP IMC system 6

6.1 General installation guidelines

Warning

Work should only be carried out by qualified personnel

Work on the SICOMP IMC CPCI system should only be carried out by qualified personnel in compliance with applicable safety regulations.

Warning

Isolate the machine from all voltage sources before starting work

The SICOMP IMC CPCI system must be voltage-free before it is opened.

Notice

Observe the safety measures for ESD

Ground yourself before touching and installing the modules and opening the SICOMP IMC CPCI system. The safety measures for ESD must be observed.

Notice

Do not alter the switch position

There is a factory-set switch on the basic module. You must not change this setting.

Notice

Do not kink flat ribbon cables

When folding flat ribbon cables, always ensure that a small bending radius is retained. To avoid damaging the cables, do not kink or fold them too tightly.

Note

Pin assignment of connectors

Details of the pin assignments of the connectors can be found in the "Technical data/Interfaces" section.

Tools required

The following tools are needed to expand the SICOMP IMC system with CIO

- Torx T8 screwdriver

6.2 Installation example: Basic module and two I/O modules

Installation

To install a basic module with a digital I/O module and an analog I/O module you will need:

Quantity	Description	Name
1	Basic module	CPCI-SFT200
1	Digital I/O module 0	CPCI-EAM220
1	Analog I/O module 0	CPCI-EAM230

Slots required

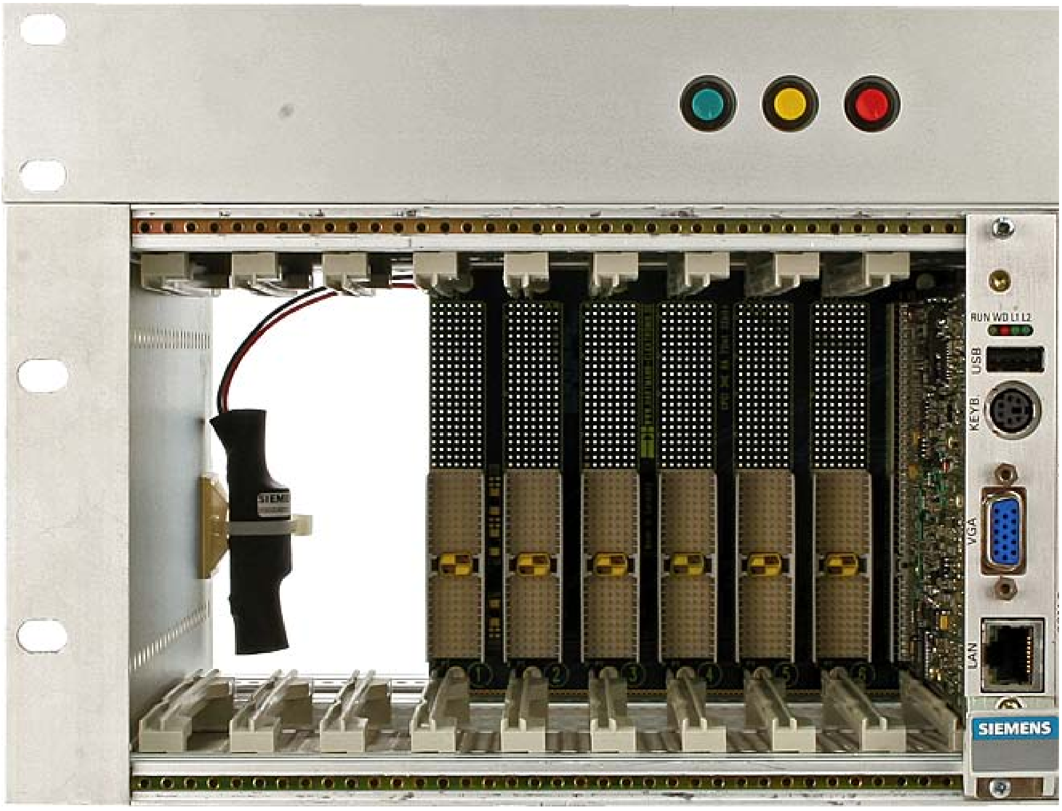
You will need 4 slots in total:

- 2 CPCI slots
- 2 I/O slots (these must not be fitted with CPCI terminals on the rear panel)

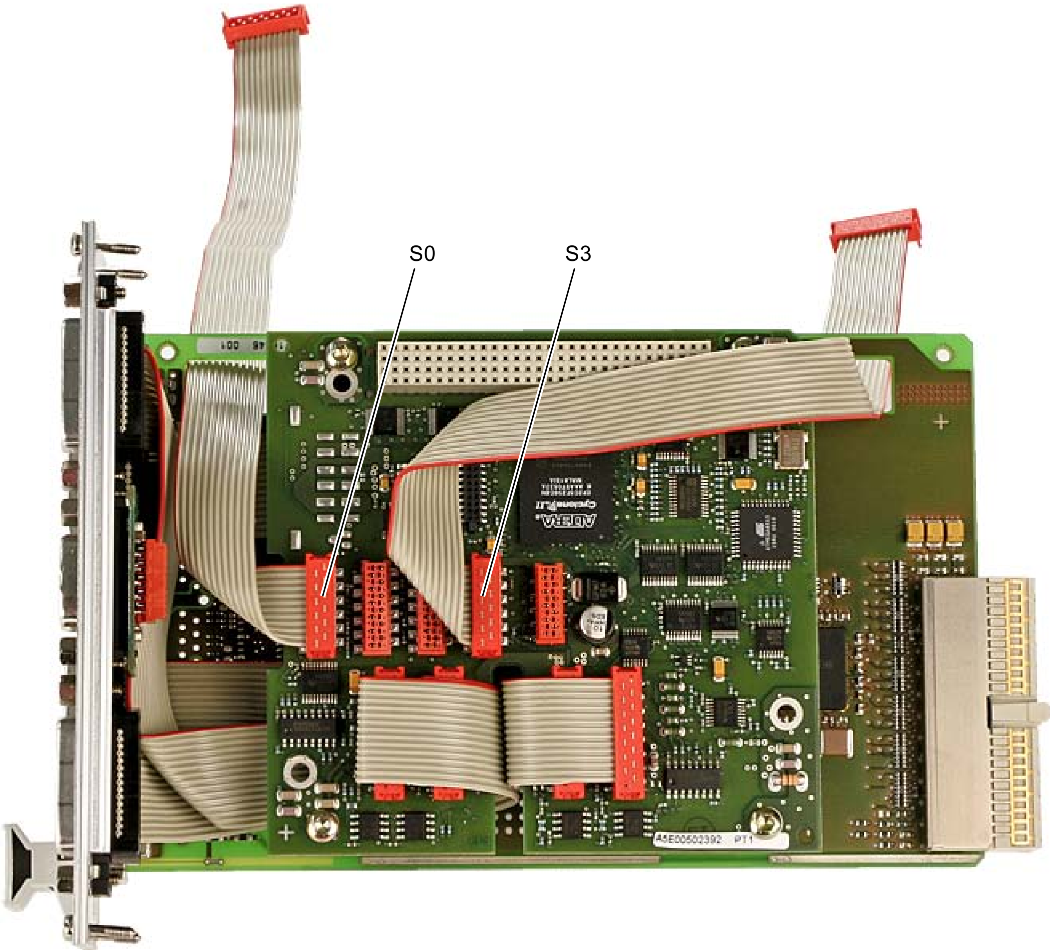
Procedure

1. Observe the safety instructions at the start of the chapter.
2. Disconnect the CPCI system from the mains.

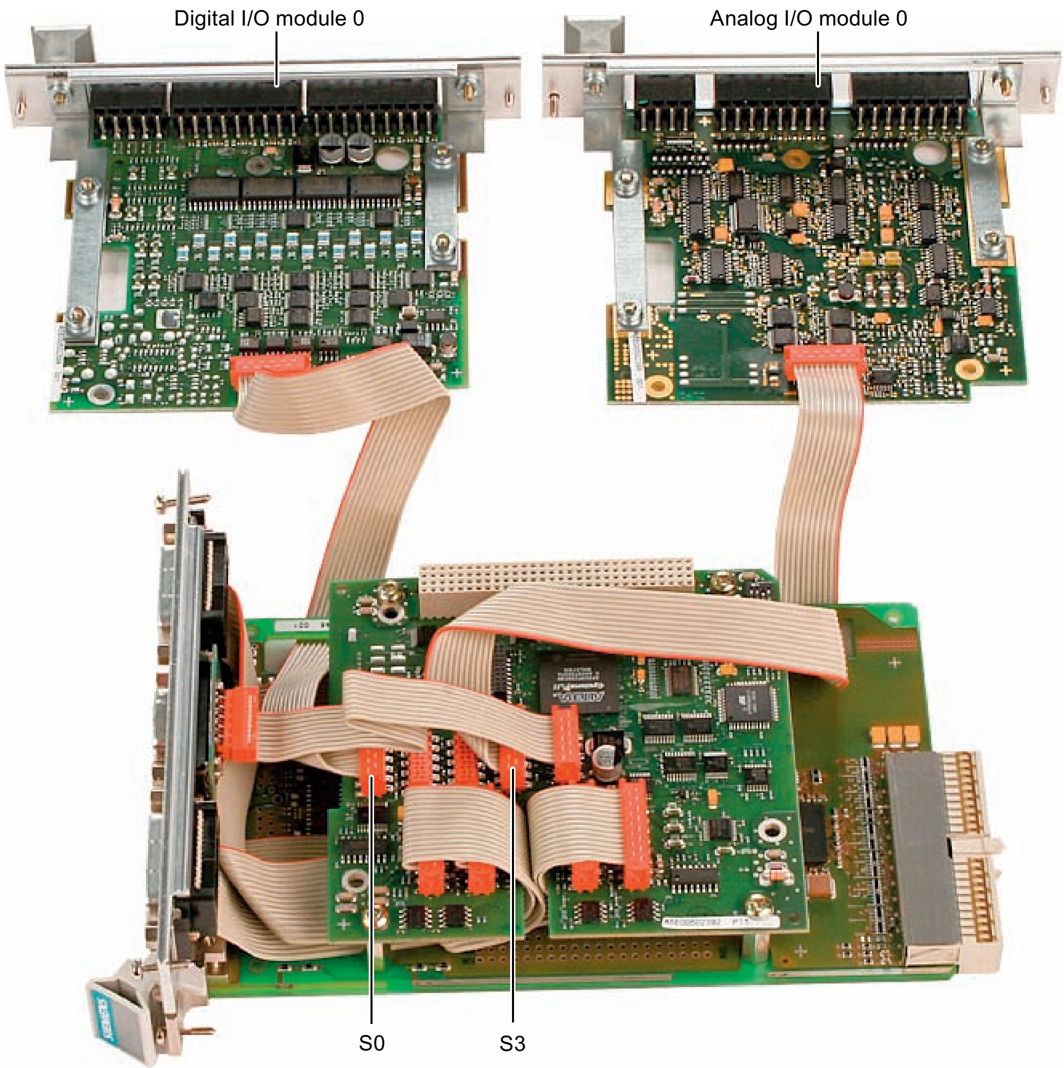
3. Set up the frame:
   - Set up the CPCI slide-in module frame so that there are at least 2 CPCI slots and at least 2 slots for I/O modules.
   - Remove any front covers on the slide-in module frame



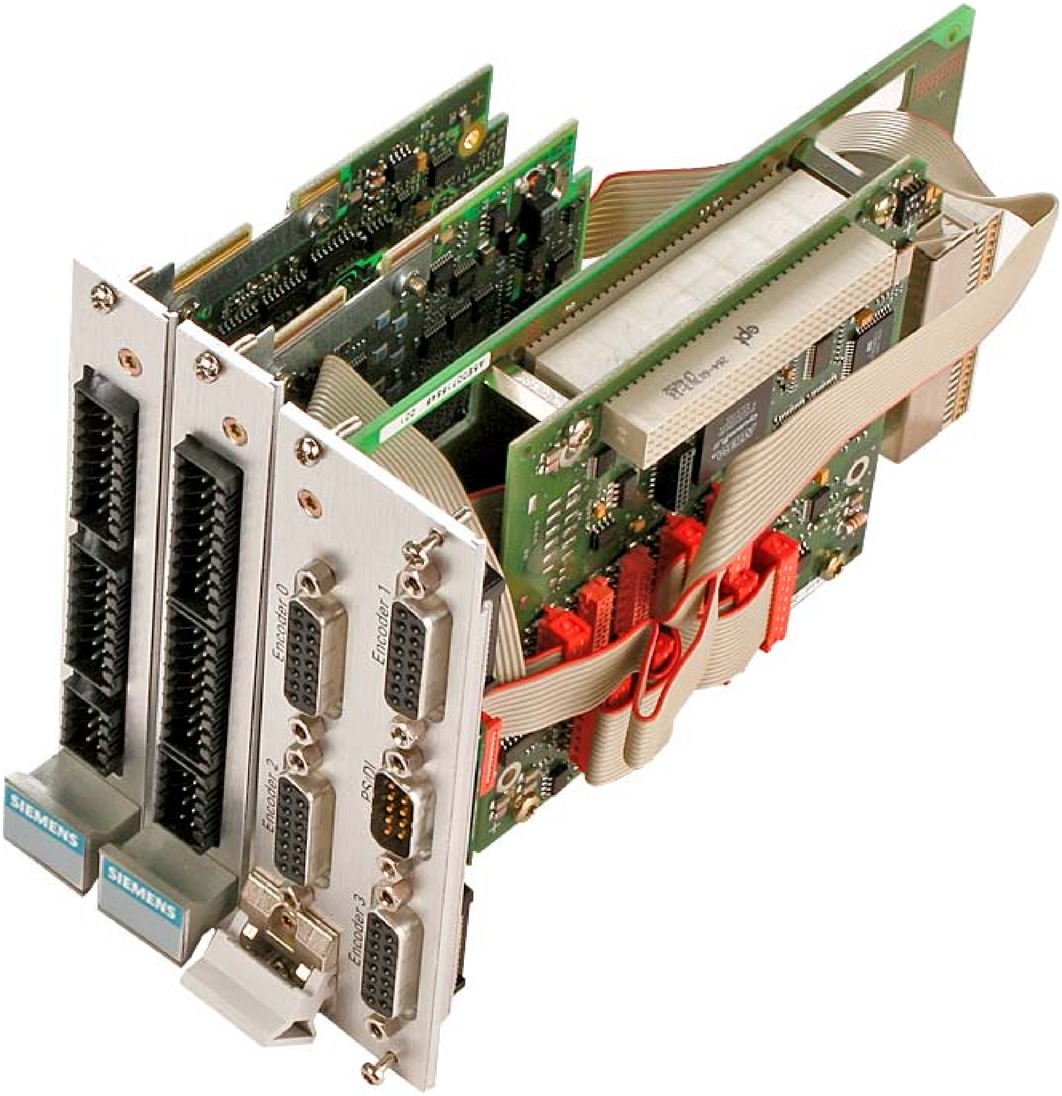
4. Attach the connectors for the flat ribbon cables used for communication between the basic module and the I/O modules to the basic module.
   - To give a better view, in the figure below the flat ribbon cable for the encoder power supply interface has been removed.
   - In this example slots S0 and S3 are connected
   - The cables for the first two slots can be passed through the front cable duct and the other two flat ribbon cables through the rear cable duct.
   - Check the order and arrangement of the flat ribbon cables. In the position shown in the figure below, the red markings on the flat ribbon cables must be on top in the sockets on the basic module.



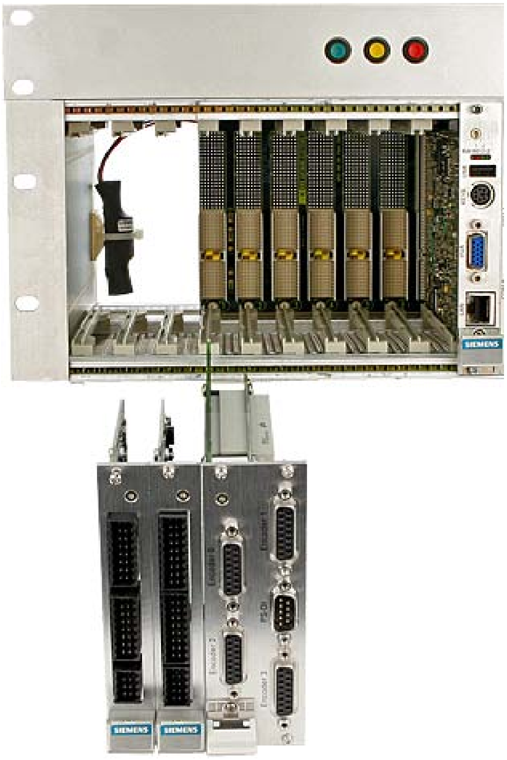
5. Attach the connectors for the flat ribbon cables to the I/O modules.
   – In this example the digital I/O module is connected to slot S0 (left).
     The analog I/O module is connected to slot S3 (right).
   – In the position shown in the figure below, the red marking on the flat ribbon cables must be on the right in the sockets on the I/O modules.



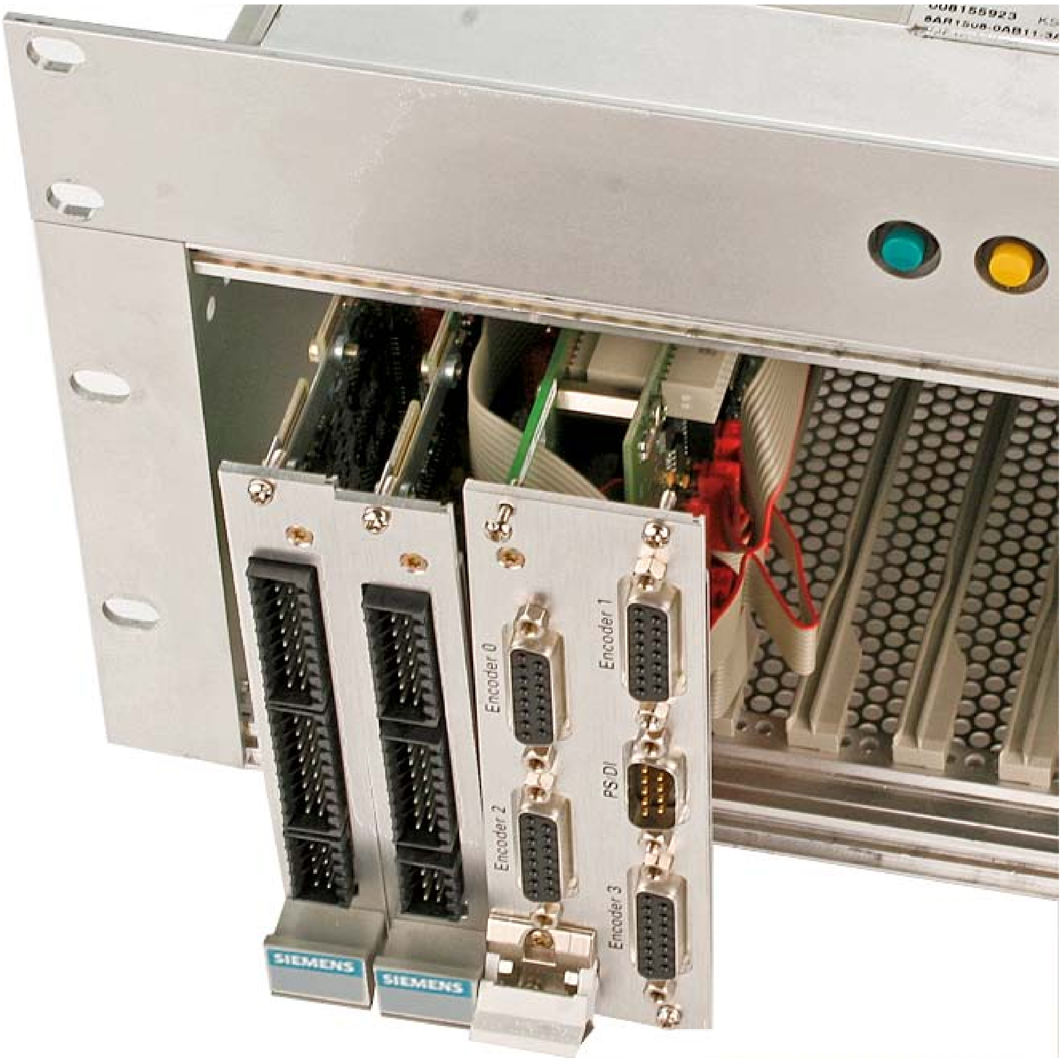
6. Turn the modules so that they are in the position in which they will later be installed in the slide-in module frame. Fold the flat ribbon cables.



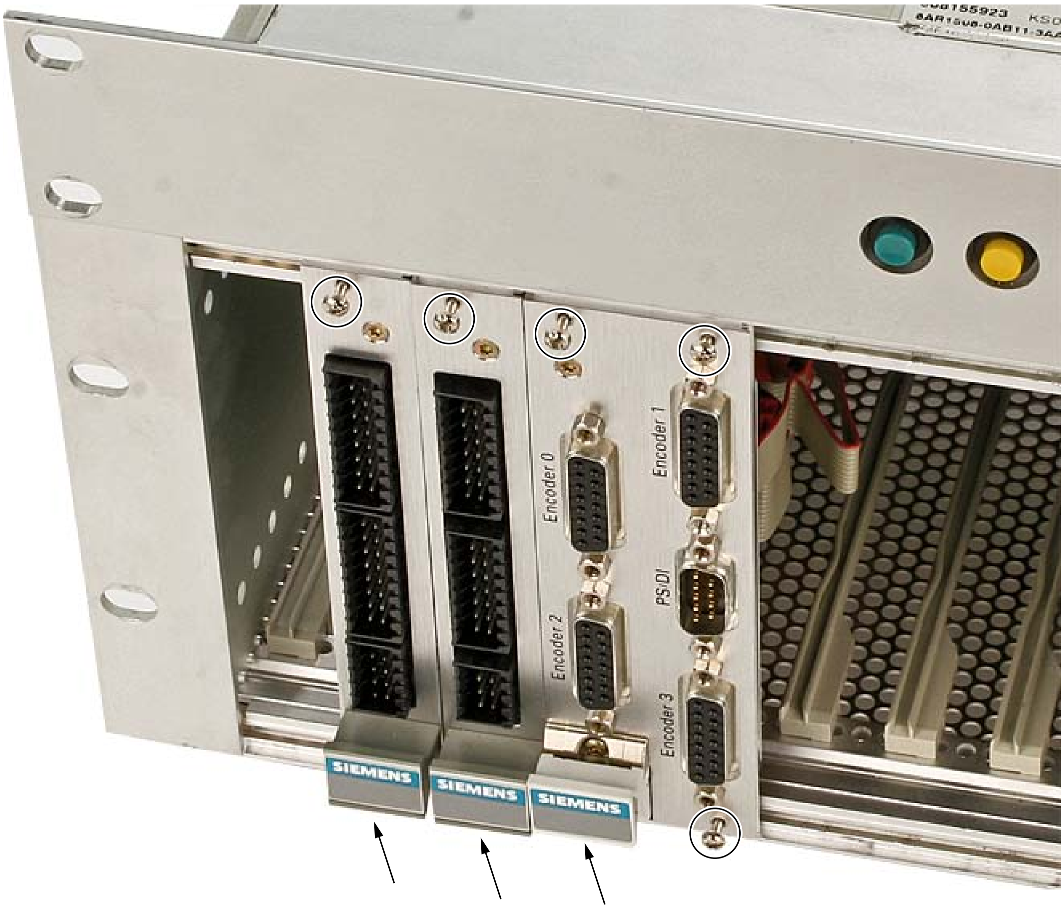
7. Position the modules in the desired slots.
   – Check that all ribbon cable connectors are correctly seated



8. Push all the modules into the slots at the same time.



9. Tighten the screws on the front panels. The screws are marked in the figure below. Concealed screws are indicated by an arrow.

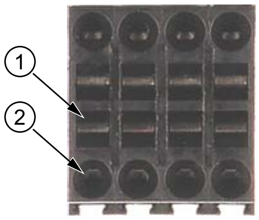


   – Attach the shield of the analog signals to the frame of the mounting cabinet.

10. Connect the encoders.

11. Connect the external 5 V or 24 V power supply for the encoders.

12. Connect the mating connectors on the analog and digital I/O module
    - The pin assignments of the connectors can be found in the "Technical data/Interfaces" section.
    - Open the springs by pushing a small slotted screwdriver, for example, into the square opening ①.
    - Push the bared wire into the matching round opening ②. After releasing the springs, check that the cable is securely seated.



13. Connect the desired analog and digital inputs and outputs.
14. Connect the external 24 V power supply for the digital I/O module 0. The digital I/O module 0 will not work without this power supply.
15. Start up the SICOMP IMC system and the CIO expansion.

Note

First function test

On booting, the firmware detects all connected I/O modules. The result is stored in the I/O module status register. The module ID indicates whether the I/O modules are correctly connected.

The following overview shows the position of the I/O module status register. Bits 0 to 3 contain the module ID: "0001" for a digital I/O module 0 and "0010" for an analog I/O module 0.

I/O module in slot	Address	Byte
S0	BA + 1BC H	0
S1	BA + 1BC H	1
S2	BA + 1BC H	2
S3	BA + 1BC H	3

Access mode	R (read-only) DW: doubleword access only

See also

Module detection by the firmware during booting (Page 111)

7 Configuration and operation

The following warnings and notes must always be observed during configuration and operation.

Notice

Always set up an associated interrupt handler before you enable an interrupt in the interrupt mask.

If an interrupt occurs and an associated interrupt handler has not been set up, the Windows operating system may crash.

Notice

Before closing the CIO software, always carry out the following steps:

- Mask the CIO interrupts again
- Close the interrupt handler
- Release the reserved memory location again

If the interrupts are not masked, then incoming signals can trigger an interrupt and cause the Windows operating system to crash.

If you do not close the interrupt handler, then the next time the interrupt handler is opened, incoming interrupt trigger signals will no longer trigger an interrupt.

If you do not release the memory location again, you will cause a memory leak.

Note

If the system is RESET, all interrupt registers return to their initial state.

7.1 Installation

Note

CIO is independent of the operating system that is used. Example applications and drivers if needed are available on the Internet for Windows XP, Windows XP embedded and RMOS3.

See also

Service and support (Page 205)

7.2 Access to the basic module

The memory area of the basic module is addressed without exception by means of memory accesses.

All addresses relate to the base address of the basic module.

Determine the base address (BA) in the PCI Config Space.

To do this you will need the following identifiers for the CIO expansion:

Device ID	1172 H
Vendor ID	0004 H
Subvendor ID	0404 H
Subsystem	0110 H

All registers in the memory area can be reached via the following address: base address + offset.

In the rest of this document the base address is abbreviated to BA.

All interrupt sources are masked during and after booting.

The structure of the memory area is described in "Technical data / Registers / Memory assignment".

64 KB of RAM are reserved for each basic module.

See also

Memory assignment (Page 150)

7.3 Microcontroller monitoring

The microcontroller has two monitoring mechanisms:

- Time monitoring (watchdog function)
- Mirroring of sent data

Watchdog

The watchdog function acts as a time-out monitor for the microcontroller. If a time-out occurs, it reboots the firmware. As it is booting, the firmware detects that the field programmable gate array (FPGA) has not received a RESET as the firmware version is already entered. In this case the firmware triggers an interrupt. Information about analog output values is lost when the microcontroller reboots.

Data mirroring

Data mirroring allows you to check from the host whether the microcontroller is still "alive":

- Use the software to write any byte to the output mirror register.
  Position: BA + 148 H, byte 0.
- The microcontroller reads this byte, inverts the bits and writes it to an input mirror register.
  Position: BA + 1B8 H, byte 0.
- The result is available in the input mirror register after 2 firmware cycles, i.e., after about 100 µs.
- After this time you can use your user software to check whether the correct value has been entered and therefore whether the microcontroller is still functioning correctly.

7.4 Counters/encoders

7.4.1 Calling functions via the control register

Control register

With the control register you can reset status signals and trigger the commands described below. A write access to the register in which the corresponding bits are set executes this function.

More details about the control register can be found in "Technical data" / "Registers" / "Control register of the counters".

Control register commands are activated by a rising edge of a given bit. The bit is then reset automatically.

The address of the control register for each counter can be found in the table below.

Counter	Address
Counter 0	BA + 64 H
Counter 1	BA + 80 H
Counter 2	BA + 9C H
Counter 3	BA + B8 H

This type of command generation means that multiple commands can be executed simultaneously. Commands for one counter can be called at the same time as those for the other counter because the counters are mutually independent.

Multiple commands can also be executed simultaneously within one counter, although care must be taken, as the command sequence in this case is undefined.

Notice

Avoiding undefined counter conditions

The commands "Software strobe" "Software clear", "Software reload" and "Revoke counter write protection" must not be executed along with other commands on the same counter because the command sequence and therefore also the result is undefined in this case.

Revoke counter write protection

Revokes write protection on the counter in question.

Application/procedure

In the control register for the corresponding counter set byte 3, bit 3 to 1.

Software strobe

The content of the counter for the counting channel in question is carried to the zero-mark buffer, from where the counter value can be read.

The command is only effective if write protection on the counter in question has been revoked.

Application/procedure

In the control register for the corresponding counter set byte 3, bit 4 to 1.

Reset zero-mark latch

The zero-mark latch is set when a zero mark is received and can be reset with this command (separately for each counting channel).

Application/procedure

In the control register for the corresponding counter set byte 3, bit 5 to 1.

Software clear

Resets the counter value to "00000000 H".

The command is only effective if write protection on the channel in question is disabled.

Application/procedure

In the control register for the corresponding counter set byte 3, bit 6 to 1.

Software reload

Resets the counter value to the content of the relevant preload value register.

The command is only effective if write protection on the counter in question is disabled.

Application/procedure

In the control register for the corresponding counter set byte 3, bit 7 to 1.

Reset alarm bits

The alarm bit CBn is set automatically if a counter overflow occurs at counter n. The Reset alarm bits command resets the alarm bit for the counter in question to 0.

Application/procedure

In the control register for the corresponding counter set byte 3, bit 0 to 1.

See also

Counter control registers (Page 185)

7.4.2 Combined functions

You can read the current counter value directly from the counter register for the relevant counter. The addresses for the counter register can be found in the table below.

How to read the counter value synchronized to a trigger event is described in the next section.

Address of the register required

The table below lists the addresses of the registers needed for the functions described in this section. The memory assignment can be found in the "Technical data / Registers / Memory assignment" section.

Counter	Address of the associated register					
	Counter register	Control register	Zero-mark register	Universal register 0	Universal register 1	Preload value register
Counter 0	BA + 50 H	BA + 64 H	BA + 58 H	BA + 5C H	BA + 60 H	BA + 54 H
Counter 1	BA + 6C H	BA + 80 H	BA + 74 H	BA + 78 H	BA + 7C H	BA + 70 H
Counter 2	BA + 88 H	BA + 9C H	BA + 90 H	BA + 94 H	BA + 98 H	BA + 8C H
Counter 3	BA + A4 H	BA + B8 H	BA + AC H	BA + B0 H	BA + B4 H	BA + A8 H

Reading the counter value synchronized to a trigger event

The counter value can be stored temporarily in the zero-mark register or in one of the universal registers when a trigger event occurs. The stored value can be read from there later.

Notice

Constraint for software strobe

The "Software strobe" command is only effective if write protection on the counter in question has been revoked. You will find additional information in the section "Incremental encoders: Position sensing by means of shaft encoder edge evaluation" in the chapter "Configuration and operation".

Procedure:

1. The counter value can only be carried if counter write protection for the channel in question is **disabled**. Therefore counter write protection must be switched off if necessary. Do this by setting byte 3, bit 3 to 1 in the control register for the corresponding counter.

2. Carry the counter value to the desired buffer
   – To carry the content of the counter to the zero-mark buffer, activate the "Software strobe" command. Do this by setting byte 3, bit 4 to 1 in the control register for the corresponding counter.
   – To carry the content of the counter to universal register 0 or 1, apply the external trigger signal Sn for universal register 0 or Tn for universal register 1 to the input of the associated encoder input.
3. Read the value from the chosen buffer.

Loading a preload value

An initial value can be assigned to the counters. The preload value register for the counter in question is used to store the desired initial value.

Procedure:

1. Enter the desired value in the preload value register for the counter in question.
2. The counter can only be loaded if write protection on the channel in question is **disabled**. Do this by setting byte 3, bit 3 to 1 in the control register for the corresponding counter.
3. Carrying of the preload value can be triggered by various events:
   – Directly by means of the "Software reload" command, by setting byte 3, bit 7 to 1 in the control register for the corresponding counter.
   – By means of the clear functions. See "Using the clear functions".

See also

Using the clear functions (Page 95)

Memory assignment (Page 150)

Incremental encoder: Position sensing by means of shaft encoder edge evaluation (Page 99)

7.4.3 Using the clear functions

Clear function

The counter on a channel can be set by various trigger events to 0 or to a value stored in the preload value register.

Using the control register for the counter in question, you can choose

- Whether trigger events are enabled or locked
- Whether the counter is set to zero (00000000 H) or to the value stored temporarily in the preload value register when a reset event occurs.

There are also direct reset commands which are always active.

Overview of the various options

The table provides an overview of the various options. All the bits listed in the table relate to the control register for the counter in question.

Trigger	Activate trigger	Function mode	Result
Receipt of zero mark from shaft encoder	Byte 1, bit 6 (CLR_n) activate: "1" lock: "0"	Byte 2, bit 1 (CLR_MDn) = "0"	Set counter to "0"
		Byte 2, bit 1 (CLR_MDn) = "1"	Set counter to value in preload value register
Equality of shaft encoder and universal register 0 for counter n	Byte 2, bit 0 (CR1n_CLR) activate: "1" lock: "0"	Byte 2, bit 1 (CLR_MDn) = "0"	Set counter to "0"
		Byte 2, bit 1 (CLR_MDn) = "1"	Set counter to value in preload value register
Special signal Sn	Byte 1, bit 2 (Sn_CLR) activate: "1" lock: "0"	Byte 2, bit 1 (CLR_MDn) = "0"	Set counter to "0"
		Byte 2, bit 1 (CLR_MDn) = "1"	Set counter to value in preload value register
Byte 3, bit 6: Software clear n = "1"	Always active	Any	Set counter to "0"
Byte 3, bit 7: Software reload n = "1"	Always active	Any	Set counter to value in preload value register

Procedure

Notice

Avoiding undefined counter conditions

The commands "Software strobe" "Software clear", "Software reload" and "Revoke counter write protection" must not be executed along with other commands on the same counter because the command sequence and therefore also the result is undefined in this case.

---

1. Use control bit CLR_MDn of the respective counter to select the function mode: "Set counter to zero" or "Reload from the preload value register for Clear"
2. Activate the desired trigger events and lock (reset to "0") any trigger events which you do not want to act as triggers.
3. Use the commands "Software clear" and "Software reload" to reset the counter to zero or to the value in the preload value register.

7.4.4 Hysteresis functions

Introduction

If the connected shaft encoders are exposed to vibration, count pulses or zero-mark signals can be generated even at rest. To avoid these zero-mark signals, three different hysteresis functions can be enabled.

Notice

Constraint for the hysteresis function

Hysteresis cannot be activated in "Frequency and pulse-width measurement" mode because in this case the bit used to set the hysteresis is used to differentiate between count directions.

Hysteresis with direction of rotation reversal

In hysteresis with direction of rotation reversal, the first pulse is ignored whenever the direction is reversed. This means that fluctuation around a counter value is minimized when the encoder shaft is stationery.

Zero-mark hysteresis

Zero-mark hysteresis is useful if the zero-mark signal is used to trigger interrupts.

The zero-mark logic is only enabled again after reaching a zero mark if the counter value moves two count pulses in one direction.

If the shaft encoder comes to rest precisely on the zero mark, vibration in the system can cause zero-mark signals to be triggered constantly. Zero-mark hysteresis prevents an avalanche of interrupts occurring in such a case.

Zero-mark hysteresis can only be activated together with "hysteresis with direction of rotation reversal".

Comparator hysteresis

Comparator hysteresis is useful if a comparator is used to trigger interrupts.

The comparator logic is only enabled again after reaching the comparator value if the counter value moves two count pulses in one direction.

If the shaft encoder stops in a position such that the counter value is exactly the same as the comparator value, vibration in the system can cause comparator interrupts to be triggered constantly.

Comparator hysteresis can only be activated together with "hysteresis with direction of rotation reversal".

Procedure for activating hysteresis functions

The procedure is shown in the table together with the addresses for the control registers for the various counters.

Hysteresis function	Activation procedure
Activate hysteresis with direction of rotation reversal	Set byte 0, bit 5 (HZn) in the control register for the relevant counter.
Activate zero-mark hysteresis	1. Set byte 0, bit 5 (HZn) in the control register for the relevant counter 2. Set byte 2, bit 3 (REFn_HYST) in the control register for the relevant counter
Activate comparator hysteresis	1. Set byte 0, bit 5 (HZ) in the control register for the relevant counter 2. Set byte 3, bit 2 (KOMPn_HYST) in the control register for the relevant counter

Procedure for resetting hysteresis functions

1. Reset zero-mark hysteresis or comparator hysteresis if it was activated. To do this, reset bit REFn_HYST for zero-mark hysteresis or KOMPn_HYST for comparator hysteresis to 0 in the register for the relevant counter.
2. To deactivate hysteresis with direction of rotation reversal too, reset bit HZn in the control register for the relevant counter.

Notice

Always reset zero-mark hysteresis or comparator hysteresis

If you only reset the hysteresis function with direction reversal, then although zero-mark hysteresis or comparator hysteresis will be disabled too, reactivation of the hysteresis function with direction reversal can have undesirable consequences.

7.4.5 Incremental encoder: Position sensing by means of shaft encoder edge evaluation

Note

A flowchart for programming the processing of an incremental encoder can be found in "Examples/Applications".

Overview

In position evaluation you can choose between the following operating modes:

- Position sensing with zero-mark evaluation

  In position sensing with zero-mark evaluation the module offers supports with editing the registers. If a zero mark is received, counter write protection is triggered automatically.
- Position sensing without zero-mark evaluation

  In position sensing without zero-mark evaluation, counter write protection is not triggered when a zero mark is received. One-off operation is not possible in this operating mode.

In both modes various settings have to be made.

Mode of operation with zero-mark evaluation	Mode of operation without zero-mark evaluation
Settings, for example: • Choice of edge evaluation • Choice of hysteresis	Settings, for example: • Choice of edge evaluation • Choice of hysteresis

The following settings and operating modes are described before looking in more detail at the mode of operation with and without zero-mark evaluation and the configuration required:

- Mode of operation of shaft encoder edge evaluation
  single, double or quadruple edge evaluation
- Mode of operation of shaft encoder edge evaluation with hysteresis function

Mode of operation of shaft encoder edge evaluation

A two-track incremental rotary transducer with a zero-mark track can be connected to each encoder input. The count pulses and count direction are calculated from the A- and B-track signals. This is done by evaluating the pulse edges of the individual tracks.

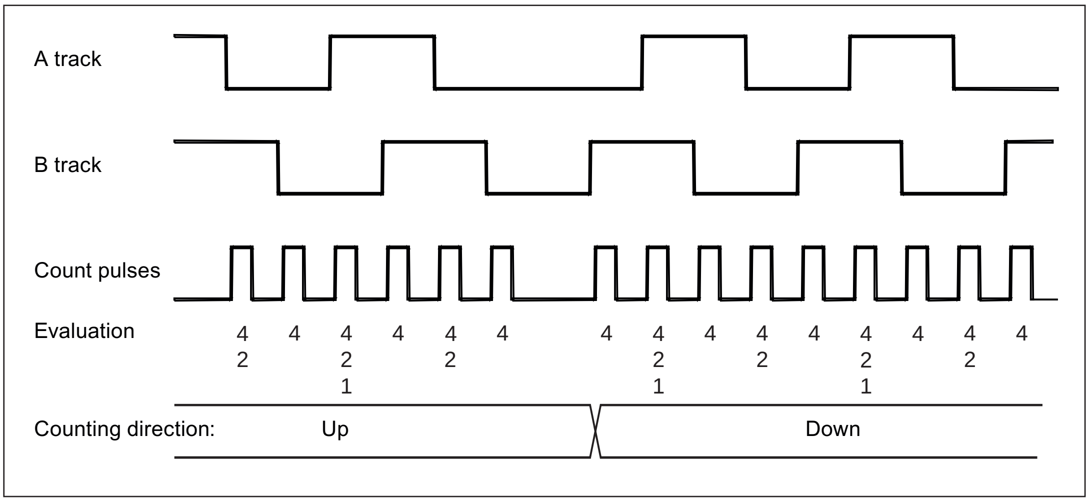


Figure 7-1 Shaft encoder edge evaluation without hysteresis function

The count direction is determined from the position of the A track relative to the B track. The number of count pulses depends on the type of edge evaluation you set in the counter's mode registers:

Quadruple edge evaluation	Each pulse edge on the A and B track is counted
Double edge evaluation	Only edge changes on the A track are counted
Single edge evaluation	Single edge evaluation: only the rising edge on the A track is counted

Mode of operation of shaft encoder edge evaluation with hysteresis function

Example: Hysteresis with direction of rotation reversal

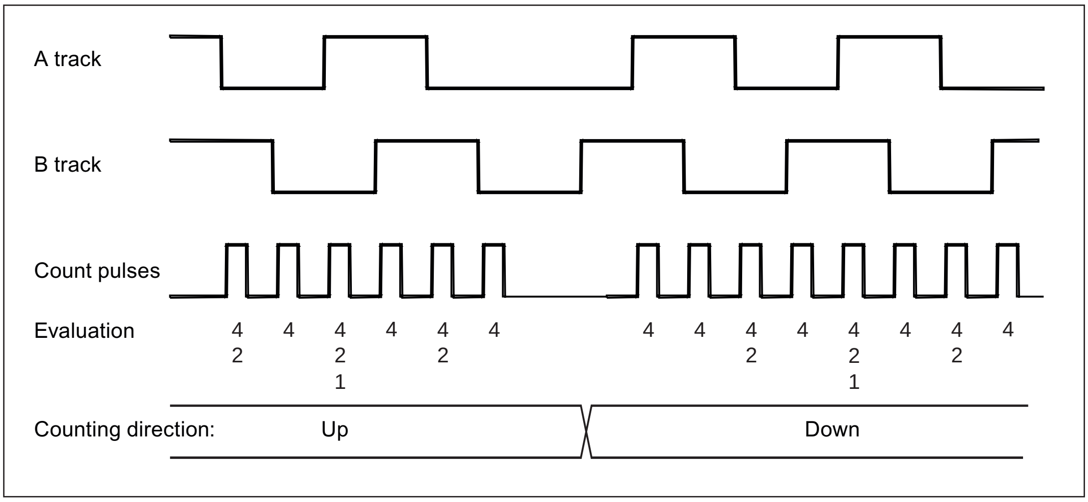


Figure 7-2 Shaft encoder edge evaluation with hysteresis function

With a change of direction the first pulse is ignored. In the example above the first rising edge on the B track does not lead to a count pulse.

Position sensing with zero-mark evaluation

In this operating mode the module offers support with editing the registers.

The zero-mark input of each counter acquires a particular importance here. When a zero mark is received, the following event is triggered on the module:

- The current counter value is stored in the zero-mark register. You can read it from there.

For counter n the following status bits are set in the control register:

Position of encoder status register: BA + 48 H

Name	Meaning	Value	Bit in encoder status register for counter n	
			Byte	Bit
REFEn	Status of zero-mark signal set	1	n	1
Qn	Buffered zero-mark signal set	1	n	5

More information can be found in the "Technical data/Registers/Encoder status register" section.

An interrupt is also set:

Position of main interrupt register: BA + 00 H

Name	Meaning	Counter	Value	Bit in main interrupt register	
				Byte	Bit
NU_INT_n	Interrupt: Zero-mark signal received at counter n	0	1	3	4
		1	1	3	5
		2	1	3	6
		3	1	3	7

Setting up position sensing with zero-mark evaluation

1. Select a source via the encoder interface switching register
2. Activate the zero-mark signal of the relevant shaft encoder for the logic.

   To do this set byte 1, bit 7 in the control register to "1": "Activate zero-mark inputs".

   The default setting for this bit is "0".
3. Program control register n
   The main control register parameters are listed below. They can be entered in the control register simultaneously. The "Technical data" section describes all the setting options for the control register.
   - Set "Position sensing" mode
     To do this set byte 0, bit 7 in the control register to "0".
   - Select edge evaluation:
     To do this set byte 0, bits 0 to 3 in the control register:
     Single edge evaluation: "0101", double "0001", quadruple "0000".
   - Switch on the hysteresis function if required
     To do this set byte 0, bit 5 in the control register to "1"
   - Activate zero-mark hysteresis or comparator hysteresis if required.
     This can only be done if the hysteresis function has been switched on.
     For comparator hysteresis set byte 2, bit 2 in the control register to "1"
     For zero-mark hysteresis set byte 2, bit 3 in the control register to "1"
   - Activate the special functions Sn and/or Tn as triggers if required, e.g., if using a limit switch
     For trigger function Tn: set byte 1, bit 0 in the control register to "1".
     For trigger function Sn: set byte 1, bit 1 in the control register to "1":
4. Set the interrupt enable via the interrupt mask register
5. If a zero mark occurs, the counter value is carried to the zero-mark register. To reset the counter value to 0 afterwards, select CLRn.
   To do this, set byte 1, bit 6 in the control register to "1".
   Further options for resetting the counter to 0 or to a preload value can be found in "Using the clear functions".

Note

Zero-mark offset with shaft encoders

The zero mark is triggered by shaft encoders once per revolution. The same number of count pulses is always delivered between two zero marks. For example, a shaft encoder that delivers 5000 pulses per revolution on the A and B track would increase or reduce the counter by 20000 count pulses per revolution with quadruple edge evaluation. Since all external signals are synchronized by the module, it can happen that the counter difference between two zero marks varies by ± 1 increment. So, in the example above, the difference in counter values between two zero marks can vary between 19999 and 20001. This variation is cancelled out again overall, however.

Position sensing without zero-mark evaluation

In this operating mode the counter value is not buffered when a zero mark is received. The functionality is that of a simple counter. With trigger signals Sn or Tn you can write counter values synchronously to the universal register.

The main difference from position sensing with zero-mark evaluation is that in this mode, receipt of a zero mark does not trigger counter write protection.

When a zero mark is received, the following events are triggered on the module:

Since counter write protection is not set, the zero-mark register can be overwritten or cleared by:

- Zero-mark signal or software strobe
- Write accesses
- Clear events

For counter n the following status bits are set in the control and command register:

Position of encoder status register: BA + 48 H

Name	Meaning	Value	Bit in encoder status register for counter n	
			Byte	Bit
REFEn	Status of zero-mark signal set	1	n	1
Qn	Buffered zero-mark signal set	1	n	5

More information can be found in the "Technical data/Registers/Encoder status register" section.

An interrupt is also set:

Position of main interrupt register: BA + 00 H

Name	Meaning	Counter	Value	Bit in main interrupt register	
				Byte	Bit
NU_INT_n	Interrupt: Zero-mark signal received at counter n	0	1	3	4
		1	1	3	5
		2	1	3	6
		3	1	3	7

Setting up position sensing without zero-mark evaluation

1. Select a source via the encoder interface switching register
2. Deactivate the zero-mark signal of the relevant shaft encoder for the logic. To do this set byte 1, bit 7 in the control register to "0": "Deactivate zero-mark inputs".

   "0" is the default setting for this bit.
3. Program control register n
   The main control register parameters are listed below. They can be entered in the control register simultaneously. The "Technical data" section describes all the setting options for the control register.
   – Set "Position sensing" mode
     To do this set byte 0, bit 7 in the control register to "0".
   – Select edge evaluation:
     To do this set byte 0, bits 0 to 3 in the control register:
     Single edge evaluation: "0101", double "0001", quadruple "0000".
   – Switch on the hysteresis function if required
     To do this set byte 0, bit 5 in the control register to "1"
   – Activate zero-mark hysteresis or comparator hysteresis if required.
     This can only be done if the hysteresis function has been switched on.
     For comparator hysteresis set byte 2, bit 2 in the control register to "1"
     For zero-mark hysteresis set byte 2, bit 3 in the control register to "1"
   – Activate the special functions Sn and/or Tn as triggers if required, e.g., if using a limit switch
     For trigger function Tn: set byte 1, bit 0 in the control register to "1".
     For trigger function Sn: set byte 1, bit 1 in the control register to "1":
4. Set the interrupt enable via the interrupt mask register

See also

Counter control registers (Page 185)

Using the clear functions (Page 95)

Encoder status register (Page 169)

7.4.6 Counters: Frequency and pulse-width measurement

The counters can be used to measure frequencies or pulse widths. This operating mode can be set for each counter in the corresponding control register. Both measurements take place in the "Frequency and pulse-width measurement" mode setting. Whether the frequency or pulse width is measured depends on how the inputs are connected and how events are evaluated.

For both functions various settings have to be made.

Frequency measurement	Pulse-width measurement
Settings, for example: • Choice of source whose frequency is to be measured • Choice of reference gate • Choice of gate generation	Settings, for example: • Choice of source whose pulse width is to be measured • Choice of reference frequency • Choice of gate generation

The following settings and operating modes are described before looking in more detail at the configuration procedure:

- General mode of operation of pulse-width measurement and frequency measurement
- Gate generation: level-controlled or edge-controlled

The addresses of the control registers for the individual counters are also listed.

Mode of operation

Pulse-width measurement

The pulse to be measured is applied to input B. While the pulse is logical 1, the counter is active and is clocked with a known frequency f. This frequency can be an internal counting frequency or a known frequency at input A. The pulse width is calculated from the formula:

t_B = counter value / f

Frequency measurement

A gate is applied at input B. The gate is open for a defined time t_B. During this time, count pulses at input A are measured. The frequency at input A is calculated by

f_A = counter value / t_B

Gate generation

You can choose between level-controlled and edge-controlled gate generation using bit TOR_MDn.

Level-controlled gate generation

Bit TOR_MDn = 0

The gate is active for as long as a high level is applied at the gate input.

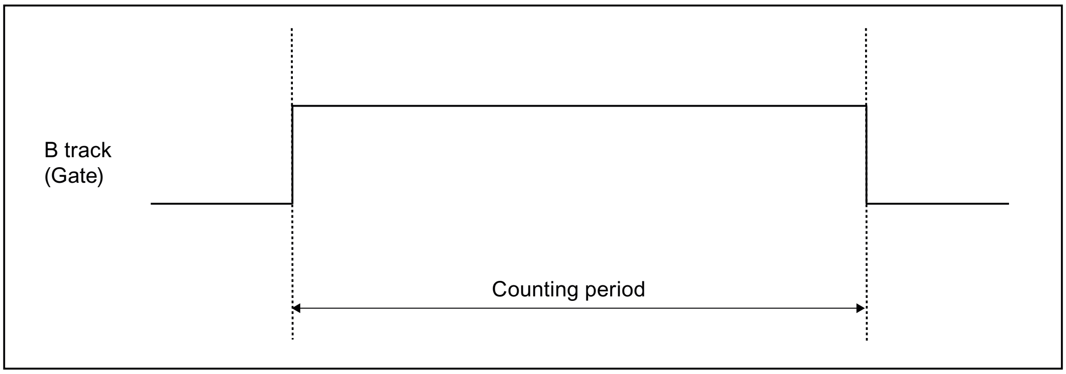


Figure 7-3 Level-controlled gate generation

In this instance, with pulse-width measurement the length of time for which the input signal level is high is measured.

Edge-controlled gate generation

Bit TOR_MDn = 1

The gate is activated with a rising edge at the gate input and deactivated again with the next rising edge at the gate input. The status bit TORn in the status register for counter n remains set for as long as the gate is active.

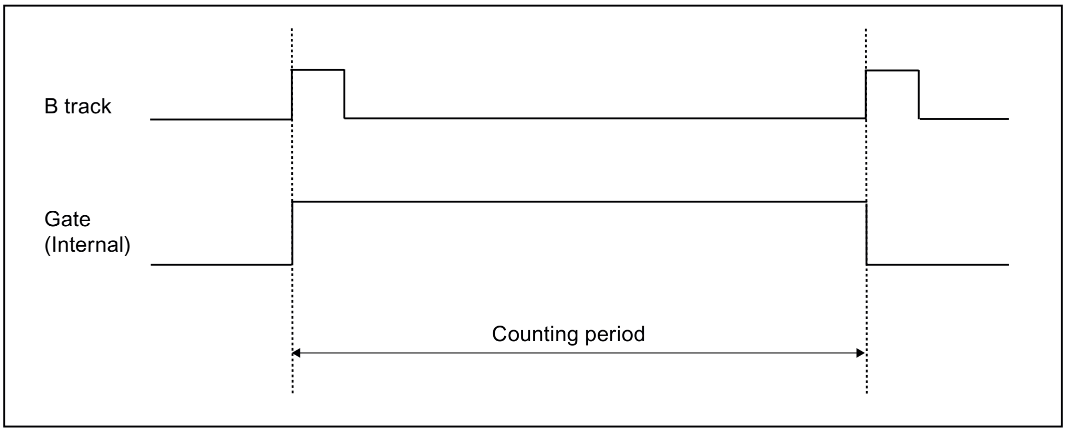


Figure 7-4 Edge-controlled gate generation

In this instance, with pulse-width measurement the period of periodic signals is measured.

Internal gate generation with frequency measurement

In the case of internal gate generation, 8 different pulse lengths ranging from 8 μs to 16777216 μs can be chosen as the gate width. The times are listed in "Encoder interface switching registers" in the "Technical data" section.

In the case of an edge-controlled gate width, the gate width is equal to one period of the internal pulse, in other words the value shown in the table.

In the case of a level-controlled gate width, the gate width is equal to the time for which the internal pulse level is high, in other words half the time shown in the table.

External gate generation using the zero-mark input

In the case of level-controlled gate measurement:

The gate signal must be inversely connected to the zero-mark input. So the non-inverting input from B must be connected to the inverting input from N and the inverted input from B to the non-inverted input from N.

In the case of edge-controlled gate measurement:

The gate signal must be connected in parallel to the zero-mark input.

Procedure for configuring a frequency measurement

Different settings are suitable for different applications:

- Without zero-mark evaluation

  In the case of measurement without zero-mark evaluation, the presence of the trigger event for the measurement must be interrogated by polling. For that reason this method of measurement is generally less accurate than measurement with zero-mark evaluation.

1. Set the selected encoder input via the encoder interface switching register.
2. Connect the signal whose frequency is to be measured differentially to input A of the selected encoder input.
3. Select "Frequency and pulse-width measurement" mode for counter n.
   To do this set byte 0, bit 7 in the control register to "1".
4. Set the count direction for counter n.
   Count direction upwards: set byte 0, bit 5 in the control register to "0".
   "0" is the default setting for this bit.
5. Select the reference gate signal with the desired accuracy. There are various options here:
   The desired source for the reference gate signal can be specified in the encoder interface switching register. The following options are available:
   – Internal reference signal:
     The desired pulse length, which determines the gate width, can be selected in the encoder interface switching register.
   – External gate signal at the encoder inputs: Connect differentially to input B of the selected encoder input.
   – External gate signal at the digital inputs or rapid I/O inputs of the digital I/O modules: Connect the signal to the selected input.

6. Select the gate generation mode:
   – Level-controlled: set byte 0, bit 6 in the control register to "0"
   – Edge-controlled: set byte 0, bit 6 in the control register to "1"

Procedure for configuring a pulse-width measurement

1. Connect the signal whose pulse width is to be measured differentially to input B of the selected encoder input. The gate is generated
2. Select "Frequency and pulse-width measurement" mode for counter n.
   To do this set byte 0, bit 7 in the control register to "1".
3. Set the count direction for counter n.
   Count direction upwards: set byte 0, bit 5 in the control register to "0".
   "0" is the default setting for this bit.
4. Select the reference gate signal with the desired accuracy.
   The desired source for the reference gate signal can be specified in the encoder interface switching register. The following options are available:
   – Internal reference signal:
     The desired sampling time can be selected in the encoder interface switching register: the options are 1 MHz and 4 MHz
   – External clock signal at the encoder inputs: Connect differentially to input A of the selected encoder input.
   – External gate signal at the digital inputs or rapid I/O inputs of the digital I/O modules: Connect the signal to the selected input.
5. Set the type of gate generation
   – "Level-controlled" gate generation: set byte 0, bit 6 in the control register to "0"
     The measuring frequency then corresponds to the clock frequency set.
   – "Edge-controlled" gate generation: set byte 0, bit 6 in the control register to "1"
     The measuring frequency then corresponds to half the clock frequency.

Frequency or pulse-width measurement using the zero-mark input

Frequency or pulse-width measurement using the zero-mark input is largely the same as position sensing via shaft encoder edge evaluation with zero-mark evaluation. The procedure is as follows:

1. Activate zero-mark signals N of the shaft encoder for the logic.
   To do this set byte 1, bit 7 in the control register to "1": "Activate zero-mark input".

   The default setting for this bit is "0".
2. Program control register n
   The main control register parameters are listed below. They can be entered in the control register simultaneously. The "Technical data" section describes all the setting options for the control register.
3. Set the interrupt enable via the interrupt mask register

Frequency or pulse-width measurement without using the zero-mark input

This type of measurement is carried out by polling the gate status bit TORn.

Procedure:

1. Reset the counter at the start of measurement
2. Start of measurement:
   – With an external gate: measurement begins as soon as the signal level for the gate is high.
   – With an internal gate: the gate starts automatically as soon as the settings are made.
3. Bit TORn is polled to determine whether the gate at the relevant B input is still open or is already closed.
4. As soon as the gate is closed, the counter value is carried to the zero-mark buffer by means of a software strobe command.
5. Read the counter value from the zero-mark buffer.

7.5 Reading the digital inputs of the basic module

The basic module has 4 digital inputs.

Note

The status of the digital inputs is stored in the encoder status register.

Note

A flowchart for reading a digital input can be found in "Examples/Applications".

The following table shows the position of the receive registers:

Digital input on the basic module	Address		
	Address	Byte	Bit
G0	BA + 48 H	2	6
G1	BA + 48 H	2	7
G2	BA + 48 H	3	6
G3	BA + 48 H	3	7

1. Read the associated register
2. Evaluate the data for the desired inputs

See also

Flowcharts (Page 117)

7.6 I/O modules

7.6.1 Overview

The microcontroller firmware carries out the following tasks with regard to managing the I/O modules

- Module detection on booting after POWER ON
- Initializing the detected modules:
  copying the relevant initialization data to the associated registers
- Supporting your software in driving the I/O modules
- Monitoring inputs and outputs and copying corresponding status messages to the associated registers

7.6.2 Booting and initialization by the firmware

7.6.2.1 Module detection by the firmware during booting

The firmware carries out module detection while the system is booting. The search for connected I/O modules begins as soon as the field programmable gate array deactivates the microcontroller RESET. The search begins with I/O module S0 and ends with I/O module S3.

The firmware reads the status byte of the I/O module for each slot. If it finds a known module, it stores the corresponding address ID in the status register. If no module or an unknown module is found, it stores the ID "0000".

The first analog I/O module that is found becomes analog module A0.

In the module detection phase, the firmware keeps the I/O modules in RESET.

The result is stored in the I/O module status register. Here you can check whether the I/O modules have been correctly detected. Depending on whether a digital I/O module 0 or an analog I/O module 0 was detected at a slot during booting, the meaning of the bits in the I/O module status register differs.

The following overview shows the position of the I/O module status register:

I/O module in slot	Address	Byte
S0	BA + 1BC H	0
S1	BA + 1BC H	1
S2	BA + 1BC H	2
S3	BA + 1BC H	3

Access mode	R (read-only) DW: doubleword access only

7.6.2.2 Initialization of the digital I/O module 0 by the firmware

The microcontroller firmware reads the initial status of the digital inputs and stores them for subsequent change detection. All outputs are deactivated (open drain).

7.6.2.3 Initialization of the analog I/O module 0 by the firmware

During initialization the microcontroller firmware carries out the following tasks with regard to the analog I/O modules:

- Initialization of all analog outputs to 0 V
- During booting or a RESET, the field programmable gate array (FPGA) is still disabled. During this time the microcontroller firmware continually refreshes the analog outputs.
- If a RESET occurs the analog outputs are set to 0 V.

7.6.3 Driving the I/O modules

7.6.3.1 Driving the I/O modules

- The firmware supports your software in driving the I/O modules that were detected and initialized during booting.
- The firmware's processing cycle time is approximately 50 µs.

7.6.3.2 Driving the digital inputs/outputs

Inputs

The signals at the inputs are carried to the receive register after a brief delay time. For digital inputs DI 0 to DI 7, interrupts can be triggered if the data content alters and the interrupt masks are set accordingly.

The following table shows the position of the transmit registers:

Digital I/O module in slot	Address
S0	BA + 10 H
S1	BA + 18 H
S2	BA + 20 H
S3	BA + 28 H

After a brief delay time the data is at the output.

Note

Application flowcharts can be found in the "Examples/Applications" section.

Reading the digital inputs at I/O module 0

Digital I/O module 0 has 24 digital inputs.

Each I/O module that is connected has its own receive register.

The following table shows the position of the receive registers:

Digital I/O module in slot	Address
S0	BA + 14 H
S1	BA + 1C H
S2	BA + 24 H
S3	BA + 2C H

The lowest 24 bits in the associated receive register contain the data for the 24 inputs of the I/O module. Bit 0 contains the value of input 0 and so on.

1. Read the receive register of the associated I/O module.
2. Evaluate the data for the desired inputs

Monitoring the digital inputs at digital I/O module 0

At each digital I/O module the firmware monitors a maximum of 8 digital inputs (digital inputs 0 to 7) for a change of state

As soon as the firmware detects a change at the inputs, it triggers the corresponding group interrupt.

In the microcontroller interrupt mask register you can enable or mask the corresponding interrupt for each I/O module individually.

You can use the user software to track which input has changed by comparing the current state with the previously saved state.

Setting the digital outputs of I/O module 0

Digital I/O module 0 has 16 digital outputs.

Each I/O module that is connected has its own transmit register.

The following table shows the position of the transmit registers:

Digital I/O module in slot	Address
S0	BA + 10 H
S1	BA + 18 H
S2	BA + 20 H
S3	BA + 28 H

The lowest 16 bits in the associated transmit register contain the data for the 16 outputs of the I/O module. Bit 0 contains the value of output 0 and so on.

1. Write the desired value to the transmit register of the associated I/O module.
2. After a brief delay time the data is at the output

See also

Flowcharts (Page 117)

7.6.3.3 Driving the analog inputs/outputs

The following registers are used to drive analog I/O module 0:

Type	Register	Address	
		Analog I/O module A0	Analog I/O module A1
Output	Analog output check register	BA + 100, byte 1	BA + 104, byte 1
Output	Analog value output register	BA + 100, byte 2 and 3	BA + 104, byte 2 and 3
Input	Analog-to-digital conversion check register	BA + 108, byte 1	BA + 10C, byte 1

Note

Application flowcharts can be found in the "Examples/Applications" section.

Analog voltage output

Principle of operation:

There is only one digital-to-analog converter, which supplies all voltage outputs on the I/O modules. A multiplexer switches the output of the digital-to-analog converter to the hold capacitors of the individual output channels in succession.

In the background the firmware controls the cyclic refreshing of the hold capacitors (refresh cycles).

Procedure for outputting a new voltage value:

Note

Both the analog value output register and the analog output check register used below are located in the same 32-bit word. You therefore write the information to both registers at the same time.

Note

If you want to set an output channel to 0 V or you no longer need it, you can simply switch off the corresponding channel in the check register. There is no need to specify the analog voltage value 0 V in this case.

---

1. Specify the associated 16-bit output value that you want to write to the analog value output register.
2. Specify the channel that you want to activate in the analog output check register.
3. Write the data to both registers at the same time in a doubleword access.

- The associated registers are described in the "Technical data/Registers" section.

Dynamic response:

In the worst-case scenario, outputting the value requires four firmware cycles, i.e., approximately 200 µs. As soon as the value to be output is at the output, the firmware triggers an interrupt if the associated bit is enabled in the interrupt mask. You can then output the next analog value.

Voltage measurement

A multiplexed analog-to-digital converter is responsible for voltage measurement and Pt100 measurement. The firmware controls access to the analog-to-digital converter.

- Specify the conversion channel and the measurement range via the analog-to-digital conversion check register.
  - The associated registers are described in the "Technical data/Registers" section.
  - The conversion request is passed on to the firmware by writing the 32-bit word to the analog-to-digital conversion check register.
- The firmware executes the analog-to-digital conversion and saves the value to the analog-to-digital conversion result register and triggers an interrupt if the associated bit is enabled in the interrupt mask.

Pt100 measurement

- Use the software to enable the desired internal and external measurement channels in the Pt100 enable register.
  - The associated registers are described in the "Technical data/Registers" section.
- For the enabled channels the microcontroller firmware executes cyclic Pt100 measurements in the background.
- The firmware stores the measurement results as a 12-bit analog value in the Pt100 registers. You can read the values from there using your software.
  - The associated registers are described in the "Technical data/Registers" section.
  - To avoid significant variations in the measured values, the firmware calculates a mean value for each Pt100 measurement. This mean value is calculated from the current and the last three measured values. For that reason, the first measured value from a Pt100 measurement is not available in the result register until approximately 25 ms after the associated measurement channel is enabled.

The firmware makes the measured values from Pt100 measurement available for calculating the temperature by comparison. This calculation requires three measured values:

- 100-Ohm reference value
- 200-Ohm reference value
- Measured value from the external channel

See also

Flowcharts (Page 117)

Examples/Applications 8

8.1 Flowcharts

The flowcharts below show the structure of a program for using the CIO expansion

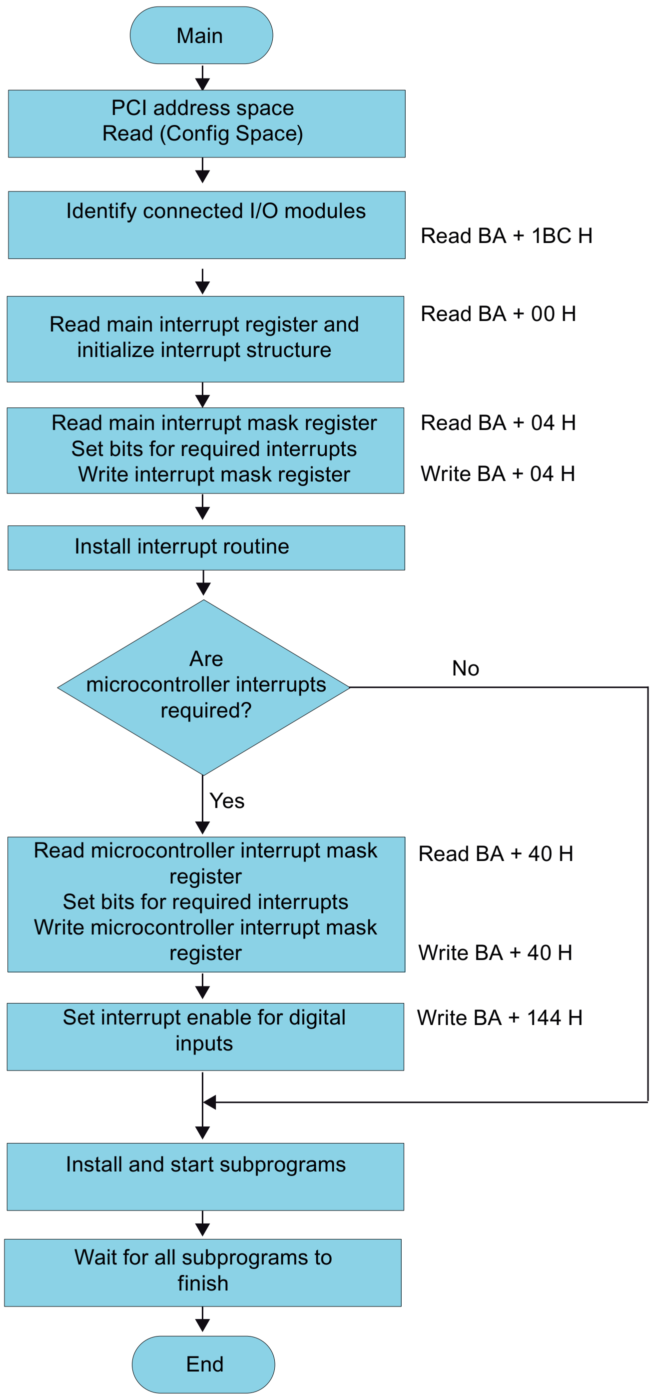
Relevant program examples for the Windows XP and RMOS3 operating systems are available on the Internet (see the "Service and support" section).

This section contains the following flowcharts:

Name	Meaning / remark
Main program	Main program, valid for all subprograms described below
Interrupt	Interrupt routine, valid for all subprograms described below
Encoder processing	Subprogram for evaluating signals from an incremental encoder in interrupt operation
Read/write digital input	Subprogram for reading a digital input and writing the data in polling mode in interrupt operation
Read digital input	Subprogram for reading a digital input in interrupt operation
Write analog value	Subprogram for writing an analog value in interrupt operation
Read analog value	Subprogram for reading an analog value in interrupt operation

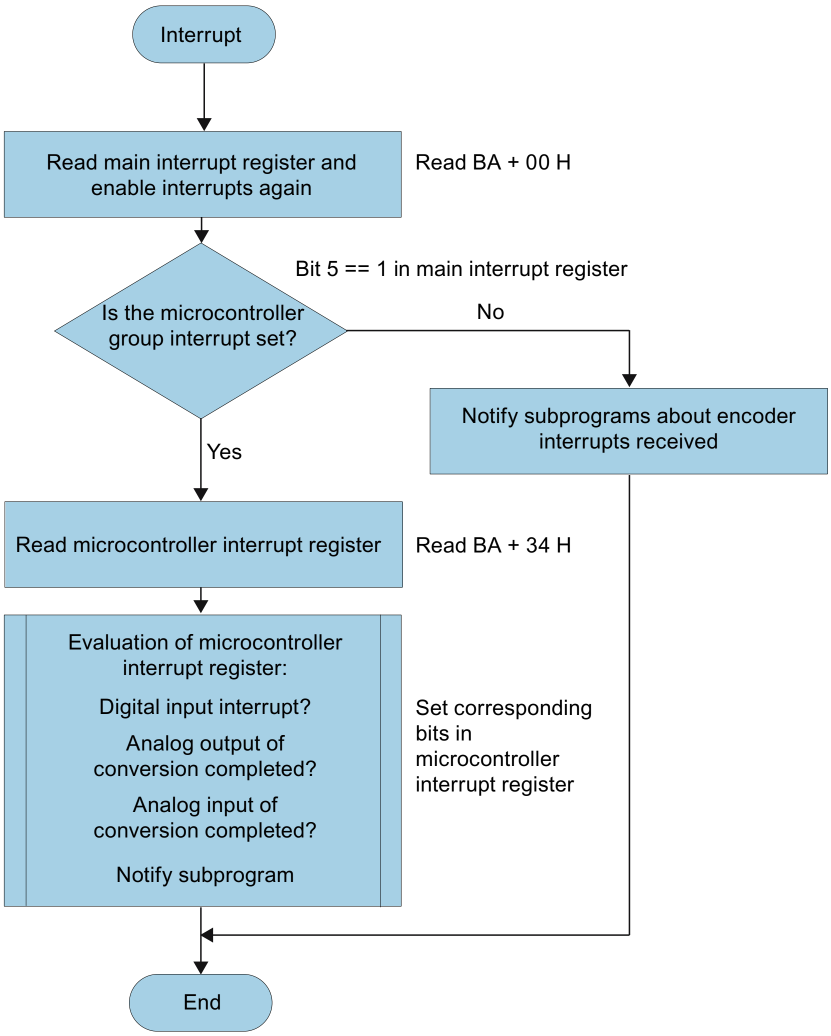
Main program: Main

The "Main" flowchart shows an example of the structure of the main program.



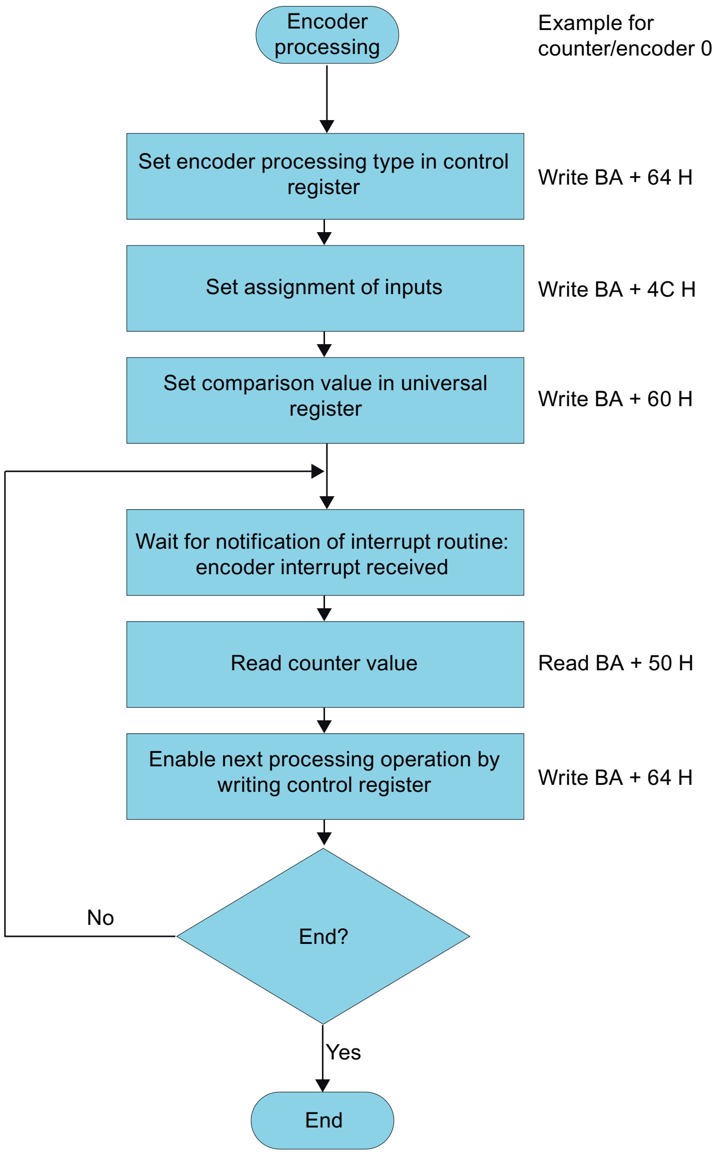
Interrupt

The "Interrupt" flowchart shows an example of the structure of the subprogram for processing interrupts.



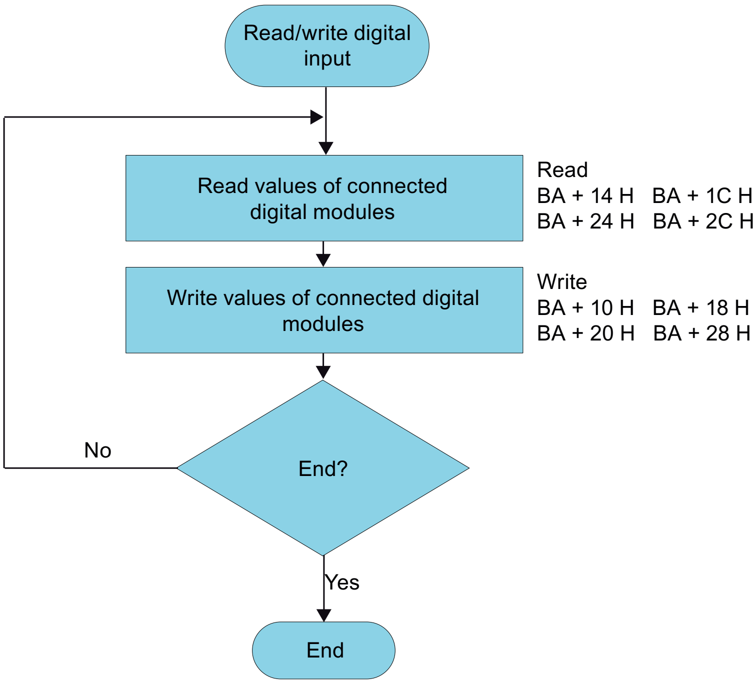
Encoder processing

The "Encoder processing" flowchart shows an example of the structure of the subprogram for processing signals from an incremental encoder.



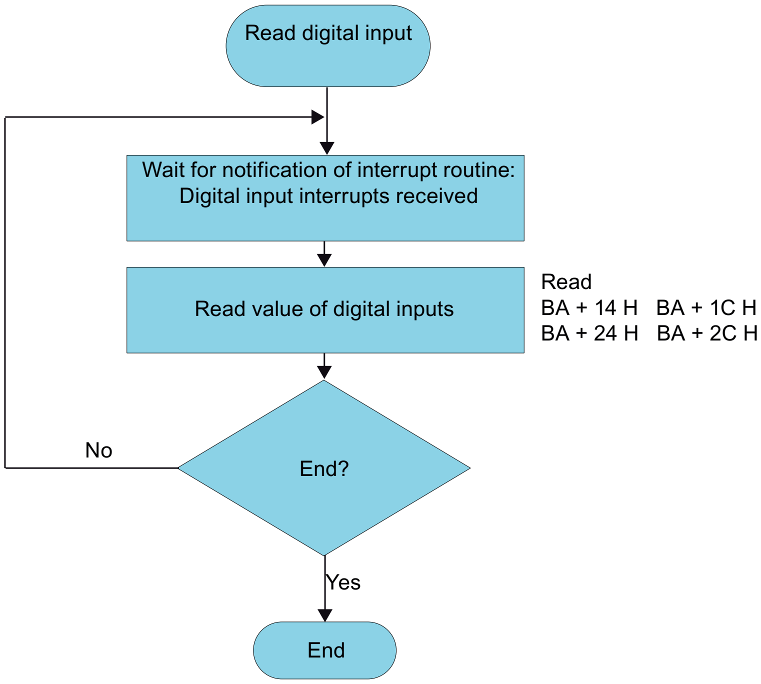
Read/write digital input

The "Read/write digital input" flowchart shows an example of the structure of the subprogram for reading and writing digital data in polling mode. The associated digital input can be an input of the basic module or a digital I/O module 0. The specified addresses apply for digital I/O modules S0 to S3 in that order.



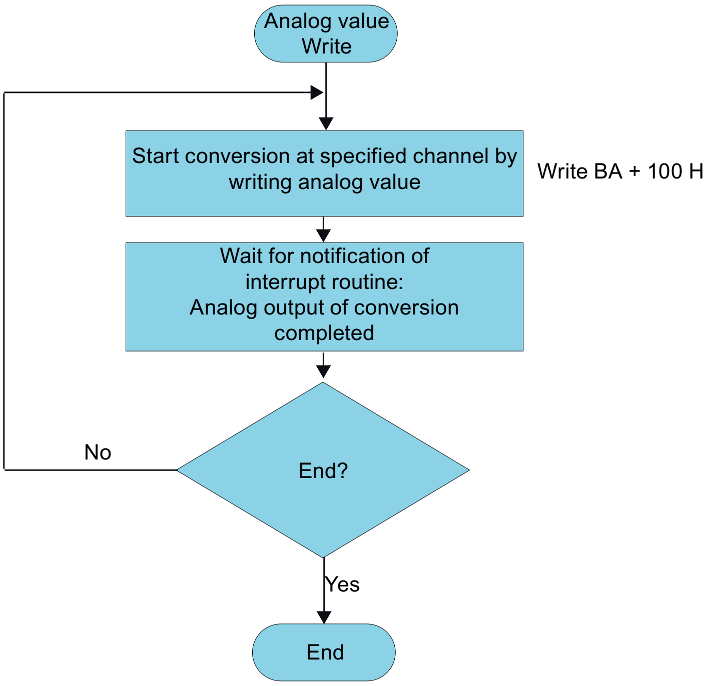
Read digital input

The "Read digital input" flowchart shows an example of the structure of the subprogram for reading signals from a digital input. The digital input can be an input of the basic module or a digital I/O module 0. The specified addresses apply for digital I/O modules S0 to S3 in that order.



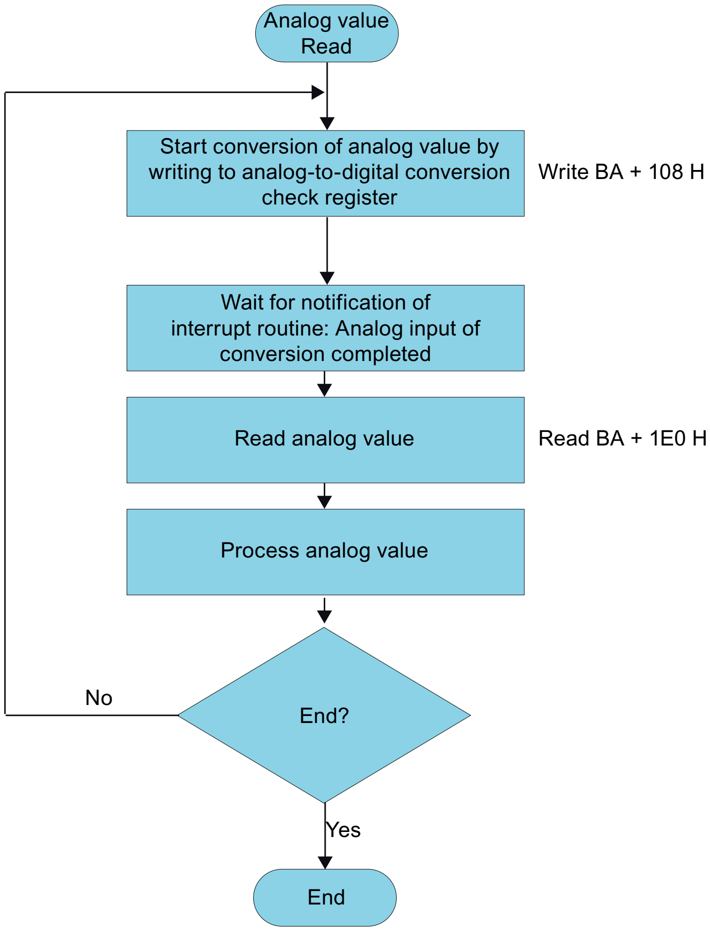
Write analog value

The "Write analog value" flowchart shows an example of the structure of the subprogram for outputting an analog value at analog I/O module 0. The specified address applies to digital I/O module A0.



Read analog value

The "Read analog value" flowchart shows an example of the structure of the subprogram for reading an analog value at analog I/O module 0. The specified address applies to digital I/O module A0.



9 Alarm, error, and system messages

9.1 Monitoring of I/O modules

Monitoring of communication to the I/O modules

The firmware monitors the data message frames returning from the I/O modules by means of status messages. If an I/O module stops delivering the correct module identifier, then a data transfer fault has occurred.

In such a case the firmware triggers an interrupt if the associated bit is enabled in the interrupt mask.

In the event of an error the firmware enters in the microcontroller interrupt register (byte 3) the I/O module which triggered an interrupt due to a communication error (CIRQ).

In the microcontroller interrupt mask register you can enable or mask the corresponding interrupt for each I/O module individually.

In both digital and analog I/O modules, current status messages are available cyclically, i.e., every 50 µs at the latest.

Monitoring the digital outputs at digital I/O module 0

The digital output drivers have one status output. It reports the following errors as status information:

- Short-circuit
- Undervoltage
- Overtemperature
- Line interruption

The firmware stores this status information in the receive register for digital I/O module 0, byte 0 (see "Technical data / Registers /Status register I/O module Sn"). You must read the status information from this register using the user software to identify the error.

Position of the receive register for digital I/O module 0:

Digital I/O module in slot	Address
S0	BA + 10 H
S1	BA + 18 H
S2	BA + 20 H
S3	BA + 28 H

Access mode	R byte

Troubleshooting 10

Digital or analog inputs or outputs are not working correctly:

None of the digital inputs/outputs are working

Possible causes:

- The 24 V power supply is not connected to the digital I/O modules.

The digital inputs/outputs on the I/O modules and the digital inputs on the basic module are electrically isolated. You must therefore feed the 24 V DC power supply separately to the digital inputs and outputs. This is necessary even if you are only using the digital inputs.

The digital inputs/outputs on one module are not working

Possible causes:

- The 24 V power supply is not connected to the corresponding digital I/O module.
- The flat ribbon cable connection between the I/O module and basic module is loose or reversed.
  - Check that the system has correctly detected all I/O modules and entered them in the register.
  - Restart the system if necessary.
- The assignment of I/O modules by the software does not correspond to the assignment of connectors on the flat ribbon cables.
  - In this case the system must detect the I/O modules correctly
  - Check the connector assignment by applying and polling signals or by opening the device and checking the actual cables.

One group of inputs/outputs on a module is not working

Possible causes:

- An AX or DX connector has not been inserted or wired correctly.

An individual input or output is not working

Possible causes:

- There is a wiring fault on the cable
- The assignment between hardware and software is wrong for this connection

Encoder inputs are not working correctly

Possible causes:

- The encoder power supply at the encoder power supply interface is not connected or is faulty
- The flat ribbon cable connection between the encoder expansion and the basic module is loose.
  - Check that the flat ribbon cables have been connected in the right order and that the connectors are plugged in correctly.

Technical data 11

11.1 General equipment data

11.1.1 Mechanical and electrical data

Mechanical data

Dimensions of CIO when installed in the SIMATIC Microbox PC 42x

Module	Dimensions
I/O expansion rack, without connectors (W x H x D in mm)	262 x 133 x 22
Encoder expansion rack, without connectors (W x H x D in mm)	262 x 133 x 17
Shield clamp height: This increases the height of a Microbox PC 420 by	 40 mm 25 mm projection above the height of the Microbox PC

Weight of CIO when installed in the SIMATIC Microbox PC 42x

Module	Weight
Basic module (without accessories)	approx. 60 g
Digital I/O module 0 (without accessories)	approx. 50 g
Analog I/O module 0 (without accessories)	approx. 100 g
I/O expansion rack (without accessories)	approx. 300 g
Encoder expansion rack (without accessories)	approx. 200 g

Width of CIO when installed in a SICOMP IMC CPCI system

Module	Dimensions
Basic module	2 CPCI slots
I/O expansion board (analog or digital)	1 slot, must not be a CPCI slot

Weight of CIO when installed in a SICOMP IMC CPCI system

Module	Weight
Basic module (without accessories)	300 g
Digital I/O module 0 (without accessories)	75 g
Analog I/O module 0 (without accessories)	125 g

Electrical data

Table 11-1 Supply voltages and current consumption

Parameter	Value
Basic module:	
Power supply to basic module	Via PCI interface: 3.3 V DC and 5 V DC
Infeed of encoder power supply on basic module:	
Voltage supplied	Depends on encoder used max. 28.8 V DC
Internal voltage drop on basic module	< 100 mV
Current consumption of encoder inputs and counters	max. 0.3 A per encoder
Fuse	The power supply must be protected with an external fuse
Fuse type	2 A, quick-response
Reverse polarity protection	Yes, with fuse
Digital I/O module:	
Power supply to digital I/O module 0	20.4 to 28.8 V DC typically: 24 V DC
Dynamic power supply: (voltage spikes)	18.5 to 30.2 V DC
Current consumption of digital I/O module 0, max. approx.	4 A
Fuse:	The power supply must be protected with an external fuse
Fuse type	4 A, quick-response
Reverse polarity protection	Yes, with fuse
Analog I/O module:	
Power supply to analog I/O module 0	Internal power supply

Counters and encoder inputs

Table 11-2 Basic module: Counters and encoder inputs

Parameter	Value
Number of counters or encoder inputs on the basic module	4
Encoder connection type	Incremental encoder AB0
Input signal from encoder	RS 422
Encoder input counting frequency	≤ 2 MHz
Sampling time for timer or pulse-width measurement	1 MHz or 4 MHz
Gate time for frequency measurement	Adjustable in the following stages: 8 µs, 32 µs, 128 µs, 512 µs, 2048 µs, 8192 µs, 16384 µs, 32768 µs, 131072 µs, 262144 µs, 524288 µs, 1048576 µs, 2097152 µs, 4194304 µs, 8388608 µs, 16777216 µs
Galvanic isolation	No
Output voltage	Depends on encoder used max. 28.8 V DC

Digital inputs on basic module

Table 11-3 Basic module: Digital Inputs

Parameter	Value
Number of digital inputs	4
Input voltage	20.4 to 28.8 V DC typically: 24 V DC
Input current	approx. 2 mA
Time constant for filter circuit	0.01 ms
Galvanic isolation	No
Signal level 0 1	 ≤ 5 V ≥ 15 V
For open-circuit input	Level 0

Digital I/O module

Table 11-4 Digital I/O module 0: Digital Inputs

Parameter	Value
Number of digital inputs	24
Cable length without lightning protection device	max. 30 m
Input voltage	24 V DC, typical
Input current	approx. 2 mA
Signal level 0 1	 ≤ 5 V ≥ 15 V
For open-circuit input	Level 0
Time constant for filter circuit: Inputs 0 to 7 Inputs 8 to 23 Inputs 8 and 9 also designed as rapid inputs	 0.1 ms 1 ms 0.01 ms
Galvanic isolation: Between communication with the basic module and the inputs of digital I/O module 0 Isolation test voltage Between the individual inputs/outputs of digital I/O module 0	 Yes 500 V DC No, one electrical circuit

Table 11-5 Digital I/O module 0: Digital outputs

Parameter	Value
Number of outputs	16 Organized in four output groups
Assignment of outputs to the output groups	0 ... 3 4 ... 7 8 ... 11 12 ... 15
Cable length without lightning protection device	max. 30 m
Output voltage	24 V DC, typical
Arc-suppression diodes	If a contactor is connected, an arc-suppression diode must be connected to the corresponding output
Voltage drop	max. 600 mV between input and output voltage with a load current of 0.5 A
Output current: Per output group Total per digital I/O module 0	 1 A 4 A
Switching frequency	≤ 2 kHz
Switching type	Current sourcing

Parameter	Value
Output delay: Register output after driver output (depending on load): 0 → 1 signal 1 → 0 signal	 max. 30 µs max. 130 µs
Signal at open-circuit output	1 signal
Galvanic isolation: Between communication with the basic module and the outputs of digital I/O module 0 Isolation test voltage Between the individual inputs/outputs of digital I/O module 0	 Yes 500 V DC No, one electrical circuit
Short-circuit protection of the output drivers	Threshold on typical 9 A max. 11 A electronically pulsing In order to comply with UL requirements, the user must limit the input current to 4 A. Use NEC Class 2 current source
Excess temperature shutdown	Above 150°C
Overvoltage protection	typical 47 V max. 52 V
Status after POWER ON and after RESET	High resistance
Detection of short-circuit, undervoltage, overtemperature, line interruption	Yes
Counter voltage	No counter emf may be applied externally at the outputs

Analog I/O module

Table 11-6 Analog I/O module 0: Analog inputs

Parameter	Value	
Number of analog inputs	8	
Type	Single-ended	
Voltage ranges	0 to 5 V, 0 to 10 V ± 5 V ± 10 V	
Permissible input voltage against analog ground	max. ± 15 V long-term	
Impedance	> 10 kilohms	
Input type	Single-ended	
Resolution	12 bits (including sign)	
Repeatability	10 bits (including sign)	
Input filters	No	
Configuration cycle time for analog-to-digital conversion:	Without Pt100	With Pt100
With one analog input	50 ... 100 µs	50 ... 200 µs
With 4 analog inputs	200 ... 400 µs	200 ... 500 µs
With 8 analog inputs	400 ... 800 µs	400 ... 1000 µs
Galvanic isolation	No	

Table 11-7 Analog I/O module 0: Pt100 inputs

Parameter	Value
Number of external Pt100 inputs	4
Type	Two-wire measurement
Dynamic response	The mean value is constantly available and is updated approximately every 6 ms
Galvanic isolation	No
Current	approx. 5 mA constant current during measuring phase

Table 11-8 Analog I/O module 0: Analog outputs

Parameter	Value
Number of analog outputs	8
Type	Single-ended
Shielded cable length	max. 30 m
Conversion principle	Resistor - DAC string
Voltage range	± 10 V
Load current	2 mA
Resolution	16 bits (including sign)
Accuracy	0,5 %
Output value after POWER ON and after RESET	0 V
Configuration cycle time for digital-to-analog conversion* With one analog output With 4 analog outputs With 8 analog outputs	 100 ... 200 µs 400 ... 800 µs 800 ... 1600 µs
Short-circuit protection	No
Galvanic isolation	No

* The times also depend on the software response time (interrupt response time or polling times)

11.1.2 Ambient conditions

The CIO modules can be used in a Microbox PC with or without a hard disk and in a SICOMP IMC system. For that reason the requirements differ, and they are listed separately in the table below according to application. Where no distinction is made by application, the details apply to all three application types.

Degree of protection

Table 11-9 Degree of protection

Parameter	Value
Degree of protection to EN 60529 (front/rear)	IP20

Mechanical loads

Table 11-10 Permissible vibrational loads

Parameter/variant	Value				
	Frequency	Displacement	Acceleration	Cycles per axis	Octaves/min
Vibrational load during operation					
When used in a Microbox PC without a hard disk (with CF card) Testing according to IEC 60068-2-6, Fc test	10 to 58 Hz	0.075 mm	-	10	1
	58 to 200 Hz	-	9.8 m/s^2	10	1
When used in a Microbox PC with hard disk: Wall mounting	10 to 58 Hz	0.035 mm	-	10	1
	58 to 200 Hz	-	4.9 m/s	10	1
When used in a Microbox PC mounted on a rail	No mechanical excitation is permissible with this usage				
When used in a SICOMP IMC system	10 to 61 Hz	0.2 mm	-	10	1
	61 to 500 Hz	-	19.6 m/s	10	1
Vibrational load during storage and transport					
Applies to all variants	5 to 9 Hz	3.5 mm	-	10	1
	9 to 500 Hz	-	9.8 m/s^2	10	1

Table 11-11 Permissible shock load

Parameter/variant	Value	
	Acceleration	Shock duration
Shock load during operation		
When used in a Microbox PC without a hard disk (with CF card) Testing according to IEC 60068-2-27, Ea test	150 m/s²	11 ms
	3 shocks in the positive and negative direction per axis, half-sine	
When used in a Microbox PC with hard disk: Wall mounting	50 m/s²	30 ms
When used in a Microbox PC mounted on a rail	No mechanical excitation is permissible with this usage	
When used in a SICOMP IMC system	300 m/s²	11 ms
Shock load during storage and transport		
Applies to all variants	250 m/s²	6 ms

Electromagnetic environmental requirements

Table 11-12 Electromagnetic compatibility (EMC)

Parameter/variant	Value
Interference emission to EN 55022	
When used in a Microbox PC	Class B In order to comply with Class B, a 230 V AC power supply unit must be used which meets the requirements of EN 55022 Class B. (e.g.: "SITOP modular 5A", part no.: 6EP1333-3BA00)
When used in a SICOMP IMC system	Class A
Immunity to conducted interference on the supply lines	
Applies to all variants	± 2 kV (IEC 61000-4-4, burst)
	± 1 kV (IEC 61000-4-5, surge symmetrical, length > 30 m) with lightning protection element (e.g., Dehn, "Blitzductor BVT AD24", part no.: 918402)
	± 2 kV (IEC 61000-4-5, surge asymmetrical, length > 10 m) with lightning protection element (e.g., Dehn, "Blitzductor BVT AD24", part no.: 918402)
Immunity to conducted interference on unshielded signal lines (digital I/O)	
Applies to all variants	± 2 kV (IEC 61000-4-4, burst)
	± 1 kV (IEC 61000-4-5, surge symmetrical, length > 10 m) with lightning protection element (e.g., Dehn, "Blitzductor BVT AD24", part no.: 918402)
	± 2 kV (IEC 61000-4-5, surge asymmetrical, length > 10 m) with lightning protection element (e.g., Dehn, "Blitzductor BVT AD24", part no.: 918402)
Immunity to conducted interference on shielded signal lines (analog I/O modules, encoders, counter inputs)	
Applies to all variants	± 2 kV (IEC 61000-4-4, burst)
	± 1 kV (IEC 61000-4-5, surge symmetrical, length > 30 m)
	± 2 kV (IEC 61000-4-5, surge asymmetrical, length > 30 m)

Parameter/variant	Value
Immunity to electrostatic discharge	
When used in a Microbox PC	± 6 kV, contact discharge (IEC 61000-4-2)
	± 8 kV, air discharge (IEC 61000-4-2)
When used in a SICOMP IMC system	± 4 kV, contact discharge (IEC 61000-4-2)
	± 8 kV, air discharge (IEC 61000-4-2)
Immunity to RF interference	
Applies to all variants	10 V/m 80 % AM; 80 MHz to 1 GHz (IEC 61000-4-3)
	10 V/m 80 % AM; 1.4 GHz to 2 GHz (IEC 61000-4-3)
Immunity to high-frequency current feed	
When used in a Microbox PC	10 V 80 % AM, 9 kHz to 80 MHz (IEC 61000-4-6) An HF (mains) filter must be provided in the 24 V supply to ensure compliance (e.g.: Timonta, model FMLB-0109-0640) For each digital module, a separate filter has to be used. For all other 24 V lines, a common filter is sufficient.
When used in a SICOMP IMC system	12 V 80 % AM, 0.15 MHz to 80 MHz (IEC 61000-4-6) An HF (mains) filter must be provided in the 24 V supply to ensure compliance (e.g.: Timonta, model FMLB-0109-0640) For each digital module, a separate filter has to be used. For all other 24 V lines, a common filter is sufficient.

Climatic environmental conditions

Table 11-13 Climatic environmental conditions

Parameter/variant	Value
Ambient temperature during operation	
When used in a Microbox PC with hard disk	+5 °C to +40 °C
When used in a Microbox PC with CompactFlash card	0 °C to +50 °C when installed horizontally 0 to +45 °C when installed vertically
When used in a SICOMP IMC system	0 °C to +55 °C
Ambient temperature during storage and transport	
When installed in a Microbox PC	-20 °C to +60 °C
When installed in a SICOMP IMC system	-40 °C to +70 °C
Moist heat	
Applies to all variants	30°C, 85 % (IEC 60068-2-78, test cab)

Parameter/variant	Value
Relative humidity	
When used in a Microbox PC	5% to 80% at 25 °C
When used in a SICOMP IMC system	10 % to 90 %
Storage/transport of Microbox PC version	5% to 95% at 25 °C
Storage/transport of SICOMP IMC system version	10 % to 90 % Condensation not permissible
permitted atmospheric pressure	
In operation (applies to all variants)	795 hPa to 1080 hPa
Storage/transport (applies to all variants)	660 hPa to 1080 hPa

Approvals

Table 11-14 Approvals

Parameter/variant	Value
CE marking	
EC directive	89/336/EEC (EMC directive)
Use in industry	Interference emission: EN 61000-6-4 Interference immunity: EN 61000-6-2
Applications in residential areas, business and trade environments as well as in workshops:	Interference emission: EN 61000-6-3 Interference immunity: EN 61000-6-1

11.2 Interfaces

11.2.1 PCI interface

The CIO expansion is connected to the Microbox PC 42x or the SICOMP IMC CPCI system via a PCI interface.

CIO-specific data

The CIO expansion generates a 3.3 V signal level and is 5 V-tolerant.

As it is a target module, some signals are not required. In addition, a 66 MHz bus is not supported, so the M66EN signal is connected to GND.

PCI-104 pin assignment

The table shows the pin assignment of the PCI-104 interface according to specification. The meaning of the signals can be found in the PCI-104 specification.

Table 11-15 PCI-104 pin assignment

Pin	Row A	Row B	Row C	Row D
1	GND	Reserved	+ 5 V	AD00
2	VI/O	AD02	AD01	+ 5 V
3	AD05	GND	AD04	AD03
4	C/BE0*	AD07	GND	AD06
5	GND	AD09	AD08	GND
6	AD11	VI/O	AD10	M66EN 2)
7	AD14	AD13	GND	AD12
8	+ 3.3 V	C/BE1*	AD15	+ 3.3 V
9	SERR*	GND	Reserved	PAR
10	GND	PERR*	+ 3.3 V	Reserved
11	STOP*	+ 3.3 V	LOCK*	GND
12	+ 3.3 V	TRDY*	GND	DEVSEL*
13	FRAME*	GND	IRDY*	+ 3.3 V
14	GND	AD16	+ 3.3 V	C/BE2*
15	AD18	+ 3.3 V	AD17	GND
16	AD21	AD20	GND	AD19
17	+ 3.3 V	AD23	AD22	+ 3.3 V
18	IDSEL0	GND	IDSEL1	IDSEL2
19	AD24	C/BE3*	VI/O	IDSEL3
20	GND	AD26	AD25	GND
21	AD29	+ 5 V	AD28	AD27
22	+ 5 V	AD30	GND	AD31
23	REQ0* 1)	GND	REQ1* 1)	VI/O
24	GND	REQ2* 1)	+ 5 V	GNT0* 1)
25	GNT1* 1)	VI/O	GNT2* 1)	GND
26	+ 5 V	CLK0	GND	CLK1
27	CLK2	+ 5 V	CLK3	GND
28	GND	INTD*	+ 5 V	RST*
29	+ 12 V	INTA*	INTB*	INTC*
30	- 12 V	REQ3* 1)	GNT3* 1)	GND

* Inverted signal

1) Signals are not needed with the basic module

2) Signal is set to GND

11.2.2 Encoder input interfaces

Encoder input interfaces

Caution

24 V DC or 5 V DC power supply

The 24 V DC or 5 V DC encoder supply must be protected with an external fuse. Use a 2 A quick-response fuse.

Only 24 V DC or 5 V DC encoders may be used. You must not combine the two encoder types.

The encoder inputs are connected via a 15-pin sub D socket.

The pin assignment is designed for incremental encoders.

The 4 different encoder interfaces are assigned encoder channel numbers 0 to 3. The encoder channel number is indicated by n below.

Pin assignment (for incremental encoders)

Table 11-16 Encoder inputs/15-pin sub D connector

Pin on sub D connector	Pin on flat ribbon cable	Signal name	Meaning
1	1	EDIx	Encoder digital input (see table below)
2	3	Bn	Encoder track B
3	5	Bn_	Encoder track B inverted
4	7	-	Reserved
5	9	P24_E	24 V encoder power supply or 5 V encoder power supply
6	11	+ 5 V	With jumper for 5 V encoder power supply*
7	13	GND	Reference potential for encoder power supply and encoder digital inputs
8	15	-	Reserved
9	2	EDIy	Encoder digital input (see table below)
10	4	Nn	Encoder zero mark
11	6	Nn_	Encoder zero mark inverted
12	8	Bn_	Encoder track B inverted
13	10	Bn	Encoder track B
14	12	An_	Encoder track A inverted
15	14	An	Encoder track A
-	16	-	Reserved

* This pin is used for the power supply for 5 V encoders. Pin 5 on the connector must be connected to pin 6 by means of a jumper. If no jumper is used, the 5 V power supply will only be available at pin 5 of the connector.

The encoder digital inputs are distributed as follows on the encoder interfaces:

Table 11-17 Distribution of encoder digital inputs

Encoder interface	EDIx	EDIy
0	EDI0	EDI1
1	EDI1	EDI0
2	EDI2	EDI3
3	EDI3	EDI2

Encoder power supply interface

- The encoder power supply interface is used
  - to feed the power supply to the encoders. The power supply is available at all four encoder outputs.
  - to connect the four digital inputs to the basic module.
- The interface is established by means of a 9-pin sub D connector.
- A 10-pin flat ribbon cable is used to connect to the CIO basic module.
- The sub D connector signals are converted to the flat ribbon cable connector by means of an adapter board.

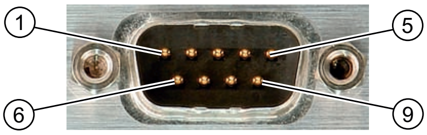


Table 11-18 Encoder inputs/9-pin sub D connector

Pin on sub D connector	Pin on flat ribbon cable	Signal name	Meaning
1	1	GND	Reference potential for encoder power supply and encoder digital inputs
2	3	GND	Reference potential for encoder power supply and encoder digital inputs
3	5	GND	Reference potential for encoder power supply and encoder digital inputs
4	7	P24_E	24 V encoder power supply or 5 V encoder power supply
5	9	P24_E	24 V encoder power supply or 5 V encoder power supply
6	2	EDI0	Encoder digital input 0
7	4	EDI1	Encoder digital input 1
8	6	EDI2	Encoder digital input 2
9	8	EDI3	Encoder digital input 3
-	10	P24_E	24 V encoder power supply or 5 V encoder power supply

Notice

Use all three P24_E connections

Use all three P24_E connections to feed the power supply for the encoders. This avoids overloading the cables.

11.2.3 I/O module interfaces

Pin assignment on digital I/O module 0

Digital I/O module 0 has three external connectors and one internal connection to the basic module:

- DX1: 18-pin connector
- DX2: 18-pin connector
- DX3: 10-pin connector
- 16-pin connector (and flat ribbon cable) for internal data communication with the basic module

---

Notice

24 V power supply

The digital I/O modules only work if the 24 V power supply is connected.

Use the connections on all three connectors for the 24 V power supply. This avoids overloading the connections.

Further information about the connectors and their wiring can be found on the weidmüller home page (http://www.weidmueller.com) . The data sheet for the connectors can be found in S2L/B2L 3.5.

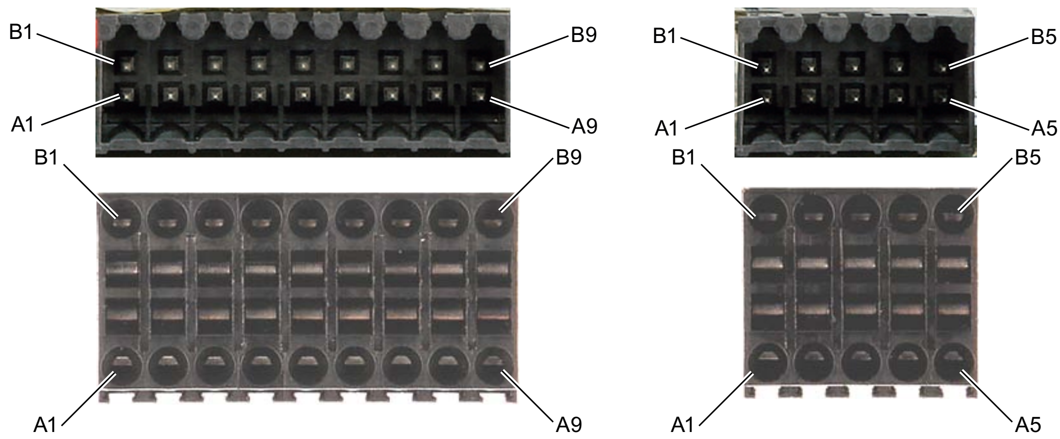


Table 11-19 Digital I/O module 0/connector DX1

Row A			Row B		
Pin	Signal name	Meaning	Pin	Signal name	Meaning
1	DI0	Digital input 0	1	DO0	Digital output 0
2	DI1	Digital input 1	2	DO1	Digital output 1
3	DI2	Digital input 2	3	DO2	Digital output 2
4	DI3	Digital input 3	4	DO3	Digital output 3
5	DI4	Digital input 4	5	DO4	Digital output 4
6	DI5	Digital input 5	6	DO5	Digital input 5
7	DI6	Digital input 6	7	DO6	Digital output 6
8	DI7	Digital input 7	8	DO7	Digital output 7
9	GND_D	Reference potential for digital inputs/outputs	9	P24_D1	24 V power supply for DO0 to DO15 and for the input/output electronics

Table 11-20 Digital I/O module 0/connector DX2

Row A			Row B		
Pin	Signal name	Meaning	Pin	Signal name	Meaning
1	DI8	Digital input 8	1	DO8	Digital output 8
2	DI9	Digital input 9	2	DO9	Digital output 9
3	DI10	Digital input 10	3	DO10	Digital output 10
4	DI11	Digital input 11	4	DO11	Digital output 11
5	DI12	Digital input 12	5	DO12	Digital output 12
6	DI13	Digital input 13	6	DO13	Digital input 13
7	DI14	Digital input 14	7	DO14	Digital output 14
8	DI15	Digital input 15	8	DO15	Digital output 15
9	GND_D	Reference potential for digital inputs/outputs	9	P24_D1	24 V power supply for DO0 to DO15 and for the input/output electronics

Table 11-21 Digital I/O module 0/connector DX3

Row A			Row B		
Pin	Signal name	Meaning	Pin	Signal name	Meaning
1	DI16	Digital input 16	1	DI20	Digital input 20
2	DI17	Digital input 17	2	DI21	Digital input 21
3	DI18	Digital input 18	3	DI22	Digital input 22
4	DI19	Digital input 19	4	DI23	Digital input 23
5	GND_D	Reference potential for digital inputs/outputs	5	-	Reserved

Pin assignment on analog I/O module 0

Analog I/O module 0 has three external connectors and one internal connection to the basic module:

- AX1: 16-pin connector
- AX2: 16-pin connector
- AX3: 8-pin connector
- 16-pin connector (and flat ribbon cable) for internal data communication with the basic module

Further information about the connectors and their wiring can be found on the weidmüller home page (http://www.weidmueller.com) .

The data sheet for the connectors can be found in S2L/B2L 3.5.

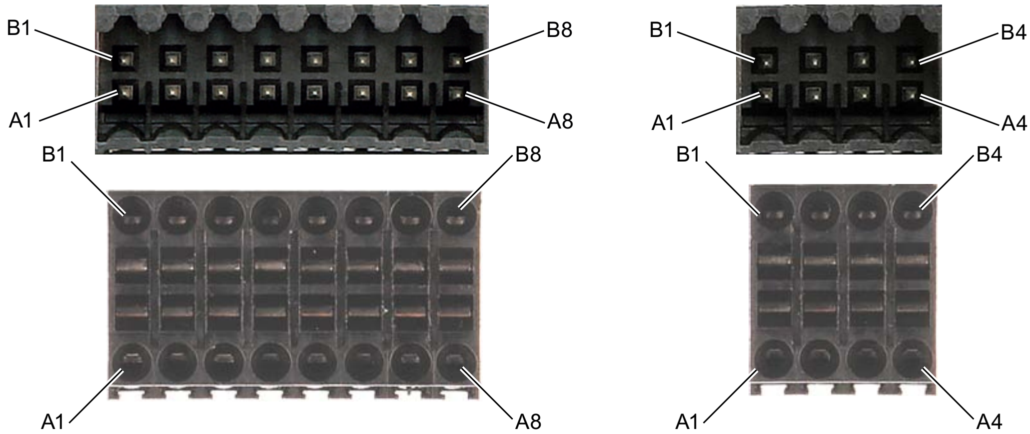


Table 11-22 Analog I/O module 0/connector AX1

Row A			Row B		
Pin	Signal name	Meaning	Pin	Signal name	Meaning
1	GND_A	Reference potential for analog inputs/outputs	1	AI0	Analog input 0
2	GND_A	"	2	AI1	Analog input 1
3	GND_A	"	3	AI2	Analog input 2
4	GND_A	"	4	AI3	Analog input 3
5	GND_A	"	5	AO0	Analog output 0
6	GND_A	"	6	AO1	Analog output 1
7	GND_A	"	7	AO2	Analog output 2
8	GND_A	"	8	AO3	Analog output 3

Table 11-23 Analog I/O module 0/connector AX2

Row A			Row B		
Pin	**Signal name**	**Meaning**	**Pin**	**Signal name**	**Meaning**
1	GND_A	Reference potential for analog inputs/outputs	1	AI4	Analog input 4
2	GND_A	"	2	AI5	Analog input 5
3	GND_A	"	3	AI6	Analog input 6
4	GND_A	"	4	AI7	Analog input 7
5	GND_A	"	5	AO4	Analog output 4
6	GND_A	"	6	AO5	Analog output 5
7	GND_A	"	7	AO6	Analog output 6
8	GND_A	"	8	AO7	Analog output 7

Table 11-24 Analog I/O module 0/connector AX3

Row A			Row B		
Pin	**Signal name**	**Meaning**	**Pin**	**Signal name**	**Meaning**
1	GND_A	Reference potential for analog inputs/outputs	1	PT0	Pt100 terminal 0
2	GND_A	"	2	PT1	Pt100 terminal 1
3	GND_A	"	3	PT2	Pt100 terminal 2
4	GND_A	"	4	PT3	Pt100 terminal 3

11.3 Registers

11.3.1 Memory assignment

The CIO basic module uses a memory area with the base address BA.

The memory area assignment is shown in the table below:

Notice

Reserved bytes must be written with 00 H.

Register access

Note

The memory area consists of several sub-areas known as registers or register areas. These are addressed in various ways.

The register content depends on the I/O modules that are connected. Registers are only available for the data from individual I/O modules if the system detects on booting that the I/O modules are connected.

Notice

Access type DW: doubleword access only

In the table below, the access type is specified for each register.

With access type "DW", you must always access the entire doubleword (4 bytes).

With access type "B" you can access the individual byte in a word (2 bytes) or the whole doubleword (4 bytes).

Notice

Read Only

The table below shows for each register whether it is read-only or whether it can also be written to.

Registers marked "R" have read-only access.

In registers marked "R/W" you can also edit the register contents (write access).

Certain bits, bytes and sub-areas of the memory area are not described in detail below. They are identified as "reserved", "internal" or "not assigned". Only write in these areas if they are located in a register for which you have write access and in which you want to change settings. You should observe the following rules:

- reserved
  All bits which are "reserved" must be written with 0 in a register.
  Exception: In the main interrupt mask register, all bits marked "internal" must be written with the value "1".
- internal
  Bits marked "internal" may not be changed when writing to the register. You must therefore proceed as follows:
  - Read the current value of the register
  - Only change the desired bits
  - Write the new value to the register
- not assigned
  This area is not assigned at present. All bits are written with "0".

Overview of the memory assignment

Table 11-25 Memory assignment

Offset	B3 (high)	B2	B1	B0 (low)	Write (W)/ read (R)	Access mode
00 H	Main interrupt register				R	B
04 H	Main interrupt mask register				R/W	B
08 H	Internal				R/W	B
0C H	Internal				R/W	B
10 H	Digital I/O module S0: Transmit data				R/W	B
14 H	Digital I/O module S0: Receive data				R	B
18 H	Digital I/O module S1: Transmit data				R/W	B
1C H	Digital I/O module S1: Receive data				R	B
20 H	Digital I/O module S2: Transmit data				R/W	B
24 H	Digital I/O module S2: Receive data				R	B
28 H	Digital I/O module S3: Transmit data				R/W	B
2C H	Digital I/O module S3: Receive data				R	B
30 H	Internal	Receive register for rapid digital inputs	Microcontroller version register	FPGA version register	R	B
34 H	Microcontroller interrupt register		reserved		R	B
38 H to 3C H	Internal				-	-
40 H	Microcontroller interrupt mask register		reserved		R/W	B
44 H	Internal				-	-
48 H	Encoder status register and digital inputs of the basic module				R	B
4C H	Counter 0: Encoder interface switching register				R/W	B
50 H	Counter 0: Counter register				R	DW
54 H	Counter 0: Preload value register				R/W	DW
58 H	Counter 0: Zero-mark register				R	DW
5C H	Counter 0: Universal register 0				R	DW
60 H	Counter 0: Universal register 1				R/W	DW
64 H	Counter 0: Control register				R/W	B
68 H	Counter 1: Encoder interface switching register				R/W	B
6C H	Counter 1: Counter register				R/W	DW
70 H	Counter 1: Preload value register				R/W	DW
74 H	Counter 1: Zero-mark register				R	DW
78 H	Counter 1: Universal register 0				R	DW
7C H	Counter 1: Universal register 1				R/W	DW
80 H	Counter 1: Control register				R/W	B
84 H	Counter 2: Encoder interface switching register				R/W	B

Offset	B3 (high)	B2	B1	B0 (low)	Write (W)/ read (R)	Access mode
88 H	Counter 2: Counter register				R/W	DW
8C H	Counter 2: Preload value register				R/W	DW
90 H	Counter 2: Zero-mark register				R	DW
94 H	Counter 2: Universal register 0				R	DW
98 H	Encoder 2: Universal register 1				R/W	DW
9C H	Counter 2: Control register				R/W	B
A0 H	Counter 3: Encoder interface switching register				R/W	B
A4 H	Counter 3: Counter register				R/W	DW
A8 H	Counter 3: Preload value register				R/W	DW
AC H	Counter 3: Zero-mark register				R	DW
B0 H	Counter 3: Universal register 0				R	DW
B4 H	Counter 3: Universal register 1				R/W	DW
B8 H	Counter 3: Control register				R/W	B
BC H to FC H	not assigned				-	-
100 H	Analog I/O module A0 Analog value output register		Analog I/O module A0 Analog output check register	reserved	R/W	DW
104 H	Analog I/O module A1 Analog value output register		Analog I/O module A1 Analog output check register	reserved	R/W	DW
108 H	reserved		Analog I/O module A0 Analog-to-digital conversion check register	reserved	R/W	DW
10C H	reserved		Analog I/O module A1 Analog-to-digital conversion check register	reserved	R/W	DW
110 H to 13C H	reserved				-	-
140 H	reserved		Analog I/O module A1 Pt100 enable register	Analog I/O module A0 Pt100 enable register	R/W	DW
144 H	I/O module S3: Interrupt mask register for digital inputs	I/O module S2: Interrupt mask register for digital inputs	I/O module S1: Interrupt mask register for digital inputs	I/O module S0: Interrupt mask register for digital inputs	R/W	DW

Offset	B3 (high)	B2	B1	B0 (low)	Write (W)/ read (R)	Access mode
148	reserved			Transmit mirror byte	R/W	DW
14C H to 1B4 H	reserved				-	-
1B8 H	reserved			Mirror byte received	R	DW
1BC H	I/O module S3 status register	I/O module S2 status register	I/O module S1 status register	I/O module S0 status register	R	DW
1C0 H	Analog I/O module A0 Pt100 input 1 result register		Analog I/O module A0 Pt100 input 0 result register		R	DW
1C4 H	Analog I/O module A0 Pt100 input 3 result register		Analog I/O module A0 Pt100 input 2 result register		R	DW
1C8 H	Analog I/O module A0 Reference value 200 Ohm result register		Analog I/O module A0 Reference value 100 Ohm result register		R	DW
1CC H	Analog I/O module A1 Pt100 input 1 result register		Analog I/O module A1 Pt100 input 0 result register		R	DW
1D0 H	Analog I/O module A1 Pt100 input 3 result register		Analog I/O module A1 Pt100 input 2 result register		R	DW
1D4 H	Analog I/O module A1 Reference value 200 Ohm result register		Analog I/O module A1 Reference value 100 Ohm result register		R	DW
1D8 H to 1DC H	reserved				-	-
1E0 H	reserved		Analog I/O module A0 Analog-to-digital conversion result register		R	DW
1E4 H to 1EC H	reserved				-	-
1F0 H	reserved		Analog I/O module A1 Analog-to-digital conversion result register		R	DW
1F4 H to 1FC H	reserved				-	-

11.3.2 Main interrupt registers and main interrupt mask registers

Interrupt assignment

The following interrupt sources are assigned to the PCI interrupt on the CIO expansion side:

Table 11-26 Interrupt distribution

Interrupt		Number of bits	Possible sources
Microcontroller group interrupt*		1	Digital and analog I/O
Encoder interrupts	Zero-mark signal at counter	4	Encoders 0 to 3
	Counter overflow	4	Encoders 0 to 3
	Interrupt signal Sn (n = 0 to 3)	4	Encoders 0 to 3
	Interrupt signal Tn (n = 0 to 3)	4	Encoders 0 to 3
	Comparator value reached	4	Encoders 0 to 3

* The group interrupt consists of one bit. The source of the microcontroller interrupt is stored in the microcontroller interrupt register. The interrupt must be read from there in order to reset the associated bit.

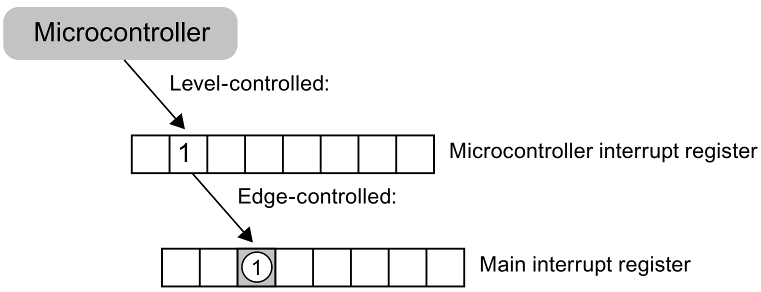
Microcontroller interrupts

The microcontroller interrupts are grouped together in the MC_Int bit (microcontroller group interrupt) in the main interrupt register. Only the main interrupt register can trigger an interrupt on the PCI bus.

The various interrupt triggers for the microcontroller can be found in the microcontroller interrupt register or the microcontroller interrupt mask register.

If a microcontroller interrupt occurs, the microcontroller sets the bit for the relevant trigger in the microcontroller interrupt register.

In an edge-triggered response, each bit in the microcontroller interrupt register sets the bit for the microcontroller group interrupt in the main interrupt register, triggering an interrupt on the PCI bus.



(1) Microcontroller group interrupt

Notice

Resetting microcontroller interrupts

Another microcontroller interrupt with the same source cannot be triggered until the associated bit in the microcontroller interrupt register has been reset. Therefore the corresponding bit must be reset at the start of the interrupt service routine by being read.

Main interrupt register

- The interrupts are reset by reading the corresponding registers.
- An interrupt that is received while the register is being read is not deleted.
- Internal interrupt sources are edge- or pulse-triggered, while the PCI interrupt is level-triggered.

Position:	BA + 00 H
Access type:	R (read-only) byte

0	Interrupt flag not set
1	Interrupt flag set

Table 11-27 Main interrupt register

Main interrupt register/byte 0								
Bit	7	6	5	4	3	2	1	0
Name	Internal		MC_INT	T3_INT	T2_INT	T1_INT	T0_INT	INT-PCI
RESET	0	0	0	0	0	0	0	0

Name	Meaning
INT-PCI	PCI interrupt
Tn_INT (n = 0 to 3)	Interrupt of Tn signal by encoder n
MC_INT	Microcontroller group interrupt

Main interrupt register/byte 1								
Bit	7	6	5	4	3	2	1	0
Name	Internal							
RESET	0	0	0	0	0	0	0	0

Main interrupt register/byte 2								
Bit	7	6	5	4	3	2	1	0
Name	CR3_INT	CR2_INT	CR1_INT	CR0_INT	S3_INT	S2_INT	S1_INT	S0_INT
RESET	0	0	0	0	0	0	0	0

Name	Meaning
Sn_INT (n = 0 to 3)	Interrupt of Sn signal by encoder n
CRn_INT (n = 0 to 3)	Interrupt of comparison register by counter n

Main interrupt register/byte 3								
Bit	7	6	5	4	3	2	1	0
Name	NU_INT_3	NU_INT_2	NU_INT_1	NU_INT_0	CB3_INT	CB2_INT	CB1_INT	CB0_INT
RESET	0	0	0	0	0	0	0	0

Name	Meaning
CBn_INT (n = 0 to 3)	Interrupt of counter overflow by counter n
NU_INT_n (n = 0 to 3)	Zero-mark signal received at counter n (counter value stored in zero-mark buffer).

Main interrupt mask register

In the main interrupt mask register, all bits marked "internal" must be written with the value "1".

Position:	BA + 04 H
Access type:	R/W byte

0 Interrupt flag not masked, i.e., an interrupt is triggered when the corresponding signal is received

1 Interrupt flag masked, i.e., an interrupt is suppressed

Table 11-28 Main interrupt mask register

Main interrupt mask register/byte 0								
Bit	7	6	5	4	3	2	1	0
Name	Internal		MASMCINT	MAST3INT	MAST2INT	MAST1INT	MAST0INT	Internal
RESET	1	1	1	1	1	1	1	1

Name	Meaning
MASTnINT (n = 0 to 3)	Mask for interrupt of Tn signal by encoder n
MASMCINT	Mask for microcontroller group interrupt

Main interrupt mask register/byte 1								
Bit	7	6	5	4	3	2	1	0
Name	Internal							
RESET	1	1	1	1	1	1	1	1

Main interrupt mask register/byte 2								
Bit	7	6	5	4	3	2	1	0
Name	MASCR3	MASCR2	MASCR1	MASCR0	MAS_S3	MAS_S2	MAS_S1	MAS_S0
RESET	1	1	1	1	1	1	1	1

Name	Meaning
MAS_Sn (n = 0 to 3)	Mask for interrupt of Sn signal by encoder n
MASCRn (n = 0 to 3)	Mask for interrupt of comparison register by counter n

Main interrupt mask register/byte 3								
Bit	7	6	5	4	3	2	1	0
Name	MASNUM3	MASNUM2	MASNUM1	MASNUM0	MAS_CB3	MAS_CB2	MAS_CB1	MAS_CB0
RESET	1	1	1	1	1	1	1	1

Name	Meaning
MAS_CBn_INT (n = 0 to 3)	Mask for interrupt of counter overflow by counter n
MASNUMn (n = 0 to 3)	Interrupt mask for interrupt: Zero-mark signal received at counter n (counter value stored in zero-mark buffer). In the interrupt registers for counter modules of counter n, bit 0 is set to "1" when a zero mark is received.

11.3.3 Digital I/O module 0: Transmit and receive registers:

Transmit register for digital I/O module 0: Digital outputs

Position:

Digital I/O module in slot	Address
S0	BA + 10 H
S1	BA + 18 H
S2	BA + 20 H
S3	BA + 28 H

Access mode	R byte

Table 11-29 Transmit register for digital I/O module 0; digital outputs

Transmit register for digital I/O module 0; digital outputs/byte 0								
Bit	7	6	5	4	3	2	1	0
Name	DO7	DO6	DO5	DO4	DO3	DO2	DO1	DO0

Transmit register for digital I/O module 0; digital outputs/byte 1								
Bit	7	6	5	4	3	2	1	0
Name	DO15	DO14	DO13	DO12	DO11	DO10	DO9	DO8

Transmit register for digital I/O module 0; digital outputs/byte 2								
Bit	7	6	5	4	3	2	1	0
Name	reserved							

Transmit register for digital I/O module 0; digital outputs/byte 3								
Bit	7	6	5	4	3	2	1	0
Name	reserved							

Name	Meaning	
DOn, n = 0 to 15	Digital output DOn (n = 0 to 15)	
	0	not driven (open drain), logical 0
	1	driven, logical 1

Receive register for digital I/O module 0: Digital inputs

Position:

Digital I/O module in slot	Address
S0	BA + 14 H
S1	BA + 1C H
S2	BA + 24 H
S3	BA + 2C H

Access mode R/W
byte

Table 11-30 Receive register for digital I/O module 0; digital inputs

Receive register for digital I/O module 0; digital inputs/byte 0								
Bit	7	6	5	4	3	2	1	0
Name	DI7	DI6	DI5	DI4	DI3	DI2	DI1	DI0

Receive register for digital I/O module 0; digital inputs/byte 1								
Bit	7	6	5	4	3	2	1	0
Name	DI15	DI14	DI13	DI12	DI11	DI10	DI9	DI8

Receive register for digital I/O module 0; digital inputs/byte 2								
Bit	7	6	5	4	3	2	1	0
Name	DI23	DI22	DI21	DI20	DI19	DI18	DI17	DI16

Receive register for digital I/O module 0; digital inputs/byte 3								
Bit	7	6	5	4	3	2	1	0
Name	RESET_	reserved	DIAG1	DIAG0	MID3	MID2	MID1	MID0

Name	Meaning	
DIn, (n = 0 to 23)	Digital output DIn (n = 0 to 23)	
	0	0 V or not connected, input assigned logical 0
	1	24 V DC input assigned logical 1
MIDn (n = 0 to 3)	Module identifier for I/O module in slot n 0001 = digital I/O module 0 Other values: other I/O module or transmission error	

Name	Meaning	
DIAG0	Diagnostics of digital outputs 0 to 7 at associated digital I/O module 0	
	0	Fault situation*
	1	Outputs OK
DIAG1	Diagnostics of digital outputs 7 to 15 at associated digital I/O module 0	
	0	Fault situation*
	1	Outputs OK
RESET_	Status of I/O module	
	0	I/O module is booting after a RESET
	1	Booting of I/O module completed, I/O module ready for use

*Fault situation indicates one of the monitored faults: short-circuit, undervoltage, overtemperature, line interruption. For more information see "Alarm, error, and system messages".

11.3.4 Receive and version registers

Overview

- Byte 0: FPGA version register
- Byte 1: Microcontroller version register
- Byte 2: Receive register for rapid digital inputs
- Byte 3: reserved

Receive and version registers

Position:	BA + 30 H
Access type:	R byte

Table 11-31 Receive and version registers/byte 0: FPGA version register

Receive and version registers/byte 0 (low byte): FPGA version register								
Bit	7	6	5	4	3	2	1	0
Name	VH3	VH2	VH1	VH0	VL3	VL2	VL1	VL0
RESET	0	0	0	0	0	0	0	0

The FPGA version register is not reset after a RESET.

Table 11-32 Function lines and version register/byte 1: Microcontroller version register

Receive and version registers/byte 1: Microcontroller version register								
Bit	7	6	5	4	3	2	1	0
Name	VH3	VH2	VH1	VH0	VL3	VL2	VL1	VL0
RESET	0	0	0	0	0	0	0	0

After a RESET the status of the microcontroller version register is refreshed while the microcontroller is booting.

Name	Meaning
VLn	Sub-version .X
VHn	Main version X.

Table 11-33 Receive and version registers/byte 2: Receive register for rapid digital inputs

Receive and version registers/byte 2: Receive register for rapid digital inputs								
Bit	7	6	5	4	3	2	1	0
Name	FUNKL7	FUNKL6	FUNKL5	FUNKL4	FUNKL3	FUNKL2	FUNKL1	FUNKL0
RESET	0	0	0	0	0	0	0	0

After a RESET the receive register for the rapid digital inputs is refreshed.

The values of the bits in the register show the levels at the various inputs.

Register value	Meaning
0	logical 0 at the input
1	logical 1 at the input

Name	Meaning: Level of the following rapid digital input	
FUNKL0	Digital I/O module S0	Digital input 8
FUNKL1	Digital I/O module S0	Digital input 9
FUNKL2	Digital I/O module S1	Digital input 8
FUNKL3	Digital I/O module S1	Digital input 9
FUNKL4	Digital I/O module S2	Digital input 8
FUNKL5	Digital I/O module S2	Digital input 9
FUNKL6	Digital I/O module S3	Digital input 8
FUNKL7	Digital I/O module S3	Digital input 9

Receive and version registers/byte 3								
Bit	7	6	5	4	3	2	1	0
Name	Internal							
RESET	0	0	0	0	0	0	0	0

11.3.5 Microcontroller interrupt registers and interrupt mask registers

Microcontroller interrupt register

Position:	BA + 34 H, bytes 2 and 3
Access type:	R (read-only) byte

Meaning of the bit values

0 Interrupt flag not set
1 Interrupt flag set

Table 11-34 Microcontroller interrupt register

Microcontroller interrupt register/byte 0								
Bit	7	6	5	4	3	2	1	0
Name	Internal							
RESET	0	0	0	0	0	0	0	0

Microcontroller interrupt register/byte 1								
Bit	7	6	5	4	3	2	1	0
Name	Internal							
RESET	0	0	0	0	0	0	0	0

Table 11-35 Microcontroller interrupt register

Microcontroller interrupt register/byte 2								
Bit	7	6	5	4	3	2	1	0
Name	AIIRQ1	AOIRQ1	AIIRQ0	AOIRQ0	DIIRQ3	DIIRQ2	DIIRQ1	DIIRQ0
RESET	0	0	0	0	0	0	0	0

Name	Interrupt	
DIIRQn (n = 0 to 3)	Change monitoring of digital inputs on digital I/O module Sn	
	0	No change
	1	Changed digital input
AOIRQn (n = 0 to 1)	Analog value output at analog I/O module An	
	0	No activity or output routine running
	1	Analog value output completed
AIIRQn (n = 0 to 1)	Analog measurement at analog I/O module An	
	0	No activity or measurement running
	1	Measurement concluded

Microcontroller interrupt register/byte 3								
Bit	7	6	5	4	3	2	1	0
Name	Internal			WDIRQ	CIRQ3	CIRQ2	CIRQ1	CIRQ0
RESET	0	0	0	0	0	0	0	0

Microcontroller interrupt register/byte 3

Name	Interrupt	
CIRQn (n = 0 to 3)	Monitoring of data communication I/O module Sn (n = 0 to 3)	
	0	Module ID error detected at slot n.
	1	No error
WDIRQ	Microcontroller watchdog	
	0	No microcontroller boot without reset
	1	Boot after watchdog error

Microcontroller interrupt mask register

Position:	BA + 40 H
Access type:	R/W byte

Table 11-36 Microcontroller interrupt mask register

Microcontroller interrupt mask register/byte 0								
Bit	7	6	5	4	3	2	1	0
Name	Internal							
RESET	0	0	0	0	0	0	0	0

Microcontroller interrupt mask register/byte 1								
Bit	7	6	5	4	3	2	1	0
Name	Internal							
RESET	0	0	0	0	0	0	0	0

Microcontroller interrupt mask register/byte 2								
Bit	7	6	5	4	3	2	1	0
Name	MAIIRQ1	MAOIRQ1	MAIIRQ0	MAOIRQ0	MDIIRQ3	MDIIRQ2	MDIIRQ1	MDIIRQ0
RESET	1	1	1	1	1	1	1	1

Microcontroller interrupt mask register/byte 2

0	Interrupt request enabled
1	Interrupt request disabled

Name	Interrupt	
MDIIRQn (n = 0 to 3)	Interrupt mask: Change monitoring of digital inputs on digital I/O module n	
	0	Interrupt on change at a digital input
	1	Interrupt request disabled
MAOIRQn (n = 0 to 1)	Interrupt mask: Analog value output at analog I/O module An	
	0	Interrupt when analog value output is completed
	1	Interrupt request disabled
MAIIRQn (n = 0 to 1)	Interrupt mask: Analog measurement at analog I/O module An	
	0	Interrupt on completion of measurement
	1	Interrupt request disabled

Microcontroller interrupt mask register/byte 3								
Bit	7	6	5	4	3	2	1	0
Name	Internal			MWDIRQ	MCIRQ3	MCIRQ2	MCIRQ1	MCIRQ0
RESET	1	1	1	1	1	1	1	1

Microcontroller interrupt mask register/byte 3

Name	Interrupt	
MCIRQn (n = 0 to 3)	Interrupt mask: Monitoring of data communication I/O module Sn (n = 0 to 3) on module ID error	
	0	Interrupt on detection of an error
	1	Interrupt request disabled
MWDIRQ	Interrupt mask: Microcontroller watchdog	
	0	Interrupt on booting after watchdog error
	1	Interrupt request disabled

See also

Monitoring of I/O modules (Page 125)

11.3.6 Encoder status register

Position: BA + 48 H

Table 11-37 Encoder status register

Encoder status register/byte 0: Counter 0								
Bit	7	6	5	4	3	2	1	0
Name	x	x	Q0	CB0	ZR0	SCH0	REFE0	TOR0
RESET	0	0	0	0	0	0	0	0

Encoder status register/byte 1: Counter 1								
Bit	7	6	5	4	3	2	1	0
Name	x	X	Q1	CB1	ZR1	SCH1	REFE1	TOR1
RESET	0	0	0	0	0	0	0	0

Encoder status register/byte 2: Counter 2								
Bit	7	6	5	4	3	2	1	0
Name	G1	G0	Q2	CB2	ZR2	SCH2	REFE2	TOR2
RESET	0	0	0	0	0	0	0	0

Encoder status register/byte 3: Counter 3								
Bit	7	6	5	4	3	2	1	0
Name	G3	G2	Q3	CB3	ZR3	SCH3	REFE3	TOR3
RESET	0	0	0	0	0	0	0	0

Name	Meaning	
TORn (n = 0 to 3)	Status of gate on counter n (only valid if "Frequency and pulse-width measurement" is active, i.e., control register byte 0, bit 7 for counter n is set to "1")	
	0	Gate closed: no clock pulses are counted
	1	Gate open: clock pulses are counted
REFEn (n = 0 to 3)	Current counter value of zero-mark signal for counter n (not buffered)	
	0	Not set, i.e., no zero-mark signal is present
	1	Set, i.e., a zero-mark signal is present
SCHn (n = 0 to 3)	Write protection for counting channel 0	
	0	Set
	1	Not set
ZRn (n = 0 to 3)	Count direction for counter n	
	0	Down

	1	Up
CBn (n = 0 to 3)	Buffered overflow display for counter n. Reset by the "Reset alarm bit" command	
	0	No overflow
	1	Overflow
Qn (n = 0 to 3)	Buffered zero-mark signal for counter n. Reset by the "Revoke counter write protection" or "Reset zero-mark latch" command	
	0	Not set
	1	Set
Gn (n = 0 to 3)	Current status of digital input n on the basic module (not buffered)	
	0	0 V or open
	1	+ 24 V

11.3.7 Encoder interface switching register

11.3.7.1 Overview

Each counter has the logical inputs A, B, N, S and T. A source can be assigned to these logical inputs, which you can select from the following options:

- Encoder inputs from the basic module
- Inputs from digital I/O modules
- Rapid inputs on digital I/O modules
- Internal signals: sampling time for pulse-width measurement or pulse for frequency measurement

Position:

Counter	Address
0	BA + 4C H
1	BA + 68 H
2	BA + 84 H
3	BA + A0 H

Access mode R/W
byte

11.3.7.2 Encoder interface switching register: Counter 0

Position:	BA + 4C H
Access type:	R/W byte

You can use the encoder interface switching register to select the source from which a counter receives its signals. As inputs you can choose encoder inputs from the basic module, rapid inputs from the digital I/O modules 0 and internal sampling times and gate widths.

The options for encoder 0 are given below.

Example:
If an incremental encoder is used at encoder input 0, you must enter the following value: 00 01 09 09 H

Table 11-38 Encoder interface switching register

Encoder interface switching register counter 0/byte 0								
Bit	7	6	5	4	3	2	1	0
Name	reserved		QuB02	QuB01	QuB00	QuA02	QuA01	QuA00
RESET	0	0	0	0	0	0	0	0

Name	Value	Meaning
QuA02, QuA01, QuA00 Encoder signal A: select source	000	No encoder signal A
	001	Encoder 0, signal A
	010	Encoder 1, signal A
	011	Digital I/O module S0, input 0
	100	Digital I/O module S0, input 4
	101	Digital I/O module S0, rapid input 0
	110	Digital I/O module S2, rapid input 0
	111	Sampling time (pulse-width measurement)
QuB02, QuB01, QuB00 Encoder signal B: select source	000	No encoder signal B
	001	Encoder 0, signal B
	010	Encoder 1, signal B
	011	Digital I/O module S0, input 1
	100	Digital I/O module S0, input 5
	101	Digital I/O module S0, rapid input 1
	110	Digital I/O module S2, rapid input 1
	111	Pulse (frequency measurement)

Example: Encoder 0 on counter 0			
	Bits 7, 6	Bits 5 to 3	Bits 2 to 0
Meaning	reserved	QuB: Encoder 0, signal B	QuA: Encoder 0, signal A
Bit pattern	00	001	001

Encoder interface switching register counter 0/byte 1								
Bit	7	6	5	4	3	2	1	0
Name	reserved		QuS02	QuS01	QuS00	QuN02	QuN01	QuN00
RESET	0	0	0	0	0	0	0	0

Name	Value	Meaning
QuN02, QuN01, QuN00 Encoder signal N (zero-mark signal): select source	000	No encoder signal N
	001	Encoder 0, signal N
	010	Encoder 1, signal N
	011	Digital I/O module S0, input 2
	100	Digital I/O module S0, input 6
	101	Digital I/O module S1, rapid input 0
	110	Pulse (frequency measurement)
	111	Pulse (frequency measurement), signal is inverted
QuS02, QuS01, QuS00 Trigger S: select source	000	No trigger S
	001	Basic module digital input 0
	010	Basic module digital input 1
	011	Digital I/O module S0, input 3
	100	Digital I/O module S0, input 7
	101	Digital I/O module S1, rapid input 1
	110	Digital I/O module S3, rapid input 1
	111	Pulse (frequency measurement)

Example: Encoder 0 on counter 0			
	Bits 7, 6	Bits 5 to 3	Bits 2 to 0
Meaning	reserved	QuS: Basic module, digital input 0	QuN: Encoder 0, signal N
Bit pattern	00	001	001

Encoder interface switching register counter 0/byte 2								
Bit	7	6	5	4	3	2	1	0
Name	Sampling time setting	TTA3	TTA2	TTA1	TTA0	QuT02	QuT01	QuT00
RESET	0	0	0	0	0	0	0	0

Name	Value	Meaning		
QuT02, QuT01, QuT00: Encoder signal T: select source	000	No trigger T		
	001	Basic module digital input 0		
	010	Basic module digital input 1		
	011	Digital I/O module S0, input 8		
	100	Digital I/O module S0, input 9		
	101	Digital I/O module S2, rapid input 0		
	110	Digital I/O module S3, rapid input 0		
	111	Pulse (frequency measurement)		
TTA3, TTA2, TTA1, TTA1 Gate width selection (pulse)*:	Value	Meaning	Value	Meaning
	0000	8 µs	1000	131072 µs
	0001	32 µs	1001	262144 µs
	0010	128 µs	1010	524288 µs
	0011	512 µs	1011	1048576 µs
	0100	2048 µs	1100	2097152 µs
	0101	8192 µs	1101	4194304 µs
	0110	16384 µs	1110	8388608 µs
	0111	32768 µs	1111	16777216 µs
Sampling time setting: select sampling time for pulse-width measurement	0	1 MHz		
	1	4 MHz		

*

In the case of an edge-controlled gate width, the gate width is equal to one period of the internal pulse, in other words the value shown in the table.
In the case of a level-controlled gate width, the gate width is equal to the time for which the internal pulse level is high, in other words half the above time.

You can choose between edge-controlled and level-controlled gate width in the control register.

Example: Encoder 0 on counter 0			
	Bits 7, 6	Bits 5 to 3	Bits 2 to 0
Meaning	Sampling time setting: 1 MHz	TTA: Gate width 8 µs	QuT: Basic module, digital input 0
Bit pattern	0	0000	001

Encoder interface switching register counter 0/byte 3								
Bit	7	6	5	4	3	2	1	0
Name	reserved							
RESET	0	0	0	0	0	0	0	0

11.3.7.3 Encoder interface switching register: Counter 1

Position:	BA + 68 H
Access type:	R/W byte

You can use the encoder interface switching register to select the source from which a counter receives its signals. As inputs you can choose encoder inputs from the basic module, rapid inputs from the digital I/O modules 0 and internal sampling times and gate widths.

The options for encoder 1 are given below.

Example:
If an incremental encoder is used at encoder input 0, you must enter the following value: 00 02 12 12 H

Table 11-39 Encoder interface switching register

Encoder interface switching register counter 1/byte 0								
Bit	7	6	5	4	3	2	1	0
Name	reserved		QuB02	QuB01	QuB00	QuA02	QuA01	QuA00
RESET	0	0	0	0	0	0	0	0

Name	Value	Meaning
QuA02, QuA01, QuA00 Encoder signal A: select source	000	No encoder signal A
	001	Encoder 0, signal A
	010	Encoder 1, signal A
	011	Digital I/O module S0, input 0
	100	Digital I/O module S0, input 4
	101	Digital I/O module S0, rapid input 1
	110	Digital I/O module S2, rapid input 0
	111	Sampling time (pulse-width measurement)
QuB02, QuB01, QuB00 Encoder signal B: select source	000	No encoder signal B
	001	Encoder 0, signal B
	010	Encoder 1, signal B
	011	Digital I/O module S0, input 1
	100	Digital I/O module S0, input 5
	101	Digital I/O module S0, rapid input 0
	110	Digital I/O module S2, rapid input 1
	111	Pulse (frequency measurement)

Example: Encoder 1 on counter 1			
	Bits 7, 6	Bits 5 to 3	Bits 2 to 0
Meaning	reserved	QuB: Encoder 1, signal B	QuA: Encoder 1, signal A
Bit pattern	00	010	010

Encoder interface switching register counter 1/byte 1								
Bit	7	6	5	4	3	2	1	0
Name	reserved		QuS02	QuS01	QuS00	QuN02	QuN01	QuN00
RESET	0	0	0	0	0	0	0	0

Name	Value	Meaning
QuN02, QuN01, QuN00 Encoder signal N (zero-mark signal): select source	000	No encoder signal N
	001	Encoder 0, signal N
	010	Encoder 1, signal N
	011	Digital I/O module S0, input 2
	100	Digital I/O module S0, input 6
	101	Digital I/O module S3, rapid input 0
	110	Pulse (frequency measurement)
	111	Pulse (frequency measurement), signal is inverted
QuS02, QuS01, QuS00 Trigger S: select source	000	No trigger S
	001	Basic module digital input 0
	010	Basic module digital input 1
	011	Digital I/O module S0, input 3
	100	Digital I/O module S0, input 7
	101	Digital I/O module S1, rapid input 1
	110	Digital I/O module S3, rapid input 1
	111	Pulse (frequency measurement)

Example: Encoder 1 on counter 1			
	Bits 7, 6	Bits 5 to 3	Bits 2 to 0
Meaning	reserved	QuS: Basic module, digital input 1	QuN: Encoder 1, signal N
Bit pattern	00	010	010

Encoder interface switching register counter 1/byte 2								
Bit	7	6	5	4	3	2	1	0
Name	Sampling time setting	TTA3	TTA2	TTA1	TTA0	QuT02	QuT01	QuT00
RESET	0	0	0	0	0	0	0	0

Name	Value	Meaning		
QuT02, QuT01, QuT00: Encoder signal T: select source	000	No trigger T		
	001	Basic module digital input 0		
	010	Basic module digital input 1		
	011	Digital I/O module S0, input 8		
	100	Digital I/O module S0, input 9		
	101	Digital I/O module S1, rapid input 0		
	110	Digital I/O module S2, rapid input 1		
	111	Pulse (frequency measurement)		
TTA3, TTA2, TTA1, TTA0 Gate width selection (pulse)*:	Value	Meaning	Value	Meaning
	0000	8 µs	1000	131072 µs
	0001	32 µs	1001	262144 µs
	0010	128 µs	1010	524288 µs
	0011	512 µs	1011	1048576 µs
	0100	2048 µs	1100	2097152 µs
	0101	8192 µs	1101	4194304 µs
	0110	16384 µs	1110	8388608 µs
	0111	32768 µs	1111	16777216 µs
Sampling time setting: select sampling time for pulse-width measurement	0	1 MHz		
	1	4 MHz		

*

In the case of an edge-controlled gate width, the gate width is equal to one period of the internal pulse, in other words the value shown in the table.
In the case of a level-controlled gate width, the gate width is equal to the time for which the internal pulse level is high, in other words half the above time.

You can choose between edge-controlled and level-controlled gate width in the control register.

Example: Encoder 1 on counter 1			
	Bits 7, 6	Bits 5 to 3	Bits 2 to 0
Meaning	Sampling time setting: 1 MHz	TTA: Gate width 8 µs	QuT: Basic module, digital input 1
Bit pattern	0	0000	010

Encoder interface switching register counter 1/byte 3								
Bit	7	6	5	4	3	2	1	0
Name	reserved							
RESET	0	0	0	0	0	0	0	0

11.3.7.4 Encoder interface switching register: Counter 2

Position:	BA + 84 H
Access type:	R/W byte

You can use the encoder interface switching register to select the source from which a counter receives its signals. As inputs you can choose encoder inputs from the basic module, rapid inputs from the digital I/O modules 0 and internal sampling times and gate widths.

The options for encoder 2 are given below.

Example:
If an incremental encoder is used at encoder input 0, you must enter the following value: 00 01 09 09 H

Table 11-40 Encoder interface switching register

Encoder interface switching register counter 2/byte 0								
Bit	7	6	5	4	3	2	1	0
Name	reserved		QuB02	QuB01	QuB00	QuA02	QuA01	QuA00
RESET	0	0	0	0	0	0	0	0

Name	Value	Meaning
QuA02, QuA01, QuA00 Encoder signal A: select source	000	No encoder signal A
	001	Encoder 2, signal A
	010	Encoder 3, signal A
	011	Digital I/O module S0, input 8
	100	Digital I/O module S1, input 0
	101	Digital I/O module S1, input 4
	110	Digital I/O module S1, rapid input 0
	111	Sampling time (pulse-width measurement)
QuB02, QuB01, QuB00 Encoder signal B: select source	000	No encoder signal B
	001	Encoder 2, signal B
	010	Encoder 3, signal B
	011	Digital I/O module S0, input 9
	100	Digital I/O module S1, input 1
	101	Digital I/O module S1, input 5
	110	Digital I/O module S1, rapid input 1
	111	Pulse (frequency measurement)

Example: Encoder 2 on counter 2			
	Bits 7, 6	Bits 5 to 3	Bits 2 to 0
Meaning	reserved	QuB: Encoder 2, signal B	QuA: Encoder 2, signal A
Bit pattern	00	001	001

Encoder interface switching register counter 2/byte 1								
Bit	7	6	5	4	3	2	1	0
Name	reserved		QuS02	QuS01	QuS00	QuN02	QuN01	QuN00
RESET	0	0	0	0	0	0	0	0

Name	Value	Meaning
QuN02, QuN01, QuN00 Encoder signal N (zero-mark signal): select source	000	No encoder signal N
	001	Encoder 2, signal N
	010	Encoder 3, signal N
	011	Digital I/O module S0, input 10
	100	Digital I/O module S1, input 2
	101	Digital I/O module S0, rapid input 0
	110	Pulse (frequency measurement)
	111	Pulse (frequency measurement), signal is inverted
QuS02, QuS01, QuS00 Trigger S: select source	000	No trigger S
	001	Basic module digital input 2
	010	Basic module digital input 3
	011	Digital I/O module S0, input 11
	100	Digital I/O module S1, input 3
	101	Digital I/O module S1, input 7
	110	Digital I/O module S0, rapid input 1
	111	Pulse (frequency measurement)

Example: Encoder 2 on counter 2			
	Bits 7, 6	Bits 5 to 3	Bits 2 to 0
Meaning	reserved	QuS: Basic module, digital input 2	QuN: Encoder 2, signal N
Bit pattern	00	001	001

Encoder interface switching register counter 2/byte 2								
Bit	7	6	5	4	3	2	1	0
Name	Sampling time setting	TTA3	TTA2	TTA1	TTA0	QuT02	QuT01	QuT00
RESET	0	0	0	0	0	0	0	0

Name	Value	Meaning		
QuT02, QuT01, QuT00: Encoder signal T: select source	000	No trigger T		
	001	Basic module digital input 2		
	010	Basic module digital input 3		
	011	Digital I/O module S0, input 12		
	100	Digital I/O module S1, input 8		
	101	Digital I/O module S1, input 9		
	110	Digital I/O module S3, rapid input 0		
	111	Pulse (frequency measurement)		
TTA3, TTA2, TTA1, TTA0 Gate width selection (pulse)*:	Value	Meaning	Value	Meaning
	0000	8 µs	1000	131072 µs
	0001	32 µs	1001	262144 µs
	0010	128 µs	1010	524288 µs
	0011	512 µs	1011	1048576 µs
	0100	2048 µs	1100	2097152 µs
	0101	8192 µs	1101	4194304 µs
	0110	16384 µs	1110	8388608 µs
	0111	32768 µs	1111	16777216 µs
Sampling time setting: select sampling time for pulse-width measurement	0	1 MHz		
	1	4 MHz		

*

In the case of an edge-controlled gate width, the gate width is equal to one period of the internal pulse, in other words the value shown in the table.
In the case of a level-controlled gate width, the gate width is equal to the time for which the internal pulse level is high, in other words half the above time.

You can choose between edge-controlled and level-controlled gate width in the control register.

Example: Encoder 2 on counter 2			
	Bits 7, 6	Bits 5 to 3	Bits 2 to 0
Meaning	Sampling time setting: 1 MHz	TTA: Gate width 8 µs	QuT: Basic module, digital input 2
Bit pattern	0	0000	001

Encoder interface switching register counter 2/byte 3								
Bit	7	6	5	4	3	2	1	0
Name	reserved							
RESET	0	0	0	0	0	0	0	0

11.3.7.5 Encoder interface switching register: Counter 3

Position:	BA + A0 H
Access type:	R/W byte

You can use the encoder interface switching register to select the source from which a counter receives its signals. As inputs you can choose encoder inputs from the basic module, rapid inputs from the digital I/O modules 0 and internal sampling times and gate widths.

The options for encoder 0 are given below.

Example:
If an incremental encoder is used at encoder input 0, you must enter the following value:
00 02 12 12 H

Table 11-41 Encoder interface switching register

Encoder interface switching register counter 3/byte 0								
Bit	7	6	5	4	3	2	1	0
Name	reserved		QuB02	QuB01	QuB00	QuA02	QuA01	QuA00
RESET	0	0	0	0	0	0	0	0

Name	Value	Meaning
QuA02, QuA01, QuA00 Encoder signal A: select source	000	No encoder signal A
	001	Encoder 2, signal A
	010	Encoder 3, signal A
	011	Digital I/O module S0, input 12
	100	Digital I/O module S1, input 0
	101	Digital I/O module S1, input 4
	110	Digital I/O module S1, rapid input 1
	111	Sampling time (pulse-width measurement)
QuB02, QuB01, QuB00 Encoder signal B: select source	000	No encoder signal B
	001	Encoder 2, signal B
	010	Encoder 3, signal B
	011	Digital I/O module S0, input 13
	100	Digital I/O module S1, input 1
	101	Digital I/O module S1, input 5
	110	Digital I/O module S1, rapid input 0
	111	Pulse (frequency measurement)

Example: Encoder 3 on counter 3			
	Bits 7, 6	Bits 5 to 3	Bits 2 to 0
Meaning	reserved	QuB: Encoder 3, signal B	QuA: Encoder 3, signal A
Bit pattern	00	010	010

Encoder interface switching register counter 3/byte 1								
Bit	7	6	5	4	3	2	1	0
Name	reserved		QuS02	QuS01	QuS00	QuN02	QuN01	QuN00
RESET	0	0	0	0	0	0	0	0

Name	Value	Meaning
QuN02, QuN01, QuN00 Encoder signal N (zero-mark signal): select source	000	No encoder signal N
	001	Encoder 2, signal N
	010	Encoder 3, signal N
	011	Digital I/O module S0, input 14
	100	Digital I/O module S1, input 6
	101	Digital I/O module S0, rapid input 0
	110	Pulse (frequency measurement)
	111	Pulse (frequency measurement), signal is inverted
QuS02, QuS01, QuS00 Trigger S: select source	000	No trigger S
	001	Basic module digital input 2
	010	Basic module digital input 3
	011	Digital I/O module S0, input 15
	100	Digital I/O module S1, input 3
	101	Digital I/O module S1, input 7
	110	Digital I/O module S0, rapid input 1
	111	Pulse (frequency measurement)

Example: Encoder 3 on counter 3			
	Bits 7, 6	Bits 5 to 3	Bits 2 to 0
Meaning	reserved	QuS: Basic module, digital input 3	QuN: Encoder 3, signal N
Bit pattern	00	010	010

Encoder interface switching register counter 3/byte 2								
Bit	7	6	5	4	3	2	1	0
Name	Sampling time setting	TTA3	TTA2	TTA1	TTA0	QuT02	QuT01	QuT00
RESET	0	0	0	0	0	0	0	0

Name	Value	Meaning		
QuT02, QuT01, QuT00: Encoder signal T: select source	000	No trigger T		
	001	Basic module digital input 2		
	010	Basic module digital input 3		
	011	Digital I/O module S0, input 14		
	100	Digital I/O module S1, input 8		
	101	Digital I/O module S1, input 9		
	110	Digital I/O module S3, rapid input 1		
	111	Pulse (frequency measurement)		
TTA3, TTA2, TTA1, TTA0 Gate width selection (pulse)*:	**Value**	**Meaning**	**Value**	**Meaning**
	0000	8 µs	1000	131072 µs
	0001	32 µs	1001	262144 µs
	0010	128 µs	1010	524288 µs
	0011	512 µs	1011	1048576 µs
	0100	2048 µs	1100	2097152 µs
	0101	8192 µs	1101	4194304 µs
	0110	16384 µs	1110	8388608 µs
	0111	32768 µs	1111	16777216 µs
Sampling time setting: select sampling time for pulse-width measurement	0	1 MHz		
	1	4 MHz		

*

In the case of an edge-controlled gate width, the gate width is equal to one period of the internal pulse, in other words the value shown in the table.
In the case of a level-controlled gate width, the gate width is equal to the time for which the internal pulse level is high, in other words half the above time.

You can choose between edge-controlled and level-controlled gate width in the control register.

Example: Encoder 3 on counter 3			
	Bits 7, 6	Bits 5 to 3	Bits 2 to 0
Meaning	Sampling time setting: 1 MHz	TTA: Gate width 8 µs	QuT: Basic module, digital input 3
Bit pattern	0	0000	010

Encoder interface switching register counter 3/byte 3								
Bit	7	6	5	4	3	2	1	0
Name	reserved							
RESET	0	0	0	0	0	0	0	0

11.3.8 Registers for counter values

Addresses

The register addresses are listed in the table below.

Counter	Address of the associated register				
	Counter register	Preload value register	Zero-mark register	Universal register 0	Universal register 1
Counter 0	BA + 50 H	BA + 54 H	BA + 58 H	BA + 5C H	BA + 60 H
Counter 1	BA + 6C H	BA + 70 H	BA + 74 H	BA + 78 H	BA + 7C H
Counter 2	BA + 88 H	BA + 8C H	BA + 90 H	BA + 94 H	BA + 98 H
Counter 3	BA + A4 H	BA + A8 H	BA + AC H	BA + B0 H	BA + B4 H

Access type:	R/W DW

Function overview of the registers

The following registers are all 32-bit registers for counter values with no sign.

- Counter register
  Contains the current counter value.
- Preload value register
  Contains the value to which you can reset a counter.
- Zero-mark register
  When set accordingly, assumes the current counter value when a zero mark is received.
- Universal register 0
  When set accordingly, assumes the current counter value when a trigger signal is received.
- Universal register 1
  This value can be used as a comparator value with which the current counter value is compared.

Function overview of the universal registers

The universal registers are used to buffer the counter values and to store the comparator value.

Table 11-42 Function overview of the universal registers

Registers	Counter function	Comparator function
Universal register 0 for counter n (n = 0 to 3)	On trigger event Sn: Accept counter value from counter n	
Universal register 1 for counter n (n = 0 to 3)	On trigger event Tn: Accept counter value from counter n	Comparator value for counter n

Comparator function

The content of universal register 1 for counter n is continuously compared with the current counter value of the relevant counter.

- If the value of the comparison register (comparator value) is reached, then bit CRn is set in the main interrupt register.
- The CRn interrupt in the main interrupt mask register can be masked or enabled:
  – Mask (default): set bit MASCRn to "1"
  – Enable: set bit MASCRn to "0"

Position of main interrupt mask register:
BA + 04 H, byte 2

Name	Meaning	Bit in main interrupt mask register (BA + 04 H) for counter n:			
		n=0	n=1	n=2	n=3
MASCRn	Interrupt mask for: Interrupt for comparator value	4	5	6	7

- The settings of the clear functions can be used to reset the counter value to 0 or to the value of the preload value register (see "Using the clear functions").

The comparator value for each counter can be loaded to universal register 1 of the associated counter by means of a write access.

See also

Using the clear functions (Page 95)

11.3.9 Counter control registers

Control register

Position of control register:

Counter	Address
Counter 0	BA + 64 H
Counter 1	BA + 80 H
Counter 2	BA + 9C H
Counter 3	BA + B8 H

Access mode	R/W byte

The control register can be used to reset status signals and trigger the commands described below. A write access to the register in which the corresponding bits are set executes this function.

This type of command generation means that multiple commands can be executed simultaneously. Commands for one counter can be called at the same time as those for the other counter because the counters are mutually independent.

Multiple commands can also be executed simultaneously within one counter, although care must be taken, as the command sequence in this case is undefined. This applies in particular to the "Software strobe", "Software clear", "Software reload", and "Revoke counter write protection" commands. These commands must never be executed at the same time as other commands on the same channel.

Example:
In the simplest case, for a standard incremental encoder you must enter the following value:

08 00 80 00 H

Note

Avoiding undefined counter conditions

The commands "Software strobe" "Software clear", "Software reload" and "Revoke counter write protection" must not be executed along with other commands on the same counter because the command sequence and therefore also the result is undefined in this case.

Table 11-43 Control register

Control register/byte 0								
Bit	7	6	5	4	3	2	1	0
Name	PDn	Tor_MDn	HZn	reserved	Edge evaluation n			
RESET	0	0	0	0	0	0	0	0

RESET: Reset to 0

Name	Meaning		
Edge evaluation n	Edge evaluation for position sensing		
	0000	Quadruple edge evaluation	
	0001	Double edge evaluation	
	0101	Single edge evaluation	
HZn	For position sensing: switch hysteresis on or off For frequency and pulse-width measurement: Counting direction		
		For position sensing:	For frequency and pulse-width measurement
	0	Hysteresis off	Count direction up
	1	Hysteresis on	Count direction down
Tor_MDn	Gate mode for frequency and pulse-width measurement		
	0	Counter runs for as long as the gate input is active	
	1	Counter starts on rising gate edge Counter stops on next rising gate edge	
PDn	Choice between position sensing and frequency and pulse-width measurement		
	0	Position sensing (shaft encoder evaluation)	
	1	Frequency and pulse-width measurement	

Example:
In the simplest case, for a standard incremental encoder you must enter the following value:

Bit pattern	Hex value
0000 0000	00 H

Control register/byte 1								
Bit	7	6	5	4	3	2	1	0
Name	NULM	CLR_n	Internal	Internal	Internal	Sn_CLR	Sn	Tn
RESET	0	0	0	0	0	0	0	0

Name	Meaning	
Tn	Activates the trigger function of Tn. This allows the current counter value to be loaded into universal register 1 of counter n on a falling edge of Tn.	
	0	Trigger function off
	1	Trigger function on
Sn	Activates the trigger function of Sn. This allows the current counter value to be loaded into universal register 1 of counter n on a falling edge of Tn.	
	0	Trigger function off
	1	Trigger function on
Sn_CLR	Activates the reset function of Sn. A rising edge of Sn resets counter n	
	0	Reset function disabled
	1	Reset function enabled
CLR_n	Reset counter n (clear) Pulse on the N track (zero mark) resets the counter	
	0	Reset function off
	1	Reset function enabled
NULM	Zero-mark evaluation	
	0	Zero-mark evaluation disabled
	1	Zero-mark evaluation enabled

Example:
In the simplest case, for a standard incremental encoder you must enter the following value:

Bit pattern	Hex value
1000 0000	80 H

Control register/byte 2								
Bit	7	6	5	4	3	2	1	0
Name	reserved			Internal	REFn_HYST	KOMPn_HYST	CLR_MDn	CR1n_CLR
RESET	0	0	0	0	0	0	0	0

Name	Meaning	
CR1n_CLR	Activates the reset function of the comparator of counter n. Reset function: Resets the counter if universal register 1 of counter n corresponds to the current counter value of counter n.	
	0	Reset function of comparator CR1n disabled
	1	Reset function of comparator CR1n enabled
CLR_MDn	Selects the reset mode for counter n	
	0	Reset counter to 00000000 H if a trigger event is received
	1	Set counter n to the value in the preload value register if a trigger event is received
KOMPn_HYST	Only effective if HZ = 1, i.e., hysteresis of counter n is enabled. Enable comparator hysteresis	
	0	Comparator hysteresis off
	1	Comparator hysteresis for counter n on (if HZ = 1)
REFn_HYST	Only effective if HZ = 1, i.e., hysteresis of counter n is enabled. Enable zero-mark hysteresis	
	0	Zero-mark hysteresis off
	1	Zero-mark hysteresis on (if HZ = 1)

Example:
In the simplest case, for a standard incremental encoder you must enter the following value:

Bit pattern	Hex value
0000 0000	00 H

Control register/byte 3								
Bit	7	6	5	4	3	2	1	0
Name	SW_ RELOAD_n	SW_ CLEAR_n	NUML_ZU R_n	SW- STROB_n	ZÄHS_AUF _n	Internal		ALAR_ ZUR_n
RESET	0	0	0	0	0	0	0	0

Name	Meaning	
ALAR_ZUR_n	Alarm bit CBn is reset. Alarm bit CBn is set in the event of a counter overflow of counter n.	
	0	No effect
	1	Reset alarm bit
ZÄHS_AUF_n	Revokes counter write protection on counter n	
	0	No effect
	1	Revoke counter write protection on counter n
SW_STROB_n	Only effective if counter write protection is disabled. Copies the counter value of counter n to the associated zero-mark register of counter n	
	0	No effect
	1	Software strobe counter n Copy counter value from counter n to associated zero-mark register
NUML_ZUR_n	Reset zero-mark latch. The latch is reset if a zero mark is received.	
	0	No effect
	1	Reset zero-mark latch on counter n
SW_CLEAR_n	Resets the counter content of counter n to 00000000 H. Only effective if counter write protection on counter n is disabled.	
	0	No effect
	1	Reset counter value of counter n (only if counter write protection is disabled)
SW_RELOAD_n	Resets the counter content to the value in the preload value register. Only effective if counter write protection on the relevant counter is disabled.	
	0	No effect
	1	Software reload for counter n: Reload counter n (only if counter write protection is disabled)

Example:
In the simplest case, for a standard incremental encoder you must enter the following value:

Bit pattern	Hex value
0000 1000	08 H

11.3.10 Output, check and enable registers for analog I/O module 0

Analog value output register and analog output check register

Position:	
Analog I/O module A0:	BA + 100 H
Analog I/O module A1:	BA + 104 H
Access type:	R/W

Table 11-44 Analog value output register and analog output check register

Analog value output register and analog output check register/byte 0								
Bit	7	6	5	4	3	2	1	0
Name	reserved							

Analog value output register and analog output check register/byte 1								
Bit	7	6	5	4	3	2	1	0
Name	reserved			DAMODE	CHMODE	AOCH2	AOCH1	AOCH0

Name	Meaning	
AOCH2, AOCH1, AOCH0	Output channel for analog value	
	000 ... 111	Selected analog output: AO0 to AO7
CHMODE	Channel status of output channel	
	0	Disable channel and set output to 0 V (output value is disregarded)
	1	Enable channel (new output value is accepted)
DAMODE	Digital-to-analog conversion mode	
	0	Single mode
	1	Block mode (currently not supported)

Analog value output register and analog output check register/byte 2								
Bit	7	6	5	4	3	2	1	0
Name	AOV7	AOV6	AOV5	AOV4	AOV3	AOV2	AOV1	AOV0

Analog value output register and analog output check register/byte 3								
Bit	7	6	5	4	3	2	1	0
Name	AOV15	AOV14	AOV13	AOV12	AOV11	AOV10	AOV9	AOV8

Name	Meaning	
AOVn (n = 0 to 15)	Output value for analog value	
	FFFF H	+ 10 V
	0000 H	- 10 V

Analog-to-digital conversion check register

Position:

Analog I/O module A0:	BA + 108 H
Analog I/O module A1:	BA + 10C H
Access type:	R/W DW: doubleword access only

Table 11-45 Analog-to-digital conversion check register

Analog-to-digital conversion check register/byte 0								
Bit	7	6	5	4	3	2	1	0
Name	reserved							

Analog-to-digital conversion check register/byte 1								
Bit	7	6	5	4	3	2	1	0
Name	ADMODE	AICH2	AICH1	AICH0	RNG	BIP	PD1	PD0

Name	Meaning	
PD1, PD0	Analog-to-digital converter mode Reserved (written with "00")	
RNG, BIP	Measuring range definition	
	00	0 to +5 V
	01	± 5 V
	10	0 to +10 V
	11	± 10 V
AICH2, AICH1, AICH0	Input channel for analog value	
	000 ... 111	Selected analog input: AI0 to AI7
DAMODE	Digital-to-analog conversion mode	
	0	Single mode
	1	Block mode (currently not supported)

Analog-to-digital conversion check register/byte 2								
Bit	7	6	5	4	3	2	1	0
Name	reserved							

Analog-to-digital conversion check register/byte 3								
Bit	7	6	5	4	3	2	1	0
Name	reserved							

Pt100 enable register

Position:	BA + 140 H
Access type:	R/W DW: doubleword access only

Table 11-46 Pt100 enable register

Pt100 enable register/byte 0								
Bit	7	6	5	4	3	2	1	0
Name	reserved		A0R1	A0R0	A0PT3	A0PT2	A0PT1	A0PT0

Name	Meaning	
A0PTn, n = 0 to 3	Analog I/O module A0, automatic measurement Pt100 input n	
	0	Disabled
	1	Enabled
A0R0	Analog I/O module A0, automatic measurement resistance reference R0 (100 Ohm)	
	0	Disabled
	1	Enabled
A0R1	Analog I/O module A0, automatic measurement resistance reference R1 (200 Ohm)	
	0	Disabled
	1	Enabled

Pt100 enable register/byte 1								
Bit	7	6	5	4	3	2	1	0
Name	reserved		A1R1	A1R0	A1PT3	A1PT2	A1PT1	A1PT0

Name	Meaning	
A1PTn, (n = 0 to 3)	Analog I/O module A1, automatic measurement Pt100 input n	
	0	Disabled
	1	Enabled
A1R0	Analog I/O module A1, automatic measurement resistance reference R0 (100 Ohm)	
	0	Disabled
	1	Enabled
A1R1	Analog I/O module A1, automatic measurement resistance reference R1 (200 Ohm)	
	0	Disabled
	1	Enabled

Pt100 enable register/byte 2								
Bit	7	6	5	4	3	2	1	0
Name	reserved							

Pt100 enable register/byte 3								
Bit	7	6	5	4	3	2	1	0
Name	reserved							

11.3.11 Interrupt mask registers for digital inputs

Position:	BA + 144 H
Access type:	R/W DW: doubleword access only

Table 11-47 Interrupt mask registers for digital inputs

Interrupt mask registers for digital inputs/byte 0								
Bit	7	6	5	4	3	2	1	0
Name	D0FDI7	D0FDI6	D0FDI5	D0FDI4	D0FDI3	D0FDI2	D0FDI1	D0FDI0

Interrupt mask registers for digital inputs/byte 1								
Bit	7	6	5	4	3	2	1	0
Name	D1FDI7	D1FDI6	D1FDI5	D1FDI4	D1FDI3	D1FDI2	D1FDI1	D1FDI0

Interrupt mask registers for digital inputs/byte 2								
Bit	7	6	5	4	3	2	1	0
Name	D2FDI7	D2FDI6	D2FDI5	D2FDI4	D2FDI3	D2FDI2	D2FDI1	D2FDI0

Interrupt mask registers for digital inputs/byte 3								
Bit	7	6	5	4	3	2	1	0
Name	D3FDI7	D3FDI6	D3FDI5	D3FDI4	D3FDI3	D3FDI2	D3FDI1	D3FDI0

0 Interrupt flag not masked, i.e., an interrupt is triggered when the corresponding signal is received

1 Interrupt flag masked, i.e., an interrupt is suppressed

Name	Meaning
D0FDIn, n = 0 to 7	Interrupt mask for digital I/O module S0: for interrupt on signal change at digital inputs DI0 to DI7
D1FDIn, n = 0 to 7	Interrupt mask for digital I/O module S1: for interrupt on signal change at digital inputs DI0 to DI7
D2FDIn, n = 0 to 7	Interrupt mask for digital I/O module S2: for interrupt on signal change at digital inputs DI0 to DI7
D3FDIn, n = 0 to 7	Interrupt mask for digital I/O module S3: for interrupt on signal change at digital inputs DI0 to DI7

11.3.12 Registers for mirror bytes

	Transmit mirror byte	Receive mirror byte with inverted bits
Position:	BA + 148 H, byte 0	BA + 1B8 H, byte 0
Access type:	W (write-only) DW	R (read-only) DW

Notice

Although the registers are only 8 bits in size, the data must be written/read with 32-bit accesses.

11.3.13 Status register for I/O module Sn

Depending on whether a digital I/O module 0 or an analog I/O module 0 was detected at a slot during booting, the meaning of the bits in the I/O module status register differs.

Position:

I/O module in slot	Address	Byte
S0	BA + 1BC H	0
S1	BA + 1BC H	1
S2	BA + 1BC H	2
S3	BA + 1BC H	3

Access mode	R (read-only) DW: doubleword access only

Status register for digital I/O module 0

Table 11-48 Status register for digital I/O module 0

Status register for digital I/O module 0								
Bit	7	6	5	4	3	2	1	0
Name	RESET_	0	DIAG1	DIAG0	ID3	ID2	ID1	ID0

Name	Meaning	
IDn, n = 0 to 3	Module ID at I/O module channel n	
	0001	Digital I/O module
	otherwise	other module or transmission error
DIAG0	Diagnostics of digital outputs DO 0 to DO 7	
	0	Short-circuit/overheating/ line interruption
	1	Error-free operation
DIAG1	Diagnostics of digital outputs DO 8 to DO 15	
	0	Short-circuit/overheating/ line interruption
	1	Error-free operation
RESET_	Module reset	
	0	Enabled, so all digital outputs logical 0
	1	Inactive

Notice

For error-free diagnostics of outputs, outputs not in use should be set to "1". This is necessary to avoid the erroneous reporting of a line interruption.

Status register for analog I/O module 0

Table 11-49 Status register for analog I/O module 0

Status register for analog I/O module 0								
Bit	7	6	5	4	3	2	1	0
Name	RESET_	0	0	0	MID3	MID2	MID1	MID0

Name	Meaning	
MIDn, n = 0 to 3	Module ID at I/O module Sn	
	0010	Analog I/O module
	otherwise	Defective module or transmission error
RESET_	Module reset	
	0	Enabled, so all analog outputs set to 0 V
	1	Inactive

11.3.14 Result registers for analog I/O module

Result register for Pt100 and analog-to-digital conversion

Result registers consist of 2 bytes. The following overview shows the position of the result registers:

Analog I/O module A0	Address	Bytes
Result register: Pt100 input 0	BA + 1C0 H	0 and 1
Result register: Pt100 input 1	BA + 1C0 H	2 and 3
Result register: Pt100 input 2	BA + 1C4 H	0 and 1
Result register: Pt100 input 3	BA + 1C4 H	2 and 3
Result register: 100-Ohm reference value	BA + 1C8 H	0 and 1
Result register: 200-Ohm reference value	BA + 1C8 H	2 and 3
Analog-to-digital conversion result register:	BA + 1E0 H	0 and 1

Analog I/O module A1	Address	Bytes
Result register: Pt100 input 0	BA + 1CC H	0 and 1
Result register: Pt100 input 1	BA + 1CC H	2 and 3
Result register: Pt100 input 2	BA + 1D0 H	0 and 1
Result register: Pt100 input 3	BA + 1D0 H	2 and 3
Result register: 100-Ohm reference value	BA + 1D4 H	0 and 1
Result register: 200-Ohm reference value	BA + 1D4 H	2 and 3
Analog-to-digital conversion result register:	BA + 1F0 H	0 and 1

Access mode	R (read-only) DW: doubleword access only

All results are 12-bit values and are structured in the same way:

Table 11-50 Result register for Pt100 or analog-to-digital conversion

Result register for Pt100 or analog-to-digital conversion/byte 0 or byte 2								
Bit	7	6	5	4	3	2	1	0
Name	AIV7	AIV6	AIV5	AIV4	AIV3	AIV2	AIV1	AIV0

Result register for Pt100 or analog-to-digital conversion/byte 1 or byte 3								
Bit	7	6	5	4	3	2	1	0
Name	0	0	0	0	AIV11	AIV10	AIV9	AIV8

Name	Meaning
AIVn (n = 0 to 11)	Measurement result for Pt100 or voltage measurement. Assignment of the values depends on the measured quantity and the chosen measuring range

Notice

Although the registers are only 16 bits in size, the data must be read with 32-bit accesses.

Value ranges:

Unipolar analog-to-digital range or range for Pt100:

0000 H	Lowest value
0FFF H	Highest value

Bipolar analog-to-digital range:

0FFF H	Lowest value
07FF H	Highest value

Bit 11 is the sign bit

Ordering units 12

12.1 Components

12.1.1 Components for SIMATIC Microbox PC 42x

Table 12-1 Ordering units for expanding a SIMATIC Microbox PC 42x

Name	Order number (MLFB)	Scope of delivery
PC IO Base 400 (basic module)	6ES7648-2CE20-0AA0	Basic module with fixing accessories: PCI-104 module for connection of up to 4 PC IO MOD xxx 010/020, with • 4 encoder interfaces • 4 DI including fixing accessories
PC IO MOD Digital 010	6ES7648-2CE40-0BA0	Digital I/O module 0: Digital I/O module with • 24 DI • 16 DO including connecting cable to PC IO Base 400 and mating connector
PC IO MOD Analog 020	6ES7648-2CE40-0CA0	Analog I/O module 0: Analog I/O module with • 8 AI • 8 AO • 4 PT100 including connecting cable to PC IO Base 400, mating connector, and shield clamp
PC IO KIT 030	6ES7648-1AA20-0XF0	I/O expansion rack: for Microbox PC 42x for installing up to 2 I/O modules, including fixing accessories and a cover plate
PC IO KIT 040	6ES7648-1AA20-0XE0	Encoder expansion rack: for Microbox PC 42x for contacting the encoder interfaces for • 4 encoders • 4 DIs of the PC IO Base 400 including fixing accessories

12.1.2 Components for expanding a SICOMP IMC CPCI system

Table 12-2 Ordering units for expanding a SICOMP IMC CPCI system

Name	Order number (MLFB)	Scope of delivery
CPCI-SFT200	6AR1344-0AB00-0AA0	**Basic module with encoder inputs:** CPCI module for connection of up to 4 CPCI-EAM2xx modules, with • 4 encoder interfaces • 4 DI
CPCI-EAM220	6AR1342-0AH00-0AA0	**Digital I/O module 0** Digital I/O module with • 24 DI • 16 DO including connecting cable to CPCI-SFT200 and mating connector
CPCI-EAM230	6AR1342-0AK00-0AA0	**Analog I/O module 0** Analog I/O module with • 8 AI • 8 AO • 4 Pt100 including connecting cable to CPCI-SFT200 and mating connector

12.2 Accessories

Accessories: Recommended incremental encoders

The external incremental encoder must be an incremental encoder with RS 422, several variants of which are available. SSI encoders cannot be connected.

Incremental encoders require an adapter cable.

Caution

Note the encoder connection voltage.

Encoders with a 24 V or 5 V power supply can be connected. When making the connections, be sure to apply the correct power supply to the encoder.

The voltage that you supply to the encoder power supply interface is looped to the encoders. If you supply the wrong voltage to the encoder power supply interface, the encoders connected to it will be damaged.

The encoder output signal must be a differential signal in accordance with RS 422.

RS 422 incremental encoders can be found in the SIEMENS mall (http://mall.automation.siemens.com/de/guest/guiRegionSelector.asp?lang=en)

Incremental encoders can be found under: Products / Drive Technology / AC motors / Encoder systems / Measuring systems SIMODRIVE sensors / Incremental encoders / TTL (RS 422) incremental encoder

Adapter cable for incremental encoders

Order no. [MLFB]	Explanation
6FM1790-1Cxxx*	Adapter cable for incremental encoders: Sub D 15-pin encoder connector

* The three xxx digits represent the length code. For more information, refer to Catalog NC Z

This can be found in the SIEMENS mall (http://mall.automation.siemens.com/de/guest/guiRegionSelector.asp?lang=en)

Appendix A

A.1 Service and support

Technical Support

You can contact Technical Support for all A&D products as follows:

- By filling out a Support Request (http://www.siemens.com/automation/support-request)
- Telephone: +49 (0) 180 5050 222
- Fax: +49 (0) 180 5050 223

Additional information about our technical support is available in the Internet at: Service (http://www.siemens.com/automation/service)

When you contact customer support, please have the order number (MLFB) of the device ready for the technician.

Service & Support on the Internet

In addition to our documentation, we offer a comprehensive online knowledge base on the Internet at: Support (http://www.siemens.com/automation/support)

There you will find:

- Our newsletter containing up-to-date information on your products.
- The documents you need via our Search function in Service & Support.
- A forum for users and specialists to exchange experiences.
- Your local Siemens partner for Automation & Drives in our Partner database
- Information about local service, repairs, and spare parts. Lots more is available on our "Services" pages.
- Software download:
  - Program examples for RMOS3 and Windows
  - IMCEA drivers for Windows

ESD directives B

B.1 ESD directives

Definition of ESD

All electronic modules are equipped with large-scale integrated ICs or components. Due to their design, these electronic elements are highly sensitive to overvoltage, and thus to any electrostatic discharge.

The electrostatic sensitive components/modules are commonly referred to as ESD devices. This is also the international abbreviation for such devices.

ESD modules are identified by the following symbol:

Caution

ESD devices can be destroyed by voltages well below the threshold of human perception. These static voltages develop when you touch a component or electrical connection of a device without having drained the static charges present on your body. The electrostatic discharge current may lead to latent failure of a module, that is, this damage may not be significant immediately, but in operation may cause malfunction.

Electrostatic charging

Anyone who is not connected to the electrical potential of their surroundings can be electrostatically charged.

The figure below shows the maximum electrostatic voltage which may build up on a person coming into contact with the materials indicated. These values correspond to IEC 801-2 specifications.

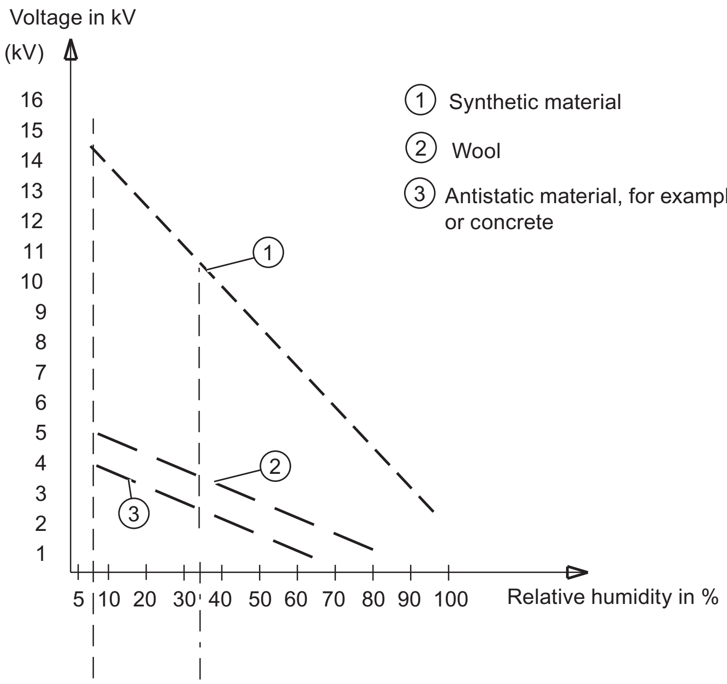


Figure B-1 Electrostatic voltages on an operator

Basic protective measures against electrostatic discharge

- Ensure good equipotential bonding:
  When handling electrostatic sensitive devices, ensure that your body, the workplace and packaging are grounded. This prevents electrostatic charge.
-
  As a general rule, only touch electrostatic sensitive devices when this is unavoidable (e.g. during maintenance work). Handle the modules without touching any chip pins or PCB traces. In this way, the discharged energy can not affect the sensitive devices.

  Discharge your body before you start taking any measurements on a module. Do so by touching grounded metallic parts. Always use grounded measuring instruments.

B.2 ESD protective measures

Caution

ESD protective measures

When handling modules and components carrying this symbol, always observe the ESD protection directives (**E**lectrostatically **S**ensitive **D**evices/).

- Never touch the boards unless necessary work makes this unavoidable.
- When handling the boards, use a conductive and grounded work surface.
- Wear a grounding bracelet.
- Never touch chip pins, component connections or circuit board conductors when handling the boards.
- Never allow boards or components to touch chargeable objects (plastics).
- Never place components or boards in the vicinity of cathode ray tube units or television sets (minimum distance: 10 cm).
- Leave the boards in their special packaging until you are ready to use them. Do not take the boards out of their packaging or touch them when registering them and so on.
- Boards may only be installed or removed when the power is off.
- This warning sign on Siemens products draws your attention to appropriate protective measures you need to take.

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J31069-D0319-U001-A1-7618

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Wichtige Information

Bitte zuerst lesen
und sorgfältig aufbewahren!

Produktbegleitbrief

PC IO zentrale Peripherieerweiterung

1 Gültigkeitsbereich dieses Dokuments

Tabelle 1 Gültigkeitsbereich

Produkt	Bestellnummer (MLFB)
PC IO Base 400 (Basisbaugruppe)	6ES7648-2CE20-0AA0
PC IO MOD Digital 010 (Digitales I/O-Modul)	6ES7648-2CE40-0BA0
PC IO MOD Analog 020 (Analoges I/O-Modul)	6ES7648-2CE40-0CA0
PC IO KIT 040 (Geber-Erweiterungsrahmen)	6ES7648-1AA20-0XE0

2 Betriebshinweise

Die zentrale Peripherieerweiterung CIO (central input/output = CIO) ermöglicht die Erweiterung eines SIMATIC Microbox PC 42x mit Gebereingängen und zugehörigen Zählern, digitalen und analogen Ein- und Ausgängen.

Achtung

EGB-Schutzmaßnahmen

Beachten Sie bei der Handhabung von Baugruppen und anderen Komponenten, die mit diesem Symbol gekennzeichnet sind, immer die EGB-Schutz-Richtlinien (**E**lektrostatisch **G**efährdete **B**auelemente/**B**augruppen).

Achtung

Gehen Sie bei der Montage und Inbetriebnahme vor wie in der Betriebsanleitung beschrieben.

Die Inbetriebnahme darf nur durch qualifiziertes Personal durchgeführt werden.

Die Betriebsanleitung zu PC IO finden Sie im Internet unter www.siemens.de/automation/csi/manual.
Suchen Sie nach PC IO.

Important Information

Please read first
and store carefully!

Product Release Letter

Central PC IO expansion

1 Scope of this document

Table 1 Scope of application

Product	Order number (MLFB)
PC IO Base 400 (Basic module)	6ES7648-2CE20-0AA0
PC IO MOD Digital 010 (Digital I/O module)	6ES7648-2CE40-0BA0
PC IO MOD Analog 020 (Analog I/O module)	6ES7648-2CE40-0CA0
PC IO KIT 040 (Encoder expansion rack)	6ES7648-1AA20-0XE0

2 Operation Remarks

The central input/output (CIO) expansion can be used to add encoder inputs and associated counters, digital and analog inputs and outputs to a SIMATIC Microbox PC 42x or a SICOMP IMC CPCI system.

Caution

ESD protective measures

When handling modules and components carrying this symbol, always observe the ESD protection directives (**E**lectrostatically **S**ensitive **D**evices)

Caution

For assembly and commissioning proceed as described in the operating manual.

Commissioning may only be performed by qualified personnel.

The PC IO operating manual is available in the internet at www.siemens.com/automation/csi/manual.
Search for PC IO.

3 Technische Daten

Tabelle 2 Basisbaugruppe

Parameter	Wert
Versorgungsspannung Basisbaugruppe	Über die PCI-Schnittstelle: DC 3,3 V und DC 5 V
Stromaufnahme Basisbaugruppe: DC 3,3 V DC 5 V	 max. 0,5 A max. 0,1 A
Versorgungsspannung Geber und digitale Eingänge	DC 24 V (20,4…28,8V) NEC CLASS 2 bzw. LPS [1,2]
Stromaufnahme der Geber-eingänge und Zähler	max. 0,3 A je Geber
Spannung je digitaler Eingang	max. 30 V
Strom je digitaler Eingang	ca. 2 mA

Tabelle 2 Digitales I/O-Modul

Parameter	Wert
Versorgungsspannung digitale Eingänge	DC 24 V (20,4…28,8V) NEC CLASS 2 bzw. LPS [1]
Stromaufnahme digitales I/O-Modul	max. 4 A
Spannung je digitaler Eingang	max. 30 V
Strom je digitaler Eingang	ca. 2 mA
Spannung digitale Ausgänge	DC 24 V (20,4…28,8V)
Strom Digitale Ausgänge: pro Ausgang insgesamt pro digitalem Modul	 max. 0,5 A max. 4 A

Tabelle 3 Analoges I/O-Modul

Parameter	Wert
Versorgungsspannung analoges I/O-Modul	Über Flachbandkabel zur Basisbaugruppe: DC 5 V
Stromaufnahme analoges I/O-Modul	max. 0,2 A
Spannungsbereich analoge Eingänge	max. ± 15 V
Strom je analoger Eingang	max. 1 mA
Spannung je Pt100 Eingang	max. ± 15 V
Strom je Pt100 Eingang	max. 5 mA Konstantstrom während der Messphase
Spannungsbereich analoge Ausgänge	± 10 V
Laststrom je analoger Ausgang	max. 2 mA

Tabelle 4 Klimatische Umweltbedingungen

Parameter / Variante	Wert
Umgebungstemperatur im Betrieb	
Beim Betrieb im Microbox PC mit Festplatte	+ 5 °C ... + 40 °C
Beim Betrieb im Microbox PC mit CF-Card	0 °C ... + 50 °C bei horizontalem Einbau 0 ... + 45 °C bei vertikalem Einbau

1) *Zur Einhaltung der UL-Anforderungen (nach UL 60950-1 bzw. UL 508) ist eine Stromquelle entsprechend NEC Class 2 erforderlich. In allen anderen Fällen (nach IEC/EN/DIN EN 60950-1) ist entweder eine Stromquelle begrenzter Leistung (LPS = Limited Power Source) oder eine vorgeschaltete Sicherung erforderlich. Der hierfür erforderliche Sicherungswert ist aus der IEC/EN/DIN EN 60950-1, Kap. 2.5 zu entnehmen.*

2) *Zur Einhaltung der UL-Anforderungen (nach UL 508) sind die Spannungstransienten am SV-Eingang des Geberrahmens mit einem Varistor auf max. 500 V zu begrenzen.*

3 Technical Data

Table 2 Basic module

Parameter	Value
Supply voltage to basic module	Via PCI interface: DC 3.3 V und DC 5 V
Current consumption of basic module: 3.3 V DC 5 V DC	 max. 0.5 A max. 0.1 A
Power supply to encoders and digital inputs	24 V DC (20.4 to 28.8 V) NEC CLASS 2 or LPS [1,2]
Current consumption of encoder inputs and counters	max. 0.3 A per encoder
Voltage per digital input	max. 30 V
Current per digital input	ca. 2 mA

Table 2 Digital I/O module

Parameter	Value
Power supply to digital inputs	24 V DC (20.4 to 28.8 V) NEC CLASS 2 or LPS [1]
Current consumption of digital I/O module	max. 4 A
Voltage per digital input	max. 30 V
Current per digital input	ca. 2 mA
Voltage for digital outputs	24 V DC (20.4 to 28.8 V)
Current of digital outputs: Per output Total per digital I/O module	 max. 0.5 A max. 4 A

Table 3 Analog I/O module

Parameter	Value
Power supply to analog I/O module	Via flat ribbon cable to basic module: 5 V DC
Current consumption of analog I/O module	max. 0.2 A
Voltage range of analog inputs	max. ± 15 V
Current per analog input	max. 1 mA
Voltage per Pt100 input	max. ± 15 V
Current per Pt 100 input	max. 5 mA constant current during measuring phase
Voltage range of analog outputs	± 10 V
Load current per analog output	max. 2 mA

Table 4 Climatic environmental conditions

Parameter/variant	Value
Ambient temperature during operation	
When used in a Microbox PC with hard disk	+ 5 °C to + 40 °C
When used in a Microbox PC with CompactFlash card	0 °C to + 50 °C when installed horizontally 0 to + 45 °C when installed vertically

1) *An NEC Class 2 current source is required for the compliance of the UL requirements (in accordance with UL 60950-1or UL 508 respectively). In all other cases (in accordance with IEC/EN/DIN EN 60950-1) either a power source of limited performance (LPS = Low Power Source) or a lined-side fuse is necessary. For the necessary fuse size refer to IEC/EN/DIN EN 60950-1, chapter 2.5.*

2) *To fulfill the requirements of UL 508 the voltage transients on the Power Supply Terminal for Encoders/Counters have to be controlled by a varistor, suppression voltage max. 500 V.*