Operating manual
decentralised I/O-modules PCD0
for PROFIBUS DP

SAIA®PCD0: the well thought out RIO-System – clever in all project phases, from planning to maintenance

Maturity in conception and functionality

- **The right RIO for every application**
  Economical, compact RIOs with up to 16 digital I/Os and integral PROFIBUS-DP connection
  Modular RIOs for up to 128 I/Os with wide range of I/O modules (digital, analogue, counters) and 2 PROFIBUS-DP connections (convenient bus coupler [BC] with comprehensive service and diagnostic functions, or low-cost economic coupler [EC])
  Digital modules with dual-purpose channels that allow flexible channel use: either as input or output.
- **Compact form**
  The offset arrangement of terminals requires only 4.4 mm of switch cabinet width per I/O point.
- **Efficient connection of I/O signals**
  Pretensioned spring terminals save time connecting I/O signals. As a result, up to 30 % of wiring time is saved when compared with conventional spring terminals.
  Additional extension terminals allow I/Os to be connected in 4-wire technology.

Smart diagnostic and service functions

- **Efficient commissioning, maintenance and diagnosis**
  Powerful service functions can be executed on site, using the BC coupler's integral keyboard and display.
  Commissioning and diagnosis even without runnable ROFIBUS DP
  No additional software tools required
- **Display and overwrite I/O signal states** with or without PROFIBUS-DP master connected:
  - Display digital and analogue I/O states
  - Display count values from counting and motion control I/Os
  - Set/reset digital I/O signal states
  - Increment/decrement analogue I/O signal level
- **Datalogging for fast signals**
  The last 20 signal states of all digital I/Os can be stored in the BC coupler and viewed on the display.
- **Built for ease of service**
  I/O module electronics are replaced without undoing the wiring.

Operating manual
PCD0 EC/BC coupler since FW 0127

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You can download all our operating manuals free of charge from our web site at *www.sbc-support.ch*

Operating manuals	
Item	Order no.
PCD0 RIO's zu Profibus-DP deutsch	26/766 D
PCD0 RIO's RIO for Profibus-DP englisch	26/766 E
Handbuch Profibus-DP deutsch	26/765 D
Manual Profibus-DP englisch	26/765 E

Previous versions of this operating manual
11/99

Document conventions

This operating manual uses the following signs to indicate safety-related and handling warnings:

Possible injury to persons or damage to the automation system or the equipment if relevant warnings are not observed.

Important information on the handling of the automation system or the part described in the operating manual.

Please read and follow the safety-related warnings at the end of this operating manual.

Other items are represented as follows.

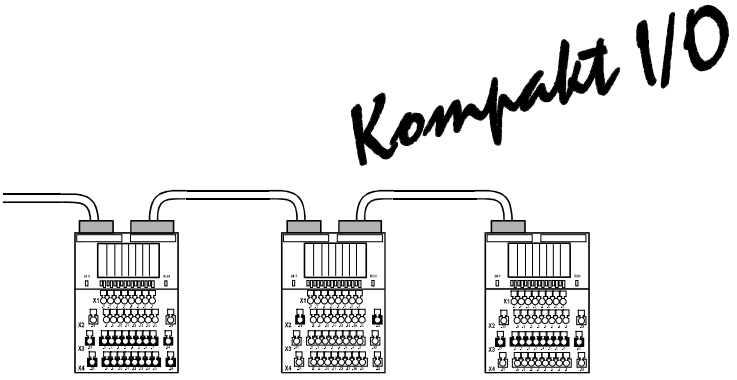
Item	Example
File names	MANUAL.DOC
Menus / Menu items	*Insert / Picture / From file*
Paths / directories	*C:\Windows\System*
Hyperlinks	*www.saia-burgess.com*
Program listings	MaxTsdr_9.6 = 60 MaxTsdr_93.75 = 60
Keys	<Esc> <Enter> (press first key and then next key) <Ctrl+Alt+Del> (press all keys at the same time)

Contents

1 Overview

PCD0 RIO for PROFIBUS-DP

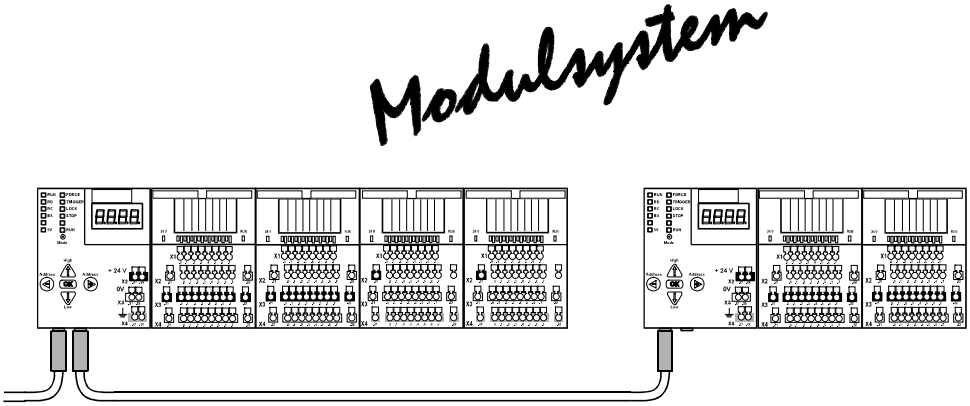
Compact RIO



Compact I/Os are particularly suitable for applications with widely distributed bus nodes with up to 16 I/O points.

Real decentralisation through compact size, fasts data transmission and integrated 4-wire system.

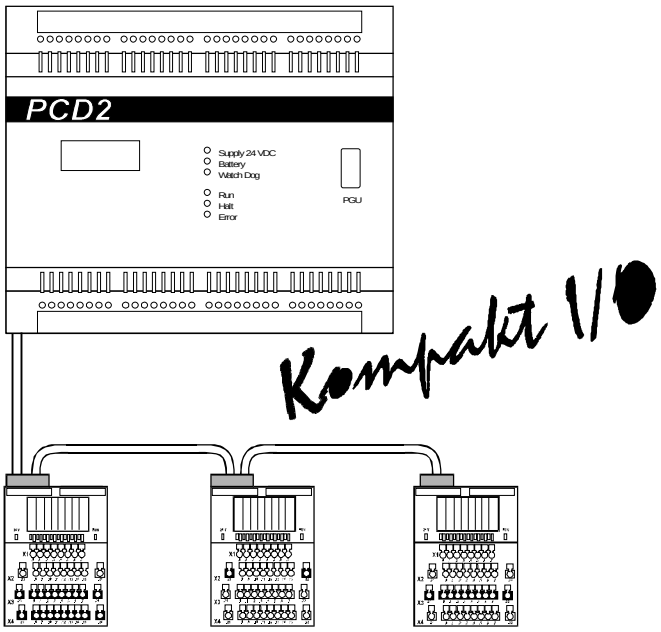
Modular system



The modular design makes it possible to realize bus nodes with widely differing I/O specifications.

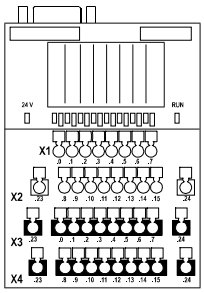
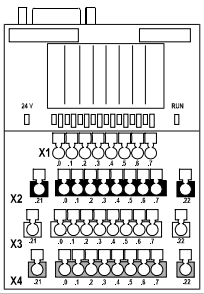
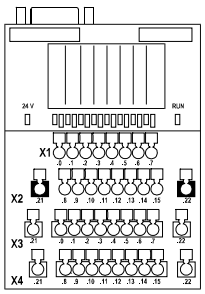
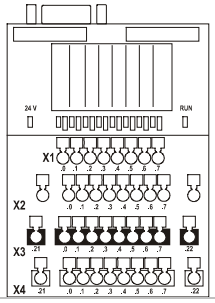
Up to 8 modules can be operated per bus coupler, allowing extension up to 128 I/O points.
Two different Profibus DP bus couplers are at the disposal for the user: The comfortable bus coupler (BC) permits extensive diagnosis and service functions or the inexpensive Economic coupler (EC).
The bus coupler BC of the modular system provides the operator with valuable support in diagnosis and commissioning of plant and machine sections, before connection to the field bus and PLC has been realized.
17 different digital, analogue, counting or positioning modules can be connected at will to both bus couplers.

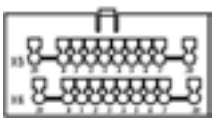
1.1 Compact RIO



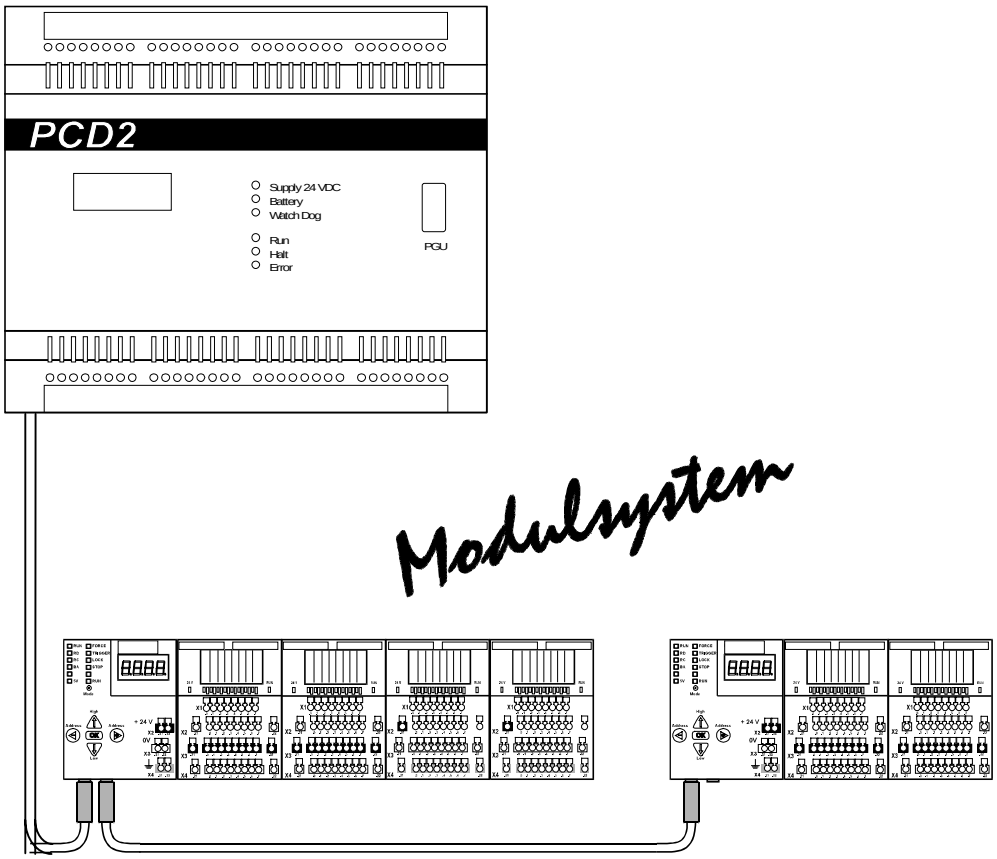
PCD0 Compact I/O on a PCD2 with Profibus-DP card.

1.1.1 Available compact RIO's

Digital module			
	RIO 16 I DP 16 24V DC inputs Two-wire connection system Part no. PCD0.G120		RIO 8 I/O DP 8 combination I/Os All combination I/Os can be used individually as 24V DC inputs or 1A outputs. Four-wire connection system Part no. PCD0.G110
	RIO 16 O DP 16 1A outputs Two-wire connection system Part no. PCD0.G130		RIO 8 I 8 I/O DP 8 24V DC inputs 8 combination I/Os All combination I/Os can be used individually as 24V DC inputs or 1A outputs. Two-wire connection system Part no. PCD0.G140

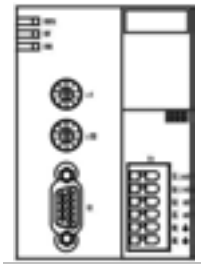
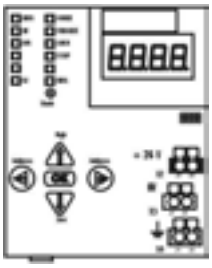
Potential distributor (terminal expansion)	
	RIO KE 16 2 rows with 10 Terminals Only for module with location notch for voltage bus. Part no. PCD0.K300

1.2 Modular System

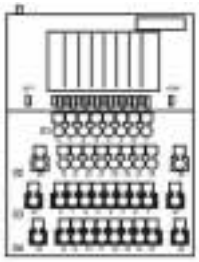
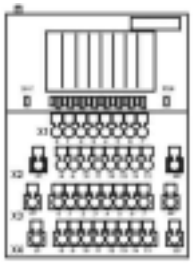
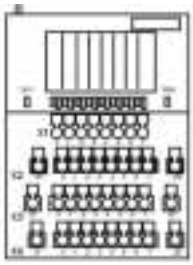
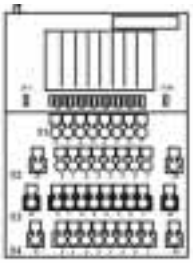
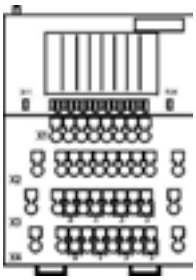
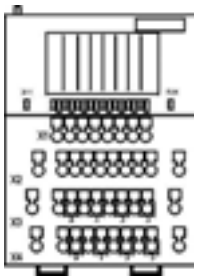
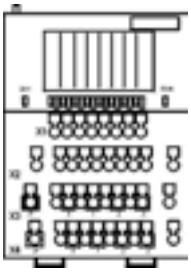


PCD0 modular system on a PCD2 with Profibus-DP card

1.2.1 Available Bus coupler for the modular system

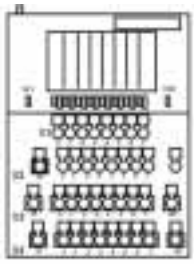
PROFIBUS-DP	
	RIO EC DP Part no. PCD0.T780
	RIO BC DP Part no. PCD0.T770

1.2.2 Available I/O modules for the modular system

Digital modules			
	RIO 16 I 16 inputs DC 24 V Two-wire connection system Part no. PCD0.E120		RIO 16 O 16 outputs 1A Two-wire connection system Part no. PCD0.A410
	RIO 8 I/O 8 combination I/Os All combination I/Os can be used individually as DC 24 V inputs or 1A outputs. Four-wire connection system Part no. PCD0.B110		RIO 8 I 8 I/O 8 24V DC inputs 8 combination I/Os All combination I/Os can be used individually as DC 24 V inputs or 1A outputs. Two-wire connection system Part no. PCD0.B120
	RIO 4 I 120 VAC 4 inputs AC 120 V Part no. PCD0.E520		RIO 4 I 230 VAC 4 inputs AC 230 V Part no. PCD0.E500
	RIO 4 O R 4 outputs relay Part no. PCD0.A200		

Analog modules

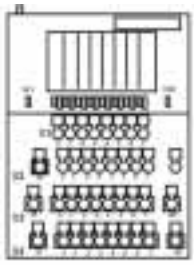
Voltage ±10V



RIO 4AI ±10 V

4 analog inputs
Resolution 12 bits

Part no. PCD0.W510

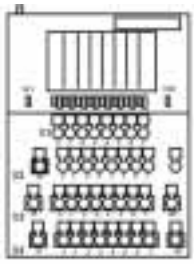


RIO 4AI/4AO ±10 V

4 analog inputs
4 analog outputs
Resolution 12 bits

Part no. PCD0.W710

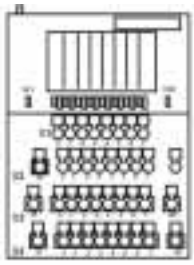
Current 20mA



RIO 4AI 20mA

4 analog inputs
Resolution 12 bits

Part no. PCD0.W520

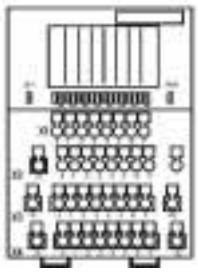


RIO 4AI/4AO 20mA

4 analog inputs
4 analog outputs
Resolution 12 bits

Part no. PCD0.W720

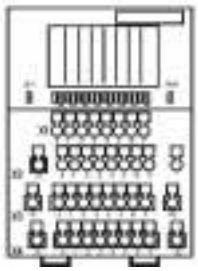
Current 4...20mA



RIO 4AI 4-20mA

4 analog inputs
Resolution 12 bits

Part no. PCD0.W524

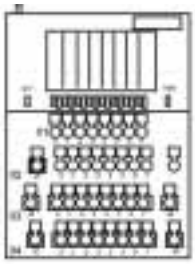


RIO 4AI/4AO 4-20mA

4 analog inputs
4 analog outputs
Resolution 12 bits

Part no. PCD0.W724

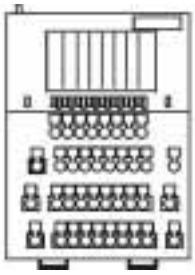
Temperature modules



RIO T10-10

4 inputs for measuring the temperature with Pt100/Pt1000

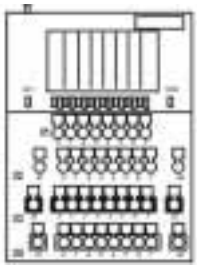
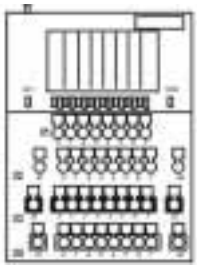
Part no. PCD0.W540

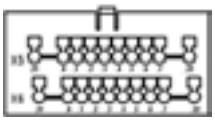


RIO T20-10

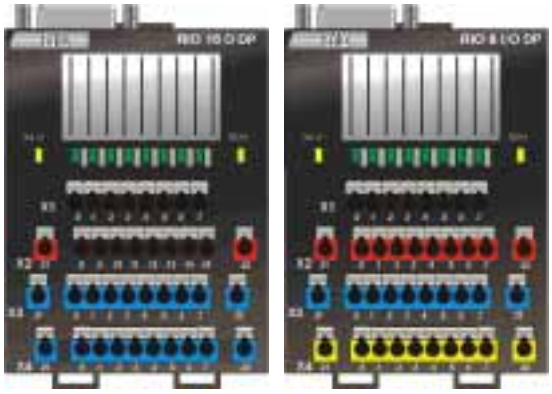
4 inputs for measuring the temperature with thermocouples

Part no. PCD0.W580

Counter module		Positioning module	
	RIO C24-10 4 counters 16 bits or 2 counters 32 bits Part no. PCD0.H110		RIO P24-10 Positioning of two axes Part no. PCD0.H300

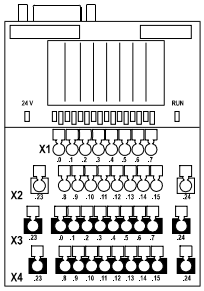
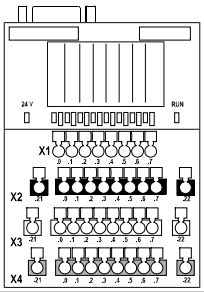
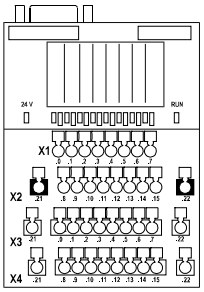
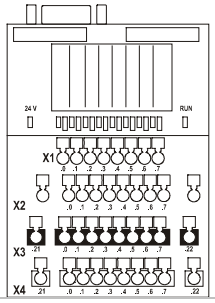
Potential distributor (terminal expansion)	
	RIO KE 16 2 distributors with 10 terminals each Only suitable for modules with clips. Part no. PCD0.K300

2 Compact RIO's

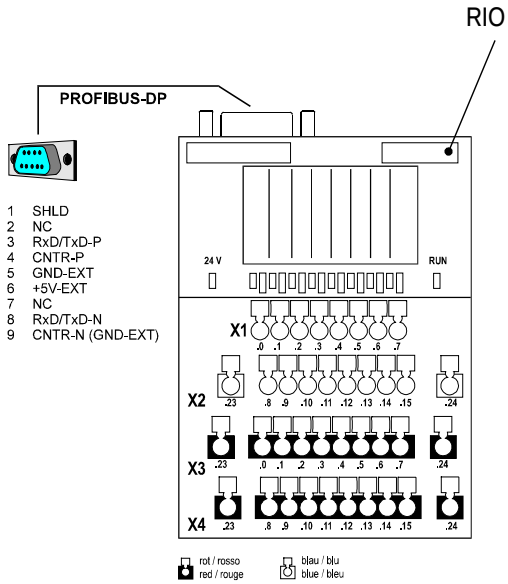


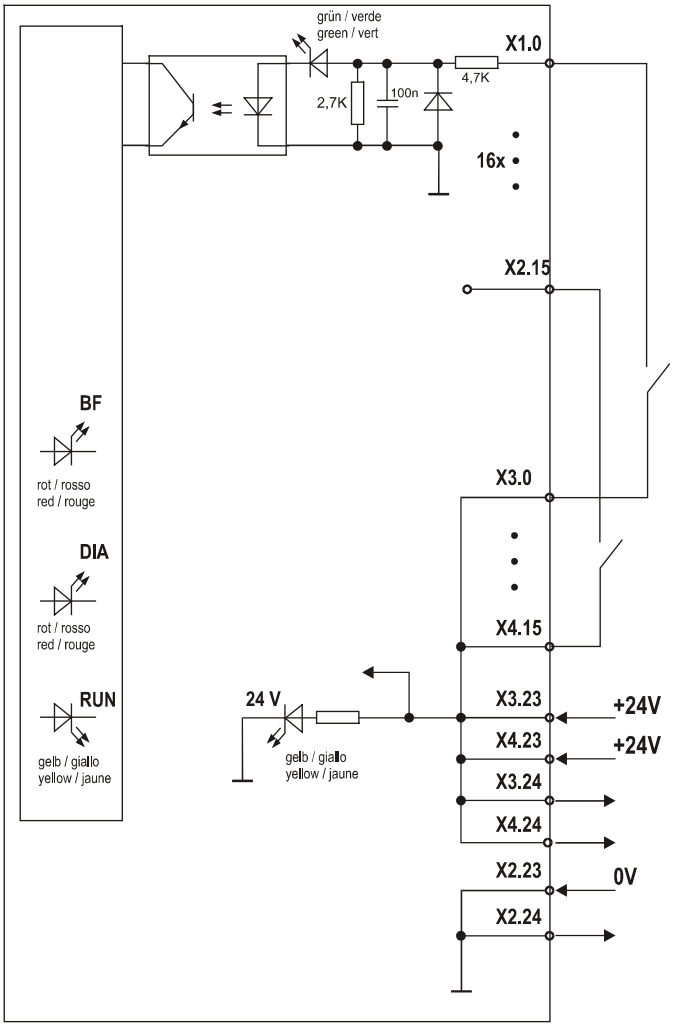
The compact RIO has a integrated PROFIBUS-DP connection and contain a fixed number of 8 or 16 digital in- or outputs which not can be extended.
Compact RIO's are particularly suitable for applications with widely distributed bus nodes with up to 16 I/O points.

2.1 Overview compact RIO's

Digital module			
	RIO 16 I DP 16 24V DC inputs Two-wire connection system Part no. PCD0.G120		RIO 8 I/O DP 8 combination I/Os All combination I/Os can be used individually as 24V DC inputs or 1A outputs. Four-wire connection system Part no. PCD0.G110
	RIO 16 O DP 16 1A outputs Two-wire connection system Part no. PCD0.G130		RIO 8 I 8 I/O DP 8 24V DC inputs 8 combination I/Os All combination I/Os can be used individually as 24V DC inputs or 1A outputs. Two-wire connection system Part no. PCD0.G140

2.2 Compact I/O RIO 16 I DP





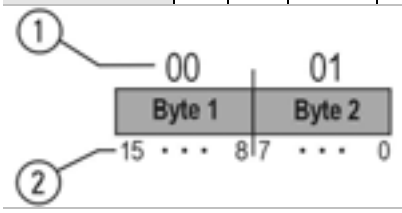
- 16 24V DC inputs
- Two-wire connection system
- Bus connection: PROFIBUS-DP subminiature, 9-pin, jack contact

RIO 16I DP	
Part no.	PCD0.G120
Bus connection	PROFIBUS-DP, subminiature, 9-pin, jack contact
DP ID	1634 hex
GSD file	Saia1634.gsd
Power supply	24V DC ± 20% max. 5% residual ripple
Inputs	
Number of inputs	16
Switching level	H level +15V to +30V L level -30V to +5V
Input current	min. H level (+15V), I >= 2.5mA max. L level (+5V), I <= 0.7mA Typical (+24V), I = 4.5mA
Isolation from internal bus	Yes, each channel separately via opto-electronic couplers
Signal delay	2ms typical (hardware) See also Response Times, page 177.

See also Technical Data, page 162.

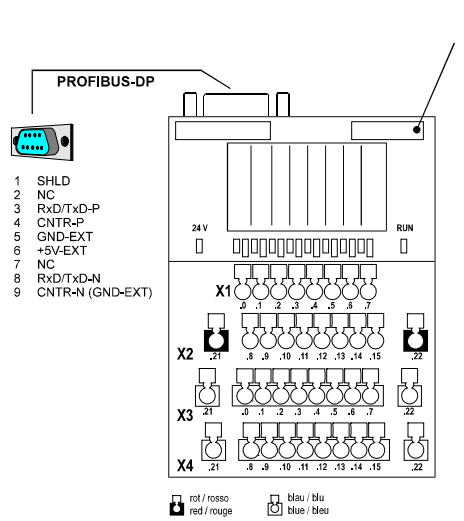
2.2.1 Data Width and Addressing RIO 16 I DP

RIO 16 I DP							
	Byte Input						Byte Output
Data width	Byte 1			Byte 2			
	Bit	SAIA Flag	Terminal	Bit	SAIA Flag	Terminal	
	8	0	X2.8	0	8	X1.0	
	9	1	X2.9	1	9	X1.1	
	10	2	X2.10	2	10	X1.2	
	11	3	X2.11	3	11	X1.3	
	12	4	X2.12	4	12	X1.4	
	13	5	X2.13	5	13	X1.5	
	14	6	X2.14	6	14	X1.6	
	15	7	X2.15	7	15	X1.7	

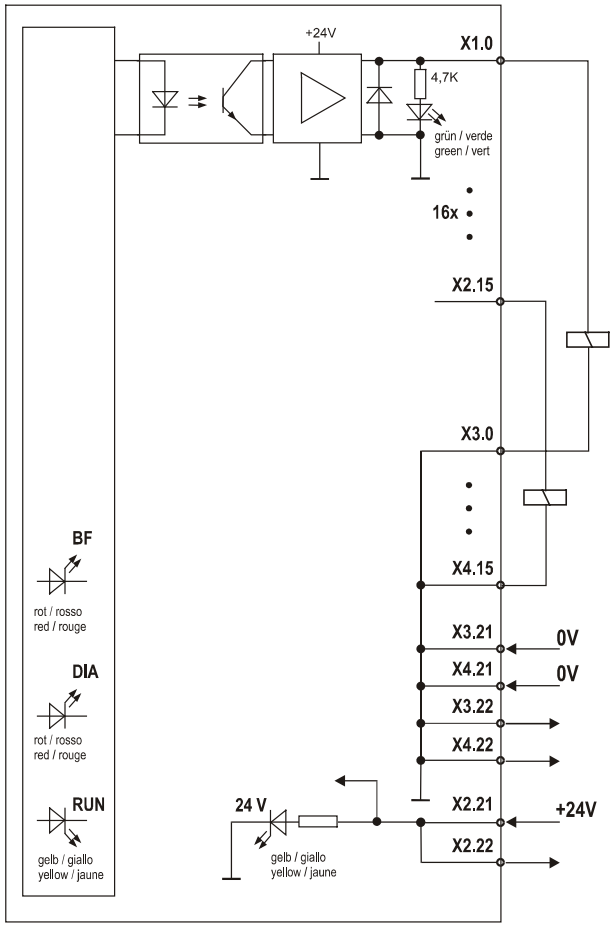


1 Byte-Startaddress
2 Bit-Numbering

2.3 Compact I/O RIO 16 O DP



- 16 1A outputs
- Two-wire connection system
- Bus connection: PROFIBUS-DP subminiature, 9-pin, jack contact

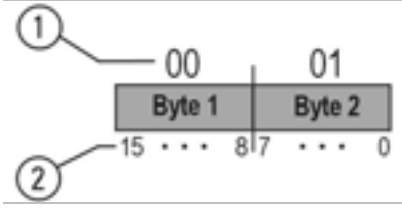


RIO 16 O DP	
Part no.	PCD0.G130
Bus connection	PROFIBUS-DP, subminiature, 9-pin, jack contact
DP ID	1633 hex
GSD file	Saia1633.gsd
Power supply	24V DC ± 20% max. 5% residual ripple
Outputs	
Number of outputs	16
Output current per output max.	1A overload and short-circuit proof
Parallel operation	Possible in groups (4 groups: 0-3,4-7,8-11,12-15)
Total current per group	2A (4 groups: 0-3,4-7,8-11,12-15)
Total current for whole module max.	4A
Switching level	H level = power supply-0.5V (I_L < 1A) L level <= 1V (I_L = 0A)
Isolation from internal bus	Yes, each channel separately via opto-electronic couplers
Simultaneity	100% @ max. 0.25A per channel
Free-wheeling diode	Integrated
Signal delay	<100µs (hardware) See also Response Times, page 177.

See also Technical Data, page 162.

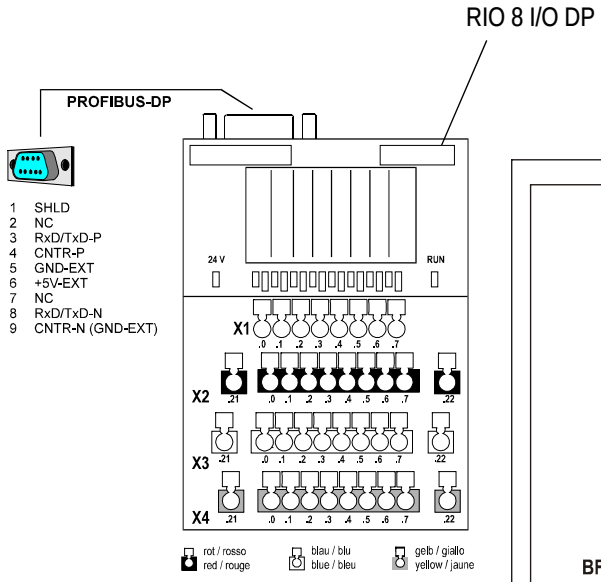
2.3.1 Data Width and Addressing RIO 16 O DP

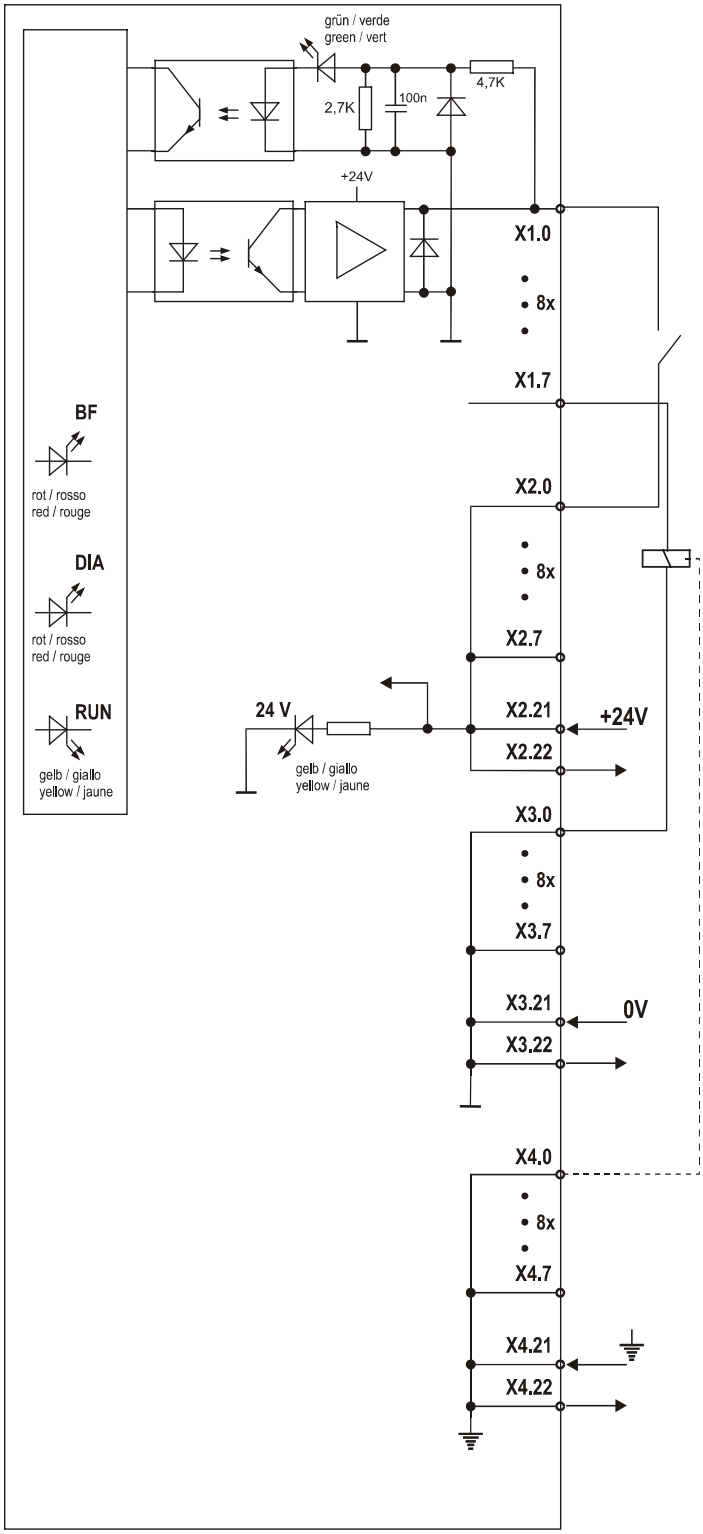
RIO 16 O DP								
	Byte Input	Byte Output						
Data width		Byte 1			Byte 2			
		Bit	SAIA Flag	Terminal	Bit	SAIA Flag	Terminal	
		8	0	X2.8	0	8	X1.0	
		9	1	X2.9	1	9	X1.1	
		10	2	X2.10	2	10	X1.2	
		11	3	X2.11	3	11	X1.3	
		12	4	X2.12	4	12	X1.4	
		13	5	X2.13	5	13	X1.5	
		14	6	X2.14	6	14	X1.6	
		15	7	X2.15	7	15	X1.7	



1 Byte-Startaddress
2 Bit-Numbering

2.4 Compact I/O RIO 8 I/O DP





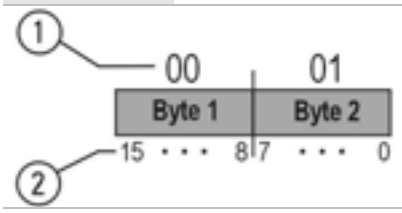
- 8 combination I/Os
  Can be used individually as 24V DC inputs or 1A outputs.
- Four-wire connection system
- Bus connection: PROFIBUS-DP subminiature, 9-pin, jack contact

RIO 8 I/O DP	
Part no.	PCD0.G110
Bus connection	PROFIBUS-DP
DP ID	1635 hex
GSD file	Saia1635.gsd
Number of inputs/outputs	8 combination I/Os which can be used individually as input or output
Power supply	24V DC ± 20% max. 5% residual ripple
Inputs	
Switching level	H level +15V to +30V L level -30V to +5V
Input current	min. H level (+15V), I >= 3.6mA max. L level (+5V), I <= 1.2mA Typical (+24V), I = 6.1mA
Isolation from internal bus	Yes, each channel separately via opto-electronic couplers
Signal delay	2ms typical (hardware) See also Response Times, page 177.
Outputs	
Output current per output max.	1A, overload and short-circuit proof, parallel operation possible in groups (2 groups: 0-3,4-7)
Total current for whole module max.	4A
Switching level	H level = power supply-0.5V (I_L < 1A) L level <= 1V (I_L = 0A)
Isolation from internal bus	Yes, each channel separately via opto-electronic couplers
Simultaneity	100% @ max. 0.5A per channel
Free-wheeling diode	Integrated
Signal delay	<100µs (hardware) See also Response Times, page 177.

See also Technical Data, page 162.

2.4.1 Data Width and Addressing RIO 8 I/O DP

RIO 8 I/O DP						
	Byte Input			Byte Output		
Data width	Byte 1	Byte 2		Byte 1	Byte 2	
	Not used	Bit	Terminal	Not used	Bit	Terminal
		0	X1.0		0	X1.0
		1	X1.1		1	X1.1
		2	X1.2		2	X1.2
		3	X1.3		3	X1.3
		4	X1.4		4	X1.4
		5	X1.5		5	X1.5
		6	X1.6		6	X1.6
		7	X1.7		7	X1.7

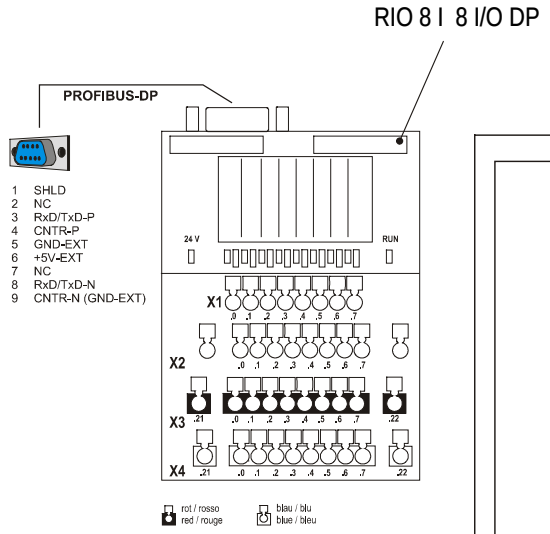


1 Byte-Startaddress
2 Bit-Numbering

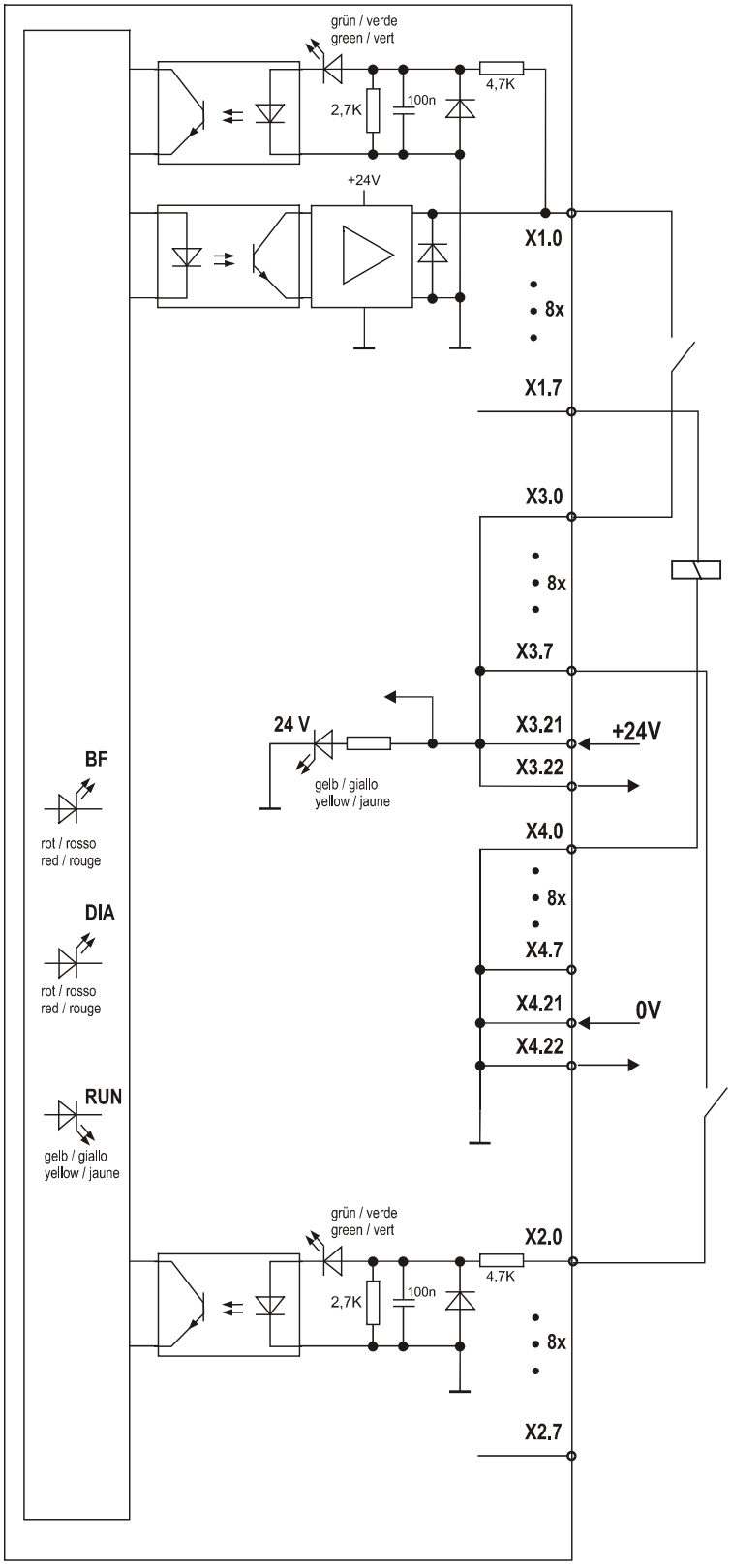
Each of the 8 channels can be used either as an input or an output. I.e.: for a process map an input address space and an output address space are reserved. Ensure that a used input channel (e.g. initiator) is not used as an output channel at the same time, however, an output can be inverted to an input. This way the PLC can monitor the switching function.

When using modules with digital combination channels note that you cannot connect a 24V supply to a combination channel without connecting the module to the power supply.
If you do, the power supply will be fed back via the output circuit of the module. This may result in a malfunction or destruction of the output circuit.

2.5 Compact I/O RIO 8 I 8 I/O DP



- 8 24V DC inputs
- 8 combination I/Os
  Can be used individually as
  24V DC inputs or 1A outputs.
- Two-wire connection system
- Bus connection: PROFIBUS-DP



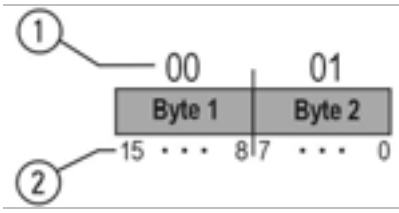
RIO 8I 8I/O DP	
Part no.	PCD0.G140
Bus connection	PROFIBUS-DP
DP ID	1632 hex
GSD file	Saia1632.gsd
Number of inputs/outputs	8 inputs and 8 combination I/Os which can be used individually as input or output
Power supply	24V DC ± 20% max. 5% residual ripple
Inputs	
Switching level	H level +15V to +30V L level -30V to +5V
Input current	min. H level (+15V), I >= 2.5mA/3.6mA* max. L level (+5V), I <= 0.7mA/1.2mA* Typical (+24V), I = 4.5mA/6.1mA* *for combination I/O
Isolation from internal bus	Yes, each channel separately via opto-electronic couplers
Signal delay	2ms typical (hardware) See also Response Times, page 177.
Outputs	
Output current per output max.	1A Overload and short-circuit proof, parallel operation possible in groups (2 groups: 0-3,4-7)
Total current for whole module max.	4A
Switching level	H level = power supply-0.5V L level <= 1V
Isolation from internal bus	Yes, each channel separately via opto-electronic couplers
Simultaneity	100% @ max. 0.5A per channel
Free-wheeling diode	Integrated
Signal delay	<100µs (hardware) See also Response Times, page 177.

See also Technical Data, page 162.

2.5.1 Data Width and Addressing RIO 8 I 8 I/O DP

RIO 8 I 8 I/O DP												
	Byte Inputs						Byte Outputs					
Data width	Byte 1			Byte 2			Byte 1			Byte 2		
	Bit	SAIA Flag	Terminal	Bit	SAIA Flag	Terminal	Not used			Bit	SAIA Flag	Terminal
	8	0	X2.0	0	8	X1.0				0	8	X1.0
	9	1	X2.1	1	9	X1.1				1	9	X1.1
	10	2	X2.2	2	10	X1.2				2	10	X1.2
	11	3	X2.3	3	11	X1.3				3	11	X1.3
	12	4	X2.4	4	12	X1.4				4	12	X1.4
	13	5	X2.5	5	13	X1.5				5	13	X1.5
	14	6	X2.6	6	14	X1.6				6	14	X1.6
	15	7	X2.7	7	15	X1.7				7	15	X1.7

Terminal X2 are for the fixed Inputs
Terminal X1 can be used for the combination I/O's

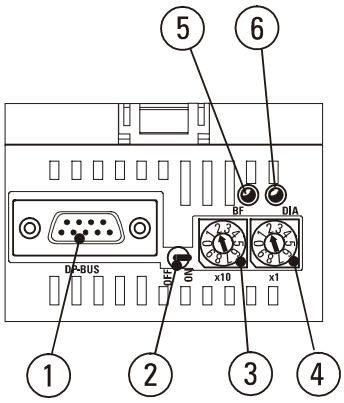


1 Byte-Startaddress
2 Bit-Numbering

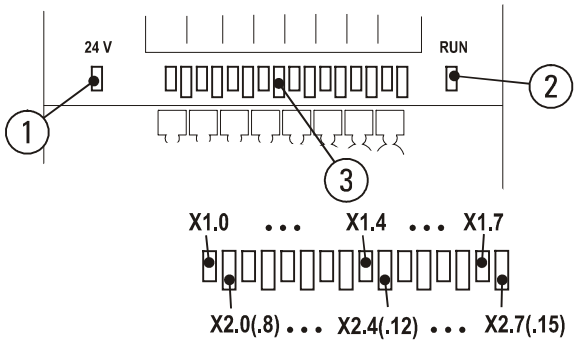
Each of the 8 combination I/O channels can be used either as an input or an output. I.e.: for a process map an input address space and an output address space are reserved in the bus coupler. Ensure that a used input channel (e.g. initiator) is not used as an output channel at the same time, however, an output can be inverted to an input. This way the PLC can monitor the switching function.

When using modules with digital combination channels note that you cannot connect a 24V supply to a combination channel without connecting the module to the power supply.
If you do, the power supply will be fed back via the output circuit of the module. This may result in a malfunction or destruction of the output circuit.

2.6 Control, Connection and Display Elements

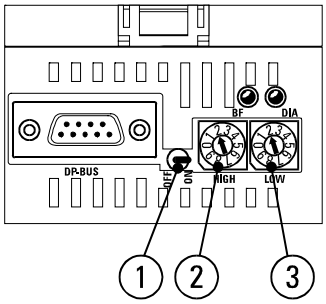


No.	Element	Meaning
1	Subminiature, 9-pin, jack contact	PROFIBUS-DP field bus interface
2	OFF/ON toggle switch	For logical disconnection of station, operating position = ON
3	Rotary switch	Station address tens position
4	Rotary switch	Station address units position
5	BF LED red	No bus connection (bus fail)
6	DIA LED red	Diagnosis message executed (on digital outputs message for short-circuit)



No.	LED	Colour	Meaning
1	24V	yellow	24V DC power supply is connected
2	RUN	yellow	Station is logically switched on
3	Channel	green	Control state at connecting terminal ON = High, OFF = Low

2.7 Setting the PROFIBUS-DP Slave Address



1. OFF/ON toggle switch for logical disconnection of station
2. Rotary switch for station address tens position
3. Rotary switch for station address units position

You can set station addresses from 00 to 99.

Procedure

- Set the station address on the rotary switches
- Switch toggle switch OFF and ON
  or
  switch power supply OFF and ON

3 Modular system

Bus couplers for PROFIBUS-DP

The RIO module system uses bus couplers to establish the connection between the I/O modules of a bus node and the field bus.

EC economy bus coupler Economy version of the BC bus coupler	BC bus coupler
	

	EC	BC
Diagnosis LEDs	+	++
Diagnosis functions	+	++
Keyboard / display for on-site service and diagnosis		++
Field bus port	+	+

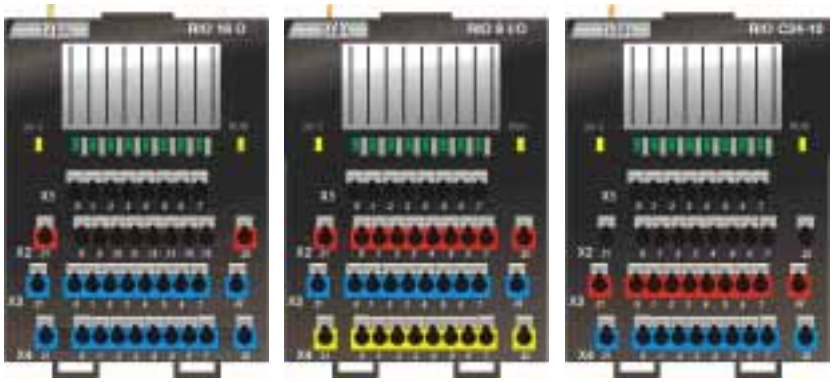
Features of the EC economy bus coupler and the BC bus coupler.

The EC economy bus coupler (EC=Economy) is the base version of the RIO bus coupler. The bus coupler provides ports for the field bus cable, the power supply and LED displays for diagnosing the operating status of the bus node.

In addition to these features the BC bus coupler provides extended service and diagnosis capabilities which can be used on-site via the integrated keypad and the four-digit display.
The BC bus coupler provides the operator with valuable help when diagnosing and commissioning plant parts and machine assemblies before they are connected to the field bus and the PLC.

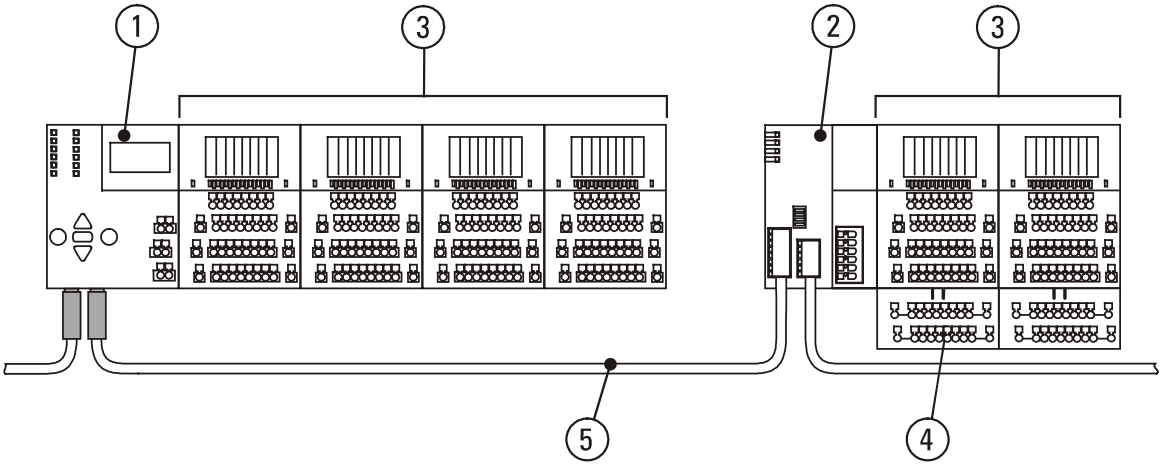
The bus coupler are interchangeable. Only if bus couplers are used for PROFIBUS-DP the master project must be changed using the respective device root file (GSD).

I/O modules for the modular system



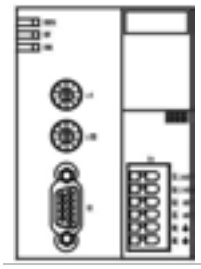
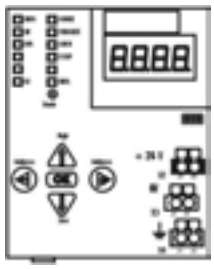
Expansion modules are used for the design of bus nodes.
A wide selection of expansion modules is available which allows an efficient design of bus nodes.

Bus node configuration

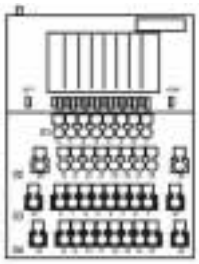
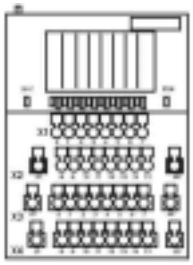
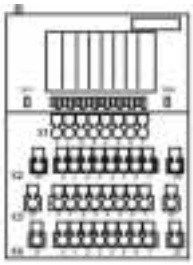
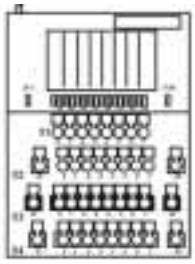
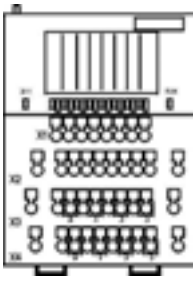
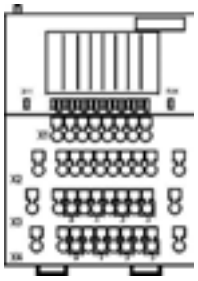
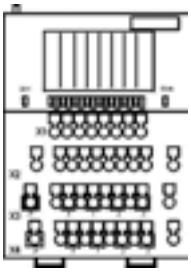


1	Bus couplers You can use either bus couplers (BC) or economy bus couplers (EC) depending on your requirements.
2	Economy bus couplers
3	Expansion modules You can use up to 8 expansion modules with different features on each bus coupler.
4	Terminal expansion for modules with more than 8 I/O channels
5	Field bus cable

3.1 Overview of bus coupler versions

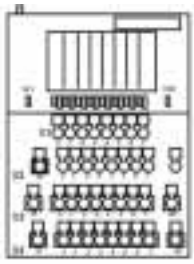
PROFIBUS-DP	
	RIO EC DP Order no.: PCD0.T780
	RIO BC DP Order no.: PCD0.T770

3.2 Overview I/O modules for the modular system

Digital modules			
	RIO 16 I 16 inputs DC 24 V Two-wire connection system Part no. PCD0.E120		RIO 16 O 16 outputs 1A Two-wire connection system Part no. PCD0.A410
	RIO 8 I/O 8 combination I/Os All combination I/Os can be used individually as DC 24 V inputs or 1A outputs. Four-wire connection system Part no. PCD0.B110		RIO 8 I 8 I/O 8 24V DC inputs 8 combination I/Os All combination I/Os can be used individually as DC 24 V inputs or 1A outputs. Two-wire connection system Part no. PCD0.B120
	RIO 4 I 120 VAC 4 inputs AC 120 V Part no. PCD0.E520		RIO 4 I 230 VAC 4 inputs AC 230 V Part no. PCD0.E500
	RIO 4 O R 4 outputs relay Part no. PCD0.A200		

Analog modules

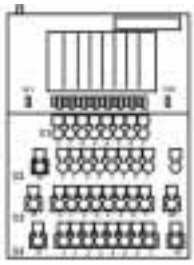
Voltage ±10V



RIO 4AI ±10 V

4 analog inputs
Resolution 12 bits

Part no. PCD0.W510

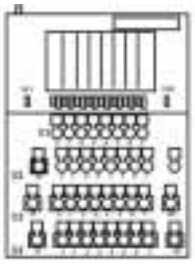


RIO 4AI/4AO ±10 V

4 analog inputs
4 analog outputs
Resolution 12 bits

Part no. PCD0.W710

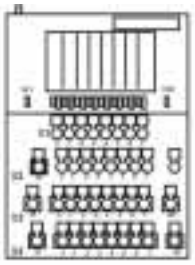
Current 20mA



RIO 4AI 20mA

4 analog inputs
Resolution 12 bits

Part no. PCD0.W520

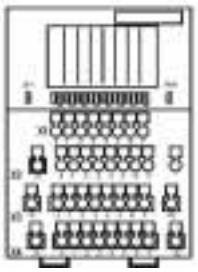


RIO 4AI/4AO 20mA

4 analog inputs
4 analog outputs
Resolution 12 bits

Part no. PCD0.W720

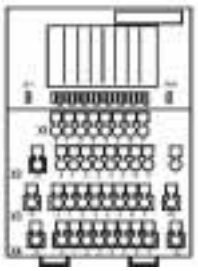
Current 4...20mA



RIO 4AI 4-20mA

4 analog inputs
Resolution 12 bits

Part no. PCD0.W524

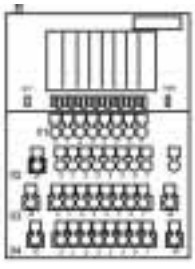


RIO 4AI/4AO 4-20mA

4 analog inputs
4 analog outputs
Resolution 12 bits

Part no. PCD0.W724

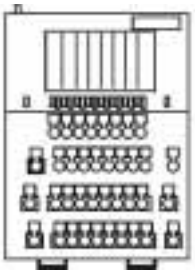
Temperature modules



RIO T10-10

4 inputs for measuring the temperature with Pt100/Pt1000

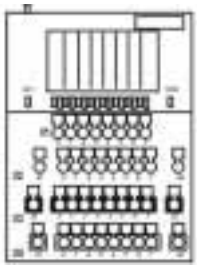
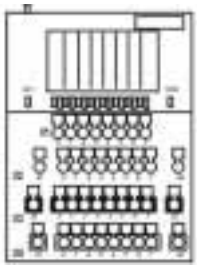
Part no. PCD0.W540

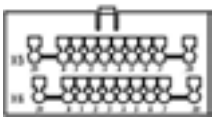


RIO T20-10

4 inputs for measuring the temperature with thermocouples

Part no. PCD0.W580

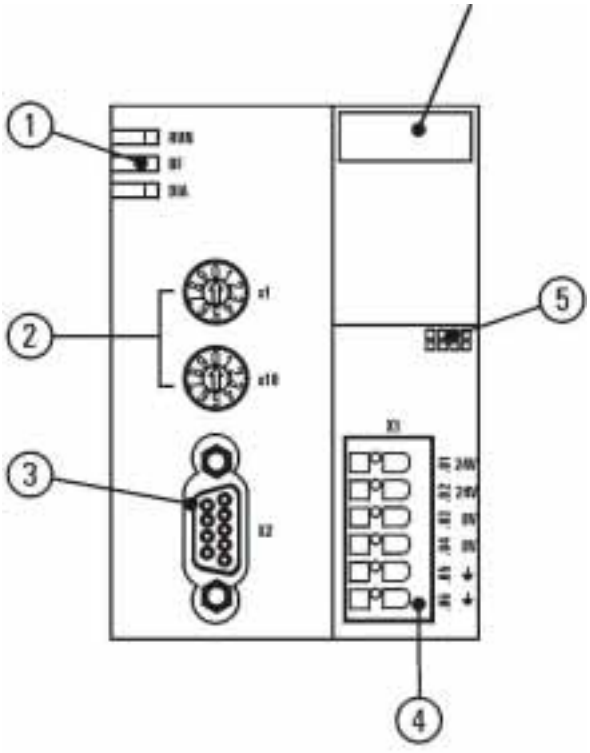
Counter module		Positioning module	
	RIO C24-10 4 counters 16 bits or 2 counters 32 bits Part no. PCD0.H110		RIO P24-10 Positioning of two axes Part no. PCD0.H300

Potential distributor (terminal expansion)	
	RIO KE 16 2 distributors with 10 terminals each Only suitable for modules with clips. Part no. PCD0.K300

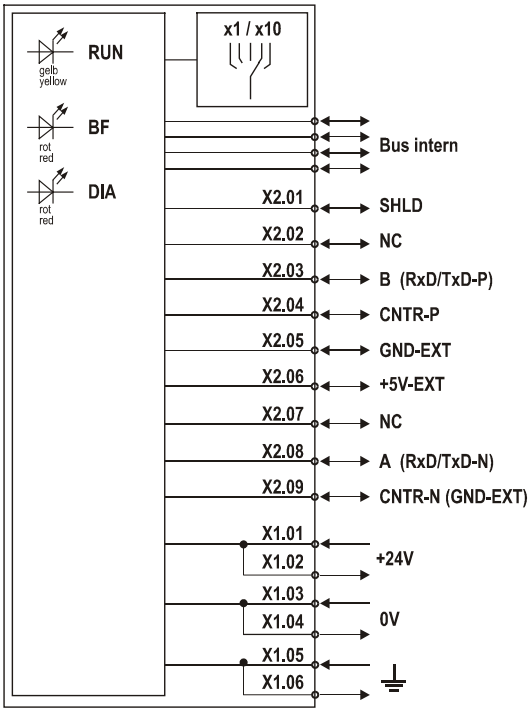
4 Technical data's and circuit diagrams for the modular system

4.1 RIO EC DP bus coupler

RIO EC DP



Block diagram

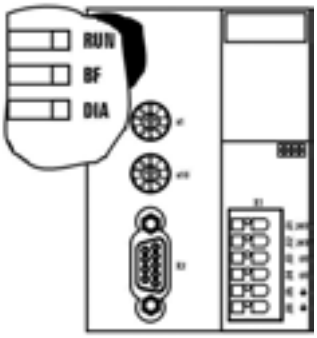


1 LED displays
2 Dial to set slave address
3 Profibus-DP PROFIBUS-DP Bus port (subminiature, 9-pin, female connector) X2
4 Connections for power supply and forwarding X1
5 Gaps to fit the item designation

Specifications RIO EC DP	
Order no.	PCD0.T780
Bus port	PROFIBUS-DP (subminiature, 9-pin, female connector)
DP ID	055A hex
GSD File	Saia055A.gsg / Saia055A.gse
Power supply	24V DC ± 20%
Residual ripple (power supply)	Max. 5%
Power consumption	See **Bus node power consumption** on page 125
Number of attachable expansion modules	8 See Process data width and address configuration on page 173 and Bus node power consumption on page 125

See also **Technical data** from page 162

4.1.1 LED displays on the EC bus coupler



LED	Color/Status	Meaning
RUN	Green	The bus coupler processor is running.
	Red/flashing	An error has occurred. The number of flashing pulses is the flashing code of the **Error messages** see page 166.
BF	Red	No bus connection (bus fail) Field bus cable break or the master does not operate the bus (any more).
DIA	Red	Diagnosis message The bus coupler has sent a PROFIBUS-DP diagnosis message to the master.

4.1.2 Dial for setting the PROFIBUS-DP slave address on the EC bus coupler

	One-digit dial
	Ten-digit dial

Slave addresses can be set from 0 to 99.

The selected address becomes active when the power supply of the bus coupler is switched on.

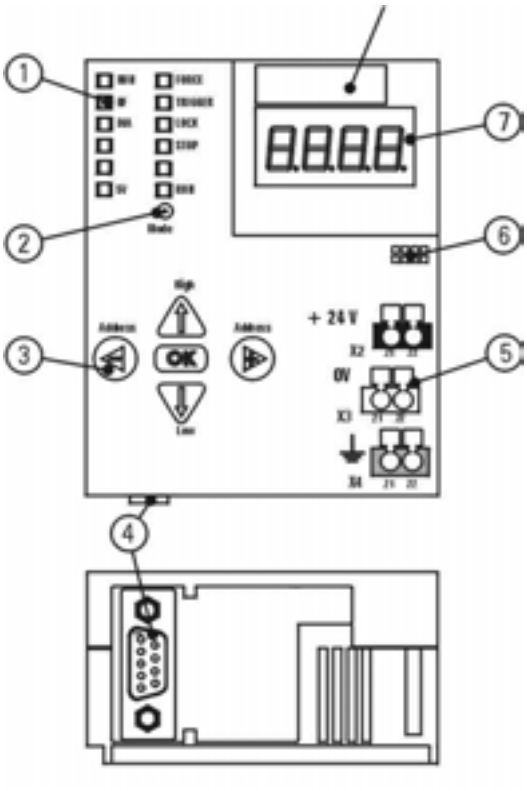
4.1.3 PROFIBUS-DP Bus port on the EC bus coupler

Subminiature, 9-pin, female connector

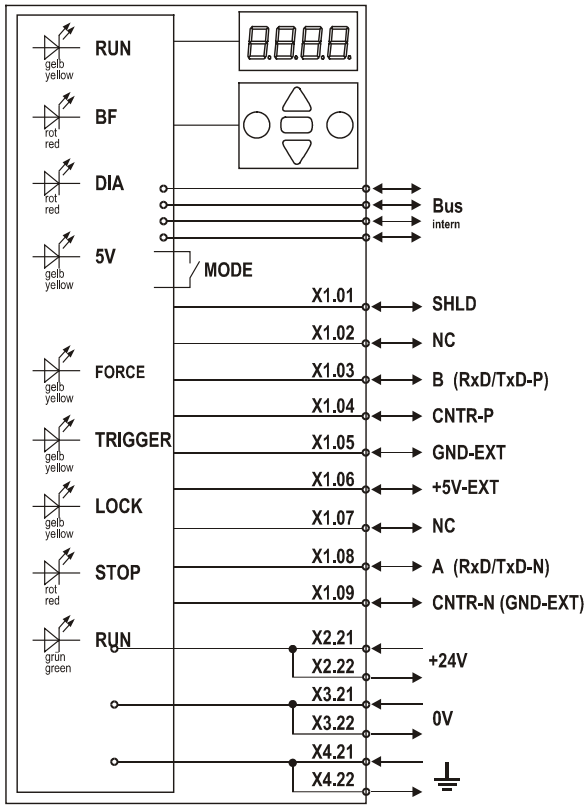
1	SHLD
2	NC
3	B = RxD/TxD-P
4	CNTR-P
5	GND-EXT
6	+5V-EXT
7	NC
8	A = RxD/TxD-N
9	CNTR-N (GND-EXT)

4.2 RIO BC DP bus coupler

RIO BC DP



Block diagram



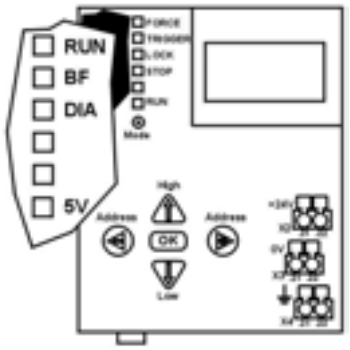
1 LED displays
2 Key (Mode) for the Setting operating modes
3 Keypad
4 PROFIBUS-DP PROFIBUS-DP Bus port (subminiature, 9-pin, female connector)
5 Connections for power supply and forwarding
6 Gaps to fit the item designation
7 Numerical display

RIO BC DP Specifications	
Order no.	363 155 48
Bus port	PROFIBUS-DP (subminiature, 9-pin, female connector)
DP ID	1631 hex
GSD File	Saia1631.gsg / Saia1631.gse
Power supply	24V DC ± 20%
Residual ripple (power supply)	Max. 5%
Power consumption	See **Bus node power consumption** on page 125
Number of attachable expansion modules	8 See Process data width and address configuration on page 173 and Bus node power consumption on page 125

See also **Technical data** from page 162

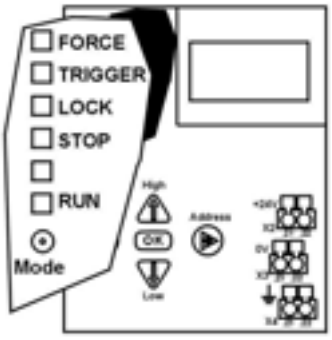
4.2.1 LED displays on the BC bus coupler

Bus-specific displays



LED	Color	Meaning
RUN	Yellow	The bus coupler processor is running.
BF	Red	No bus connection (bus fail) Field bus cable break or the master does not operate the bus (any more).
DIA	Red	Diagnosis message The bus coupler has sent a PROFIBUS-DP diagnosis message to the master.
5V	Yellow	Internal 5V power supply operates correctly.

Operating mode display



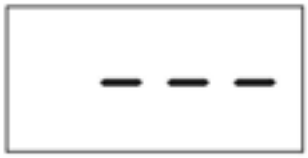
See Operating modes of the BC bus coupler from page 129

4.2.2 Numerical display on the BC bus coupler

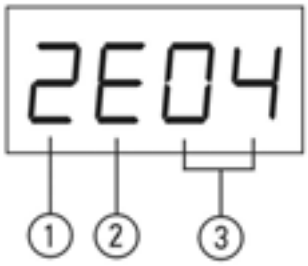
Display of the active operating mode

RUN mode

RUN mode can also include information on the TRIGGER and LOCK modes (for details see descriptions from page 129).



STOP mode (see page 138)



Display, TRIGGER, FORCE, LOCK modes show the selected channel.

1. Hexadecimal number of the expansion module
2. Input (E) or output (A)
3. Channel # (decimal)

Example 2E04: module 2, input, channel 04

During power on the actual firmware version is shown quickly

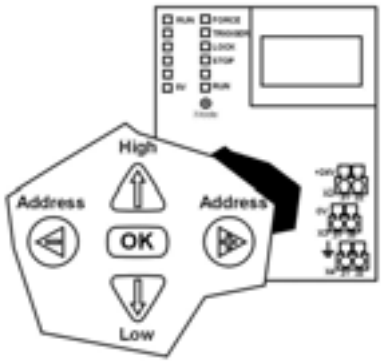
Display of error messages

An error message is displayed if a fault occurs.

Example E004: Internal data transfer between bus coupler and module interrupted

See Error messages on the bus coupler display on page 166.

4.2.3 Keypad of the BC bus coupler



Each key on the keypad has several functions. The function of each key is described in the corresponding section of the manual.

4.2.4 Setting the PROFIBUS-DP slave address for the BC bus coupler

The address can be set with **Service function 12** (see page 142) or as follows:

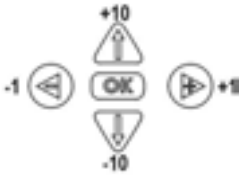
Select STOP mode, then press both Address keys simultaneously.

The selected slave address is displayed.

If you do not want to change the address press OK.

Use the keypad to enter a new slave address. You can set addresses from 3 to 126.

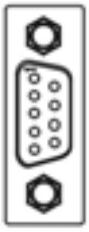
The keys have the following functions:



Pressing the OK key stores the selected slave address in the bus coupler.

The new slave address becomes active when the power supply is switched off and then switched on again.

4.2.5 PROFIBUS-DP Bus port on the BC bus coupler



Subminiature, 9-pin, female connector

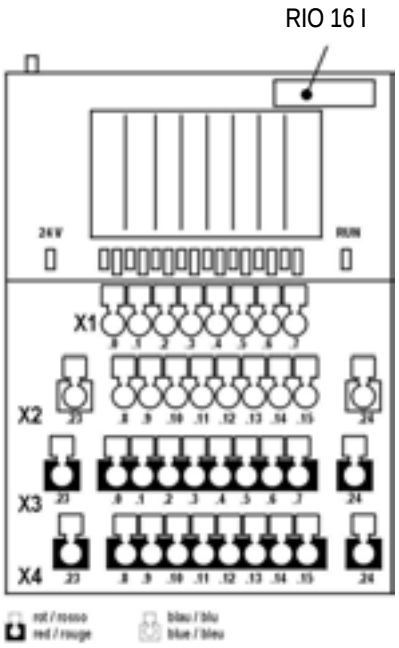
1	SHLD
2	NC
3	B = RxD/TxD-P
4	CNTR-P
5	GND-EXT
6	+5V-EXT
7	NC
8	A = RxD/TxD-N
9	CNTR-N (GND-EXT)

4.3 Compatibility of the EC economy bus coupler and the BC bus coupler

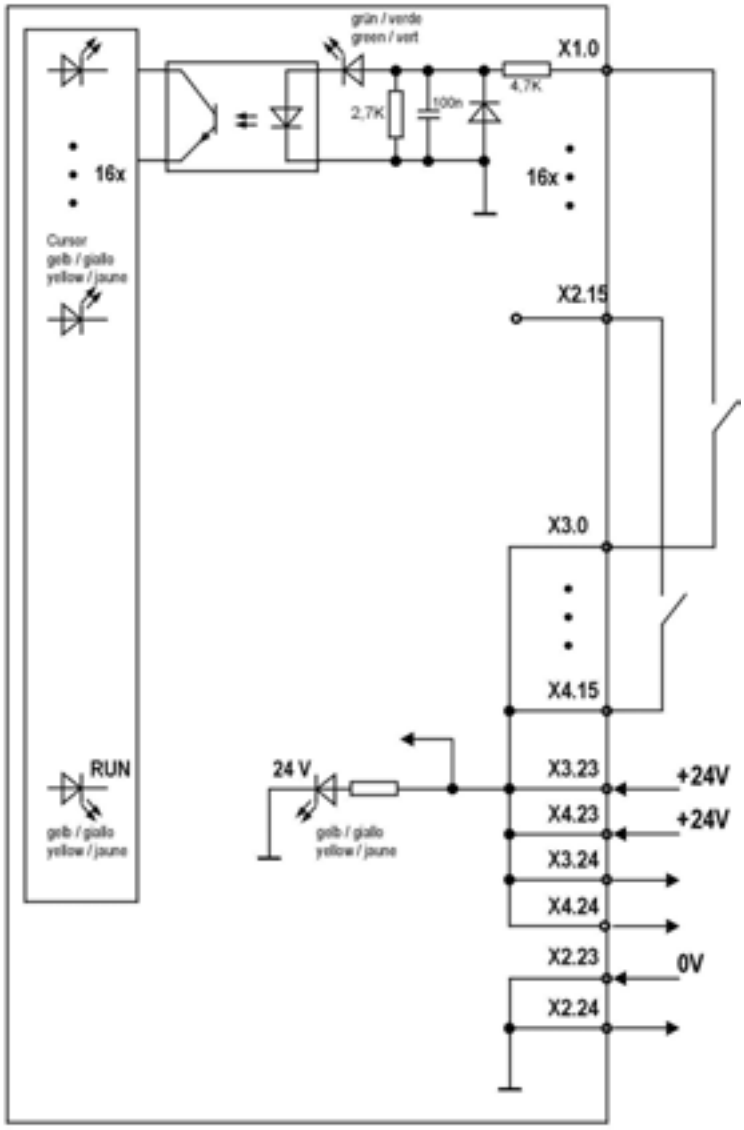
The bus couplers are interchangeable. If they are interchanged the PROFIBUS master configuration must be changed. The following table shows the differences between the key features and differences for handling the units.

Features	EC bus coupler	BC bus coupler
DP slave address	0 - 99	3 - 126
DP ID	055A hex	1631 hex
Switch off parameterizing and diagnosis functions	Do not configure the EC.	When configuring without GSD do not configure the BC. For configurations with GSD Service function 5 is important.
Save bus node configuration	Parameterizing and diagnosis Function 21	Service function 6
Error display	RUN-LED flashes red, the number of flashing pulses is the error code.	Displays the error number on the display.
Set data width for counter and positioning modules.	Set data width when configuring.	Set data width when configuring and set with Service function 13.

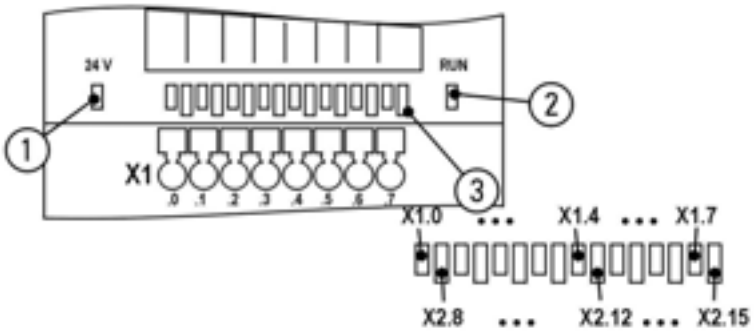
4.4 Digital I/O module 16 inputs RIO 16 I



- 16 inputs DC 24 V
- Two-wire connection system



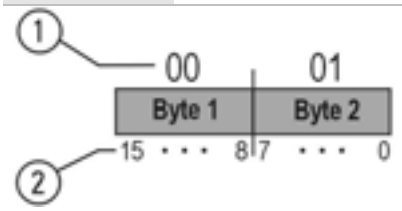
4.4.1 LED displays RIO 16 I



LED displays RIO 16 I			
No.	LED	Color	Meaning
1	24 V	Yellow	DC 24 V power supply is connected
2	RUN	Yellow	Internal data transmission to bus coupler
3	Control state of terminals X1.0 ... X1.7 X2.8 ... X2.15	Green	Control state
		Yellow	Channel cursor

4.4.2 Data width, addressing and terminal assignment RIO 16 I

RIO 16 I				
	Bytes Inputs		Bytes Outputs	
Data width	Byte 1		Byte 2	
	Bit	Terminal	Bit	Terminal
	8	X2.8	0	X1.0
	9	X2.9	1	X1.1
	10	X2.10	2	X1.2
	11	X2.11	3	X1.3
	12	X2.12	4	X1.4
	13	X2.13	5	X1.5
	14	X2.14	6	X1.6
	15	X2.15	7	X1.7



The Bit position can be changed with the Byte-Swap instruction. See page 159.

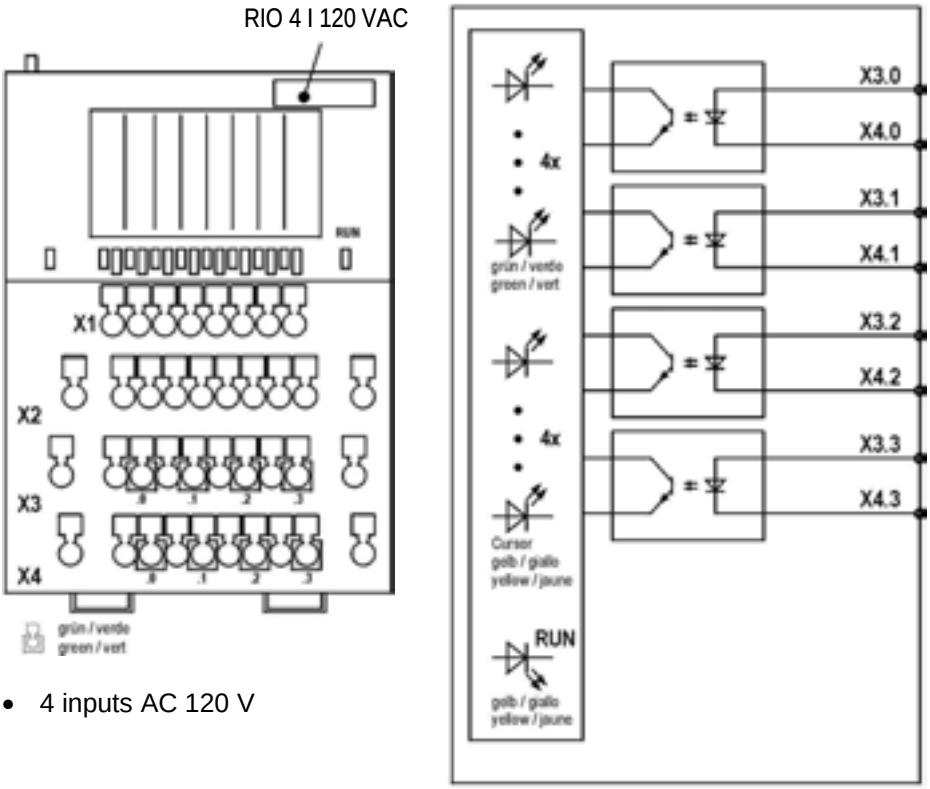
1 Byte start addresses
2 Bit numbering

4.4.3 Specifications RIO 16 I

RIO 16 I	
Order no.	PCD0.E120
Module ID	2
Number of inputs	16
External power supply	DC 24 V ± 20% max. 5% residual ripple
Power consumption from external 24 V power supply	0.25 W (without input current)
Power consumption from internal 5 V power supply	0.275 W
Inputs	
Switching level	H level +15 V to +30 V L level -30 V to +5 V
Input current	Min. H level (+15 V), I >= 2.5 mA Max. L level (+5 V), I <= 0.7 mA Typical (+24 V), I = 4.5 mA
Isolation from internal bus	Yes, each channel separately via opto-electronic couplers
Signal delay	Typically 100 µs (hardware)

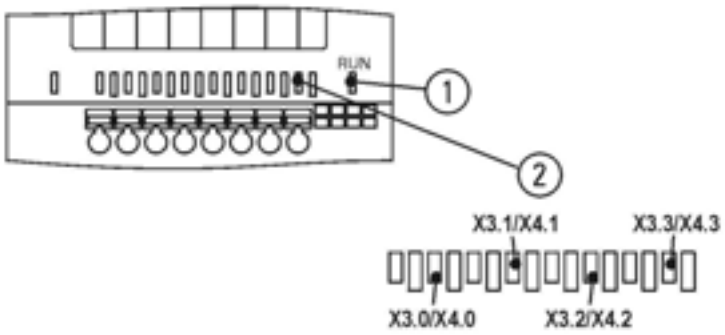
See also General specifications on page 162.

4.5 Digital I/O module 4 inputs AC 120 V RIO 4 I 120 VAC



- 4 inputs AC 120 V

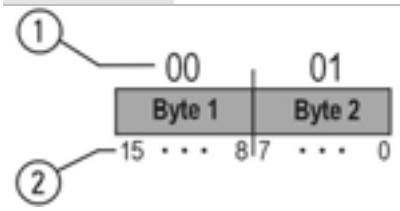
4.5.1 LED displays RIO 4 I 120 VAC



LED displays RIO 4 I 120 VAC			
No.	LED	Color	Meaning
1	RUN	Yellow	Internal data transmission to bus coupler
2	Control state of terminals X3.0/X4.0 X3.1/X4.1 X3.2/X4.2 X3.3/X4.3	Green	Control state
		Yellow	Channel cursor

4.5.2 Data width, addressing and terminal assignment RIO 4 I 120 VAC

RIO 4 I 120 VAC				
	Bytes Inputs		Bytes Outputs	
Data width	Byte 1	Byte 2		
	Not used	Bit	Terminal	
		0	X3.0/4.0	
		1	X3.1/4.1	
		2	X3.2/4.2	
		3	X3.3/4.3	
		4	Not used	
		5		
		6		
		7		



The Bit position can be changed with the Byte-Swap instruction. See page 159.

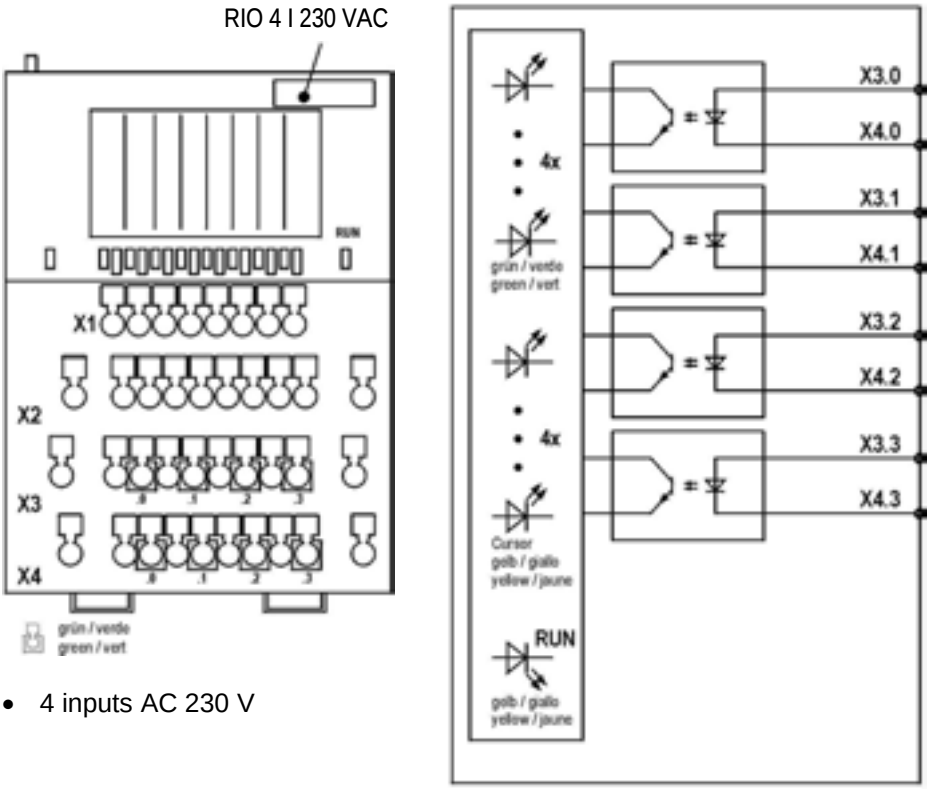
1 Byte start addresses
2 Bit numbering

4.5.3 Specifications RIO 4 I 120 VAC

RIO 4 I 120 VAC	
Order no.	PCD0.E520
Module ID	24d / 18h
Number of inputs	4
External power supply	None
Power consumption from external 24V power supply	None
Power consumption from internal 5V power supply	0.2 W
Inputs	
Switching level	H level AC 74 to 132 V L level AC 0 to 20 V
Input current	Min. H level (AC 74 V) 5 mA Max. L level (AC 20 V) ≥ 2.3 mA
Isolation from internal bus	Yes, each channel separately via opto-electronic couplers

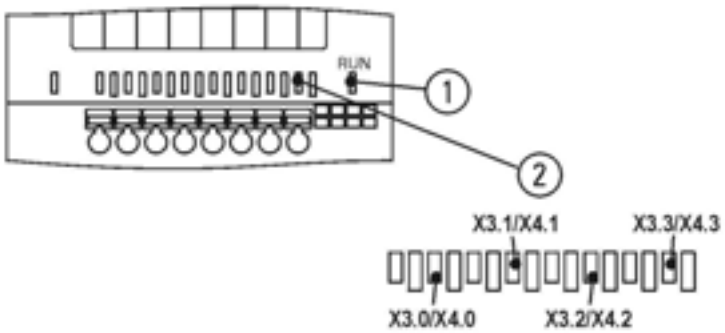
See also General specifications on page 162.

4.6 Digital I/O module 4 inputs AC 230 V RIO 4 I 230 VAC



- 4 inputs AC 230 V

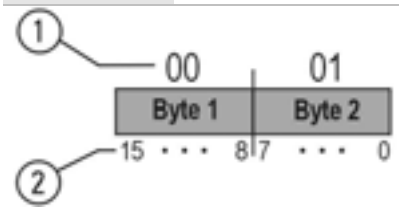
4.6.1 LED displays RIO 4 I 230 VAC



LED displays RIO 4 I 230 VAC			
No.	LED	Color	Meaning
1	RUN	Yellow	Internal data transmission to bus coupler
2	Control state of terminals X3.0/X4.0 X3.1/X4.1 X3.2/X4.2 X3.3/X4.3	Green	Control state
		Yellow	Channel cursor

4.6.2 Data width, addressing and terminal assignment RIO 4 I 230 VAC

RIO 4 I 230 VAC				
	Bytes Inputs			Bytes Outputs
Data width	Byte 1	Byte 2		
	Not used	Bit	Terminal	
		0	X3.0/4.0	
		1	X3.1/4.1	
		2	X3.2/4.2	
		3	X3.3/4.3	
		4	Not used	
		5		
		6		
		7		



The Bit position can be changed with the Byte-Swap instruction. See page 159.

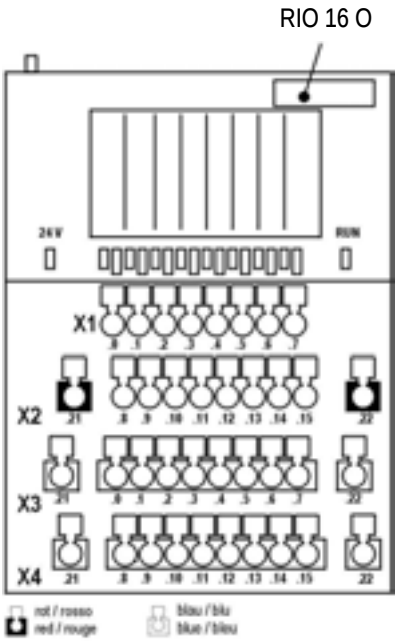
1 Byte start addresses
2 Bit numbering

4.6.3 Specifications RIO 4 I 230 VAC

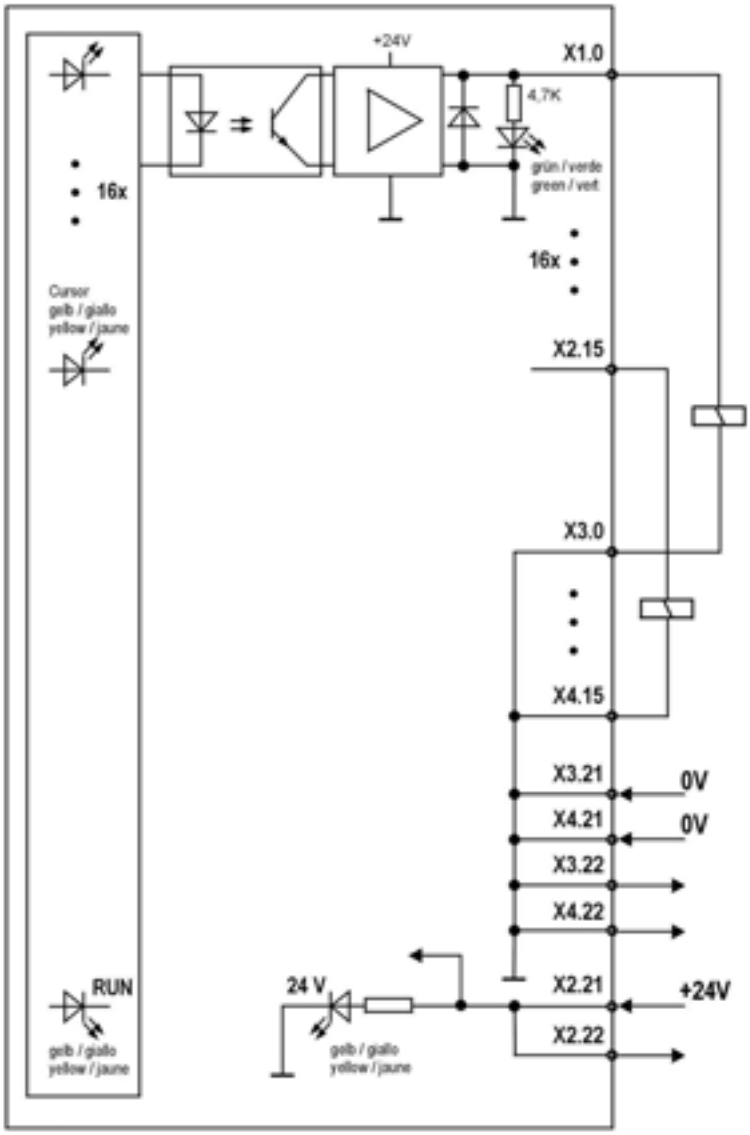
RIO 4 I 230 VAC	
Order no.	PCD0.E500
Module ID	25d / 19h
Number of inputs	4
External power supply	None
Power consumption from external 24V power supply	None
Power consumption from internal 5V power supply	0.2 W
Inputs	
Switching level	H level AC 159 to 253 V L level AC 0 to 40 V
Input current	Min. H level (AC 159 V) ≥ 5 mA Max. L level (AC 40 V) ≥ 2.3 mA
Isolation from internal bus	Yes, each channel separately via opto-electronic couplers

See also General specifications on page 162.

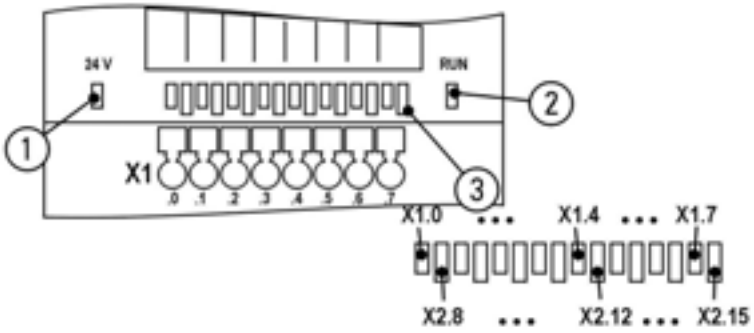
4.7 Digital I/O module 16 outputs RIO 16 O



- 16 outputs 1 A
- Two-wire connection system



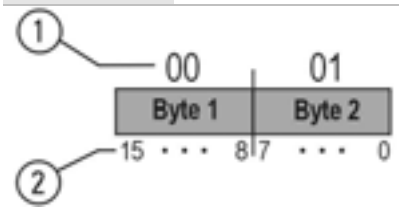
4.7.1 LED displays RIO 16 O



LED displays RIO 16 O			
No.	LED	Color	Meaning
1	24 V	Yellow	DC 24 V power supply is connected
2	RUN	Yellow	Internal data transmission to bus coupler
3	Control state of terminals X1.0 ... X1.7 X2.8 ... X2.15	Green	Control state
		Yellow	Channel cursor

4.7.2 Data width, addressing and terminal assignment RIO 16 O

RIO 16 O					
	Bytes Inputs	Bytes Outputs			
Data width		Byte 1		Byte 2	
		Bit	Terminal	Bit	Terminal
		8	X2.8	0	X1.0
		9	X2.9	1	X1.1
		10	X2.10	2	X1.2
		11	X2.11	3	X1.3
		12	X2.12	4	X1.4
		13	X2.13	5	X1.5
		14	X2.14	6	X1.6
		15	X2.15	7	X1.7



The Bit position can be changed with the Byte-Swap instruction. See page 159.

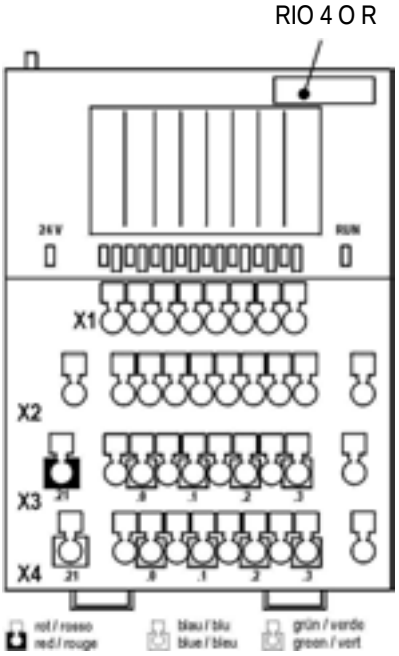
1 Byte start addresses
2 Bit numbering

4.7.3 Specifications RIO 16 O

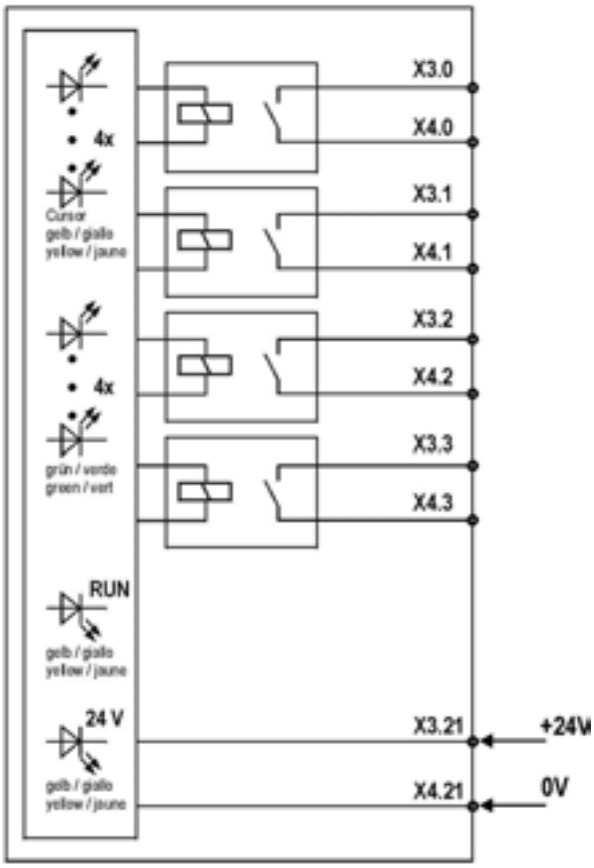
RIO 16 O	
Order no.	PCD0.A410
Module ID	3
Number of outputs	16
External power supply	DC 24 V ± 20% max. 5% residual ripple
Power consumption from external 24 V power supply	0.25 W (without load current)
Power consumption from internal 5 V power supply	0.325 W
Outputs	
Output current per output max.	1 A Overload and short-circuit proof, parallel operation possible in groups (4 groups: 0-3,4-7,8-11,12-15)
Total current for whole module max.	8 A
Switching level	H level = power supply - 0.5 V (IL < 1 A) L level <= 1 V (IL = 0 A)
Isolation from internal bus	Yes, each channel separately via opto-electronic couplers
Simultaneity	50%
Free-wheeling diode	Integrated
Signal delay	<100 µs (hardware) see also Response Times section on page 177.

See also General specifications on page 162.

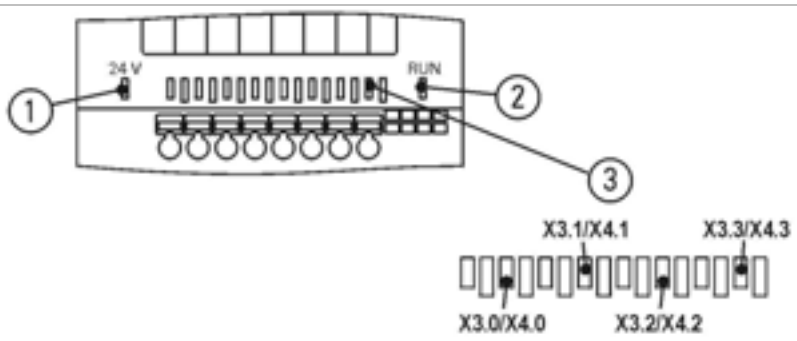
4.8 Digital I/O module 4 outputs relay RIO 4 O R



- 4 outputs relay contact (make contact)



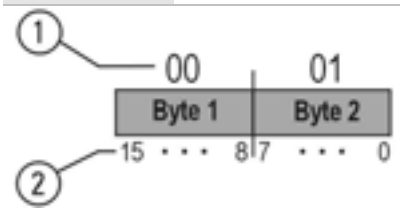
4.8.1 LED displays RIO 4 O R



LED displays RIO 16 O			
No.	LED	Color	Meaning
1	24 V	Yellow	DC 24 V power supply is connected
2	RUN	Yellow	Internal data transmission to bus coupler
3	Control state of terminals X3.0/X4.0 X3.1/X4.1 X3.2/X4.2 X3.3/X4.3	Green	Control state
		Yellow	Channel cursor

4.8.2 Data width, addressing and terminal assignment RIO 4 O R

RIO 4 O R				
	Bytes Inputs	Bytes Outputs		
Data width		Byte 1	Byte 2	
		Not used	Bit	Terminal
			0	X3.0/4.0
			1	X3.1/4.1
			2	X3.2/4.2
			3	X3.3/4.3
			4	Not used
			5	
			6	
			7	



The Bit position can be changed with the Byte-Swap instruction. See page 159.

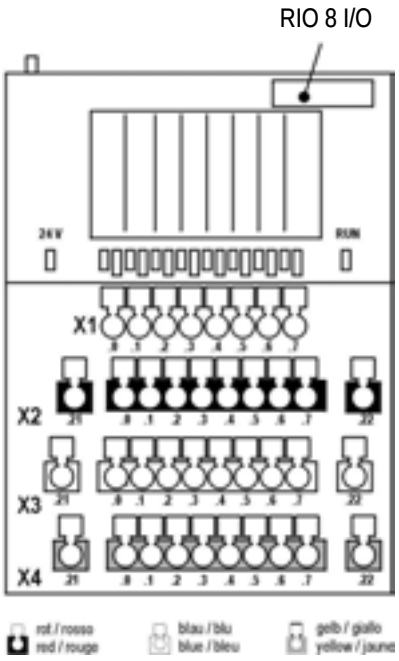
1 Byte start addresses
2 Bit numbering

4.8.3 Specifications RIO 4 O R

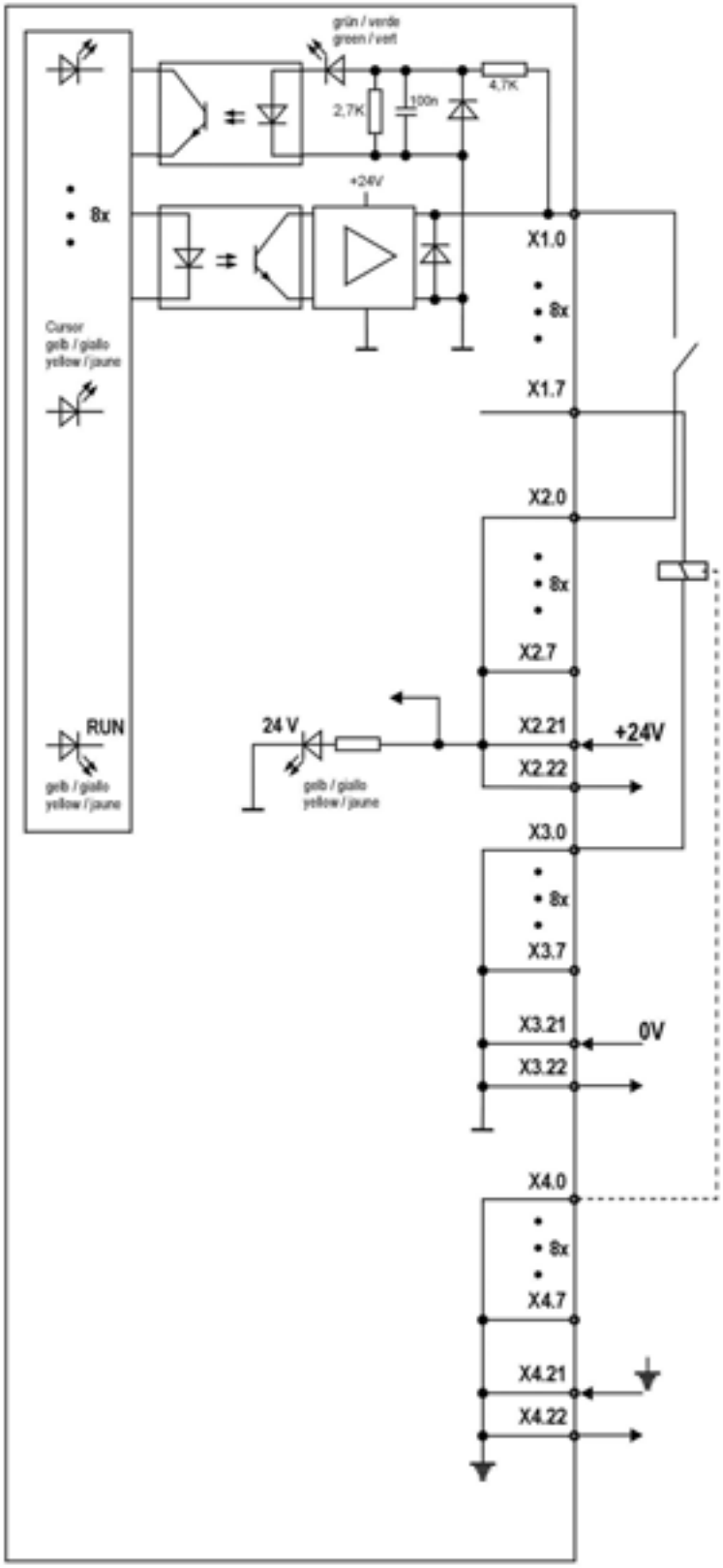
RIO 4 O R	
Order no.	PCD0.A200
Module ID	19d / 13h
Number of outputs	4
External power supply	DC 24 V ± 20% max. 5% residual ripple
Power consumption from external 24 V power supply	2 W
Power consumption from internal 5 V power supply	0.25 W
Outputs	
Output current per output max.	5 A
Total current for whole module max.	12 A
Minimum contact load	AC/DC 5 V / 10 mA
Rated operating voltage	AC/DC 24 to 240 V
Utilization category according to IEC 60947-5-1	AC-15 U_e AC 230 V, I_e 3 A DC-13 U_e DC 24 V, I_e 2 A
Permissible frequency of operation	≤ 3600 operating cycles / h
Mechanical life	30 x 10^6 operating cycles
Electrical life 20/2 A, AC 250 V, cosφ = 0.3	0.12 x 10^6 operating cycles AC-15
Isolation from internal bus	Yes, each channel separately relay contact
Simultaneity	100%
Free-wheeling diode	Integrated
Signal delay	<100 µs (hardware) see also Response Times section on page 177.

See also General specifications on page 162.

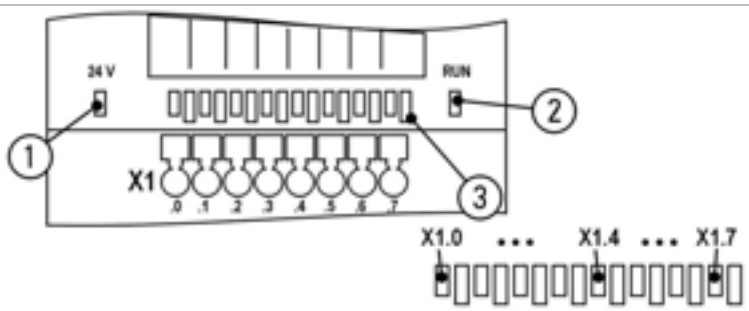
4.9 Digital I/O module 8 inputs/outputs RIO 8 I/O



- 8 combination I/Os
  Can be used individually as DC 24 V inputs or 1 A outputs
- Four-wire connection system



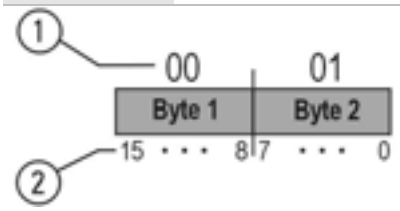
4.9.1 LED displays RIO 8 I/O



LED displays RIO 8 I/O			
No.	LED	Color	Meaning
1	24 V	Yellow	DC 24 V power supply is connected
2	RUN	Yellow	Internal data transmission to bus coupler
3	Control state of terminals X1.0 ... X1.7	Green	Control state
		Yellow	Channel cursor

4.9.2 Data width, addressing and terminal assignment RIO 8 I/O

RIO 8 I/O						
	Bytes Inputs			Bytes Outputs		
Data width	Byte 1	Byte 2		Byte 1	Byte 2	
	Not used	Bit	Terminal	Not used	Bit	Terminal
		0	X1.0		0	X1.0
		1	X1.1		1	X1.1
		2	X1.2		2	X1.2
		3	X1.3		3	X1.3
		4	X1.4		4	X1.4
		5	X1.5		5	X1.5
		6	X1.6		6	X1.6
		7	X1.7		7	X1.7



The Bit position can be changed with the Byte-Swap instruction. See page 159.

1 Byte start addresses
2 Bit numbering

4.9.3 Specifications RIO 8 I/O

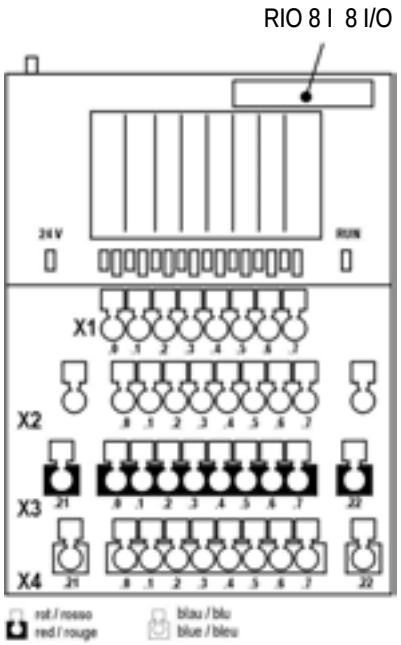
RIO 8I/O	
Order no.	PCD0.B110
Module ID	1
Number of inputs/outputs	8 combination I/Os which can be used individually as input or output
External power supply	DC 24 V ± 20% max. 5% residual ripple
Power consumption from external 24 V power supply	0.25 W (without input currents / load currents)
Power consumption from internal 5 V power supply	0.325 W
Inputs	
Switching level	H level +15 V to +30 V L level -30 V to +5 V
Input current	Min. H level (+15 V), I >= 3.6 mA Max. L level (+5 V), I <= 1.2 mA Typical (+24 V), I = 6.1 mA
Isolation from internal bus	Yes, each channel separately via opto-electronic couplers
Signal delay	<100 µs (hardware) see also Response Times section
Outputs	
Output current per output max.	1A Overload and short-circuit proof, parallel operation possible in groups (2 groups: 0-3,4-7)
Total current for whole module max.	8 A
Switching level	H level = power supply - 0.5 V (IL < 1 A) L level <= 1 V (IL = 0 A)
Isolation from internal bus	Yes, each channel separately via opto-electronic couplers
Simultaneity	100%
Free-wheeling diode	Integrated
Signal delay	<100 µs (hardware) see also Response Times section on page 177.

See also General specifications on page 162.

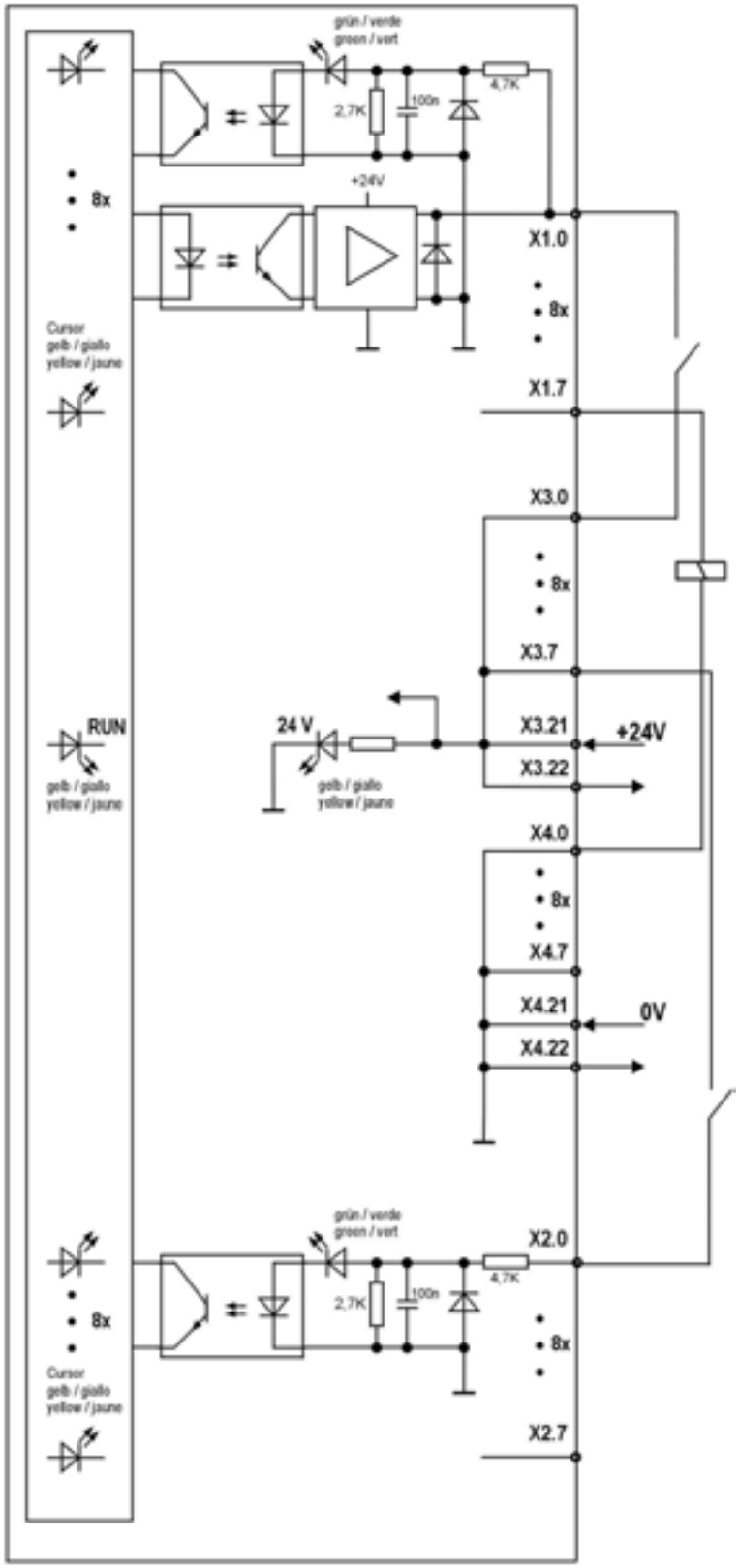
Each of the 8 channels can be used either as an input or an output. This means that both an input address space and an output address space are reserved for the process map in the bus coupler. A channel used as an input (e.g. initiator) cannot be used as an output channel at the same time, however, an output can be inverted to an input. This way the PLC can monitor the switching function.

Note on modules with digital combination channels that it is not allowed to connect a 24 V supply to a combination channel without feeding in the power supply. Otherwise the power supply will be fed back over the output circuit of the combination channel to the power supply terminal of the module which may result in a malfunction or destruction of the output circuit.

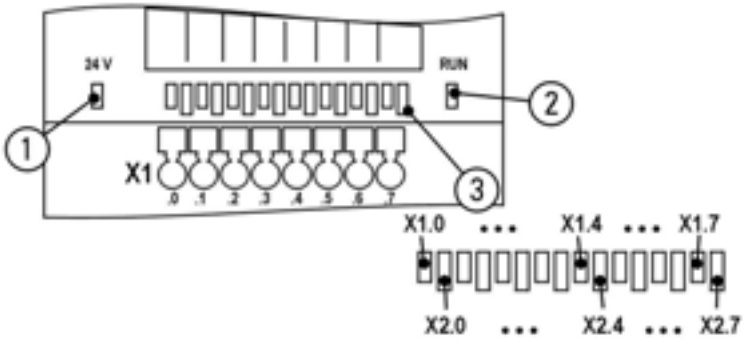
4.10 Digital I/O module 8 inputs/outputs RIO 8 I 8 I/O



- 8 inputs DC 24 V
- 8 combination I/Os
  Can be used individually as DC 24 V inputs or 1 A outputs
- Two-wire connection system



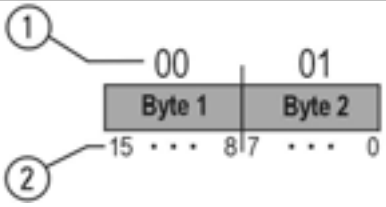
4.10.1 LED displays RIO 8 I 8 I/O



LED displays RIO 8 I 8 I/O			
No.	LED	Color	Meaning
1	24 V	Yellow	DC 24 V power supply is connected
2	RUN	Yellow	Internal data transmission to bus coupler
3	Control state of terminals X1.0 ... X1.7 X2.0 ... X2.7	Green	Control state
		Yellow	Channel cursor

4.10.2 Data width, addressing and terminal assignment RIO 8 I 8 I/O

RIO 8 I 8 I/O							
	Bytes Inputs				Bytes Outputs		
Data width	Byte 1		Byte 2		Byte 1	Byte 2	
	Bit	Terminal	Bit	Terminal	Not used	Bit	Terminal
	8	X2.0	0	X1.0		0	X1.0
	9	X2.1	1	X1.1		1	X1.1
	10	X2.2	2	X1.2		2	X1.2
	11	X2.3	3	X1.3		3	X1.3
	12	X2.4	4	X1.4		4	X1.4
	13	X2.5	5	X1.5		5	X1.5
	14	X2.6	6	X1.6		6	X1.6
	15	X2.7	7	X1.7		7	X1.7



The Bit position can be changed with the Byte-Swap instruction. See page 159.

1 Byte start addresses
2 Bit numbering

4.10.3 Specifications RIO 8 I 8 I/O

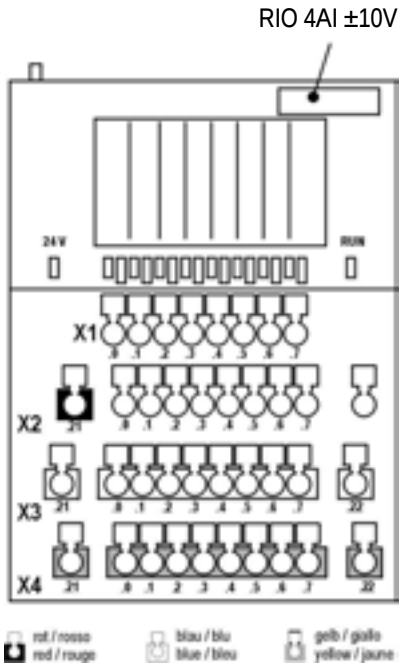
RIO 8I 8I/O	
Order no.	PCD0.B120
Module ID	4
Number of inputs/outputs	8 inputs and 8 combination I/Os which can be used individually as input or output
External power supply	DC 24 V ± 20% max. 5% residual ripple
Power consumption from external 24 V power supply	0.25 W (without input currents / load currents)
Power consumption from internal 5 V power supply	0.325 W
Inputs	
Switching level	H level +15 V to +30 V L level -30 V to +5 V
Input current	Min. H level (+15 V), I >= 2.5 mA / 3.6 mA* Max. L level (+5 V), I <= 0.7 mA / 1.2 mA* Typical (+24 V), I = 4.5 mA / 6.1 mA* *for combination I/O
Isolation from internal bus	Yes, each channel separately via opto-electronic couplers
Signal delay	<100 µs (hardware) see also Response Times section on page 177.
Outputs	
Output current per output max.	1 A Overload and short-circuit proof, parallel operation possible in groups (2 groups: 0-3,4-7)
Total current for whole module max.	8 A
Switching level	H level = power supply - 0.5 V L level <= 1V
Isolation from internal bus	Yes, each channel separately via opto-electronic couplers
Simultaneity	100%
Free-wheeling diode	Integrated
Signal delay	<100 µs (hardware) see also Response Times section on page 177.

See also General specifications on page 162.

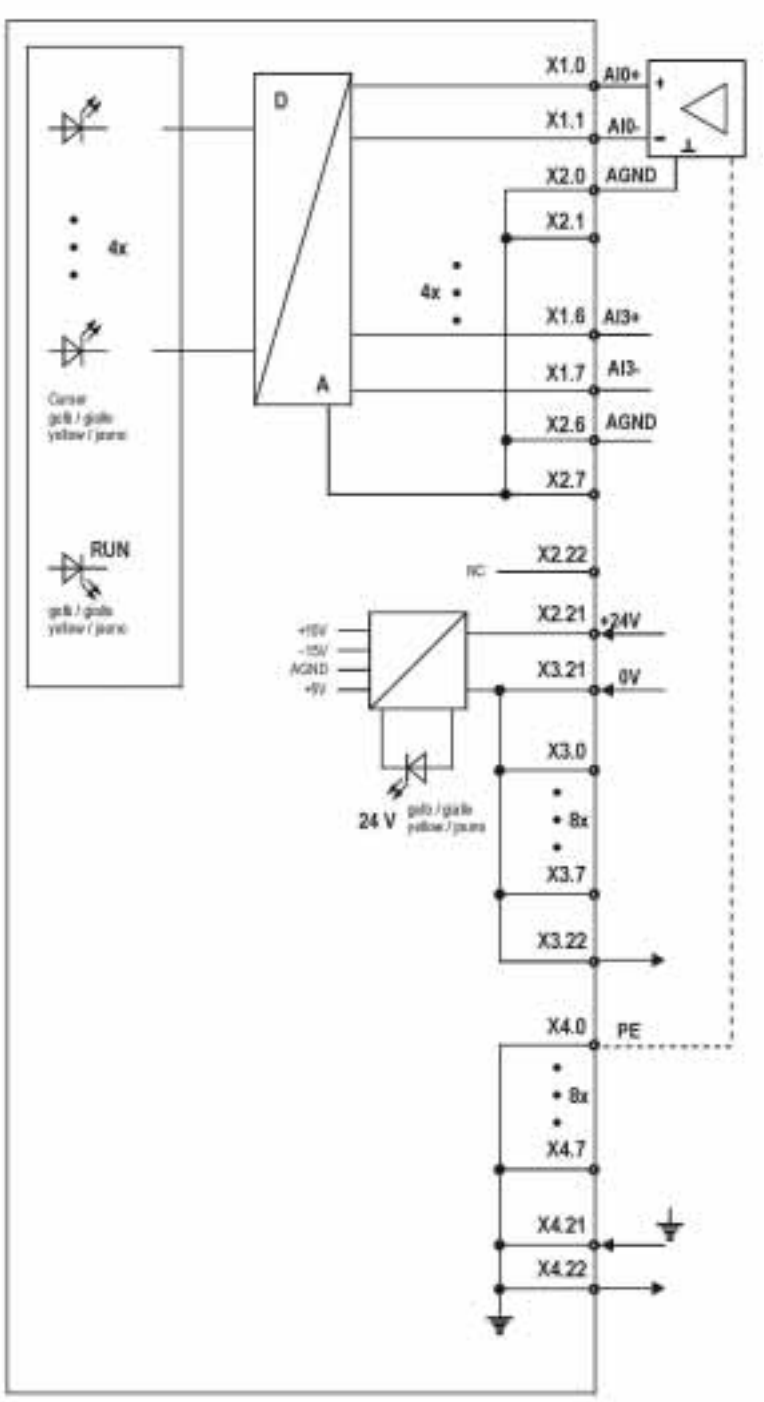
Each of the 8 combination I/O channels can be used either as an input or an output. This means that both an input address space and an output address space are reserved for the process map in the bus coupler. A channel used as an input(e.g. initiator) cannot be used as an output channel at the same time, however, an output can be inverted to an input. This way the PLC can monitor the switching function.

Note on modules with digital combination channels that it is not allowed to connect a 24 V supply to a combination channel without feeding in the power supply. Otherwise the power supply will be fed back over the output circuit of the combination channel to the power supply terminal of the module which may result in a malfunction or destruction of the output circuit.

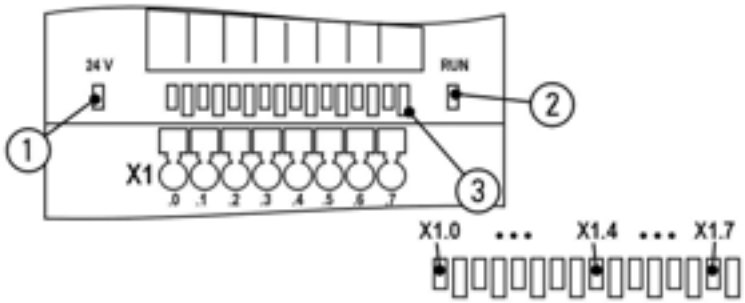
4.11 Analog module 4 inputs ±10 V RIO 4AI ±10 V



- 4 analog inputs ±10 V



4.11.1 LED displays RIO 4AI ±10 V

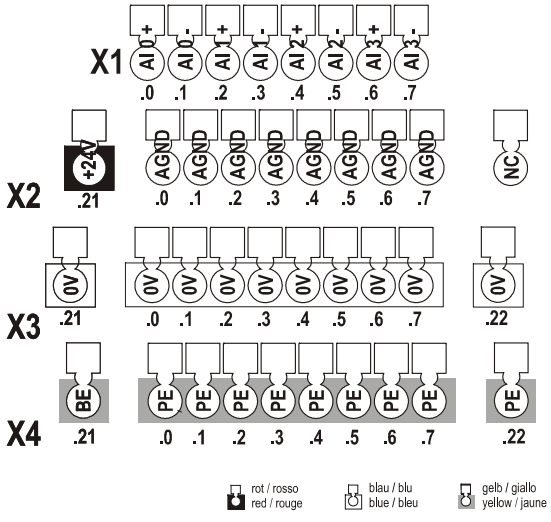


LED displays RIO 4AI ±10 V			
No.	LED	Color	Meaning
1	24 V	Yellow	DC 24 V power supply is connected
2	RUN	Yellow	Internal data transmission to bus coupler
3		Yellow	Channel cursor

4.11.2 Data width RIO 4AI ±10 V

RIO 4AI ±10 V		
	Word Inputs	Word Outputs
Data width	Word 1 to 4 (channel 0 to 3)	

4.11.3 Terminal assignment RIO 4AI ±10 V

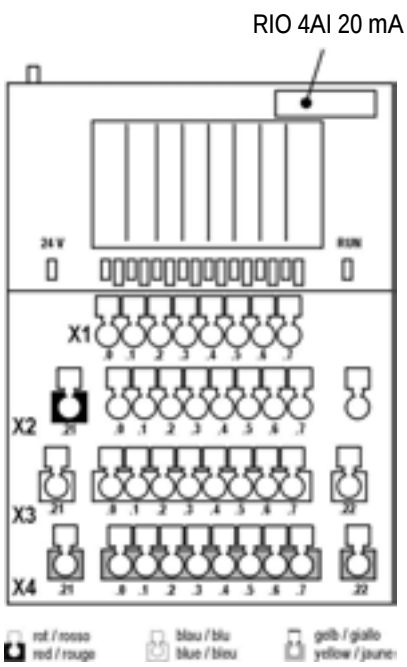


4.11.4 Specifications RIO 4AI ±10 V

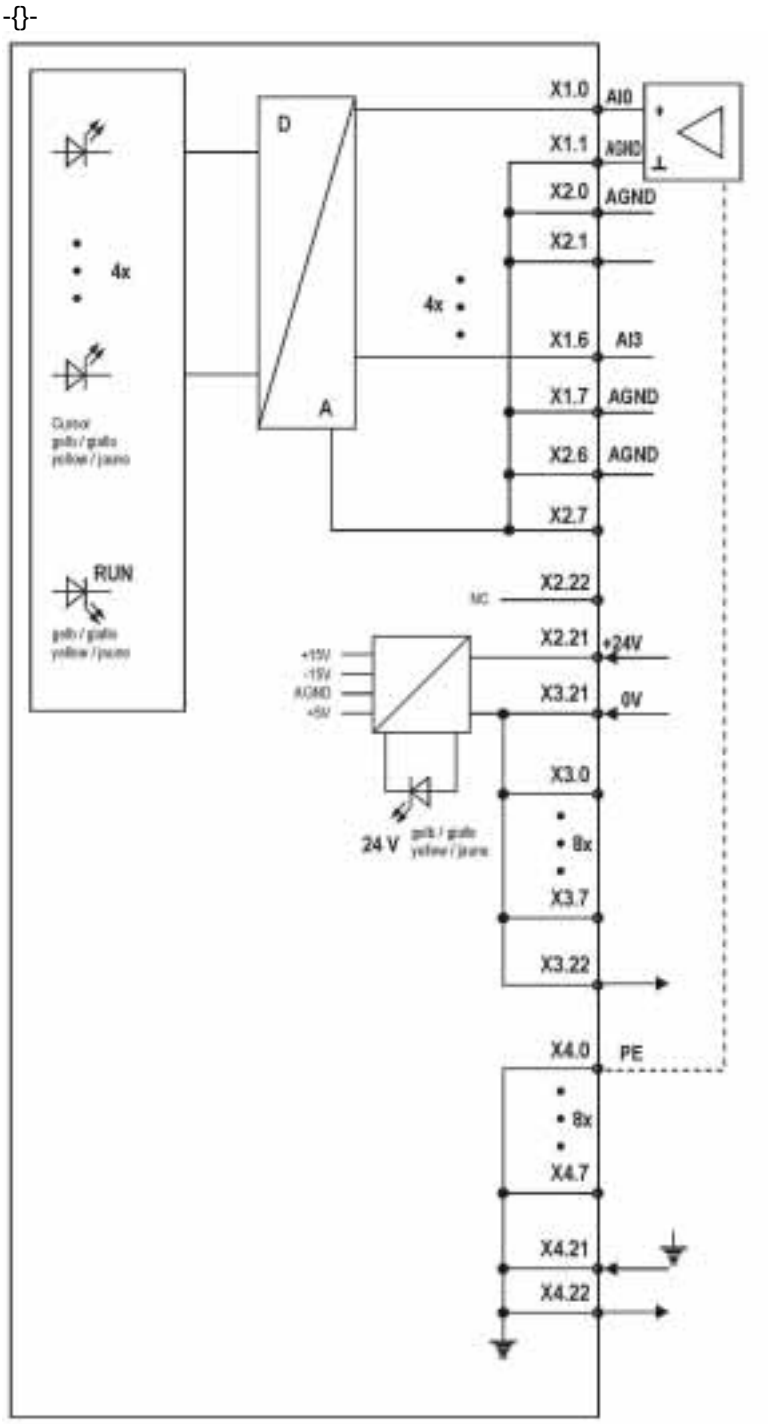
RIO 4AI ±10 V	
Order no.	PCD0.W510
Module ID	6
Number of inputs	4
External power supply	DC 24 V ± 20% max. 5% residual ripple
Power consumption from external 24 V power supply	3.6 W
Power consumption from internal 5 V power supply	0.325 W
Data format default setting	±10 V in two's complement –2048...+2047 (can be configured in software, see Analog module data formats on page 181)

See Specifications Analog inputs/outputs on page 163 and
General specifications on page 162.

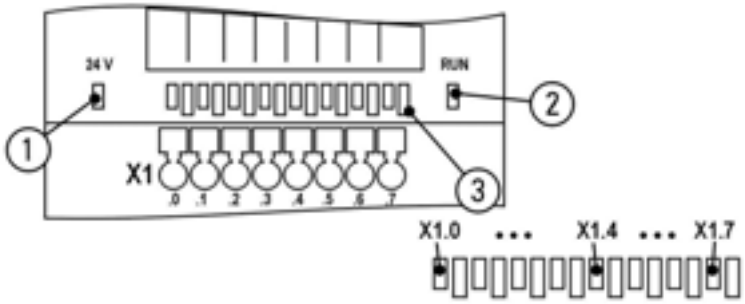
4.12 Analog module 4 inputs 20 mA RIO 4AI 20 mA



- 4 analog inputs 20 mA



4.12.1 LED displays RIO 4AI 20mA

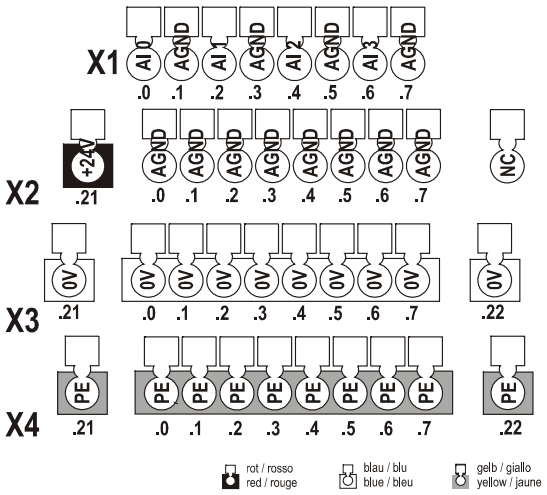


LED displays RIO 4AI 20mA			
No.	LED	Color	Meaning
1	24 V	Yellow	DC 24 V power supply is connected
2	RUN	Yellow	Internal data transmission to bus coupler
3		Yellow	Channel cursor

4.12.2 Data width RIO 4AI 20mA

RIO 4AI 20mA		
	Word Inputs	Word Outputs
Data width	Word 1 to 4 (channel 0 to 3)	

4.12.3 Terminal assignment RIO 4AI 20mA

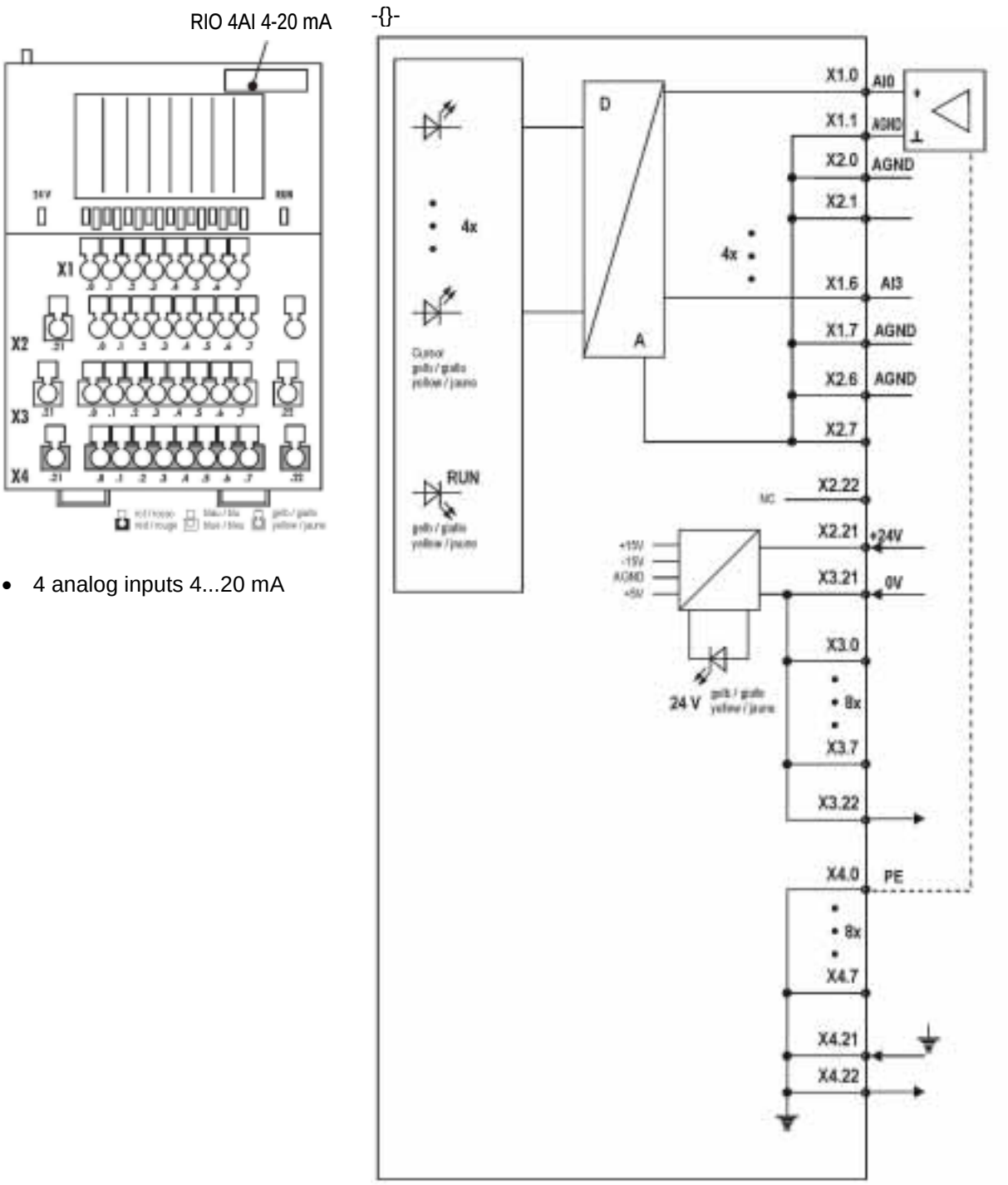


4.12.4 Specifications RIO 4AI 20mA

RIO 4AI 20mA	
Order no.	PCD0.W520
Module ID	8
Number of inputs	4
External power supply	DC 24 V ± 20% max. 5% residual ripple
Power consumption from external 24 V power supply	3.6 W
Power consumption from internal 5 V power supply	0.325 W
Data format default setting	0...20 mA (0...4095) (can be configured in software, see Analog module data formats on page 181)

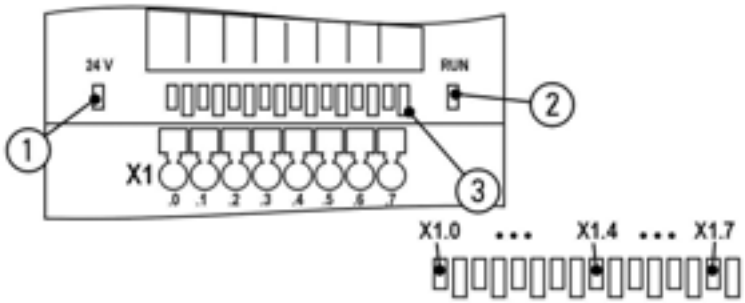
See Specifications Analog inputs/outputs on page 163 and General specifications on page 162.

4.13 Analog module 4 inputs 20 mA RIO 4AI 4-20 mA



- 4 analog inputs 4...20 mA

4.13.1 LED displays RIO 4AI 4-20mA

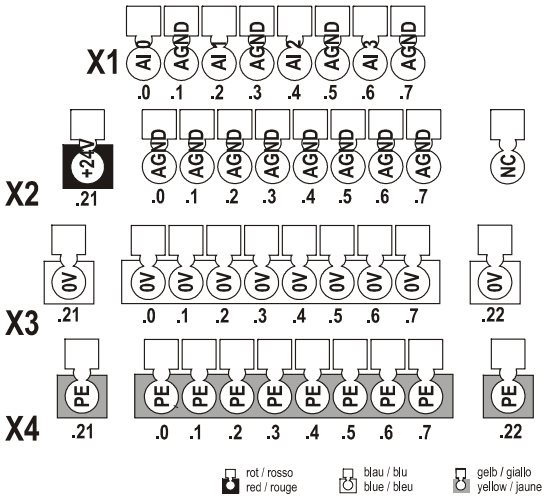


LED displays RIO 4AI 4-20mA			
No.	LED	Color	Meaning
1	24 V	Yellow	DC 24 V power supply is connected
2	RUN	Yellow	Internal data transmission to bus coupler
3		Yellow	Channel cursor

4.13.2 Data width RIO 4AI 4-20mA

RIO 4AI 4-20mA		
	Word Inputs	Word Outputs
Data width	Word 1 to 4 (channel 0 to 3)	

4.13.3 Terminal assignment RIO 4AI 4-20mA

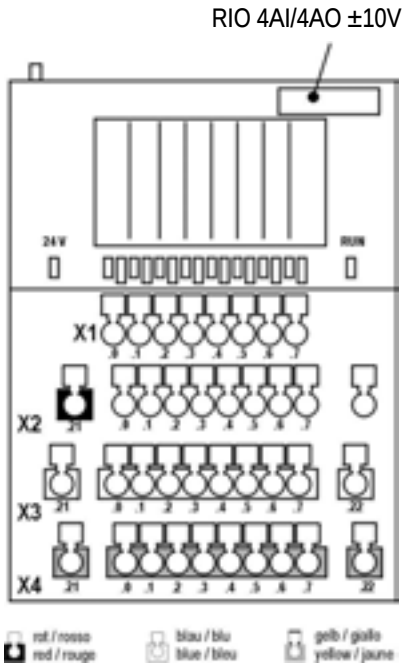


4.13.4 Specifications RIO 4AI 4-20mA

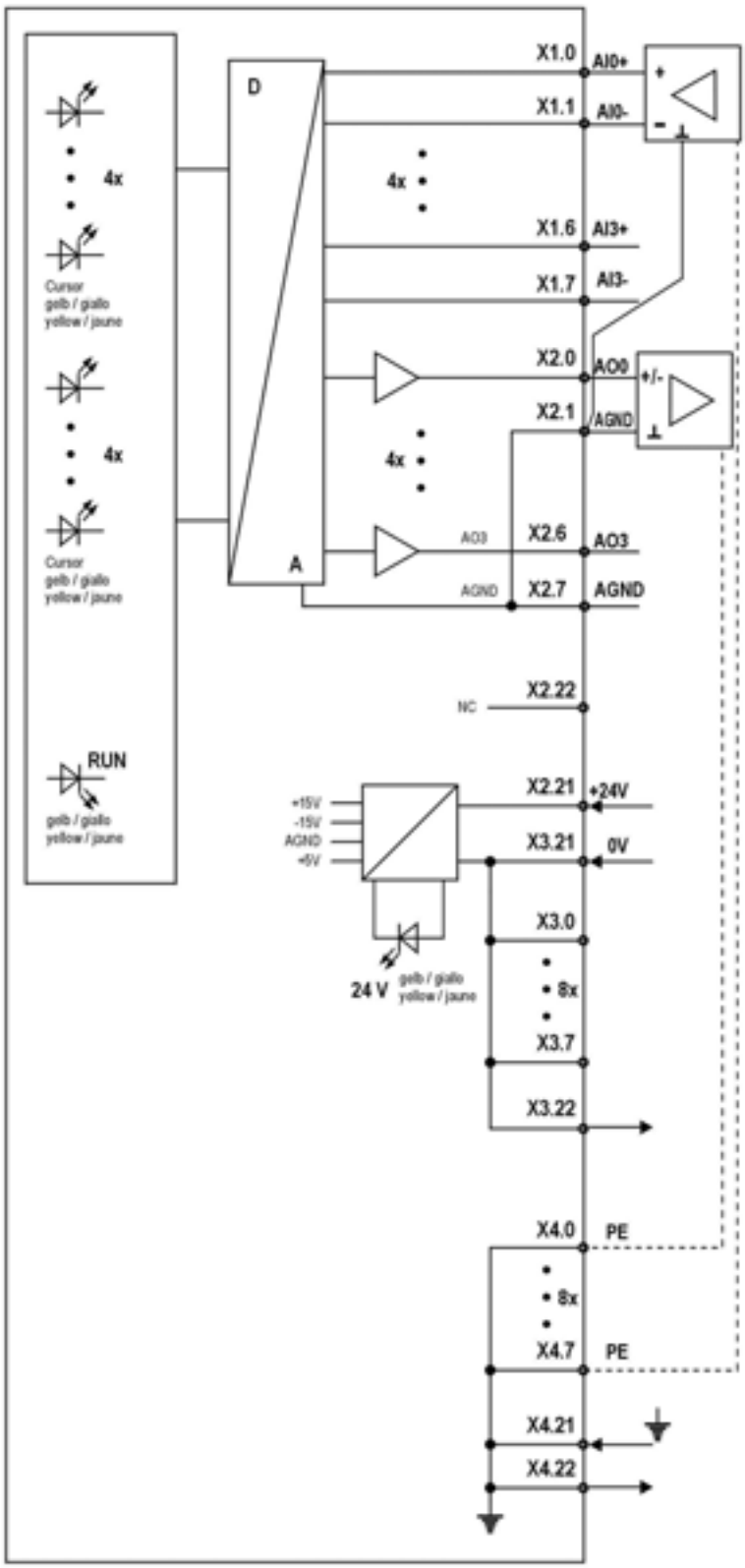
RIO 4AI 4-20mA	
Order no.	PCD0.W524
Module ID	17d / 11h
Number of inputs	4
External power supply	DC 24 V ± 20% max. 5% residual ripple
Power consumption from external 24 V power supply	3.6 W
Power consumption from internal 5 V power supply	0.325 W
Data format default setting	4...20 mA S7 format (can be configured in software, see Analog module data formats on page 181)

See Specifications Analog inputs/outputs on page 163 and General specifications on page 162.

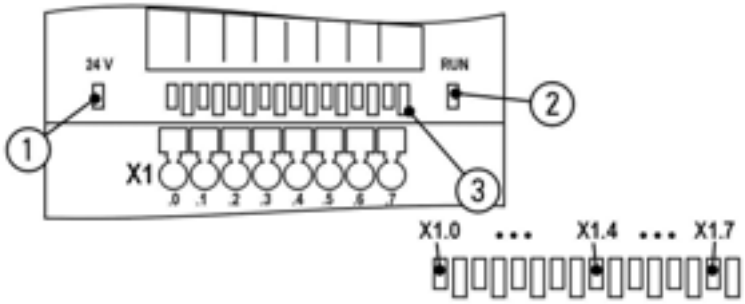
4.14 Analog module 4 inputs 4 outputs ±10 V RIO 4AI/4AO ±10 V



- 4 analog inputs ±10 V
- 4 analog outputs ±10 V



4.14.1 LED displays RIO 4AI/4AO ±10 V

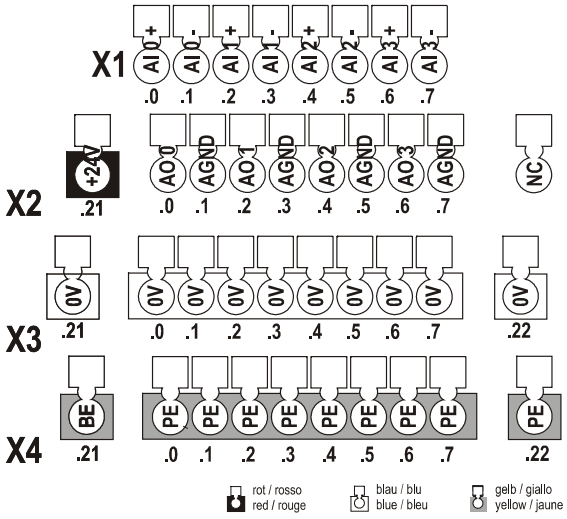


LED displays RIO 4AI/4AO ±10 V			
No.	LED	Color	Meaning
1	24 V	Yellow	DC 24 V power supply is connected
2	RUN	Yellow	Internal data transmission to bus coupler
3		Yellow	Channel cursor

4.14.2 Data width RIO 4AI/4AO ±10 V

RIO 4AI/4AO ±10V		
	Word Inputs	Word Outputs
Data width	Word 1 to 4 (channel 0 to 3)	Word 1 to 4

4.14.3 Terminal assignment RIO 4AI/4AO ±10 V

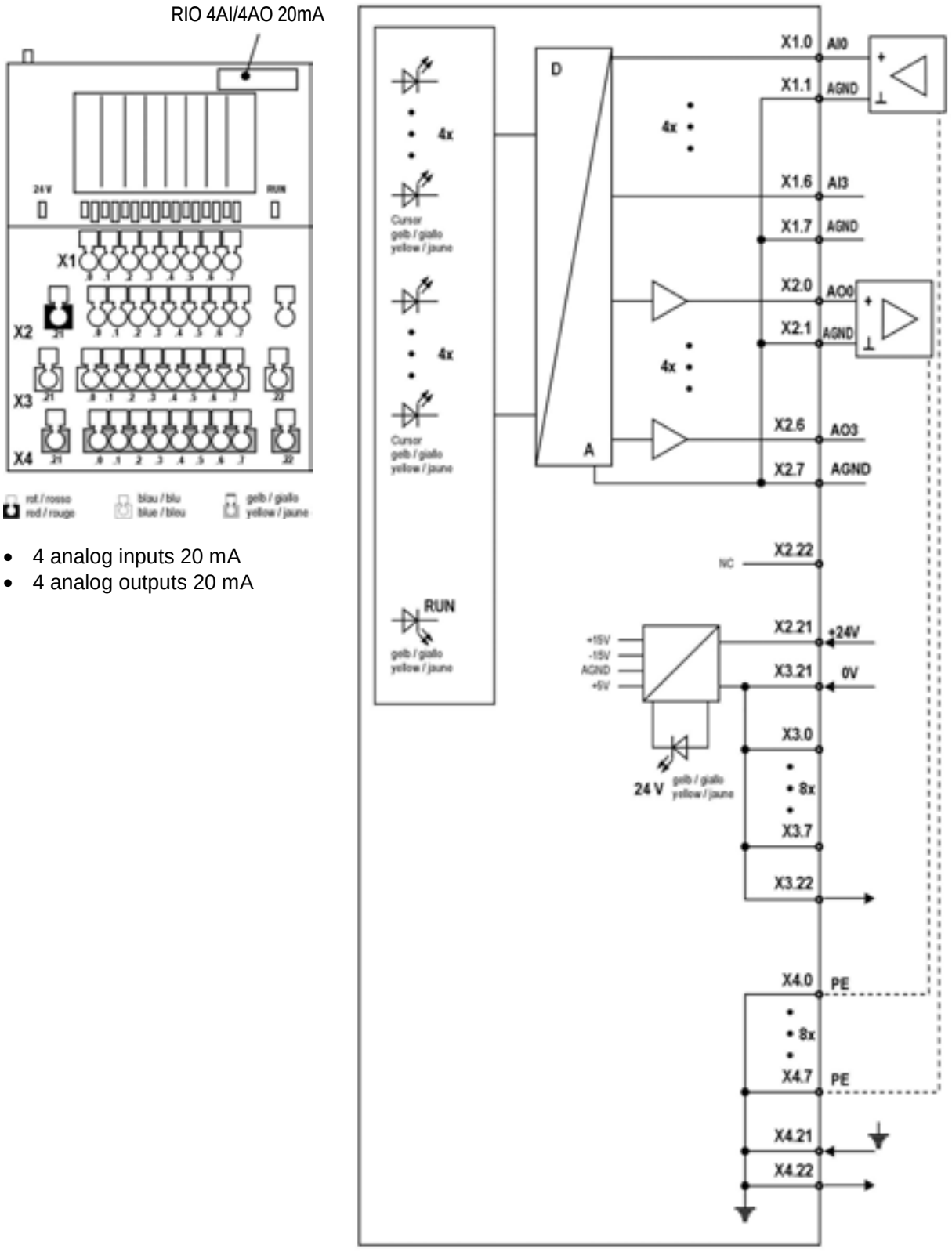


4.14.4 Specifications RIO 4AI/4AO±10 V

RIO 4AI/4AO ±10V	
Order no.	PCD0.W710
Module ID	5
Number of inputs/outputs	4/4
External power supply	DC 24 V ± 20% max. 5% residual ripple
Power consumption from external 24 V power supply	4.3 W (maximum load on analog outputs)
Power consumption from internal 5 V power supply	0.325 W
Data format default setting	±10 V in two's complement -2048...+2047 (can be configured in software, see Analog module data formats on page 181)

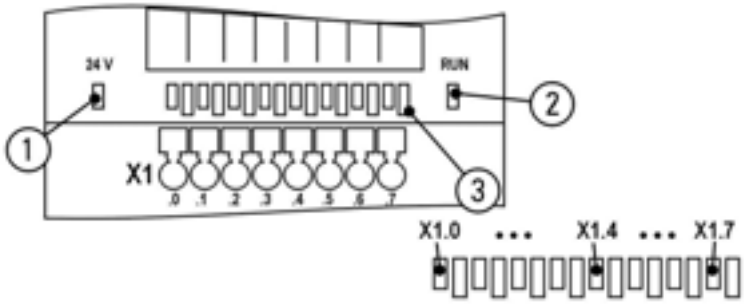
See Specifications Analog inputs/outputs on page 163 and General specifications on page 162.

4.15 Analog module 4 inputs 4 outputs 20mA RIO 4AI/4AO 20mA



- 4 analog inputs 20 mA
- 4 analog outputs 20 mA

4.15.1 LED displays RIO 4AI/4AO 20mA

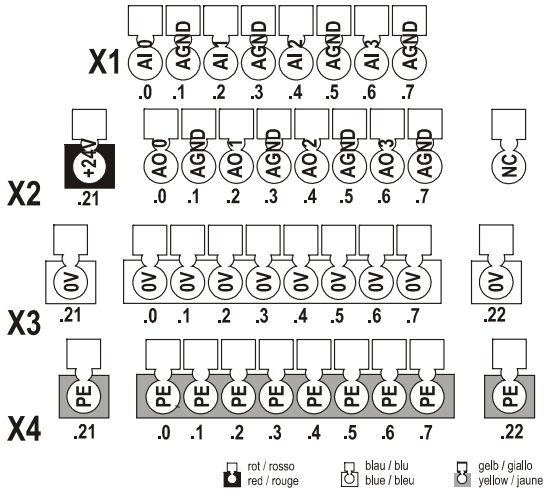


LED displays RIO 4AI/4AO 20mA			
No.	LED	Color	Meaning
1	24 V	Yellow	DC 24 V power supply is connected
2	RUN	Yellow	Internal data transmission to bus coupler
3		Yellow	Channel cursor

4.15.2 Data width RIO 4AI/4AO 20mA

RIO 4AI/4AO 20mA		
	Word Inputs	Word Outputs
Data width	Word 1 to 4 (channel 0 to 3)	Word 1 to 4

4.15.3 Terminal assignment RIO 4AI/4AO 20mA

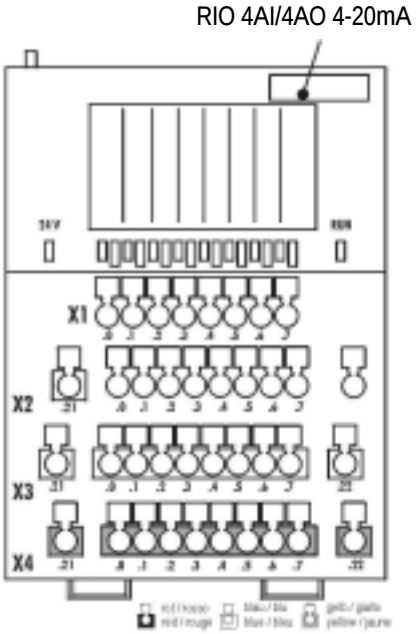


4.15.4 Specifications RIO 4AI/4AO 20mA

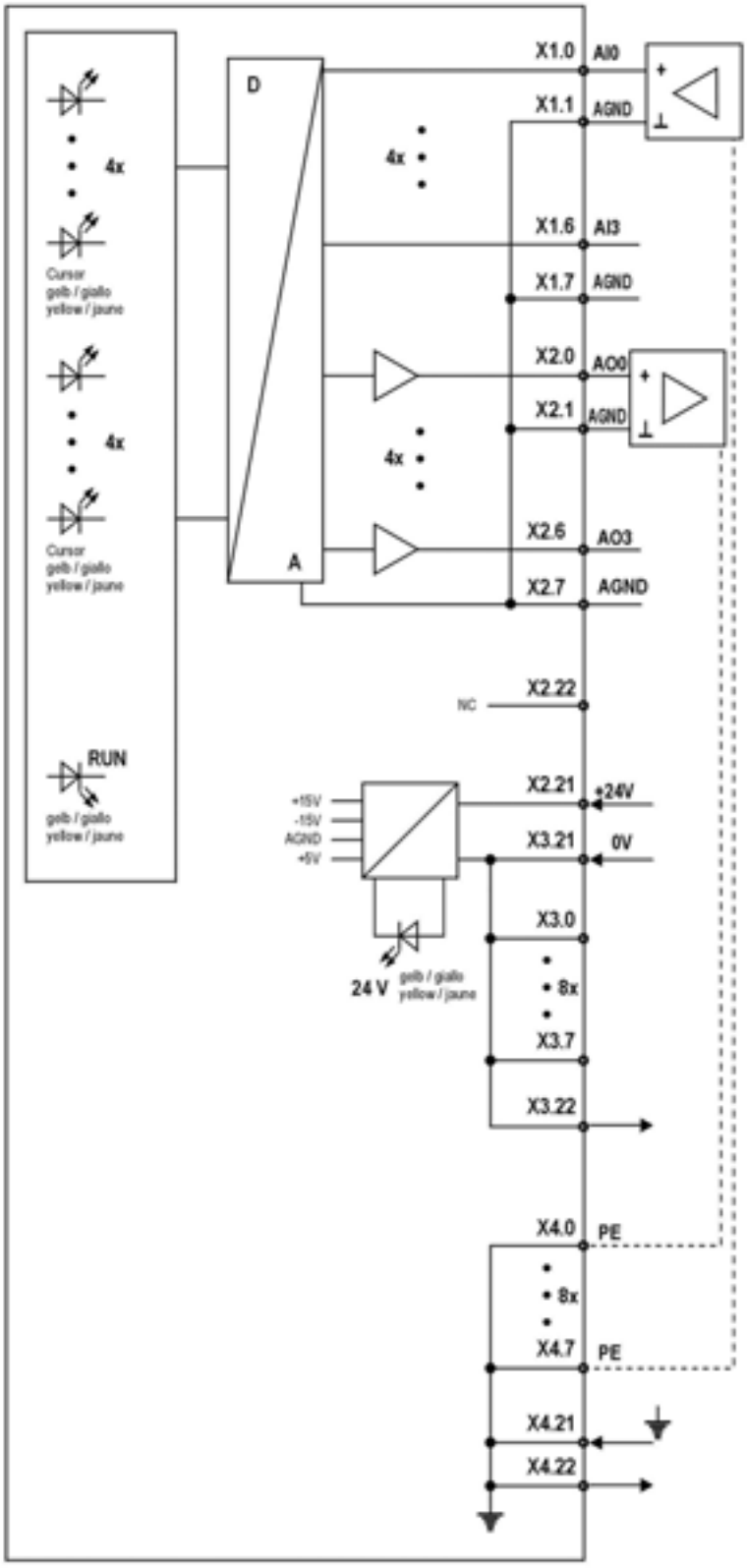
RIO 4AI/4AO 20mA	
Order no.	PCD0.W720
Module ID	7
Number of inputs/outputs	4/4
External power supply	DC 24 V ± 20% max. 5% residual ripple
Power consumption from external 24 V power supply	6 W (maximum load on analog outputs)
Power consumption from internal 5 V power supply	0.325 W
Data format default setting	0...20 mA in two's complement 0...4095 (can be configured in software, see Analog module data formats on page 181)

See Specifications Analog inputs/outputs on page 163 and General specifications on page 162.

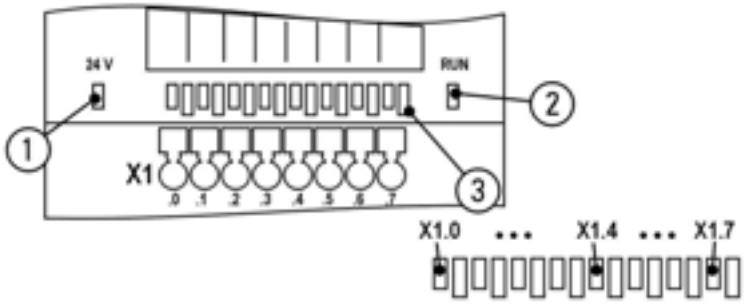
Analog module 4 inputs 4 outputs 4-20mA RIO 4AI/4AO 4-20mA



- 4 analog inputs 4...20 mA
- 4 analog outputs 4...20 mA



4.15.5 LED displays RIO 4AI/4AO 4-20mA

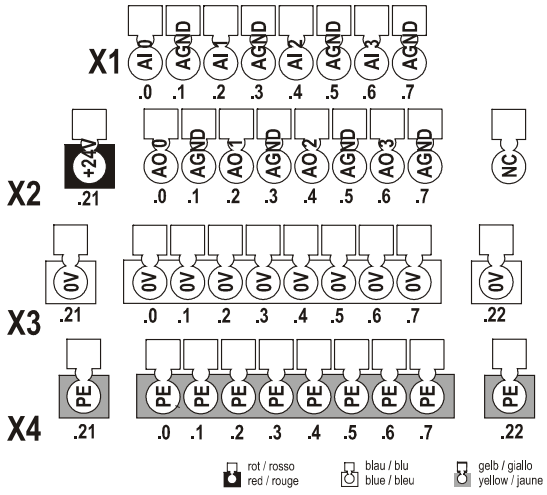


LED displays RIO 4AI/4AO 4-20mA			
No.	LED	Color	Meaning
1	24 V	Yellow	DC 24 V power supply is connected
2	RUN	Yellow	Internal data transmission to bus coupler
3		Yellow	Channel cursor

4.15.6 Data width RIO 4AI/4AO 4-20mA

RIO 4AI/4AO 4-20mA		
	Word Inputs	Word Outputs
Data width	Word 1 to 4 (channel 0 to 3)	Word 1 to 4

4.15.7 Terminal assignment RIO 4AI/4AO 4-20mA

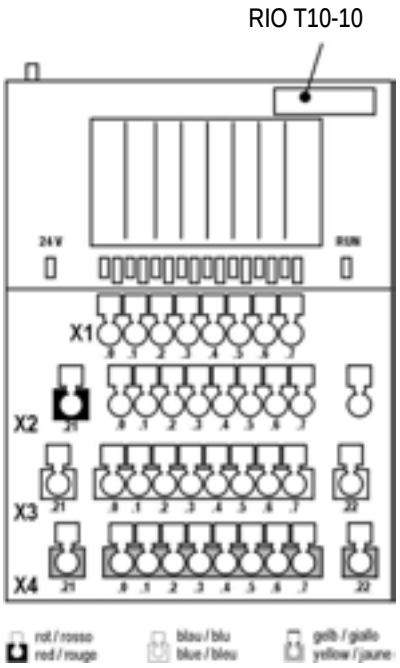


4.15.8 Specifications RIO 4AI/4AO 4-20mA

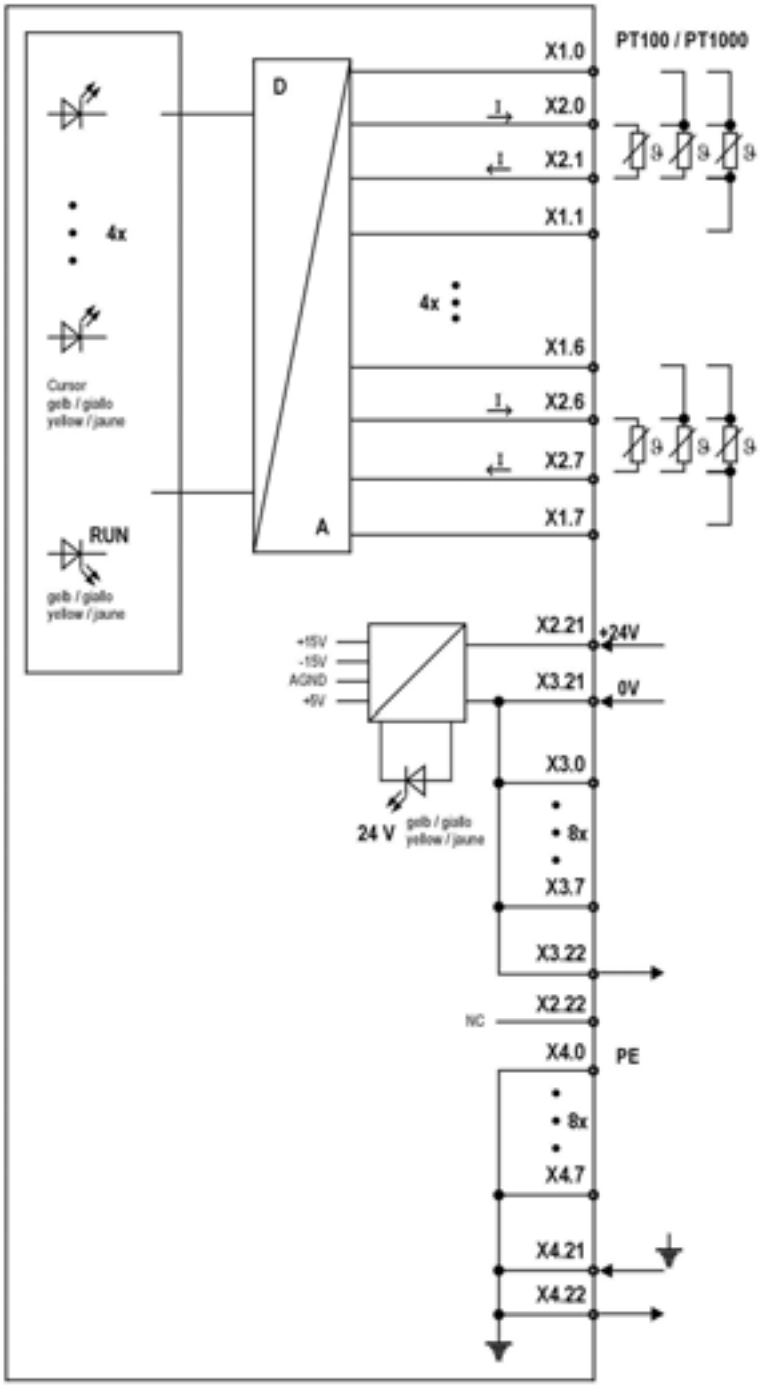
RIO 4AI/4AO 4-20mA	
Order no.	PCD0.W724
Module ID	16d / 10h
Number of inputs/outputs	4/4
External power supply	DC 24 V ± 20% max. 5% residual ripple
Power consumption from external 24 V power supply	6 W (maximum load on analog outputs)
Power consumption from internal 5 V power supply	0.325 W
Data format default setting	4...20 mA in S7 format (can be configured in software, see Analog module data formats on page 181)

See Specifications Analog inputs/outputs on page 163 and General specifications on page 162.

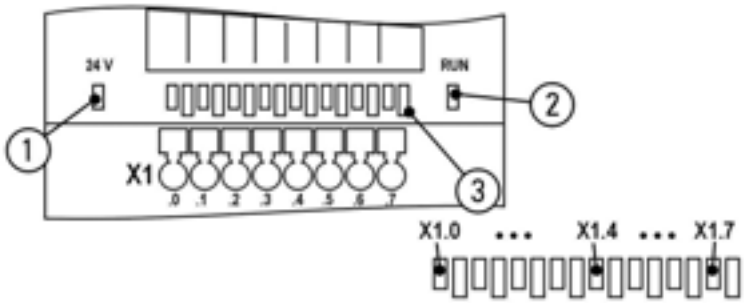
4.16 Temperature module PT100/PT1000 RIO T10-10



- 4 inputs for Pt100 or Pt1000
- Adjusts automatically to Pt100 or Pt1000
- 2-, 3- or 4-wire connection system
- Measuring range -100°C to +450°C
- Resolution 0.1°C



4.16.1 LED displays RIO T10-10



LED displays RIO T10-10			
No.	LED	Color	Meaning
1	24 V	Yellow	DC 24 V power supply is connected
2	RUN	Yellow	Internal data transmission to bus coupler
3		Yellow	Channel cursor

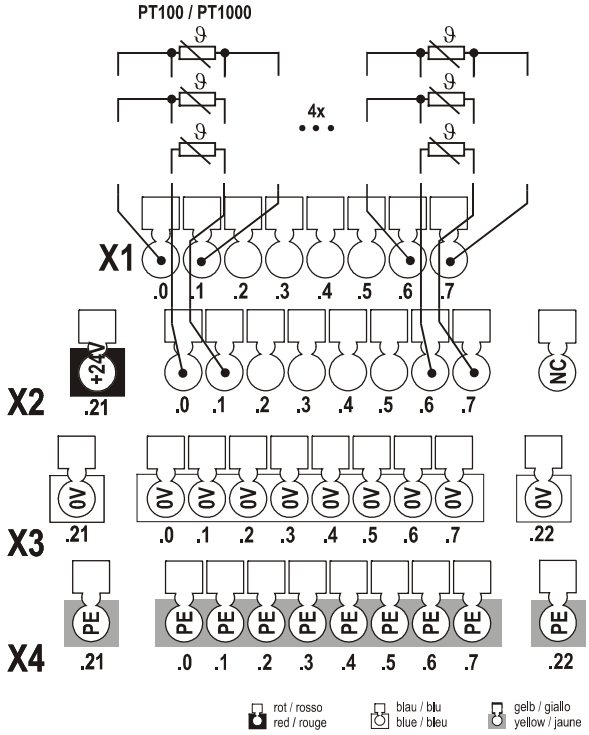
4.16.2 Data width RIO T10-10

RIO T10-10					
	Word Inputs				Word Outputs
Data width	Word 1 to 4				
Two-wire connection	Word	Channel	Terminal	3-wire	4-wire
	1	0	X2.0/2.1	X1.0	X1.1
	2	1	X2.2/2.3	X1.2	X1.3
	3	2	X2.4/2.5	X1.4	X1.5
	4	3	X2.6/2.7	X1.6	X1.7

4.16.3 Data format RIO T10-10

Measured value in °C	Binary																Dec.	Hex.
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0		
400	0	0	0	0	1	1	1	1	1	0	1	0	0	0	0	0	4000	0FA0
50	0	0	0	0	0	0	0	1	1	1	1	1	0	1	0	0	500	01F4
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-50	1	1	1	1	1	1	1	0	0	0	0	0	1	1	0	0	-500	FE0C
-75	1	1	1	1	1	1	0	1	0	0	0	1	0	0	1	0	-750	FD12

4.16.4 Terminal assignment RIO T10-10



No external bridges to unconnected terminals are required when using 2- and 3-wire connections.

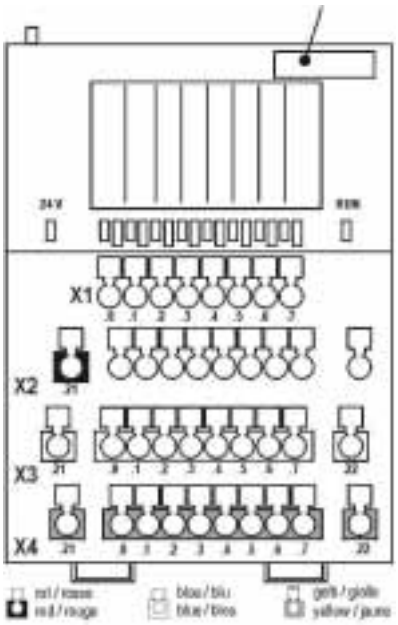
4.16.5 Specifications RIO T10-10

RIO T10-10		
Order no.		PCD0.W540
Module ID		14d / 0Eh
Number of inputs		4, automatically adjusting to Pt100 / Pt1000
Temperature sensor		Pt100 / Pt1000
Measuring range		-100°C to +450°C
Measuring error	Typical	<±1°C
	Max.	±0.3°C ±0.25% from measured value
Resolution		0.1°C
A/D converter		16 bits
Integration period		< 100 ms
External power supply		DC 24 V ± 20% max. 5% residual ripple
Power consumption from external 24 V power supply		3.8 W (including load current 4 x Pt100)
Power consumption from internal 5 V power supply		0.325 W

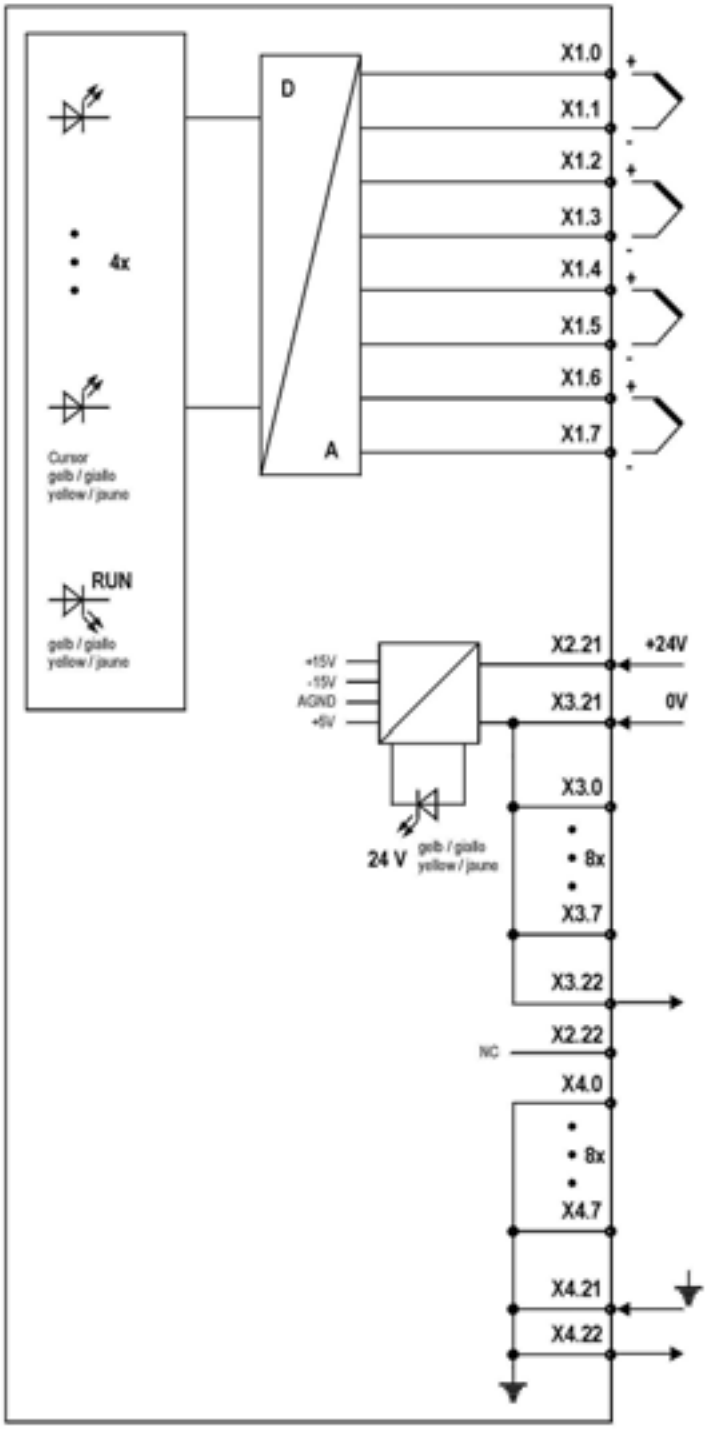
See also General specifications on page 162.

4.17 Temperature module thermocouples RIO T20-10

RIO T20-10

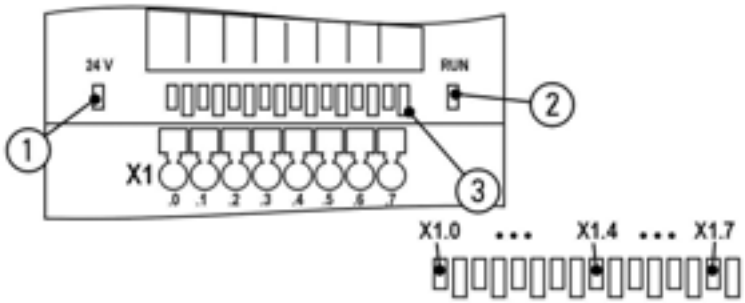


- 4 inputs for thermocouples
- Adjustable for thermocouples K, J and L
- Resolution 0.1°C
- Internal reference junction



Thermocouple		Measuring range
K	NiCr-Ni	-200°C to +1369°C
J	FeCu-Ni	-200°C to 1200°C
L	FeCu-Ni	-199°C to 900°C

4.17.1 LED displays RIO T20-10



LED displays RIO T20-10			
No.	LED	Color	Meaning
1	24 V	Yellow	DC 24 V power supply is connected
2	RUN	Yellow	Internal data transmission to bus coupler
3		Yellow	Channel cursor

4.17.2 Data width channel and terminal assignment RIO T20-10

RIO T20-10			
	Word Inputs		Word Outputs
Data width	Word 1 to 4		
	Word	Channel	Terminal
	1	0	X1.0/1.1
	2	1	X1.2/1.3
	3	2	X1.4/1.5
	4	3	X1.6/1.7

4.17.3 Data format RIO T20-10

For information on setting the data format see Parameterizing RIO T20-10 on page 82

The following data formats can be set:

SIMATIC S7 format

SIMATIC S7 format for thermocouples K, J and L																		
Measured value in °C	Binary representation																Hex.	Units
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0		
+100	0	0	0	0	0	0	1	1	1	1	1	0	1	0	0	0	03E8	1000
+1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	000A	10
+0,1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0001	1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0000	0
-0,1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	FFFF	-1
-1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	FFF6	-10
-100	1	1	1	1	1	1	0	0	0	0	0	1	1	0	0	0	FC18	-1000

SIMATIC S5 format

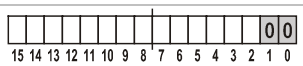
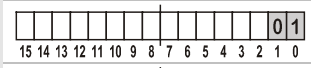
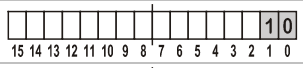
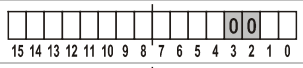
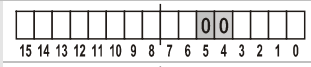
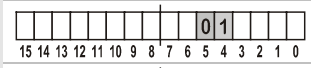
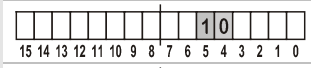
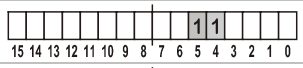
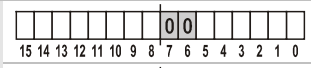
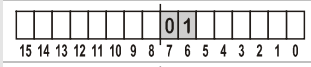
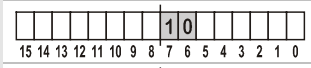
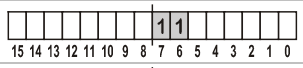
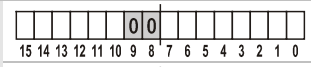
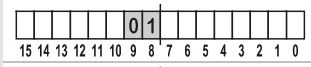
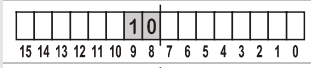
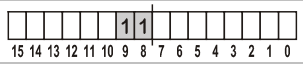
SIMATIC S5 format for thermocouples K, J and L																	
Measured value in °C	Binary representation																Units
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
+100	0	0	0	0	0	0	1	1	0	0	1	0	0	x	x	x	100
+1	0	0	0	0	0	0	0	0	0	0	0	0	1	x	x	x	1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	x	x	x	0
-1	1	1	1	1	1	1	1	1	1	1	1	1	1	x	x	x	-1
-100	1	1	1	1	1	1	0	0	1	1	1	0	0	x	x	x	-100

x No meaning

4.17.4 Parameterizing RIO T20-10

The data format is set using parameterizing and diagnosis function 11 of the respective bus coupler (e.g. RIO BC or EC).

The following parameters can be set:

Parameter	Mode word	Meaning
Characteristics		K-characteristic
		J-characteristic
		L-characteristic
Spare		Spare (must always be 00)
Channel number		4 channels used
		1 channel used
		2 channels used
		3 channels used
Resolution		0.1°C
		0.2°C
		Spare
		Spare
Numerical format		SIMATIC S7
		SIMATIC S5
		Spare
		Spare

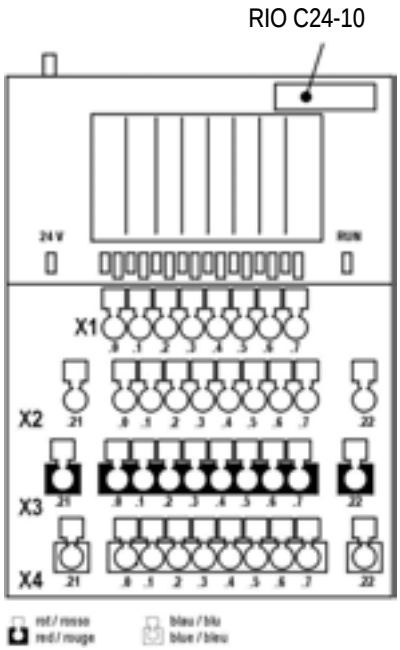
Default setting: all bits = 0 (K-characteristic; 4 channels; 0.1°C; S7)

4.17.5 Specifications RIO T20-10

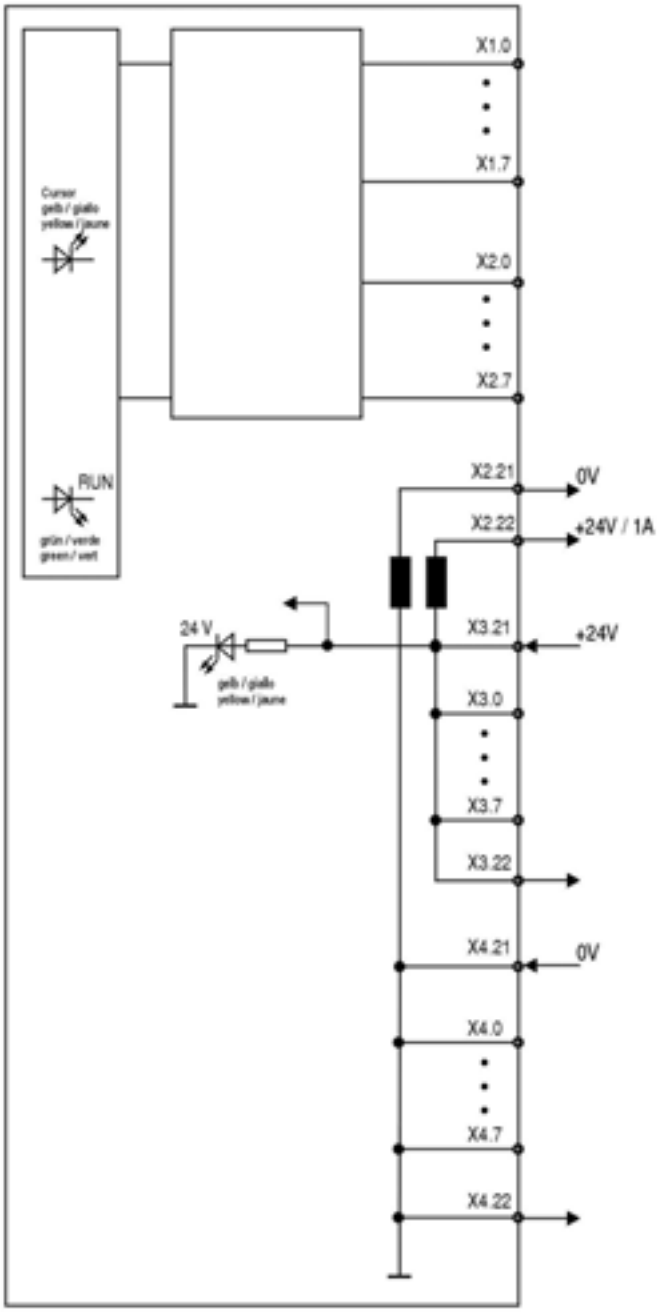
RIO T20-10	
Order no.	PCD0.W580
Module ID	20d / 14h
Number of inputs	4
Thermocouples	K, J and L
Measuring range	-268°C to +1372°C
Resolution	0.1°C
A/D converter	24 bits
Power supply	DC 24 V ± 20% max. 5% residual ripple
Power consumption from external 24 V power supply	2.9 W
Power consumption from internal 5 V power supply	0.325 W

See also General specifications on page 162.

4.18 Counter module RIO C24-10



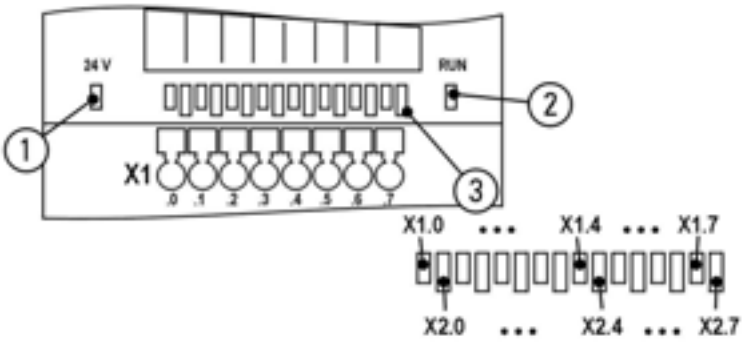
- 4 up/down counters (16 bits) or 2 up/down counters (32 bits) which can be configured in software
- Counting frequency up to 200 kHz
- Interference suppression can be adjusted in software using digital filters
- Maximum/minimum final counter values can be set in software
- Threshold values can be set in software
- Signal output threshold reached
- Enable input



4.18.1 Notes on connecting

- If the interference suppression is turned on for counting frequencies ≤ 20 kHz the signal cables do not require shielding. The encoders can be supplied with power through terminal row X3 (0 V) and X4 (DC 24 V).
- If the interference suppression is turned off (counting frequency up to 200 kHz) the signal cables must be shielded. The encoders must be supplied with power through the filtered power supply via terminals X2.21 (0 V) and X2.22 (DC 24 V / 1 A). The interference suppression is set in the control data.

4.18.2 LED displays RIO C24-10



LED displays RIO C24-10			
No.	LED	Color	Meaning
1	24 V	Yellow	DC 24 V power supply is connected
2	RUN	Yellow	Internal data transmission to bus coupler
3	X1.0 ... X1.7 X2.0 ... X2.7	Green	Control state
		Yellow	Channel cursor

4.18.3 Terminal assignment RIO C24-10

Terminal assignment 4 counters 16 bits

4 counters with 16 bits each				
Counter	Clock pulse+ Input counter +)	Clock pulse- (Input counter –)	Gate (enable inputs)	Signal outputs (default setting iOFF)
1	X1.0	X1.2	X1.4	X1.6 Threshold comparison
2	X1.1	X1.3	X1.5	X1.7 Threshold comparison
3	X2.0	X2.2	X2.4	X2.6 Threshold comparison
4	X2.1	X2.3	X2.5	X2.7 Threshold comparison

Terminal assignment 2 counters 32 bits

Terminal assignment for 2 counters with 32 bits each				
Counter	Clock pulse+ Input counter +)	Clock pulse- (Input counter –)	Gate (enable inputs)	Signal outputs (default setting OFF)
1	X1.0	X1.2	X1.4	X1.6 Threshold comparison 1 X1.7 Threshold comparison 2
2	X2.0	X2.2	X2.4	X2.6 Threshold comparison 1 X2.7 Threshold comparison 2

Clock pulse+ Counter is incremented at rising edge:
Clock pulse- Counter is decremented at rising edge:
Gate 0 (0 V): Counter disabled, 1 (24 V): Counter enabled

The clock pulse- terminal can be used more than once (see optional functions)

4.18.4 Data width RIO C24-10

	Input	Output
Data width in words	5 or 3*	5 or 3*

*If only 1 32 bit counter or 2 16 bit counters are used the data width to be transferred can be reduced to 3 words. The data width is set using service function 13 on the bus coupler.
If the data width is 3 words word 3 and 4 are not transmitted. Word 5 will be transmitted as word 3.

4.18.5 Basic functions RIO C24-10

The following basic functions are active after the power supply has been switched on:

- Actual counter values = 0
- Counter start values = 0
- 4 16 bit counters (2 32 bit counters can be set in control data word 5)
- Interference suppression for counting frequencies up to 20 kHz
- Every counter counts the input signals as long as the enable signal (gate) is set.
- Counting method: Up to the respective minimum/maximum value, no reset when the maximum number is reached

Data configuration 4 counters 16 bit

Word		Input	Output
1		Actual value counter 1	Start value counter 1
2		Actual value counter 2	Start value counter 2
3		Actual value counter 3	Start value counter 3
4		Actual value counter 4	Start value counter 4
5		Control state of terminals X1.0 ... X1.7 and X2.0 ... 2.7	Control data (see next table)
Control data word 5			
Bit	Value	Function	
0-7		No function	
8-10	0	For optional functions	
11	i0	4 counters 16 bit	
12	1	Set counter 1 to start value	
13	1	Set counter 2 to start value	
14	1	Set counter 3 to start value	
15	1	Set counter 4 to start value	

Data configuration 2 counters 32 bit

Word	Input	Output
1	Counter 1 MSB	Counter 1 start MSB value
2	Counter 1 actual LSB value	Counter 1 start LSB value
3	Actual value counter 2	Start value counter 2
4	Actual value counter 2	Start value counter 2
5	Control state of terminals X1.0 ... X1.7 and X2.0 ... 2.7	Control data (see next table)
Control data word 5		
Bit	Value	Function
0-7		No function
8-10		For optional functions
11	Always 1	Selection: Module operates as 2x 32 bit counter
12	1	Set counter 1 to start value
13		No function
14	1	Set counter 2 to start value
15		No function

4.18.6 Optional functions RIO C24-10

The optional functions can be activated in the control data. The functions are available for every counter.

- The function of the input terminal clock pulse- can be changed to:
  1. Reset counter
  2. Select count direction
- Threshold comparison with fast output signals. (Control delay approx. 0.02 ms when switched on, approx. 0.2 ms when switched off)
- Two variations for threshold comparisons:
  1. Counter value < Threshold
  2. Counter value >= Threshold
- If the module for two 32 bit counters is used 2 thresholds can be set.
- Interference suppression with digital filters for 200 Hz, 2 kHz, 20 kHz, 200 kHz.

4.18.7 Complete control data from the PLC to the module (outputs)

5 words are transferred from the PLC to the module. Depending on word 5 the first 4 words have different meanings.

4 counters 16 bit (word 5 bit 11 = 0)					
Word 1	Word 2	Word 3*	Word 4*	Word 5	
X	X	X	X	0000 0000 xxxx xxxx b	No impact, i.e. no data loaded in the module
Counter value Counter 1	X	X	X	xxx1 0000 xxxx xxxx b	Load counter 1
X	Counter value Counter 2	X	X	xx1x 0000 xxxx xxxx b	Load counter 2
X	X	Counter value Counter 3	X	x1xx 0000 xxxx xxxx b	Load counter 3
X	X	X	Counter value Counter 4	1xxx 0000 xxxx xxxx b	Load counter 4
Counter value Counter 1	Counter value Counter 2	Counter value Counter 3	Counter value Counter 4	1111 0000 xxxx xxxx b	Load counters 1 to 4
Threshold value 1 Counter 1	Threshold value 1 Counter 2	Threshold value 1 Counter 3	Threshold value 1 Counter 4	xxxx 0001 xxxx xxxx b	Load threshold values 1 (Counters 1 to 4)
Override data Counter 1*	Override data Counter 2*	Override data Counter 3*	Override data Counter 4*	xxxx 0011 xxxx xxxx b	Load override data (Counters 1 to 4)
Configuration data Counter 1*	Configuration data Counter 2*	Configuration data Counter 3*	Configuration data Counter 4*	xxxx 0100 xxxx xxxx b	Load configuration data (Counters 1 to 4)

X: any word value x: any bit value MSB: Most Significant Byte
b: binary representation *: For details see below LSB: Least Significant Byte

*Word 3 and 4 are not transmitted if the data width is set to 3. Word 5 will then be transmitted as word 3.

2 counters 32 bit (word 5 bit 11 = 1)					
Word 1	Word 2	Word 3	Word 4	Word 5	
X	X	X	X	0000 1000 xxxx xxxx b	No impact, i.e. no data loaded in module
Counter value Counter 1 (MSB)	Counter value Counter 1 (LSB)	X	X	xxx1 1000 xxxx xxxx b	Load counter 1
X	X	Counter value Counter 2 (MSB)	Counter value Counter 2 (LSB)	x1xx 1000 xxxx xxxx b	Load counter 2
Counter value Counter 1 (MSB)	Counter value Counter 1 (LSB)	Counter value Counter 2 (MSB)	Counter value Counter 2 (LSB)	x1x1 1000 xxxx xxxx b	Load counters 1 and 2
Threshold value 1 Counter 1 (MSB)	Threshold value 1 Counter 1 (LSB)	Threshold value 1 Counter 2 (MSB)	Threshold value 1 Counter 2 (LSB)	xxxx 1001 xxxx xxxx b	Load threshold values 1 (Counters 1 and 2)
Threshold value 2 Counter 1 (MSB)	Threshold value 2 Counter 1 (LSB)	Threshold value 2 Counter 2 (MSB)	Threshold value 2 Counter 2 (LSB)	xxxx 1010 xxxx xxxx b	Load threshold values 2 (Counters 1 and 2)
Override data Counter 1*	X	Override data Counter 2*	X	xxxx 1011 xxxx xxxx b	Load override data (Counters 1 and 2)
Configuration data Counter 1*	X	Configuration data Counter 2*	X	xxxx 1100 xxxx xxxx b	Load configuration data (Counters 1 and 2)

X: any word value x: any bit value MSB: Most Significant Byte
b: binary representation *: For details see below LSB: Least Significant Byte

Configuration data

Bit values	Description
xxxx xxxx xxxx xx00 b	Default function of clock pulse- terminal
xxxx xxxx xxxx xx01 b	Reset function of clock pulse- terminal
xxxx xxxx xxxx xx10 b	Direction function of clock pulse- terminal
xxxx xxxx xxxx 00xx b	Interference suppression 20 kHz
xxxx xxxx xxxx 01xx b	Interference suppression 2 kHz
xxxx xxxx xxxx 10xx b	Interference suppression 200 Hz
xxxx xxxx xxxx 11xx b	Interference suppression 200 kHz
xxxx xxxx xxx0 xxxx b	Threshold comparison 1 = 1 if counter value < threshold value 1
xxxx xxxx xxx1 xxxx b	Threshold comparison 1 = 1 if counter value ≥ threshold value 1
xxxx xxxx xx0x xxxx b	Threshold comparison 2 = 1 if counter value < threshold value 2
xxxx xxxx xx1x xxxx b	Threshold comparison 2 = 2 if counter value ≥ threshold value 1

x: any bit value b: binary representation

Optional function of the clock pulse- terminal

Reset function	
Input signal	Function
0	Do not reset
1	Set counter to zero
Count direction function	
0	Count direction + (rising edge incremented)
1	Count direction - (rising edge decremented)

Override data

Bit values	Description
xxxx xxx0 xxxx xxxx b	Do not overwrite clock pulse+
xxxx xxx1 xxxx xxx0 b	Overwrite clock pulse+ with 0
xxxx xxx1 xxxx xxx1 b	Overwrite clock pulse+ with 1
xxxx xx0x xxxx xxxx b	Do not overwrite clock pulse-
xxxx xx1x xxxx xx0x b	Overwrite clock pulse- with 0
xxxx xx1x xxxx xx1x b	Overwrite clock pulse- with
xxxx x0xx xxxx xxxx b	Do not overwrite gate
xxxx x1xx xxxx x0xx b	Overwrite gate with 0
xxxx x1xx xxxx x1xx b	Overwrite gate with 1
xxxx 0xxx xxxx xxxx b	Do not overwrite reset
xxxx 1xxx xxxx 0xxx b	Overwrite reset with 0
xxxx 1xxx xxxx 1xxx b	Overwrite reset with 1
xxx0 xxxx xxxx xxxx b	Do not overwrite direction
xxx1 xxxx xxx0 xxxx b	Overwrite direction with 0
xxx1 xxxx xxx1 xxxx b	Overwrite direction with 1
xx0x xxxx xxxx xxxx b	Do not overwrite threshold comparison 1
xx1x xxxx xx0x xxxx b	Overwrite threshold comparison 1 with 0
xx1x xxxx xx1x xxxx b	Overwrite threshold comparison 1 with 1
x0xx xxxx xxxx xxxx b	Do not overwrite threshold comparison 2
x1xx xxxx x0xx xxxx b	Overwrite threshold comparison 2 with 0
x1xx xxxx x1xx xxxx b	Overwrite threshold comparison 2 with 1

x: any bit value b: binary representation

4.18.8 Process data from the module to the PLC (inputs)

5 words* are transmitted to the PLC. Words 1-4 always contain the current counter positions.

*Word 3 and 4 are not transmitted if the data width is set to 3. Word 5 will then be transmitted as word 3.

Word 5: Input/output states	
Bit values	Description
Xxxx xxxx xxxx xxx0 b	State of clock pulse+ counter 1/16 or 1/32 is 0 (0 V)
Xxxx xxxx xxxx xxx1 b	State of clock pulse+ counter 1/16 or 1/32 is 1 (24 V)
Xxxx xxxx xxxx xx0x b	State of clock pulse+ counter 2/16 is 0 (0 V)
Xxxx xxxx xxxx xx1x b	State of clock pulse+ counter 2/16 is 1 (24 V)
Xxxx xxxx xxxx x0xx b	State of clock pulse-/reset/direction counter 1/16 or 1/32 is 0 (0 V)
Xxxx xxxx xxxx x1xx b	State of clock pulse-/reset/direction counter 1/16 or 1/32 is 1 (24 V)
Xxxx xxxx xxxx 0xxx b	State of clock pulse-/reset/direction counter 2/16 is 0 (0 V)
Xxxx xxxx xxxx 1xxx b	State of clock pulse-/reset/direction counter 2/16 is 1 (24 V)
xxxx xxxx xxx0 xxxx b	State of gate counter 1/16 or 1/32 is 0 (0 V)
xxxx xxxx xxx1 xxxx b	State of gate counter 1/16 or 1/32 is 1 (24 V)
xxxx xxxx xx0x xxxx b	State of gate counter 2/16 is 0 (0 V)
xxxx xxxx xx1x xxxx b	State of gate counter 2/16 is 1 (24 V)
xxxx xxxx x0xx xxxx b	State of threshold value 1 counter 1/16 or 1/32 is 0 (0 V)
xxxx xxxx x1xx xxxx b	State of threshold value 1 counter 1/16 or 1/32 is 1 (24 V)
xxxx xxxx 0xxx xxxx b	State of threshold 1 counter 2/16 or threshold 2 counter 1/32 is 0 (0 V)
xxxx xxxx 1xxx xxxx b	State of threshold 1 counter 2/16 or threshold 2 counter 1/32 is 1 (24 V)
xxxx xxx0 xxxx xxxx b	State of clock pulse+ counter 3/16 or 2/32 is 0 (0 V)
xxxx xxx1 xxxx xxxx b	State of clock pulse+ counter 3/16 or 2/32 is 1 (24 V)
xxxx xx0x xxxx xxxx b	State of clock pulse+ counter 4/16 is 0 (0 V)
xxxx xx1x xxxx xxxx b	State of clock pulse+ counter 4/16 is 1 (24 V)
xxxx x0xx xxxx xxxx b	State of clock pulse-/reset/direction counter 3/16 or 2/32 is 0 (0 V)
xxxx x1xx xxxx xxxx b	State of clock pulse-/reset/direction counter 3/16 or 2/32 is 1 (24 V)
Xxxx 0xxx xxxx xxxx b	State of clock pulse-/reset/direction counter 4/16 is 0 (0 V)
Xxxx 1xxx xxxx xxxx b	State of clock pulse-/reset/direction counter 4/16 is 1 (24 V)
xxx0 xxxx xxxx xxxx b	State of gate counter 3/16 or 2/32 is 0 (0 V)
xxx1 xxxx xxxx xxxx b	State of gate counter 3/16 or 2/32 is 1 (24 V)
xx0x xxxx xxxx xxxx b	State of gate counter 4/16 is 0 (0 V)
xx1x xxxx xxxx xxxx b	State of gate counter 4/16 is 1 (24 V)
x0xx xxxx xxxx xxxx b	State of threshold value 1 counter 3/16 or 2/32 is 0 (0 V)
x1xx xxxx xxxx xxxx b	State of threshold value 1 counter 3/16 or 2/32 is 1 (24 V)
0xxx xxxx xxxx xxxx b	State of threshold 1 counter 4/16 or threshold 2 counter 2/32 is 0 (0 V)
1xxx xxxx xxxx xxxx b	State of threshold 1 counter 4/16 or threshold 2 counter 2/32 is 1 (24 V)

x: any bit value b: binary representation

4.18.9 Examples

General

- A specific sequence must sometimes be followed when writing thresholds, configuration data or override data.
- If the module is used with a field bus system you must wait at least one field bus cycle before writing data to the module to ensure that the data is transferred securely to the module.

Example 1 Basic function

- Configuration as 4 counters with 16 bits each.
- The PLC reads the counters. The PLC also resets the counters.
- Connection: Signal on X1.0 (clock pulse+) and +24 V on X1.4 (gate)

1. The PLC reads the input words 1 to 5 and evaluates them.
2. Example of resetting counter 1: PLC writes counter to zero
   → word 1 = 0; word 5 = 2000h
3. Next cycle: PLC resets control word
   → word 5 = 0
   h:Hex. format

Example 2 Clock pulse- terminal with reset function

- Configuration as 4 counters with 16 bits each.
- The PLC reads the counters.
- Counter 1 and 2 are to be reset by an external signal.
- Maximum input frequency of signals 1 kHz
- Connection: Signal for counter 1on X1.0 clock pulse+, external reset signal on X1.2 and +24 V on X1.4
  Signal for counter 2 on X1.1 clock pulse+, external reset signal on X1.3 and +24 V on X1.5

1. The PLC waits until the field bus delivers valid values or input word 5 is not zero.
2. The PLC writes configuration data, interference suppression 2 kHz and terminal assignment
3. Reset → word 1 = 0005h; word 2 = 0005h; word 5 = 0400h
4. The PLC resets the control word
   → word 1 = 0; word 2 = 0; word 5 = 0
5. The PLC reads input words 1 to 5 and evaluates them.
   h:Hex. format

Example 3 Threshold comparison

- Configuration 4 counters with 16 bits each.
- Counter channel 1 is supposed to switch on output X1.6 at pulse 35000.
  The PLC determines when the output is switched off and when the counters resets.
- Maximum input frequency of signals 10 kHz
- Connection: Signal for counter 1 on X1.0 (clock pulse+)

1. The PLC waits until the field bus delivers valid values.
2. The PLC writes override data: Output signal counter 1 to zero
   → word 1 = 2000h; word 5 = 0300h
3. The PLC writes configuration data: Output counter 1=1 if counter1>=Threshold
   → word 1 = 0010h; word 5 = 0400h
4. The PLC writes the threshold in counter 1
   → word 1 = dec35000 ; word 5 = 0100h
5. The PLC writes reset counter 1 if necessary (only if actual counter value <> 0)
   → word 1 = 0 ; word 5 = 1000h
6. The PLC writes override data: Output signal counter 1 enabled and enable counter 1 (gate)
   → word 1 = 0404h ; word 5 = 0300h
7. The PLC writes everything to zero
   → word 1 = 0; word 5 = 0
8. The module is now counting. On pulse 35000 the module switches output X1.6 to 1
9. The PLC waits until the module has switched the output (input word 5 / bit 6 = 1)
   & the PLC waits until the counting process is supposed to restart.

The PLC writes: Reset counter 1
→ word 1 = 0 ; word 5 = 1000h

10. Output X1.6 is switched off and the PLC writes everything to zero
    → word 1 = 0 ; word 5 = 0
11. Continued at step 8.

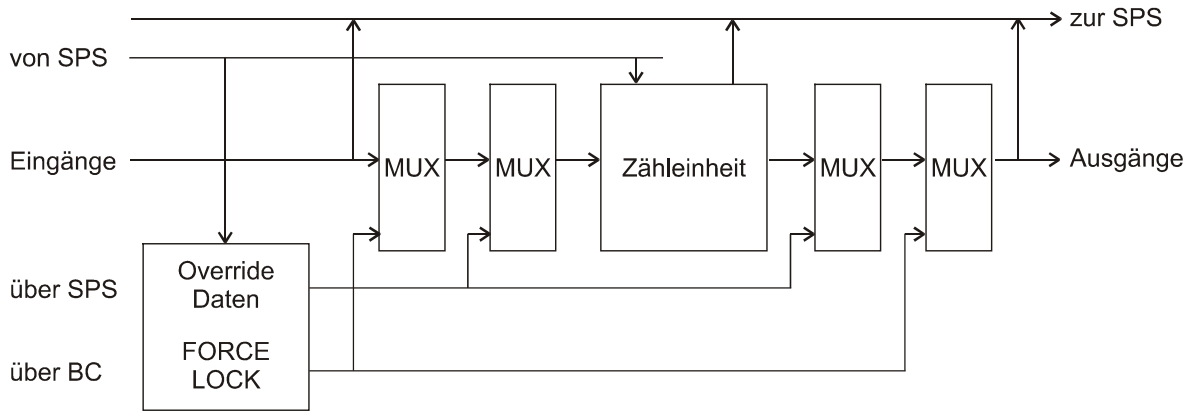
h:Hex. format

Always choose an appropriate interference suppression in relation to the maximum input signal frequency. This ensures a safe operation of the counter.
Example:
Maximum input signal frequency = 120 Hz → interference suppression 200 Hz

4.18.10 FORCE, LOCK and Display mode priorities

All inputs and outputs can be overwritten in FORCE or LOCK. FORCE/LOCK have a direct impact on inputs and outputs.

If FORCE/LOCK are selected simultaneously and override data are sent from the PLC the following case applies:



Key:
From PLC, To PLC
Inputs, MUX, Counter, Outputs
Via PLC, Via BC, Override data, FORCE, LOCK

In Display mode counter data is displayed with four digits in hex. format. On 32 bit counters the 4 lower and the 4 higher digits are displayed separately. The display looks as follows this depending on the position of the channel cursor (yellow LED):

Number and type of counters	Channel cursor position on:	Display
4 x 16 bits	X1.0, X1.2, X1.4, X1.6	Counter value Z1
	X1.1, X1.3, X1.5, X1.7	Counter value Z2
	X2.0, X2.2, X2.4, X2.6	Counter value Z3
	X2.1, X2.3, X2.5, X2.7	Counter value Z4
2 x 32 bits	X1.0, X1.2, X1.4, X1.6	Counter value Z1 MSW
	X1.1, X1.3, X1.5, X1.7	Counter value Z1 LSW
	X2.0, X2.2, X2.4, X2.6	Counter value Z2 MSW
	X2.1, X2.3, X2.5, X2.7	Counter value Z2 LSW

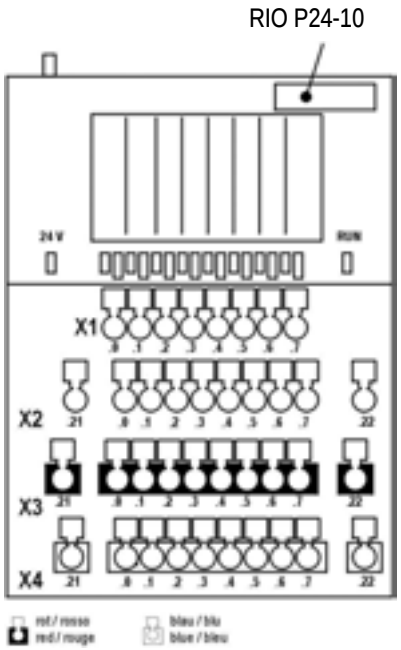
MSW: Most Significant Word
LSW: Least Significant Word

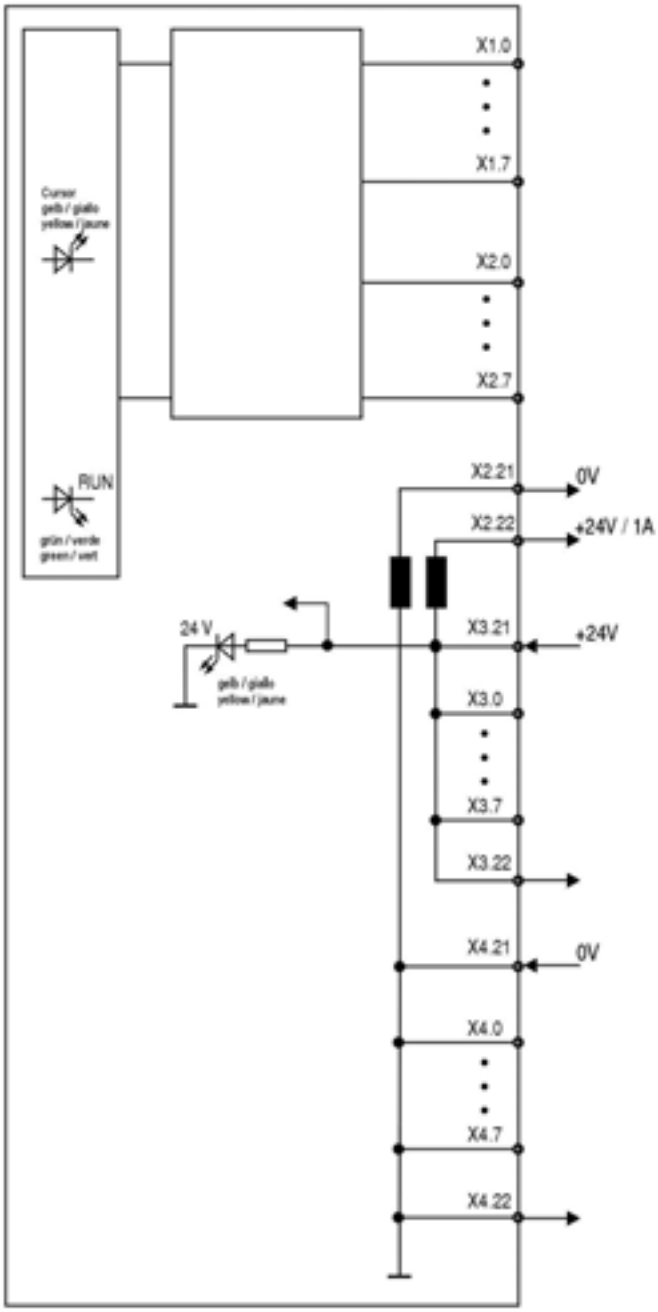
4.18.11 Specifications RIO C24-10

RIO C24-10	
Order no.	PCD0.H110
Module ID	10d / 0Ah (6 I/O bytes) 11d / 0Bh (10 I/O bytes)
Number of counters	4 (16 bit) or 2 (32 bit)
Counting frequency	Max. 200 kHz Interference suppression adjustable 200 Hz, 2 kHz, 20 kHz, 200 kHz
Number of inputs/outputs	12 inputs 4 outputs
External power supply	DC 24 V ± 20% max. 5% residual ripple
Power consumption from external 24 V power supply	0.25 W (without input currents / load currents)
Power consumption from internal 5 V power supply	1.1 W
Inputs	
Switching level	H level +15 V to +30 V L level -30 V to +5 V
Input current	Min. H level (+15 V), I ≥ 3.5 mA Max. L level (+5 V), I ≤ 1.0 mA Typical (+24 V), I = 7.5 mA
Isolation from internal bus	Yes, each channel separately via opto-electronic couplers
Simultaneity	100%
Signal delay	<1 µs (hardware)
Outputs	
Output current per output max.	1A overload and short-circuit proof
Total current for whole module max.	4 A
Switching level	H level = power supply - 0.5 V L level <= 1V
Isolation from internal bus	Yes, each channel separately via opto-electronic couplers
Simultaneity	100%
Free-wheeling diode	Integrated
Signal delay	<300 µs (hardware)
Power supply for fast encoders (terminals X2.21 / X2.22)	
Voltage	DC 24 V
Current	Max. 1A

See also General specifications on page 162.

4.19 Positioning module RIO P24-10

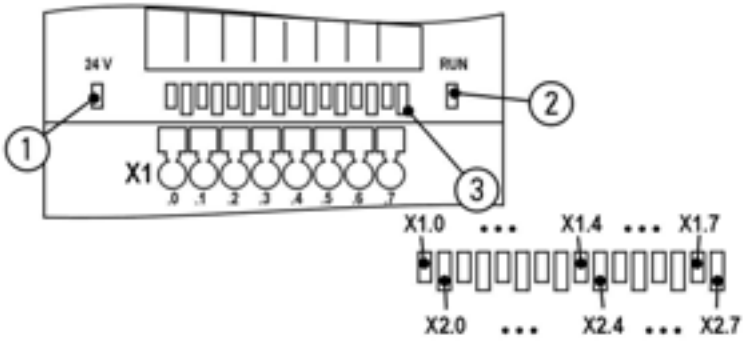




- The positioning module is designed for positioning two axes.
  It provides two independent up/down counters with 24 V inputs/outputs in one housing.

- 16 terminals are available for I/O, and 10 terminals each for 24 V / 0 V and one terminal each for 24 V / 0 V with interference suppression. These can be used for encoders (for fast encoders voltage with interference suppression) and outputs as reference or to supply power. There is only one common GND for all encoders and outputs.

4.19.1 LED displays RIO P24-10



LED displays RIO P24-10			
No.	LED	Color	Meaning
1	24 V	Yellow	DC 24 V power supply is connected
2	RUN	Yellow	Internal data transmission to bus coupler
3	Control state of terminals X1.0 ... X1.7 X2.0 ... X2.7	Green	Control state
		Yellow	Channel cursor

4.19.2 Terminal assignment RIO P24-10

Inputs	Counter 1	Counter 2	
Tracking signal A	X1.0	X2.0	Incremental encoder track A
Tracking signal B	X1.1	X2.1	Incremental encoder track B
Tracking signal N	X1.2	X2.2	Incremental encoder track N, zero pulse
End+	X1.3	X2.3	Limit switch End+, actuated 0 V, not actuated 24 V
End-	X1.4	X2.4	Limit switch End-, actuated 0 V, not actuated 24 V
Outputs (default configuration)			
Move+	X1.5	X2.5	Move axis towards +
Move-	X1.6	X2.6	Move axis towards -
Speed	X1.7	X2.7	Speed 0: slow, 1: fast
Outputs can also be changed from the master PLC.			Any alternative configurations of outputs must be selected in the PLC program.
Travel direction	X1.5	X2.5	Move axis, 0: -, 1: + direction
Travel	X1.6	X2.6	Move axis
Speed	X1.7	X2.7	Speed 0: slow, 1: fast

4.19.3 Functions

Every up/down counter counts the pulses of an incremental encoder (it is not possible to connect absolute value encoders). The counter value is compared with two threshold values thus allowing to control an axis.

The movement of the axis is stopped independently from the counting procedure by the limit switch inputs. The counters can be configured in the PLC. The PLC can write in configuration memories, threshold and counter values and read counter values and input/output states with the exception of tracking signals A, B.

- Counting method: Periodical,
- when maximum has been reached the counter continues at the minimum value, when minimum has been reached counter continues at maximum

- Counting frequency: up to 200 kHz
- Width: 32 bits
- Range: -2^{31} to $2^{31}-1$
- Edge evaluation: 4-fold
- Setting on the PLC:
  Mode, homing direction, homing speed, using N for homing, select outputs, reset counter, counting direction inverted, motion direction outputs inverted, speed output inverted, counter value, pre-shutdown value, shutdown value, override for inputs/outputs
- Setting on the bus coupler
  Overwrite inputs/outputs with FORCE/LOCK
- Storage of data:
  Data or configurations will not be saved if there is a power cut.
- DC 24 V signal level for input and output signals
- Inputs: Tracking signals A, B and N, End+, End-
- Outputs: Move+, Move-, Speed
  can be switched to: Direction, Move, Speed

Operating modes

Homing 1st variation (feed positioning)

Fast (default; can be changed to slow) in homing direction until End+ or End- active. Then slowly in the opposite direction until N is active. Reset counter and turn off.

Homing 2nd variation (feed positioning)

Fast (can be changed to slow) in homing direction until End+ or End- active. Then slowly in the opposite direction until the limit switch is no longer active. Reset counter and turn off.

Homing 3rd variation (band positioning)

Fast (can be changed to slow) in homing direction. After End+ on 24 V (i.e. alternative use of this limit switch) until N is active. Reset counter and turn off. The PLC is notified when homing is completed.

Positioning:

Fast until pre-shutdown threshold, slowly until shutdown threshold, then turn off.
The PLC is notified when positioning is completed.

Positioning 2nd variation (measurement of distance after zero pulse)

Fast in pre-selected homing direction until input N becomes active. Reset counter. Fast until pre-shutoff value is reached, slow until shut-off value is reached and then turn off.
The PLC is notified when positioning is completed.

OFF

Move outputs off.

If the module is used with a RIO bus coupler the outputs of the RIO P24-10 module are not shut off if a cable breaks on the field bus.

From HW version 02 of the RIO P24-10 module a reset of the outputs can be forced if a cable break occurs or at PLC STOP. To do this, set the Enable for outputs bit in word 5 of the control data.

4.19.4 Data width RIO P24-10

RIO P24-10		
	Word Inputs	Word Outputs
Data width	Word 1 to 5 or 1 to 3 depending on setting with service function 13	Word 1 to 5 or 1 to 3 depending on setting with service function 13

*If only one axis is positioned the data width to be transmitted can be reduced to 3 words. The data width is set on the bus coupler using service function 13 (not CANopen bus coupler).

4.19.5 Control data from the PLC to the module (outputs)

5 words are transferred from the PLC to the module. Their meanings depend on word 5 (see below):

Word 1	Word 2	Word 3*	Word 4*	Word 5	
X	X	X	X	xx00 x000 xxxx xxxx b	No impact, i.e. no data loaded in module
X	X	X	X	xxxx xxxx xxxx xx1x b	Enable outputs (0=off)
X	X	X	X	xxxx xxxx nnnn 1xxr b	Feedback bit active, i.e. the state of r is mirrored on bit n of word 5 to the PLC
Counter value Counter 1 (MSB)	Counter value Counter 1 (LSB)	X	X	xx01 x000 xxxx xxxx b	Load counter 1
X	X	Counter value Counter 2 (MSB)	Counter value Counter 2 (LSB)	xx10 x000 xxxx xxxx b	Load counter 2
Counter value Counter 1 (MSB)	Counter value Counter 1 (LSB)	Counter value Counter 2 (MSB)	Counter value Counter 2 (LSB)	xx11 x000 xxxx xxxx b	Load counters 1 and 2
Pre-shutdown value Counter 1 (MSB)	Pre-shutdown value Counter 1 (LSB)	Pre-shutdown value Counter 2 (MSB)	Pre-shutdown value Counter 2 (LSB)	xxxx x001 xxxx xxxx b	Load pre-shutdown values (Counters 1 and 2)
Shutdown value Counter 1 (MSB)	Shutdown value Counter 1 (LSB)	Shutdown value Counter 2 (MSB)	Shutdown value Counter 2 (LSB)	xxxx x010 xxxx xxxx b	Load shutdown values (Counters 1 and 2)
Override data Counter 1*	X	Override data Counter 2*	X	xxxx x011 xxxx xxxx b	Load override data (Counters 1 and 2)
Configuration data Counter 1*	X	Configuration data Counter 2*	X	xxxx x100 xxxx xxxx b	Load configuration data (Counters 1 and 2)

X: any word value x: any bit value MSB: Most Significant Bit
b: binary representation *: For details see below LSB: Least Significant Bit

*Word 3 and 4 are not transmitted if the data width is set to 3. Word 5 will then be transmitted as word 3.

Override data

Bit values	Description
xxxx xxx0 xxxx xxxx b	Do not overwrite tracking signal A
xxxx xxx1 xxxx xxx0 b	Overwrite tracking signal A with 0
xxxx xxx1 xxxx xxx1 b	Overwrite tracking signal A with 1
xxxx xx0x xxxx xxxx b	Do not overwrite tracking signal B
xxxx xx1x xxxx xx0x b	Overwrite tracking signal B with 0
xxxx xx1x xxxx xx1x b	Overwrite tracking signal B with
xxxx x0xx xxxx xxxx b	Do not overwrite tracking signal N
xxxx x1xx xxxx x0xx b	Overwrite tracking signal N with 0
xxxx x1xx xxxx x1xx b	Overwrite tracking signal N with 1
xxxx 0xxx xxxx xxxx b	Do not overwrite limit switch End+
xxxx 1xxx xxxx 0xxx b	Overwrite limit switch End+ with 0
xxxx 1xxx xxxx 1xxx b	Overwrite limit switch End+ with 1
xxx0 xxxx xxxx xxxx b	Do not overwrite limit switch End-
xxx1 xxxx xxx0 xxxx b	Overwrite limit switch End- with 0
xxx1 xxxx xxx1 xxxx b	Overwrite limit switch End- with 1
xx0x xxxx xxxx xxxx b	Do not overwrite Move+/Direction
xx1x xxxx xx0x xxxx b	Overwrite Move+/Direction with 0
xx1x xxxx xx1x xxxx b	Overwrite Move+/Direction with 1
x0xx xxxx xxxx xxxx b	Do not overwrite Move-/Move
x1xx xxxx x0xx xxxx b	Overwrite Move-/Move with 0
x1xx xxxx x1xx xxxx b	Overwrite Move-/Move with 1
0xxx xxxx xxxx xxxx b	Do not overwrite Speed
1xxx xxxx 0xxx xxxx b	Overwrite Speed with 0
1xxx xxxx 1xxx xxxx b	Overwrite Speed with 1

x: any bit value b: binary representation

Configuration data

Bit values	Description
xxxx xxxx xxxx xxx0 b	Select outputs: Move+, Move-, Speed
xxxx xxxx xxxx xxx1 b	Select outputs: Direction, Move, Speed
xxxx xxxx xxxx xx0x b	Motion direction outputs not inverted
xxxx xxxx xxxx xx1x b	Motion direction outputs inverted, i.e. Move+ and Move- inverted or direction inverted
xxxx xxxx xxxx x0xx b	Speed output not inverted, i.e. Speed=0: slow Speed=1: fast
xxxx xxxx xxxx x1xx b	Speed output inverted, i.e. Speed=0: fast Speed=1: slow
xxxx xxxx xxxx 0xxx b	Counting direction not inverted
xxxx xxxx xxxx 1xxx b	Counting direction inverted
xxxx xxxx xxx0 xxxx b	Counter counts according to tracking signals A and B
xxxx xxxx xxx1 xxxx b	Counter is reset
xxxx x000 0xxx xxxx b	Operating mode turned off (for description see below)
xxxx x001 0xxx xxxx b	Operating mode Homing 1st variation (for description see below)
xxxx x001 1xxx xxxx b	Operating mode Homing 2nd variation Measurement after zero pulse (for description see below)
xxxx x010 0xxx xxxx b	Operating mode Homing 1st variation (for description see below)
xxxx x011 0xxx xxxx b	Operating mode Homing 2nd variation (for description see below)
xxxx x100 0xxx xxxx b	Operating mode Homing 3rd variation (for description see below)
xxxx 0xxx xxxx xxxx b	Homing direction, decrementing to limit switch End-
xxxx 1xxx xxxx xxxx b	Homing direction, incrementing to limit switch End+
xxx0 xxxx xxxx xxxx b	Homing speed: slow
xxx1 xxxx xxxx xxxx b	Homing speed: fast

x: any bit value b: binary representation

4.19.6 Process data from the module to the PLC (inputs)

5 words are transmitted to the PLC.

Word 1	Word 2	Word 3*	Word 4*	Word 5
Counter value Counter 1 (MSB)	Counter value Counter 1 (LSB)	Counter value Counter 2 (MSB)	Counter value Counter 2 (LSB)	Input/output states*

*Word 3 and 4 are not transmitted if the data width is set to 3. Word 5 will then be transmitted as word 3. Single bits are used differently, see below.

Input/output states

Bit values word 5	Description
xxxx xxxx xxxx xxx0 b	Message homing counter 1 reset
xxxx xxxx xxxx xxx1 b	Homing counter 1 successfully completed
xxxx xxxx xxxx xx0x b	Message positioning counter 1 reset
xxxx xxxx xxxx xx1x b	Positioning counter 1 successfully completed
xxxx xxxx xxxx x0xx b	State of tracking signal N counter 1 is 0 (0 V)
xxxx xxxx xxxx x1xx b	State of tracking signal N counter 1 is 1 (24 V)
xxxx xxxx xxxx 0xxx b	State of End+ counter 1 is 0 (0 V)
xxxx xxxx xxxx 1xxx b	State of End+ counter 1 is 1 (24 V)
xxxx xxxx xxx0 xxxx b	State of End- counter 1 is 0 (0 V)
xxxx xxxx xxx1 xxxx b	State of End- counter 1 is 1 (24 V)
xxxx xxxx xx0x xxxx b	State of Move+/Direction counter 1 is 0 (0 V)
xxxx xxxx xx1x xxxx b	State of Move+/Direction counter 1 is 1 (24 V)
xxxx xxxx x0xx xxxx b	State of Move-/Move counter 1 is 0 (0 V)
xxxx xxxx x1xx xxxx b	State of Move-/Move counter 1 is 1 (24 V)
xxxx xxxx 0xxx xxxx b	State of Speed counter 1 is 0 (0 V)
xxxx xxxx 1xxx xxxx b	State of Speed counter 1 is 1 (24 V)
xxxx xxx0 xxxx xxxx b	Message homing counter 2 reset
xxxx xxx1 xxxx xxxx b	Homing counter 2 successfully completed
xxxx xx0x xxxx xxxx b	Message positioning counter 2 reset
xxxx xx1x xxxx xxxx b	Positioning counter 2 successfully completed
xxxx x0xx xxxx xxxx b	State of tracking signal N counter 2 is 0 (0 V)
xxxx x1xx xxxx xxxx b	State of tracking signal N counter 2 is 1 (24 V)
xxxx 0xxx xxxx xxxx b	State of End+ counter 2 is 0 (0 V)
xxxx 1xxx xxxx xxxx b	State of End+ counter 2 is 1 (24 V)
xxx0 xxxx xxxx xxxx b	State of End- counter 2 is 0 (0 V)
xxx1 xxxx xxxx xxxx b	State of End- counter 2 is 1 (24 V)
xx0x xxxx xxxx xxxx b	State of Move+/Direction counter 2 is 0 (0 V)
xx1x xxxx xxxx xxxx b	State of Move+/Direction counter 2 is 1 (24 V)
x0xx xxxx xxxx xxxx b	State of Move-/Move counter 2 is 0 (0 V)
x1xx xxxx xxxx xxxx b	State of Move-/Move counter 2 is 1 (24 V)
0xxx xxxx xxxx xxxx b	State of Speed counter 2 is 0 (0 V)
1xxx xxxx xxxx xxxx b	State of Speed counter 2 is 1 (24 V)

x: any bit value b: binary representation

Depending on word 5 of the control data a bit can alternatively also function as a feedback bit.

4.19.7 Operation / operating modes

Powering up

When you power the module up all settings in the module are reset, i.e.

- Counter values, pre-shutdown values, shutdown values are 0000 0000 h
- Override data is 0000 h
- Configuration data is 0000 h

After the module is powered up the following settings are active:

- No data loaded in module.
- No inputs/outputs are overwritten.
- Select outputs: Move+, Move-, Speed
- Direction outputs not inverted
- Speed output not inverted, i.e. speed = 0: slow, speed = 1: fast
- Counting direction not inverted
- Counter counts according to tracking signals A and B
- Operating mode off
- Homing direction, decrementing to limit switch End-
- Homing speed: slow

OFF

Move+ and Move- or Move outputs are off.

Enable outputs after turning them off due to a limit switch.

Positioning 1st variation

1. Fast up to pre-shutdown value
2. Slowly up to shutdown value
3. Move+ and Move- or Move outputs off

A message is sent to the PLC indicating successful completion of positioning.

When you switch to another operating mode this message is deleted.

The direction is determined by comparing the thresholds with the current counter value.

Positioning with pre-shutdown value behind the shutdown value is possible. In this case the direction is inverted when the pre-shutdown value is reached.

If End+=0 or End-=0 the Move+ and Move- or Move outputs are switched off. Select operating mode Off once to re-activate the outputs.

Positioning 2nd variation measurement of distance after zero pulse

1. Fast in defined direction (bit direction for homing) up to zero point (input tracking signal N)
2. Reset counter and move fast up to pre-shutdown value
3. Slowly up to shutdown value
4. Shut down outputs for movement

A message is sent to the PLC indicating successful completion of positioning.

When you switch to another operating mode this message is deleted.

If End+=0 or End-=0 the Move+ and Move- or Move outputs are switched off. Select operating mode Off once to re-activate the outputs.

Homing 1st variation

1. Home at pre-set speed and direction (speed and direction for homing) until the corresponding limit switch is active. If the counting direction at homing is incrementing the axis must reach End+. If not it must reach End-.
2. Inverting the motion direction. Leave limit switch at slow speed. Carry on to zero pulse (tracking signal N).
3. Reset counter and switch off Move+ and Move- or Move.

A message is sent to the PLC indicating successful completion of homing.

When you switch to another operating mode this message is deleted.

If the "other" limit switch becomes active during homing the Move+ and Move- or Move outputs are switched off. Select operating mode Off once to re-activate the outputs.

Homing 2nd variation

1. Home at pre-set speed and direction (speed and direction for homing) until the corresponding limit switch is active. If the counting direction at homing is incrementing the axis must reach End+. If not it must reach End-.
2. Inverting the motion direction. Leave limit switch at slow speed.
3. Reset counter and switch off Move+ and Move- or Move.

A message is sent to the PLC indicating successful completion of homing.

When you switch to another operating mode this message is deleted.

If the "other" limit switch becomes active during homing the Move+ and Move- or Move outputs are switched off. Select operating mode Off once to re-activate the outputs.

Homing 3rd variation

1. Home at pre-set speed and direction (speed and direction for homing) until End+=1 (24 V) (alternative use of this limit switch).
2. Carry on in the same direction at slow speed until the axis reaches the zero pulse (tracking signal N).
3. Reset counter and switch off Move+ and Move- or Move.

A message is sent to the PLC indicating successful completion of homing.

When you switch to another operating mode this message is deleted.

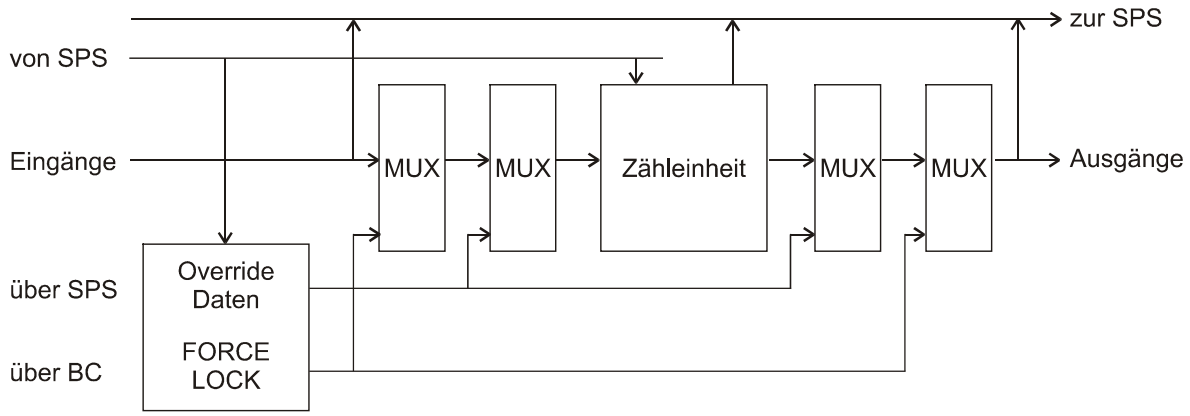
End- is not evaluated during homing.

4.19.8 Operation on the RIO bus coupler

All inputs and outputs can be overwritten in FORCE or LOCK.

FORCE/LOCK have a direct impact on inputs and outputs.

If FORCE/LOCK are selected at the same time on the BC and override data are sent via the PLC the following case applies:



Key
From PLC To PLC
Inputs MUX Counter Outputs
Via PLC
Via BC
Override data
FORCE
LOCK

In Display mode counter data is displayed with four digits in hex. format. The 4 lower and the 4 higher digits are displayed separately. The display looks like as follows depending on the position of the channel cursor (yellow LED):

Number and type of counters	Channel cursor position on:	Display
2 x 32 bit	X1.0, X1.2, X1.4, X1.6	Counter value Z1 MSW
	X1.1, X1.3, X1.5, X1.7	Counter value Z1 LSW
	X2.0, X2.2, X2.4, X2.6	Counter value Z2 MSW
	X2.1, X2.3, X2.5, X2.7	Counter value Z2 LSW

MSW: Most Significant Word
LSW: Least Significant Word

4.19.9 Example

Connecting an incremental position encoder

1. Tracking signal A on X1.0
2. Tracking signal B on X1.1
3. Tracking signal N on X1.2

Connecting a limit switch (active 0 V, open-circuit potential 24 V)

1. Limit switch End+ on X1.3 (reached by incrementing)
2. Limit switch End- on X1.4 (reached by decrementing)

Connecting a drive

1. Move+ on X1.5 (incremental axis movement)
2. Move- on X1.6 (decremental axis movement)
3. Speed on X1.7 (0 V: slow; 24 V: fast)

Powering up

Homing 1st variation to limit switch End+

1. Load mode setting
   0A00 0000 0000 0000 0400
   (PLC->Module, words 1 - 5, hex. format)
2. Axis moves slowly towards End+
   (Move+=24 V, Move-=0 V, Speed=0 V)
3. At End+ (End+=0 V) the axis travels back (Move+=0 V, Move-=24 V, Speed=0 V)
4. When the axis leaves the limit switch in decrementing direction the axis is stopped after the first zero pulse (Move+=0 V, Move-=0 V, Speed=0 V), the counter is reset and the end of the homing procedure is signaled.
   0000 0000 0000 0000 0019
   (Module->PLC, words 1 - 5, hex. format)

OFF

1. Load mode setting
   0000 0000 0000 0000 0400
   (PLC->Module, words 1 - 5, hex. format)

Positioning 1st variation

1. Load pre-shutdown value (0000 0800)
   0000 0800 0000 0000 0100
   (PLC->Module, words 1 - 5, hex format)
2. Load shutdown value (0000 1000)
   0000 1000 0000 0000 0200
   (PLC->Module, words 1 - 5, hex format)
3. Load mode setting
   0100 0000 0000 0000 0400
   (PLC->Module, words 1 - 5, hex. format)
4. Fast incremental axis movement
   (Move+=24 V, Move-=0 V, Speed=24 V)
5. When the axis reaches the pre-shutdown value it moves slowly (incremental axis movement)
   (Move+=24 V, Move-=0 V, Speed=0 V)

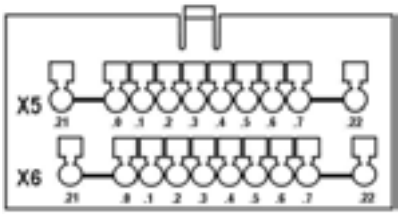
6. When the axis reaches the shutdown value the axis is stopped (Move+=0 V, Move-=0 V, Speed=0 V) and the end of the homing procedure is signaled.
   0000 1000 0000 0000 001A
   (PLC->Module, words 1 - 5, hex. format)

4.19.10 Specifications RIO P24-10

RIO P24-10	
Order no.	PCD0.H300
Module ID	12d / 0Ch (6 I/O bytes) 13d / 0Dh (10 I/O bytes)
Number of controllable axes	2
Counting frequency	Max. 200 kHz
Number of inputs/outputs	10 inputs 6 outputs
Power supply	DC 24 V ± 20% max. 5% residual ripple
Power consumption from external 24 V power supply	0.25 W (without input currents / load currents)
Power consumption from internal 5 V power supply	1.25 W
Inputs	
Input signal level	H level +15 V to +30 V L level -30 V to +5 V
Input current	Min. H level (+15 V), I ≥ 3.5 mA Max. L level (+5 V), I ≤ 1.0 mA Typical (+24 V), I = 7.5 mA
Isolation from internal bus	Yes, each channel separately via opto-electronic couplers
Simultaneity	100%
Signal delay	<1 µs (hardware)
Outputs	
Output signal level	H level = power supply- 0,5V L level <= 1V
Output current per output max.	1 A, overcurrent-protected and short-circuit-proof
Total current for whole module max.	6 A
Isolation from internal bus	Yes, each channel separately via opto-electronic couplers
Simultaneity	100%
Free-wheeling diode	Integrated
Signal delay	<300 µs (hardware)
Power supply for fast encoders (terminals X2.21 / X2.22)	
Voltage	DC 24 V
Current	max. 1 A

See also General specifications on page 162.

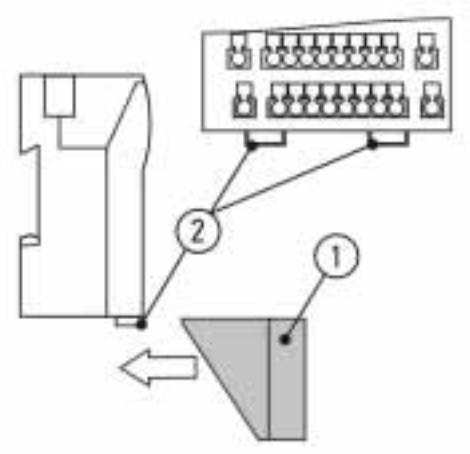
4.20 Potential distributor RIO KE 16



The potential distributor is used to extend the terminal of the DC 24 V and 0 V potentials. It has 2 separate terminal rows with 10 terminals on each row. This allows an extension of the connection system to 3 - or 4-wires.

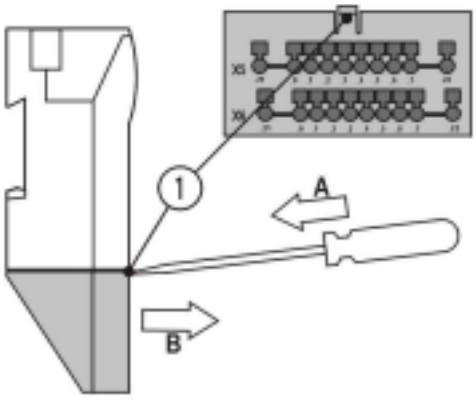
The potential distributor can only be mounted on modules with suitable clips. Modules with clips have a separate order no. (see Overview).

Installation



Push the potential distributor (1) onto the bracket (2) on the module until the latch of the potential distributor locks into place.

Dismantling



Open the latch (1) of the potential distributor by pushing a screwdriver between the distributor and the unit. Remove the potential distributor by pulling it in direction B.

4.20.1 Specifications Potential distributor RIO KE 16

RIO KE16	
Order no.	PCD0.K300
Number of terminal rows	2 (isolated)
Number of terminals	20 (10 in each row)
Max. current load on each terminal	8 A

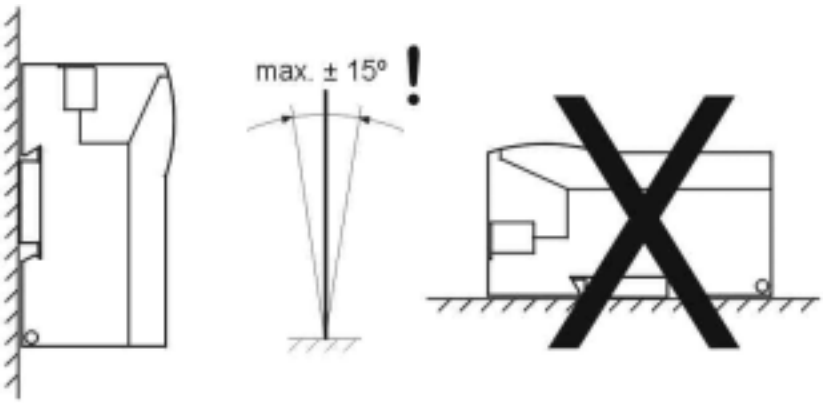
See also General specifications on page 162.

5 Installation

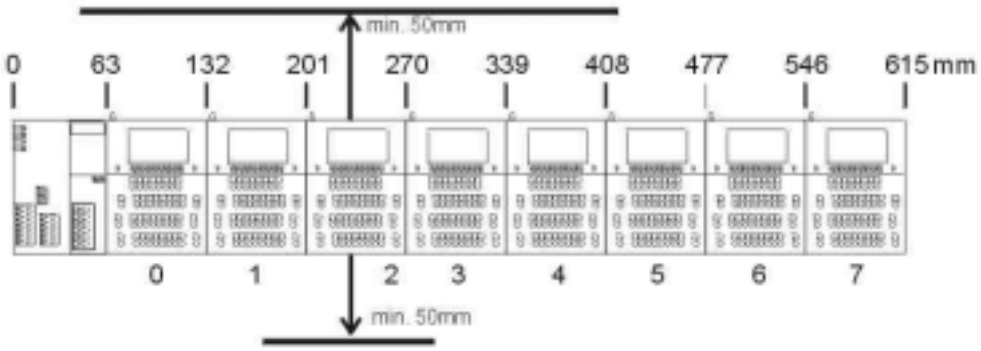
5.1 Mechanical installation

5.1.1 Mounting position for the EC and BC bus couplers

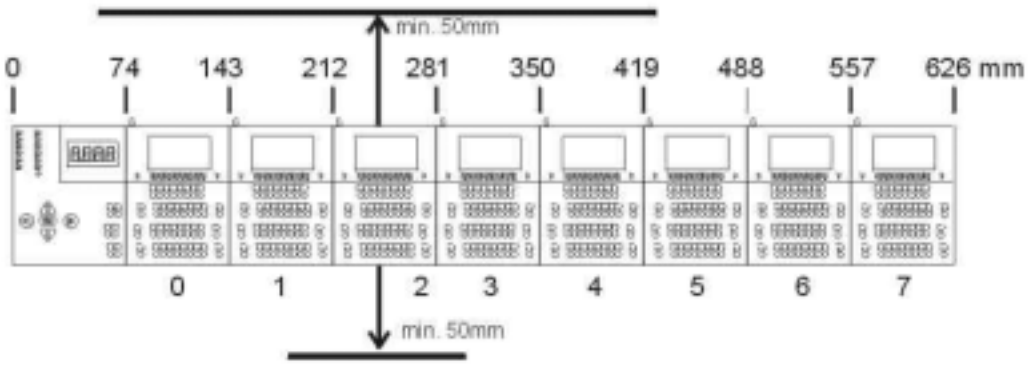
Modules must be installed vertically.



5.1.2 Mounting dimensions and distance between modules – EC bus coupler

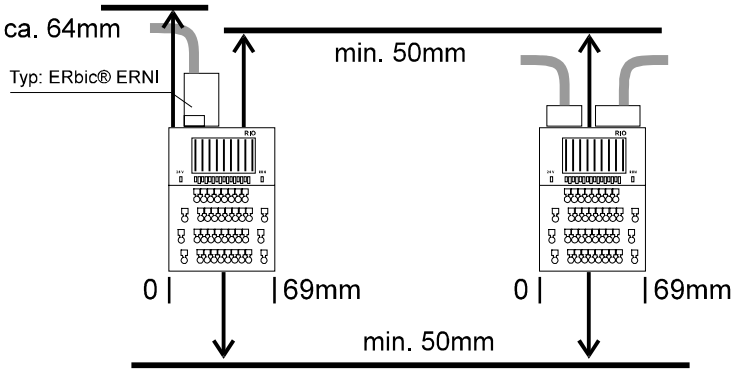


5.1.3 Mounting dimensions and distance between modules – BC bus coupler



Do not attach more than 8 modules to one bus coupler. We do not recommend attaching more than 8 modules to one bus coupler.

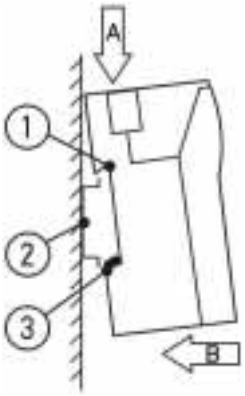
5.1.4 Mounting dimensions and distance compact RIO's



5.1.5 DIN rail installation

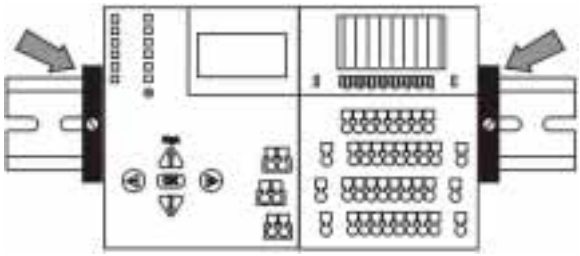
Use DIN rail type TS 35mm/7.5 to DIN EN 50022.

Installation

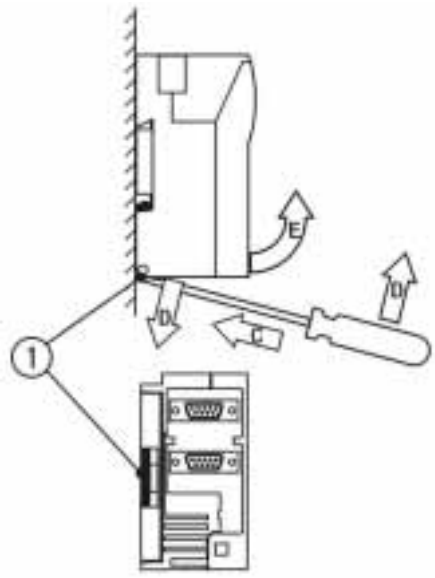


A Tilt device slightly and position in guide (1) on DIN rail (2).
B Push device towards DIN rail (2) until the latch (3) locks into place.

Install the modules directly next to each other and secure them with an end clip.



Dismantling



Open the orange slide contact on top of the module (move to the right).
C Insert screwdriver in latch (1).
D Use the screwdriver to lever the latch downwards. The latch remains in the open position.
E Tilt device and remove it. Push the latch (1) back into place.

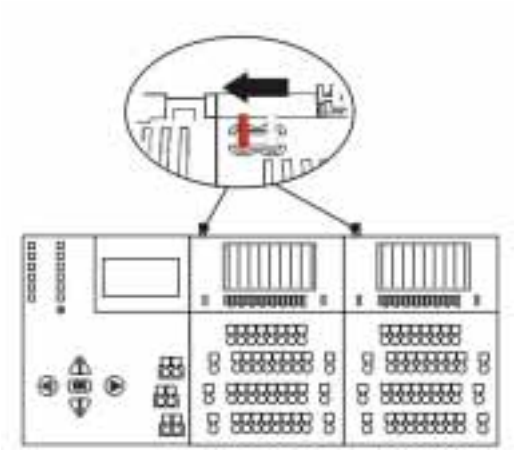
5.1.6 Connecting modules with each other

The orange slide contacts on top of the module connect the modules to the bus coupler.

Make sure that the slide contacts are open when actuating (opening) the spring terminals in order to reduce mechanical wear on the contact points.

Align the modules before you close the slide contacts. Do not use force when closing the slide contacts.
Close the slide contacts before commissioning the unit.

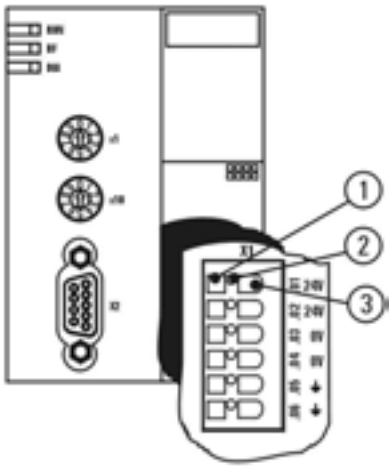
Do not open the slide contacts during operation.



6 Electrical installation

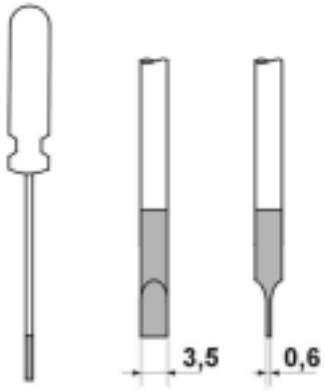
6.1 Spring terminals of the EC bus coupler

The EC bus coupler is powered via spring terminals.



1 Actuator opening
2 Measuring point
3 Terminal area

To actuate the spring terminal you need a screwdriver with a 0.6x3.5 blade according to DIN 5264 B. The shaft diameter must not exceed the blade width of 3.5mm.



Opening the terminal

Push the screwdriver vertically in the actuator opening (1).
Insert the wire in the terminal area (3).

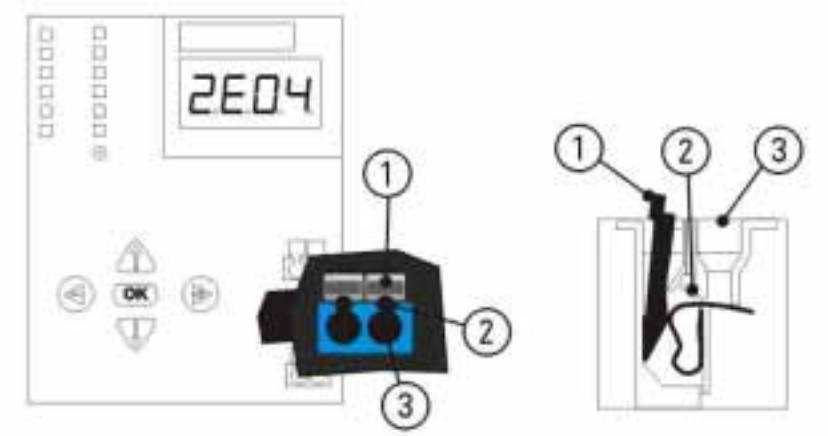
Closing the terminal

Remove the screwdriver from the actuator opening (1).

Each terminal has a measuring point (2) which can be accessed using a normal 2mm test prod.

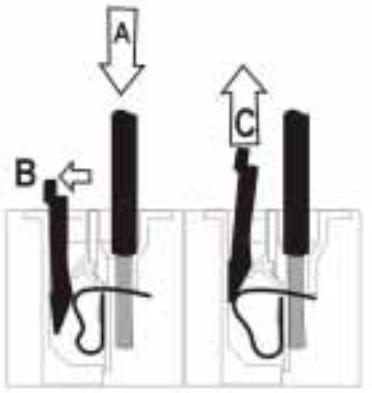
6.2 Spring terminals of the BC bus coupler, I/O modules modular system and compact RIO's

At delivery: Terminals open



The terminals are pre-tensioned with a clamping key (1). The terminal area (3) is open. Each terminal has a measuring point (2) which can be accessed using a normal 2mm test prod.

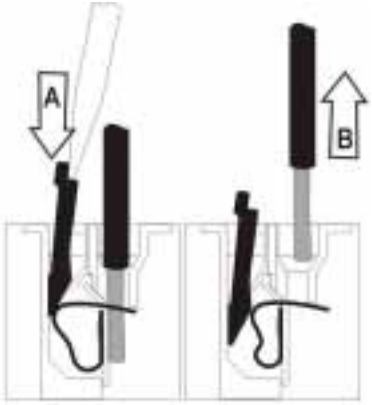
Closing the terminal



A Insert wire in terminal area.
Push the clamping key towards **B**.
The clamping key is pushed up towards **C** by the tension of the spring and remains in the terminal.

Opening the terminal

Make sure that the slide contacts of the module are open before opening the terminals to reduce mechanical wear on the contact points.

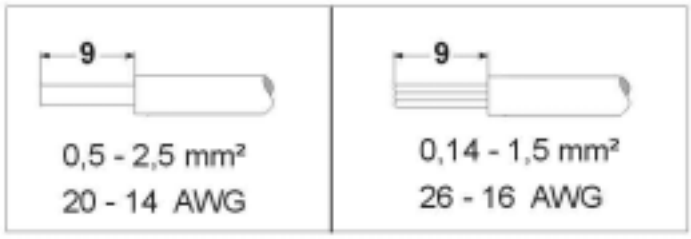


Use the screwdriver to push the clamping key towards **A**.
The clamping key levers the spring terminal open and remains in this position.
Remove the cable by pulling it towards **B**.

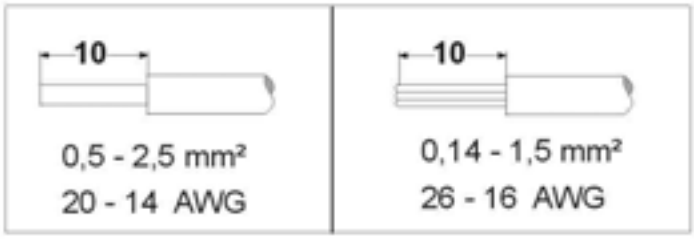
You can also open the spring terminal without a clamping key. Use a screwdriver in place of the clamping key.

6.3 Conductor sizes and stripping length

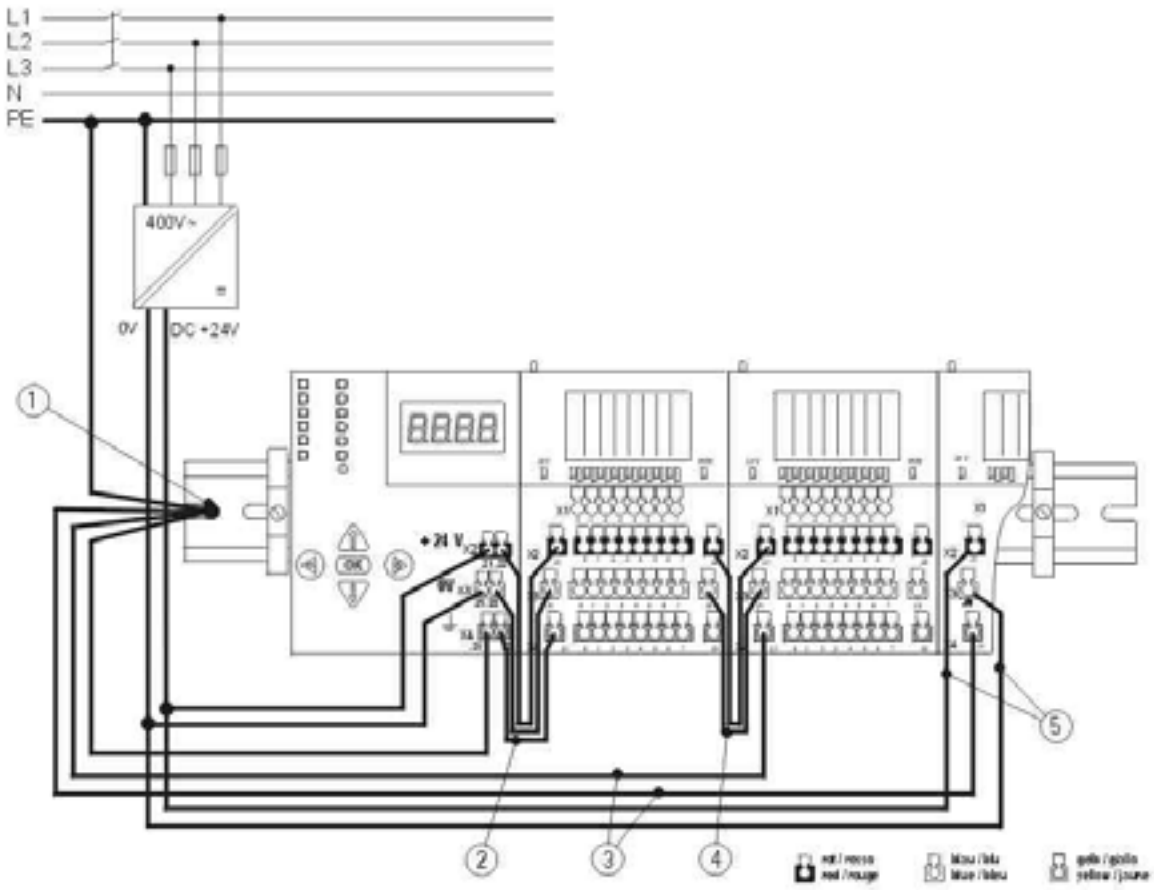
EC bus coupler



BC bus coupler,
I/O modules,
compact RIO's



6.4 Connecting the power supply



The diagram shows a bus coupler with expansion modules of the RIO 8 I/O type.

For details on the diagram refer to the following section Installation guidelines.

6.5 Installation guidelines

Control cabinet installation

RIO bus nodes must be installed in closed metal housings connected to ground (e.g. control boxes or control cabinets).

To protect the modules against electrostatic discharge, operators must not carry any electrostatic charge when opening control boxes or control cabinets.

Connecting the DIN rail to ground (1)

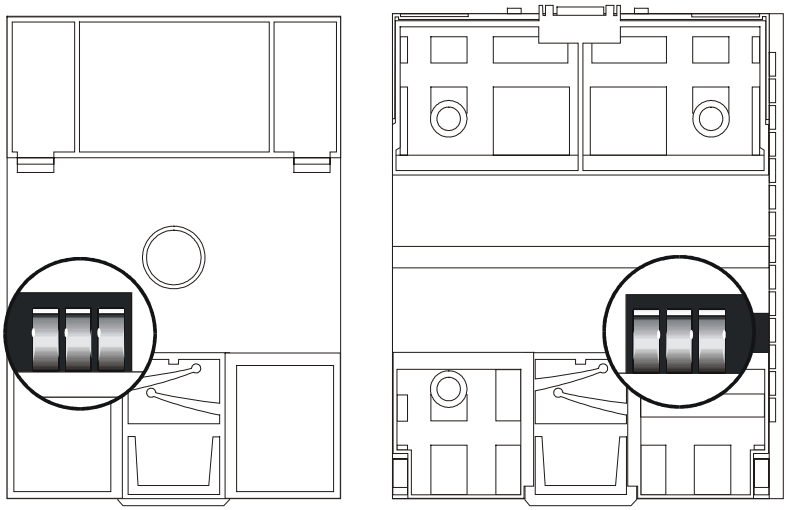
The DIN rail which holds the modules must have a broad-surface connection to ground providing adequate conduction.

Connecting the bus coupler and expansion modules to ground (2) (3)

The bus coupler and the 8 I/O expansion module (8I/O) have a connecting terminal marked with the ground symbol. To increase interference immunity this terminal must be connected to ground (or PE potential) with a conductor which is as short as possible (2.5mm^2).

For optimum EMC properties the first expansion module on the right of the bus coupler should be powered via the potential relay terminal on the bus coupler.
All other modules can also be powered individually.

The contact spring located in the module clamp base is used to divert EMC interference. This spring provides the connection between the PCB shield potential and the DIN rail. Do not fit modules without a contact spring or with a defective contact spring.



Contact springs of the EC and BC bus couplers in the clamp base on the rear of the housing.

Relaying the power supply (4)

To provide an optimum wiring the power supply can be relayed from one module to the next. When using modules with digital outputs the current on each relay terminal must not exceed a specific value. If the maximum current is exceeded an additional power supply feed must be provided (see below).

Additional power supply feeds (5)

When relay terminals are used to relay the power supply from one module to the next the current on each relay terminal must not exceed a specific value.

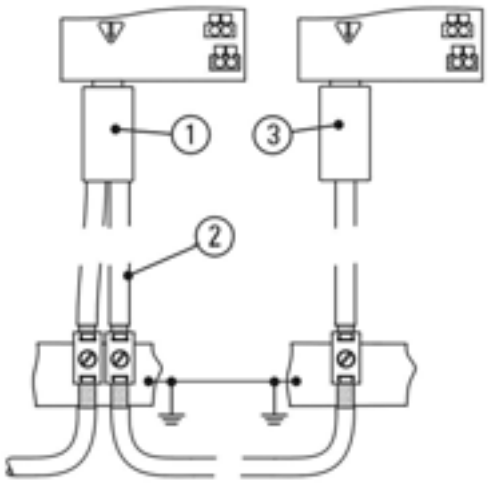
Make sure that the load on a terminal does **not exceed Imax = 8A**.

If the maximum current may be exceeded you need to provide additional power supply feeds.

Shielding the bus cable

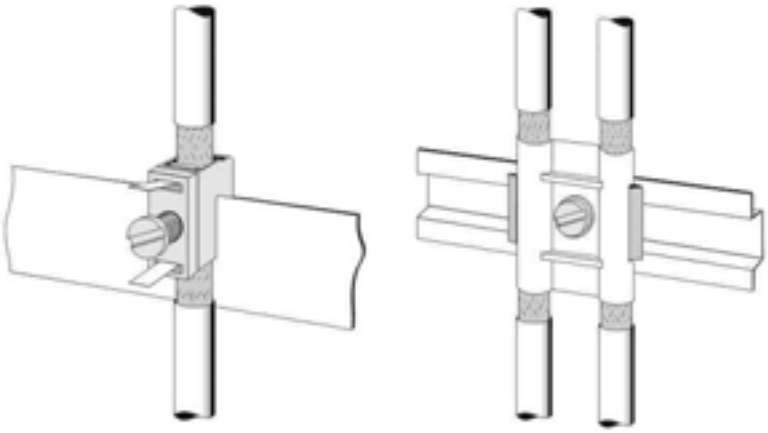
The bus cable must be shielded. The shields of the bus cables must have a broad-surface connection to the potential balance rail providing adequate conduction at the cabinet opening. The potential balance rail must be connected to ground for each electronics cabinet and connected to the potential balance rails of other cabinets. The shield must be applied on both sides.

The shield must cover the whole cable up to the bus coupler and be fitted according to the manufacturer's instructions. Ensure that contact is made over a broad surface area and that it is sufficiently conductive.



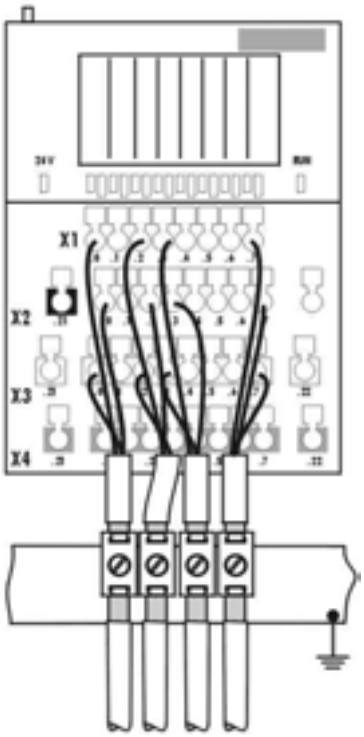
1 PROFIBUS node
2 Shielded bus cable
3 PROFIBUS terminator

Example of proper fitting of the shield.



Shielding analog signal lines

Analog signal lines must be shielded. The shield must be fitted with a large-surface connection to ground in the immediate vicinity of the modules. To secure the shield use metal cable clips which surround a large area of the shield and provide a good contact to GND. The conductive shield must be fitted on both sides.



Power supply for modules with combination channels

When using modules with digital combination channels note that you cannot connect a 24V supply to a combination channel without connecting the module to the power supply.
If you do, the power supply will be fed back via the output circuit of the module. This may result in a malfunction or destruction of the output circuit.

In an emergency stop do not just switch off the power supply to the modules with combination channels. You must switch off the power supply to the modules and the sensors and actuators at the same time.
The same also applies to digital output signals if they have been incorrectly connected to 24V.

Wiring

All digital and analog I/O lines must be wired separately from DC/AC conductors > 60V. Always wire modules vertically starting from the top to enable modules to be tilted.

6.6 Connecting signal sources to analog modules

Voltage inputs

The 4 analog inputs are non-floating differential inputs. The voltage potentials of the positive and negative signal poles should not exceed the acceptable common-mode range (-12.1 ... + 12.8 V in relation to AGND). Signals in excess of these limits would be clipped by the following amplifiers. The result would be a corrupted measuring value.

The analog input potentials are isolated from the supply (+24 V, 0 V) and from PE.

Observe the following when connecting signal sources to analog inputs:

a) Floating signal sources:

If you connect a completely potential-free signal source to AIx+ and AIx- only, high-resistance resistors in the module ensure that the pole potentials are drawn to approximately the middle of the range. However, since the potential coupling is only very high-resistance (to prevent corruption of measured data) and thus very soft, the typically occurring ripple voltages can result in a strong fluctuation of the pole potentials and even exceed the common-mode range. Strongly fluctuating or completely corrupted measured values are an indication of this problem. To prevent this, fix the pole potentials by adding an external potential connection to AGND.

b) Non-floating signal sources:

If you connect several non-floating signal sources to the various analog inputs of the module, add a potential connection to AGND to avoid freely floating signal potentials. Normally connection of a single signal source potential with AGND is sufficient. If you use non-floating signal sources make sure that the respective pole potentials are within the common-mode range. If the pole potentials of two signal sources are very different (example: 1st signal source supplies voltages related to 0 V external, the 2nd signal source supplies voltages related to +24 V external), NEVER connect them to the same analog input module!

If you have open voltage inputs (differential input) the digital value 07FF hex is transferred.

Current inputs

The 4 analog inputs are “single ended” inputs, i.e. the negative signal pole of all inputs is AGND.
The analog potentials (AIx and AGND) are isolated from the supply (+24 V, 0 V) and from PE.

Observe the following when connecting current sources to analog inputs:

a) Floating signal sources:

Required potential coupling is already provided by referencing the input signal potential to AGND.

b) Non-floating signal sources:

If you use different non-floating signal sources make sure that the signal sources are not shorted between them when connected to AGND.

6.7 Emergency stop switches

The switches and information outlined in this section are examples of setting up emergency stop devices. They are not generally applicable and cannot be used in every application.

Follow the safety guidelines and guidelines for preventing accidents (e.g. machinery safety directive) and the division in safety categories.

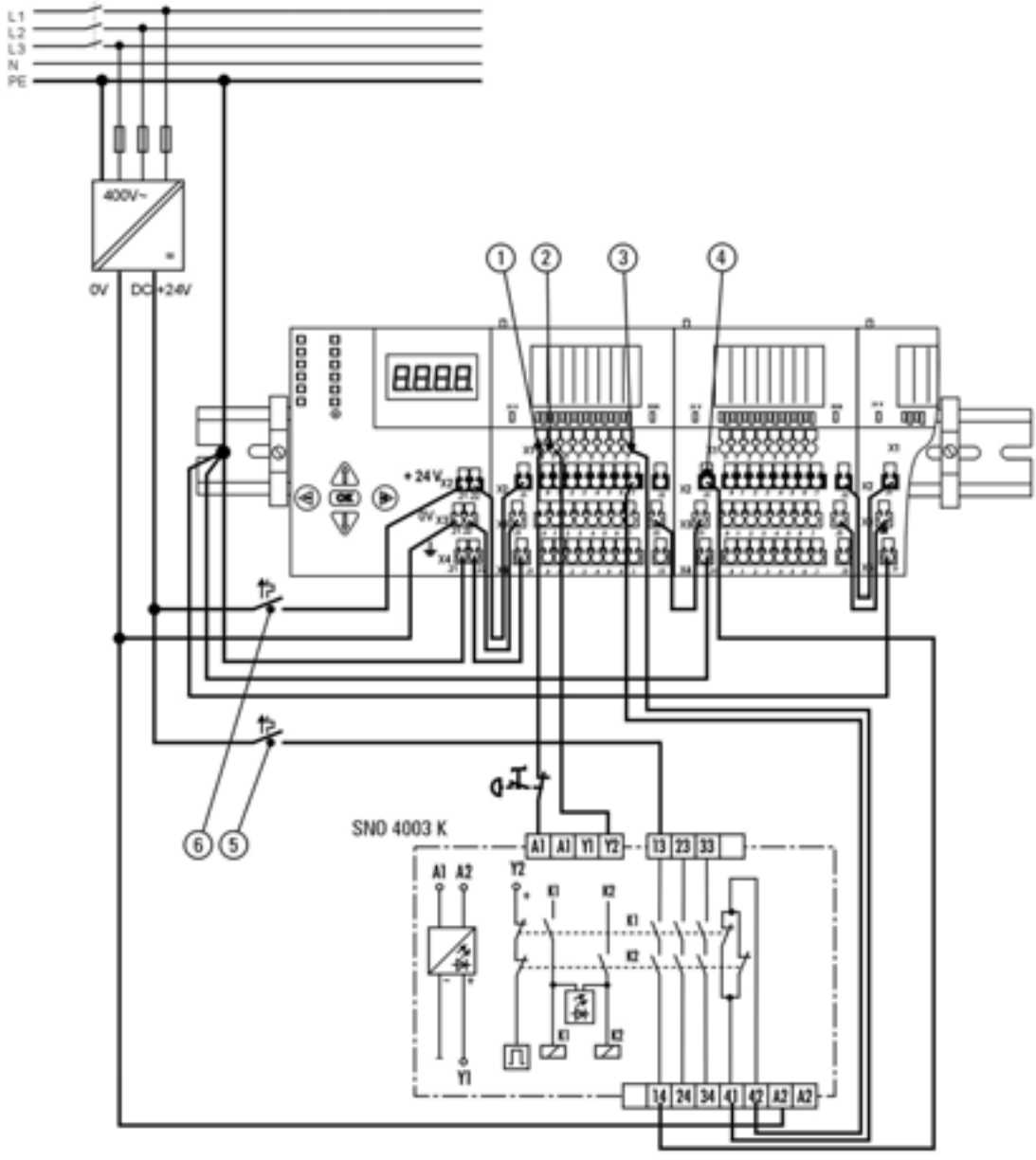
Emergency stop devices according to IEC 204 must be operational in all operating modes of the plant or the system.

If the emergency stop is released the bus node must restart without uncontrolled or undefined responses.

The examples refer to bus nodes with 8I/O expansion modules fitted with combination channels.
If combination channels are used and emergency stop is triggered the power supply to the module and the sensors and actuators must be turned off at the same time. It is therefore a good idea to supply power to sensors and actuators via the modules.
If a separate power supply is used it must be turned off when the emergency stop is triggered.

Emergency stop circuit with partial disconnection of expansion modules

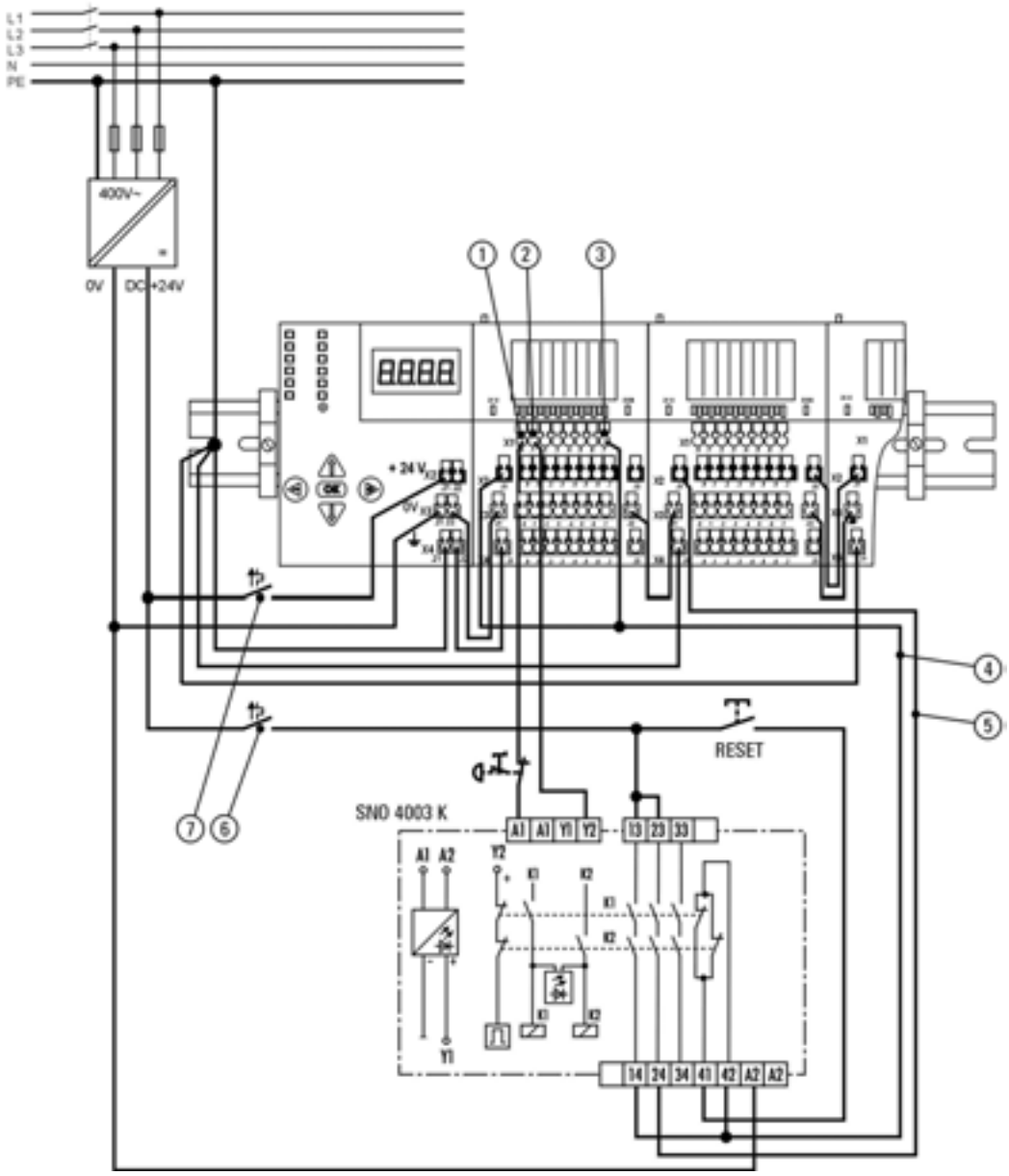
In this case the bus coupler and the first module are not turned off. This enables you to release the emergency stop from the PLC and initiate a restart.
However, the first module is reserved for the emergency stop circuit and cannot be used to process sensors and actuators.
If the bus coupler or PLC stop fails an emergency stop is forced via output (1) because the output switches to zero (preferred shut-off state must be set to zero).



1	Emergency stop output signal active (permanent signal) The PLC can force an emergency stop via this output if necessary.
2	Release emergency stop output signal (pulse signal)
3	Emergency stop input signal not triggered Can be used to check the emergency stop status via the PLC.
4	Power supply feed (with disconnection via emergency stop)
5	Power supply for expansion modules 2 to n (with automatic circuit breaker, max. 6A).
6	Power supply for bus coupler and first expansion module (with automatic circuit breaker).

Emergency stop circuit with disconnection of all expansion modules

If all modules are turned off the first module can also be used for control tasks. However, to initiate the bus node the RESET key must be used to supply the first expansion module with power. If the bus coupler or PLC stop fails an emergency stop is forced via output (1) because the output switches to zero (preferred shut-off state must be set to zero).



1	Emergency stop output signal active (permanent signal) The PLC can force an emergency stop via this output if necessary
2	Release emergency stop output signal (pulse signal)
3	Emergency stop input signal not triggered Can be used to check the emergency stop status via the PLC.
4	Power supply feed at emergency stop for the first module (emergency stop can be bypassed with RESET key).
5	Power supply feed (with disconnection via emergency stop) for all following modules.
6	Power supply for all expansion modules (with automatic circuit breaker).
7	Power supply for the bus coupler (with automatic circuit breaker).

6.8 Bus node power consumption

Load of the internal 5V power supply

The bus coupler is supplied with a built-in power supply unit which provides the internal 5V power supply for the expansion modules from the 24V power supply.

To determine the load of the internal 5V power supply the maximum power consumption of every expansion module connected to it must be added together.

The maximum load of the internal 5V power supply is 5 watts.

If the maximum load is exceeded expansion modules must be removed from the bus node.

Power consumption of expansion modules from the internal 5V power supply (maximum values)	
RIO 16 I	0.275W
RIO 4 I 120 VAC	0.2W
RIO 4 I 230 VAC	0.2W
RIO 16 O	0.325W
RIO 4 O R	0.25W
RIO 8 I/O	0.325W
RIO 8 I 8 I/O	0.325W
RIO 4AI ±10V	0.325W
RIO 4AI/4AO ±10V	0.325W
RIO 4AI 20mA	0.325W
RIO 4AI/4AO 20mA	0.325W
RIO 4AI 4-20mA	0.325W
RIO 4AI/4AO 4-20mA	0.325W
RIO T10-10	0.325W
RIO T20-10	0.325W
RIO C24-10	1.1W
RIO P24-10	1.25W

Power consumption from the external 24V power supply

To determine the power consumption of a bus node from the external 24V power supply the power consumption of the bus coupler and the power consumption of the expansion modules connected to it must be added together.

The power consumption of the bus coupler is calculated by adding the bus coupler's own consumption (5 watts) to the internal (5V power supply) consumption of the expansion modules connected to it.

Power consumption from the external 24V power supply (maximum values) for the bus coupler and expansion modules		
Bus coupler	5W + total of internal power consumption (from internal 5V power supply) of the expansion modules connected to it	
RIO 16 I	0.25W	Without input currents
RIO 4 I 120 VAC	None	
RIO 4 I 230 VAC	None	
RIO 16 O	0.25W	Without load currents
RIO 4 O R	2W	
RIO 8 I/O	0.25W	Without input / load currents
RIO 8 I 8 I/O	0.25W	Without input / load currents
RIO 4AI ±10V	3.6W	With maximum load on analog outputs
RIO 4AI/4AO ±10V	4.3W	
RIO 4AI 20mA	3.6W	
RIO 4AI/4AO 20mA	6W	
RIO 4AI 4-20mA	3.6W	
RIO 4AI/4AO 4-20mA	6W	
RIO T10-10	3.8W	Including load current 4 x PT 100
RIO T20-10	2.9W	
RIO C24-10	0.25W	Without input / load currents
RIO P24-10	0.25W	Without input / load currents

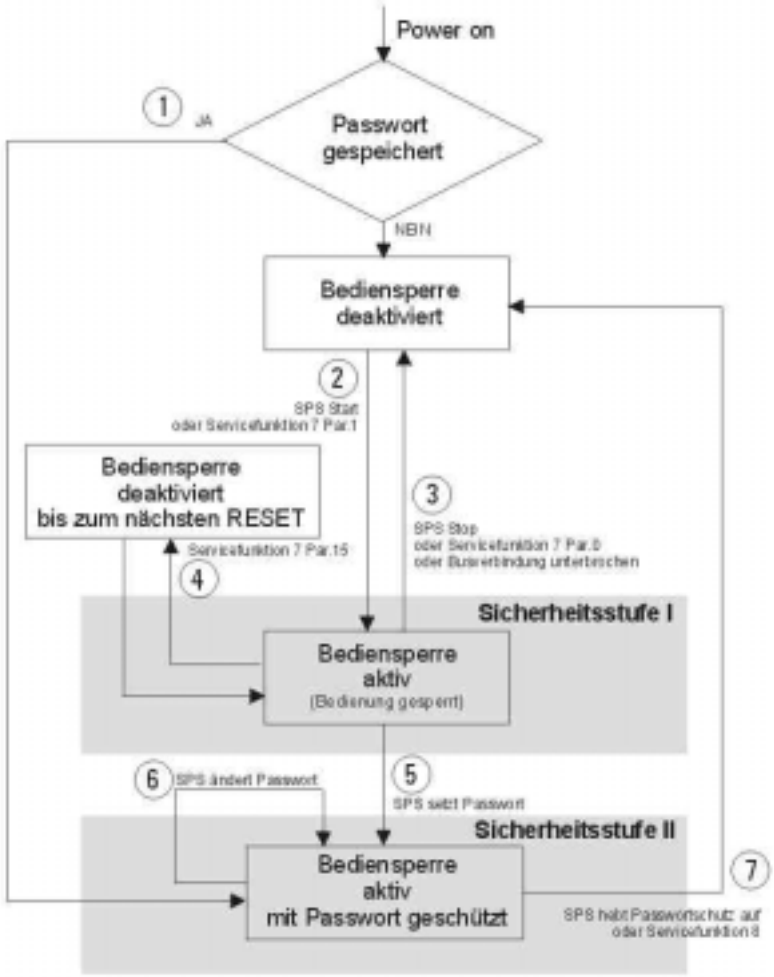
Power consumption from the external 24V power supply (maximum values) for compact RIO‘s		
RIO 16 I DP	2,4 W	Without input currents
RIO 16 O DP	2,4 W	Without load currents
RIO 8 I/O DP	2,4 W	Without input currents / load currents
RIO 8 I 8 I/O DP	2,4 W	Without input currents / load currents

7 User lock-out of the BC bus coupler

Some functions which you can access via the keypad of the bus coupler must be protected against unauthorized use as they will have a direct impact on the operation of the controlled plant.

A user lock-out is therefore provided for FORCE, LOCK, STOP modes and service functions 1, 2, 5, 6, 9, 10.

You can activate a user lock-out on **safety level I or II**. Safety level II uses a password protection.



Key to picture:

Power on

1 Password saved YES / NO

User lock-out deactivated

2 PLC Start or Service function 7 par. 1

3 PLC Stop or Service function 7 par. 0 or bus connection interrupted

4 User lock-out deactivated until next Reset

Service function 7 par. 15

Safety level I

5 User lock-out active (Operation locked)

PLC sets password

6 PLC changes password

Safety level II

User lock-out active, password-protected

PLC releases password protection or service function 8

1. When you switch the bus coupler on it will check whether or not a password has been saved in the bus coupler. If a password has been saved the user lock-out on safety level II will be activated.
2. If no password has been saved the unit can be operated until the PLC or bus is started. The user lock-out will be activated on safety level I when you start up the PLC.
3. If the PLC is stopped, a bus cable breaks or you enter service function 7 (page 141) using parameter 0000 the user lock-out function will be disabled.
4. If you have to carry out maintenance work on the unit you can use service function 7, parameter 0015 to disable the user lock-out function until you reset the bus coupler again.

5. The PLC can lock the operation with a password via the diagnosis data (diagnosis code 6). The password will be saved in the bus coupler. The password must be a four-digit number between 0000 and 9999.
6. The password can be changed at any time from the PLC.
7. If you enter the password on the bus coupler (via service function 8, password as the parameter) the user lock-out will be deactivated. The password will not be deleted.
   If the PLC changes the password to 0000 the password protection is deactivated and the password in the bus coupler is deleted.

Confirm or cancel activation of the above operating modes and service functions with error code E016 (on safety level I) or error code E017 (on safety level II).

8 Operating modes of the BC bus coupler

8.1 Overview of operating modes

Operating modes		Description
RUN		Bus interface running, I/Os are refreshed, active LOCK and TRIGGER conditions are analyzed. You can display the control states of individual I/O channels on the bus coupler.
	FORCE	You can use this mode to set the control status of individual I/O channels. FORCE overrides the I/O control states and the lock definitions.
	TRIGGER	After a trigger event the I/O map will be saved with a memory depth of 20. The trigger event is an I/O status change that can be defined.
	LOCK	Like FORCE but used to permanently set the control status of individual I/O channels. The LOCK definition will be stored permanently in the bus coupler.
STOP		RUN mode is interrupted. I/O refresh is switched off. The unit is set to a preferred shut-off state (see diagnosis code 5).

RUN mode is active after the bus coupler has been switched on.

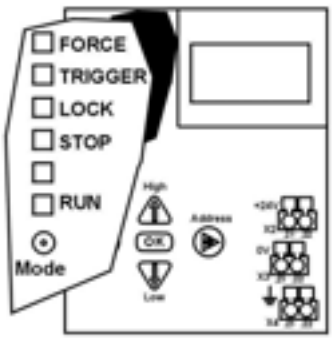
The FORCE, TRIGGER, LOCK modes can be activated during RUN mode. The RUN mode will not be interrupted.

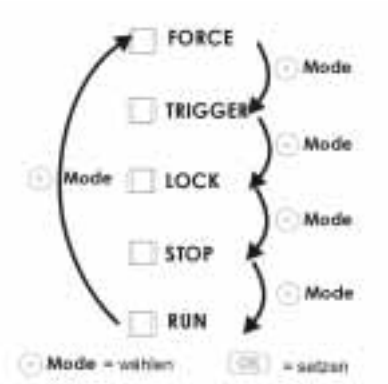
FORCE and LOCK directly influence the control states of I/O channels. Beware of dangerous operating states in the controlled processes!

Take appropriate measures to prevent invalid operating states.

Setting operating modes

The bus coupler is protected from unauthorized operation by a user lock-out.
To select an operating mode the user lock-out must be deactivated.
See User lock-out of the BC bus coupler on page 127



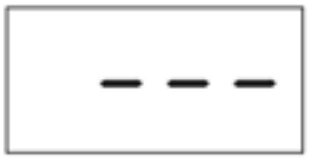


Press the Mode key to move the flashing LED from one mode to the next.
Press OK to confirm the selected mode.

Display of the active operating mode

The active operating mode and its sub-modes are indicated by the respective LED. In addition, the following information is shown on the bus coupler display:

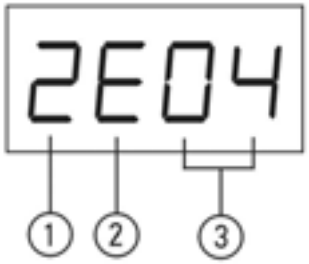
RUN mode



STOP mode

Display of the selected I/O channel

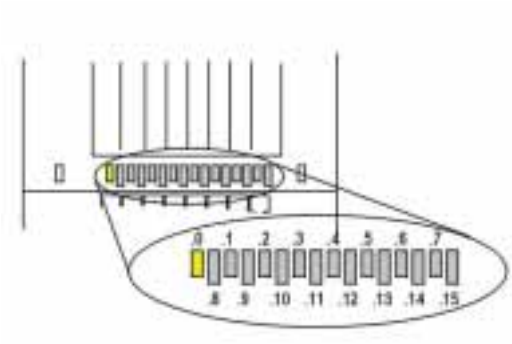
If you manually select a channel in RUN mode with Display, FORCE, TRIGGER and LOCK mode the following will be displayed:



1. Hexadecimal number of the expansion module
2. Input (E) or output (A)
3. Channel # (decimal)

Example: 2E04 module 2, input, channel 4

Display of the channel cursor



In RUN with FORCE, TRIGGER, LOCK mode and Display mode the two-color channel LED turns yellow (= channel cursor) when you press the left or right key. This has no impact on the control state of the respective input/output.

Each channel LED is assigned to a channel (0-15).
On 8-channel modules only channel LEDs 0-7 are active.
On analog modules the channel LEDs 0, 2, 4, and 6 are assigned to the inputs, LEDs 8, 10, 12, and 14 to the outputs.

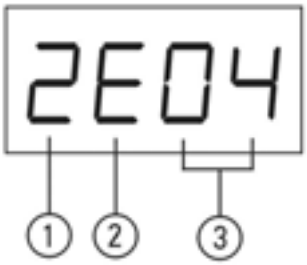
8.2 RUN

In RUN mode I/O channels are refreshed with the current PLC data.

Display mode

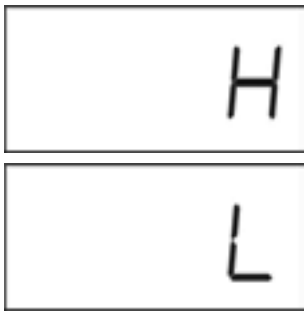
In RUN mode you can select Display mode. This continuously shows the current control status of an I/O channel on the bus coupler display.
Select the channel using the left/right keys (active yellow LED on the expansion modules = channel cursor).

The bus coupler display shows the selected channel.



1. Hexadecimal number of the expansion module
2. Input (E) or output (A)
3. Channel # (decimal)

Example: 2E04 module 2, input, channel 4



The control status will be displayed after about 0.5s and is updated continuously. On analog channels the current/voltage will be displayed in mV or µA.
On counting- or positioningmodules the actual counting- or positioning value will be displayed.

Press OK to exit Display mode.

8.3 FORCE

FORCE mode allows you to set the control status of individual I/O channels.

FORCE has a direct impact on the control states of I/O channels. FORCE overrides any control states set using LOCK.

Beware of dangerous operating states in the controlled processes! Take appropriate measures to prevent invalid operating states.

Procedure

Press the Mode key to select FORCE. Press OK to confirm your selection.

Select the channel using the Left/Right keys. (The selected channel will be displayed on the bus coupler. The active yellow LED on the expansion modules is the channel cursor.)

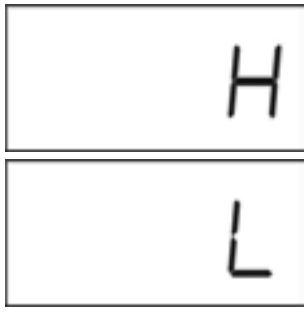
Select the control status using the High/Low keys.

The selected control status is immediately active.

If you have selected an analog channel the input/output value will be increased/reduced by 100mV or 100µA every time you press one of the keys.

Press OK to review the FORCE status of a selected channel.

The FORCE status is displayed for approx. 0.5s after you have pressed the OK key. On analog channels the input/output value will be displayed in mV or µA.



The channel LED of the forced channel is yellow even if you move the channel cursor to a different channel.

Resetting FORCE for all channels

Exit FORCE mode.

Resetting FORCE for one channel

Move the channel cursor to the channel which you want to reset and press OK 3 times.

3X

The display briefly looks as follows:

8.4 TRIGGER

TRIGGER mode is used to display the last 20 saved changes to the digital process map when a trigger condition occurs.

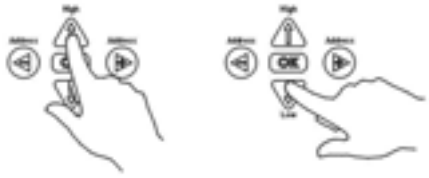
Not for analog modules.

Procedure

Press the Mode key to select TRIGGER. Press OK to confirm your selection.

Select the channel which you want to use to activate the trigger stop: Move the channel cursor using the Left/Right keys.

Set the trigger condition using the High/Low keys.
High key: Triggers to rising edge
Low key: Triggers to falling edge



You can define any number of inputs and outputs as trigger inputs. They are linked by OR which means that the trigger condition which is fulfilled first ends the recording.

Press the Mode key to set the mode back to RUN and press OK. The trigger function is active when you have returned to RUN.

The display shows the trigger status as follows:

Trigger condition defined.
The I/O maps will now be saved every time data is modified.

Trigger condition defined and occurred.
No more maps are saved.

Display of the last 20 I/O maps

Return to TRIGGER mode when the trigger condition has been fulfilled. E-00 is displayed. The last current input map when the trigger condition occurred is now displayed as a yellow LED on the expansion module. Use the Left key to see the previous map. The display will show the previous number E=n (n=0..19). Use the Right key to display the next map.

Use the High key to set the display to input and the Low key to set it to output.

Resetting the trigger condition

Press the Mode key to select TRIGGER. Press OK to confirm your selection.

Trigger condition is not fulfilled:

Move the channel cursor to the channel which you want to reset and press OK 3 times.

3X

This deletes one trigger condition. The display briefly looks as follows:

Trigger condition is fulfilled:

If a trigger condition has been fulfilled delete all the trigger conditions and the trigger buffer by pressing OK 3 times.

Trigger conditions are not permanently stored. They are, however, stored until the bus coupler is switched off.

8.5 LOCK

LOCK mode allows you to permanently set the control status of individual I/O channels.

Procedure

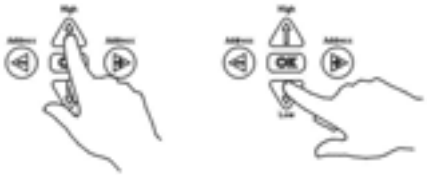
LOCK has a direct impact on the control states of I/O channels. Beware of dangerous operating states in the controlled processes!

Take appropriate measures to prevent invalid operating states.

Press the Mode key to select LOCK. Press OK to confirm your selection.

Move the channel cursor to the desired channel using the Left/Right keys.

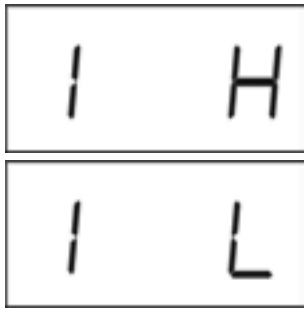
Use the High/Low keys to select the control status.



If you have selected an analog channel the input/output value will be increased/reduced by 100mV or 100µA every time you press one of the keys. You can lock up to 8 analog channels.

The selected control status is immediately active.

The selected control status will be briefly displayed.



The LOCK setting will be permanently stored in the bus coupler when you exit LOCK mode. Do not switch the bus coupler off for about 5 seconds after exiting the mode.

As in FORCE you can review the current control status by pressing OK. The value with which the channel is LOCKed will be displayed when you press OK.

You can recognize LOCK by the vertical bar in the display.

Resetting the LOCK status

Go to LOCK mode and move the channel cursor to the channel which you want to reset. Press OK 3 times.

3X

The display briefly looks as follows:

8.6 STOP

In Stop mode all inputs/outputs are switched off, i.e. all outputs are set to zero and are no longer refreshed. Inputs are no longer sent to the PLC.

If a preferred shut-off state has been set this state is adopted in Stop mode. For preferred shut-off states see parameterizing function 5.

Channels whose control status was set using LOCK will **not** be overridden by the preferred shut-off state.

If you have set shut-off code 2 for a module the I/O channels of this module will continue to be refreshed.
The shut-off code is set using parameterizing and diagnosis function 5.

9 Service functions on the BC bus coupler

The BC bus coupler allows you to carry out service functions via the integrated keypad and the display.

9.1 Overview of service functions

Service function 1	Reserved
Service function 2	Reserved
Service function 3	Display process data width of inputs
Service function 4	Display process data width of outputs
Service function 5	Bus coupler diagnosis range ON/OFF
Service function 6	Save specified bus node configuration
Service function 7	User lock-out ON/OFF
Service function 8	User lock-out with password
Service function 9	Advanced PROFIBUS-DP diagnosis ON/OFF
Service function 10	Byte swap mode ON/OFF
Service function 11	Delete bus coupler EEPROM
Service function 12	Display/set bus address
Service function 13	Set data width of counter and positioning modules

9.2 Selecting and using a service function

Press the High/Low keys simultaneously in RUN or STOP mode.

The display shows S 00.

If error code E016 or E017 is displayed the user lock-out on the bus coupler is active.

Use service function 7 to deactivate the user lock-out.

Use the Right key to set the required service function.

Then press the OK key.

Service function without parameters

The value of this function is immediately displayed. After 1s the display returns automatically to its initial state.
e.g. service functions 3 and 4.

Service function with parameters

The currently set parameter value is displayed.
Change the value with the Left/Right keys.

Press OK to confirm the new parameter.

9.3 Service function 1

Reserved

9.4 Service function 2

Reserved

9.5 Service function 3 Display process data width of inputs

Displays the size of the input address area used by the bus node in bytes.

9.6 Service function 4 Display process data width of outputs

Displays the size of the output address area used by the bus node in bytes.

9.7 Service function 5 Switch bus coupler diagnosis on/off

Parameter = 1	Bus coupler uses the first 4 bytes of I/O data for diagnosis data
Parameter = 0	Bus coupler does not provide diagnosis data, and does not use the 4 bytes of the I/O data

Default setting: Parameter 1

9.8 Service function 6 Save bus node configuration

You can save the current bus node configuration as the specified configuration. If the configuration is changed (e.g. if a slide contact is opened accidentally) error E012 will be displayed when you switch the bus coupler on.

Parameter = 0	No specified configuration
Parameter = 1	Save current configuration as specified configuration

Default setting: Parameter 0

9.9 Service function 7 User lock-out

Parameter = 0	User lock-out OFF
Parameter = 1	User lock-out ON
Parameter = 15	User lock-out deactivated until next RESET

Default setting: Parameter 0 (must be confirmed with service function)

See also User lock-out of the BC bus coupler on page 126

9.10 Service function 8 Deactivate user lock-out with password

To deactivate the user lock-out enter the password specified by the PLC (a number between 0001 and 9999) as the parameter.

Parameter = 1.. 9999	Operation enabled

See also User Lock-out on page 126

9.11 Service function 9 Advanced PROFIBUS-DP diagnosis ON/OFF

Parameter = 0	Advanced PROFIBUS-DP diagnosis OFF
Parameter = 1	Advanced PROFIBUS-DP diagnosis ON

Default setting: Parameter 1

9.12 Service function 10 Byte swap mode

Byte swap mode changes the assignment of input/output data to the I/O maps.

Parameter = 0	OFF
Parameter = 1	ON for all digital expansion modules
Parameter = 2	ON for all digital expansion modules, counter, positioning and analog modules, and diagnosis data
Parameter = 3	ON for all counter, positioning and analog modules, and diagnosis data

Default setting: Parameter 0

9.13 Service function 11 Delete bus coupler EEPROM

All settings for the bus node configuration, bus address, lock masks and service functions are deleted or set to the default setting.

Parameter <>15	No changes
Parameter = 15	EEPROM is deleted, the default settings are set.

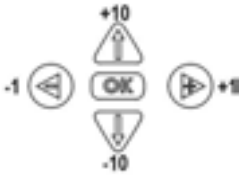
Press OK to confirm the service function. The following delete message appears:

You have to switch the bus coupler power supply off and on after the delete message has disappeared.

9.14 Service function 12 Display/set bus address

Displays the bus address.

Change the bus address using the keypad on the bus coupler. The keys have the following values:

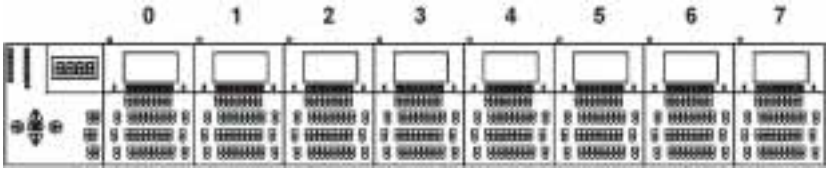


9.15 Service function 13 Set data width of counter and positioning modules

For counter and positioning modules only, not for BC CANopen.

Select this service function to set the module location number for the selected module.

Module location numbers:



Press OK to confirm the new values.

Set the required data width using the following parameters:

Parameter = 1	Data width 3 words
Parameter = 2	Data width 5 words

Default setting: Parameter 2

Turn the bus coupler off and on again. This will activate your new settings.

10 Parameterizing and diagnosis functions for all bus couplers

The PLC can initiate parameterizing and diagnosis functions in the bus coupler. To initiate a function a function code (FC) - with parameters if required - is transmitted to the bus coupler. The bus coupler executes the functions, creates diagnostic data (if required) and makes the data available for the PLC. The data can then be evaluated and processed in the user program.

10.1 Overview

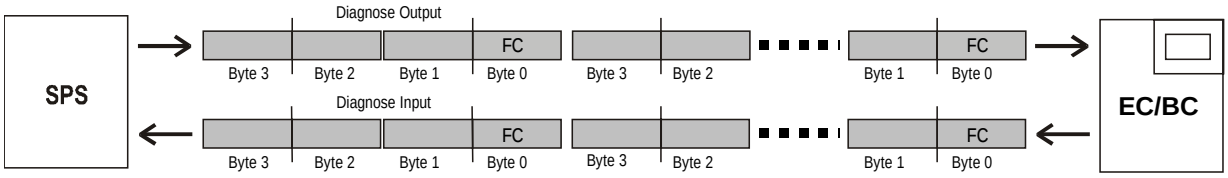
Function 0	Output group error
Function 1	Monitor module power supply
Function 0	Monitor output driver overload
Function 3	Determine bus node process data width
Function 4	Output bus node module configuration
Function 5	Set preferred shut-off state
Function 6	Activate/deactivate bus node user lock-out (BC bus coupler only)
Function 7	Determine bus node system status
Function 8	Output firmware version
Function 9	Set data formats for analog modules
Function 10	Output temperature module sensor information (PT100/PT1000)
Function 11	Mode word for temperature module with thermo elements
12..16	Reserved
Function 17	Set bus address of bus node
Function 18	Byte swap mode ON/OFF
Function 19	Advanced PROFIBUS-DP diagnosis ON/OFF
Function 20	Delete error messages
Function 21	Save/delete bus node configuration (EC bus coupler only)
Function 255	Reset

You can switch the functions on and off using service function 5 (see page 141).

If the functions are switched off no address space is used.

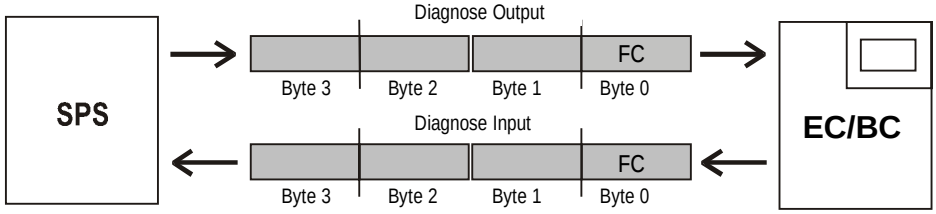
10.2 Data structure

Parameterizing and diagnosis data is always mapped on the first 2 words (4 Byte) of output data (PLC --> bus coupler) and the first 2 words (4 Byte) of input data (bus coupler --> PLC).



EC/BC = EC / BC bus coupler

Byte 0 of Diagnose Output and Diagnose Input is always reserved for the function code (FC).



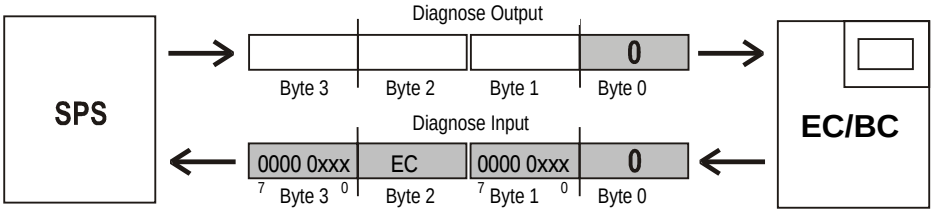
10.3 Sequence

The PLC initiates a function by sending the relevant function code to the bus coupler in byte 0 of diagnose Output. The bus coupler executes the function within one bus or PLC cycle. Once the function has been processed, the function code is repeated in the bus coupler response in byte 0 of diagnose Input.

If the master uses the same function several times in sequence, function 255 (Reset) must be executed in-between. This ensures correct evaluation of the finished message from the bus coupler.

10.4 Function 0 Output group error

Function 0 supplies the group error message and the last error code.



Diagnose Input

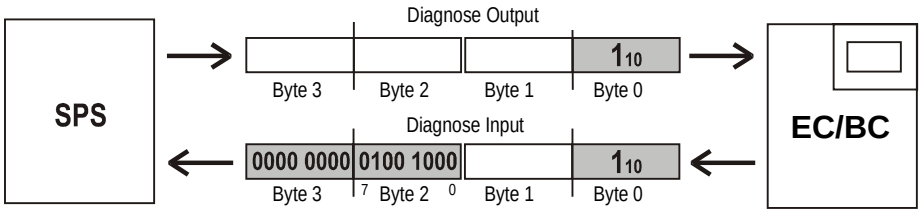
Byte3	Current errors	
	Bit no.	
	0	A module on the bus node signals output driver overload.
	1	A module on the bus node has signaled an error in the 24V power supply.
	2	An error message is generated and displayed on the bus coupler. The error message is transmitted in coded form in Byte 2 (see below).
Byte 1	Error bits from Byte 3 saved statically Error bits are deleted when diagnosis has been reset with function 255 (Reset) or the bus coupler has been switched off.	

Byte 2 EC (error code)

The error code is also displayed as an error message on the BC bus coupler.

10.5 Function 1 Monitor module power supply

Function 1 provides information on the status of the output driver power supply of the expansion modules.



In the above example the bus coupler signals a fault on the output driver power supply for expansion modules 3 and 6.

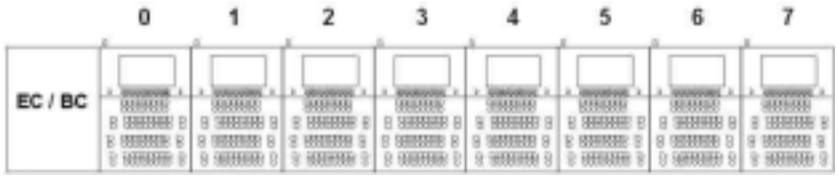
Diagnose Input

Byte 2

Bit value	Meaning
0	Output driver of expansion module at position n is correctly supplied with 24V
1	24V supply to module at position n* not connected

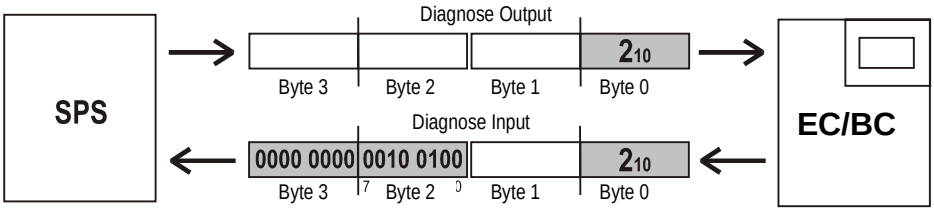
The module position n is the same as the bit position in Byte 2

Module location numbers:



10.6 Function 2 Monitor output driver overload

Function 2 provides information on the status of the 24V output drivers of the expansion modules.



In the above example the bus coupler signals an overload fault on the output drivers of expansion modules 2 and 5.

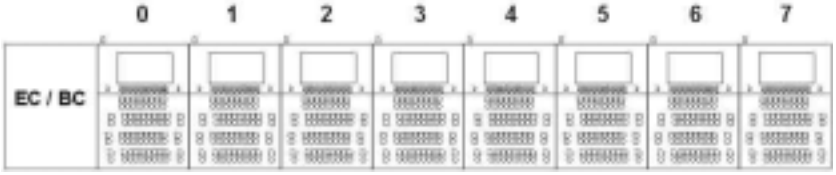
Diagnose Input

Byte 2

Bit value	Meaning
0	All output drivers of module at position n* functioning correctly
1	At least one of the output drivers of the expansion module at position n* is overloaded

* The module position n is the same as the bit position in Byte 2.

Module location numbers:

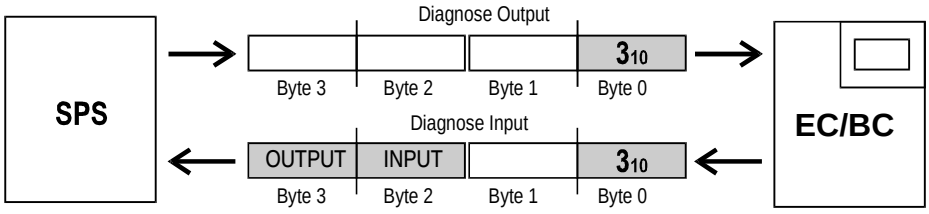


This diagnosis refers to the whole module and not to the individual channels.

This diagnosis is only applicable if the relevant module has a 24V supply. Where there is no voltage supply this diagnosis bit is irrelevant.

10.7 Function 3 Determine bus node process data width

Function 3 supplies the process data width of the bus node.

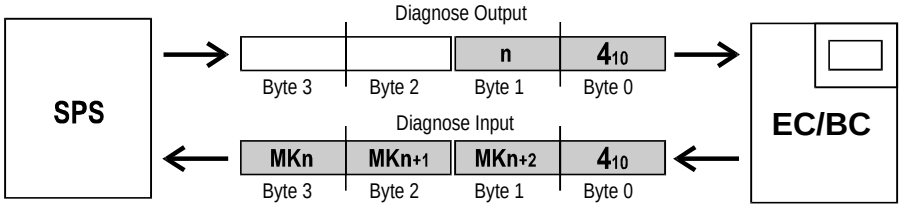


Diagnose Input

Byte 3, OUTPUT	Number of output bytes
Byte 2, Input	Number of input bytes

10.8 Function 4 Output bus node module configuration

Function 4 supplies the current configuration of any 3 consecutive expansion modules.

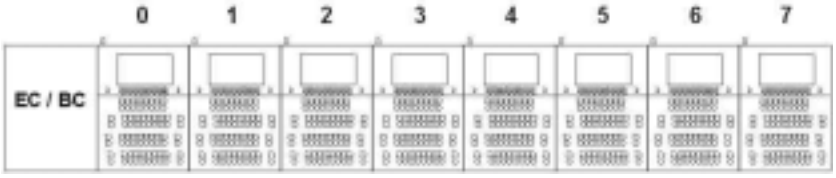


Diagnose Output

Byte 1, n (position of first module*)

You have to enter the position n of the module from which the actual configuration on positions n, n+1, n+2 is to be determined.

Module location numbers:



Diagnose Input

Byte 1, 2, 3 MK (module ID)

Diagnosis words 1 and 2 provide the module IDs (MK) of the modules which are currently connected to the bus module starting from position n.

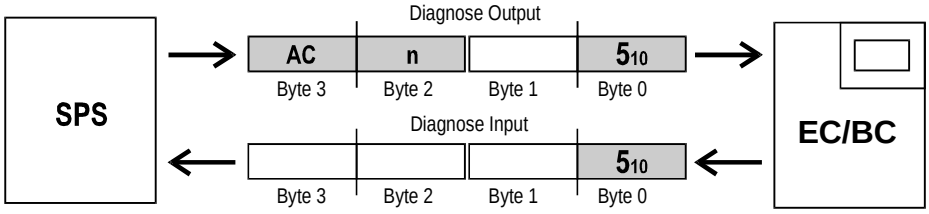
Module IDs	Module name
1	RIO 8 I/O
2	RIO 16 I
3	RIO 16 O
4	RIO 8I 8I/O
5	RIO 4AI/4AO ±10V
6	RIO 4AI ±10V
7	RIO 4AI/4AO 20mA
8	RIO 4AI 20mA
14d / 0Eh	RIO T10-10
10d / 0Ah (6 I/O bytes) 11d / 0Bh (10 I/O bytes)	RIO C24-10
12d / 0Ch (6 I/O bytes) 13d / 0Dh (10 I/O bytes)	RIO P24-10
16d / 10h	RIO 4AI/4AO 4-20mA
17d / 11h	RIO 4AI 4-20mA
19d / 13h	RIO 4 O R
20d / 14h	RIO T20-10
24d / 18h	RIO 4 I 120 VAC
25d / 19h	RIO 4 I 230 VAC

10.9 Function 5 Set preferred shut-off state

Function 5 provides a preferred shut-off state to define the shut-off behavior of outputs. The preferred shut-off state is adopted:

- If the bus connection is interrupted.
- In STOP mode

Each module can have its own shut-off code (AC) which defines its preferred shut-off state.



Diagnose Output

Byte 3, AC (shut-off codes)

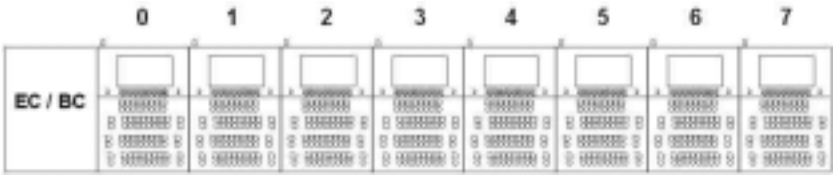
Shut-off codes		Meaning
dec.	bin.	
0	0000 0000	All digital outputs on the respective expansion module are set to Low, all analog outputs are set to 0V / 0mA.
1	0000 0001	All outputs on the respective expansion module are set to High, all analog outputs are set to +10V / 20mA.
2	0000 0010	All outputs on the respective expansion module continue to be refreshed. If the bus connection is interrupted the last control status of the I/O channels is retained.

Default setting: Shut-off code 0 for all modules

Byte 2, n (position of module)

You have to enter the position (n) of the module for which you want to define the preferred shut-off state.

Module location numbers:

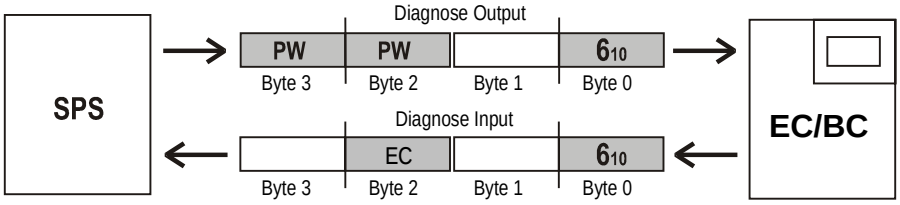


The LOCK configuration overrides the preferred shut-off state.

10.10 Function 6 Activate / deactivate bus node user lock-out

For BC bus coupler only.

Function 6 activates the user lock-out with password on safety level II. The password (PW) is a decimal 16-bit number between 0001 and 9999.



Diagnose Output

Byte 2 und Byte 3, PW (password)	
0000	Local operation of bus coupler is enabled if a user lock-out had previously been active on safety level II.
0001 to 9999	User lock-out active on safety level II, password-protected.

The password will be permanently saved in the bus coupler.

If you change the password from (0001 to 9999) to 0000 operation is enabled and safety levels 1 and 2 are not active.

See also User Lock-out on page 126.

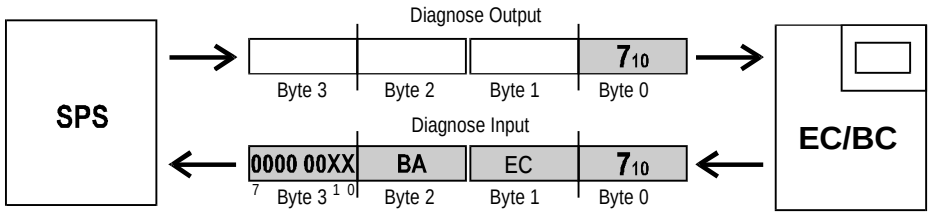
Diagnose Input

Byte 2 EC (error code)	
1	Successful
FFhex	Password outside range

Byte 2 signals whether the password was saved successfully.

10.11 Function 7 Determine bus node system status

Function 7 supplies the current system status of the bus node.



Diagnose Input

The system status includes the following information:

Byte 3, status of TRIGGER- or LOCK conditions

Bit no.	Bit value	Status
0	0	Trigger input not defined
	1	Trigger input defined
1	0	Lock condition not defined
	1	Lock condition defined

Byte 2, BA (mode)

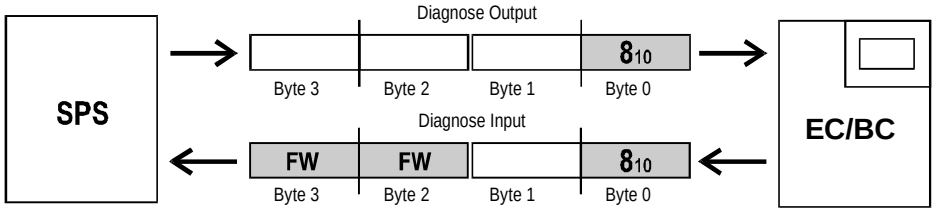
Value	Operating mode
6	FORCE
7	TRIGGER
8	LOCK
9	STOP
10dec	ONLINE
11dec	RUN

Byte 1, EC (error code)

The error code is the same as the error message which is displayed on the bus coupler.

10.12 Function 8 Output firmware version

Function 8 supplies the firmware version of the bus coupler.



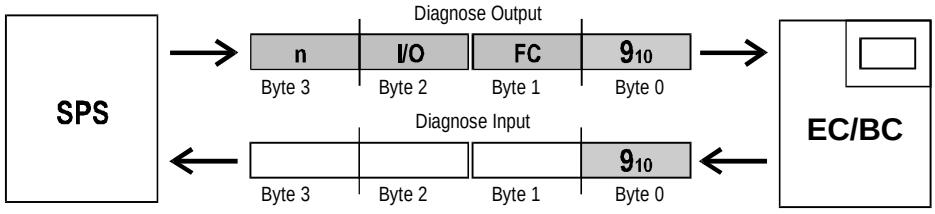
Diagnose Input

Byte 2, Byte 3, FW (firmware version)

The firmware version appears in hexadecimal code in Byte 2 and Byte 3.

10.13 Function 9 Set data formats for analog modules

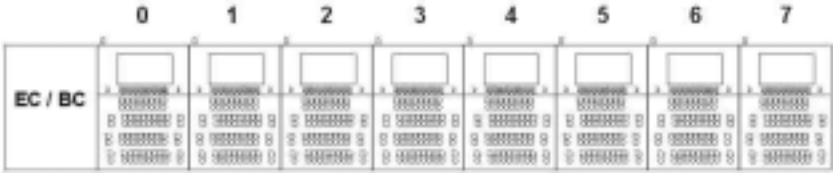
Function 9 sets the data format of analog values for the analog modules.



Diagnose Output

Byte 3, n (position of module)

Byte 3 defines the module for which the data format is to be set.
Module location numbers:



Byte 2, I/O selection inputs or outputs

0 = Inputs 1 = Outputs

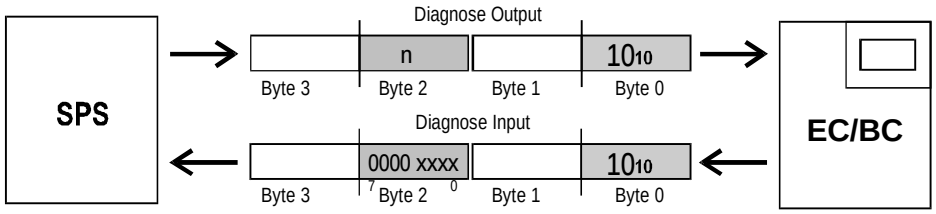
Byte 1, FC (format code)

Format code	Data format
0	±10V in two's complement (-2048 .... +2047)
1	±10V in mV (-10000 .... +10000)
2	0...20mA in two's complement (0...4095)
3	0...20mA in µA (0...20000)
4	4...20mA (S5 format for 0 ... 20mA module)
5	0 ... 10V (in mV 0 ... 10000)
6	PT 100 in 0.1°C
7	4...20mA S7 format
8	4...20mA S5 format

If the mV or µA data format is used the input signal of the digital I/O modules which are operated on the same bus coupler is delayed by 2ms.

10.14 Function 10 Output temperature module PT100/PT1000 sensor information

Function 10 supplies data on the sensors on the temperature module.

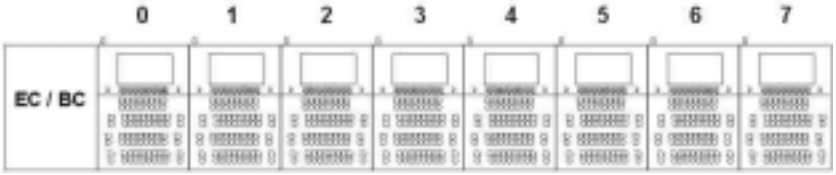


Diagnose Output

Byte 2, n (position of module)

Byte 2 defines the temperature module from which information is to be obtained.

Module location numbers:



Input data

Byte 2 sensor information

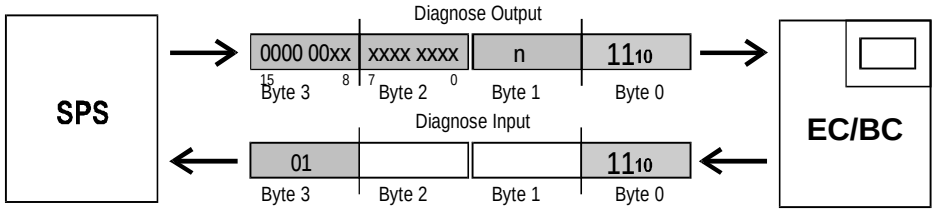
Bit no.	Bit value	Meaning
0	0	PT100 on channel 1
	1	PT1000 on channel 1
1	0	PT100 on channel 2
	1	PT1000 on channel 2
2	0	PT100 on channel 3
	1	PT1000 on channel 3
3	0	PT100 on channel 4
	1	PT1000 on channel 4

If there is a constant measured value of 4500 there is a malfunction on the associated channel. The sensor data can be used to distinguish between cable break and short-circuit.

Bit value	Meaning
0	Short-circuit
1	Cable break or sensor not connected

10.15 Function 11 Mode word for temperature module with thermo elements

Function 11 is used for parameterizing a temperature module with thermo elements.



Diagnose Output

Byte 2 and Byte 3 Mode word

Byte 2 and Byte 3 are used to transmit the parameters for characteristics, channel numbers, resolutions and number formats.

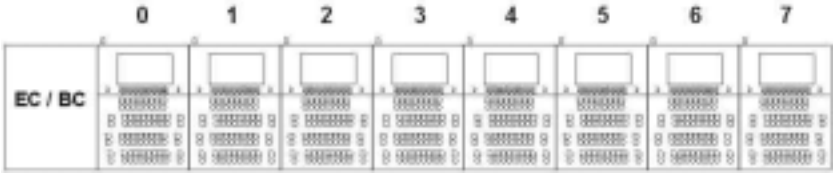
Parameter		Meaning
Characteristics	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 — 0 0	K-characteristic
	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 — 0 1	J-characteristic
	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 — 1 0	L-characteristic
Spare	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 — 0 0	Spare (must always be 00)
Channel number	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 — 0 0	4 channels used
	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 — 0 1	1 channel used
	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 — 1 0	2 channels used
	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 — 1 1	3 channels used
Resolution	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 — 0 0	0.1°C
	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 — 0 1	0.2°C
	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 — 1 0	Spare
	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 — 1 1	Spare
Number format	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 — 0 0	SIMATIC S7
	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 — 0 1	SIMATIC S5
	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 — 1 0	Voltage
	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 — 1 1	Spare

Default setting: all bits = 0 (K-characteristic; 4 channels; 0.1°C; S7)

Byte 1, n (position of module)

Data word 2 Byte 2 transmits for which temperature module the information applies.

Module location numbers:

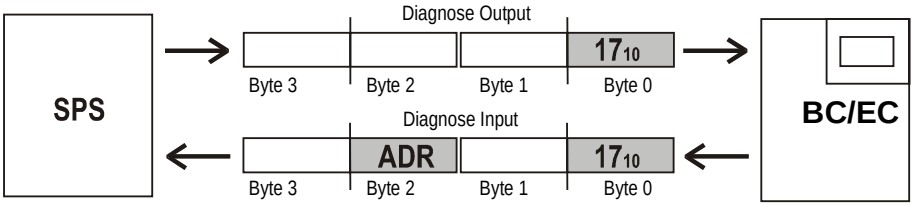


Diagnose Input

Byte 3, always 01

10.16 Function 17 Output bus address

Function 17 supplies the bus address of the bus coupler.

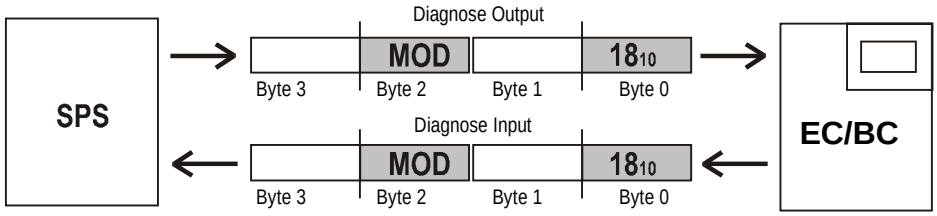


Diagnose Input

Byte 2, ADR (bus address 0 to 255)

10.17 Function 18 Byte swap mode ON/OFF

Function 18 sets the byte swap mode. The byte swap mode changes the assignment of input/output data to the I/O maps. See also service function 10 on page 141.



Diagnose Output

Byte 2 MOD (mode)	
0	OFF
1	ON for all digital expansion modules
2	ON for all digital expansion modules, counter, positioning and analog modules, and diagnosis data
3	ON for all counter, positioning and analog modules, and diagnosis data

Default setting: Mode 0

Diagnose Input

Byte 2 0/1	
0	Setting rejected
1	Byte swap mode turned on successfully

The setting will be stored permanently in the bus coupler.

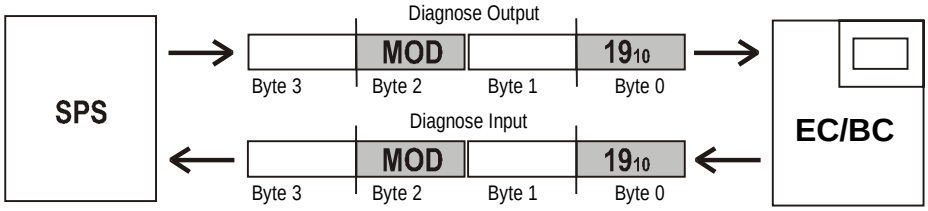
Example

RIO 16 I without byte swap			
Byte 1		Byte 2	
Bit	Terminal	Bit	Terminal
8	X2.8	0	X1.0
9	X2.9	1	X1.1
10	X2.10	2	X1.2
11	X2.11	3	X1.3
12	X2.12	4	X1.4
13	X2.13	5	X1.5
14	X2.14	6	X1.6
15	X2.15	7	X1.7

With byte swap			
Byte 1		Byte 2	
Bit	Terminal	Bit	Terminal
8	X1.0	0	X2.8
9	X1.1	1	X2.9
10	X1.2	2	X2.10
11	X1.3	3	X2.11
12	X1.4	4	X2.12
13	X1.5	5	X2.13
14	X1.6	6	X2.14
15	X1.7	7	X2.15

10.18 Function 19 Advanced PROFIBUS-DP diagnosis ON/OFF

Function 19 switches advanced PROFIBUS-DP diagnosis ON or OFF.



Diagnose Output

Byte 2 MOD (mode)

><1	Advanced diagnosis OFF
1	Advanced diagnosis ON

Default setting: Mode 1

Diagnose Input

Byte 2 MOD (mode)

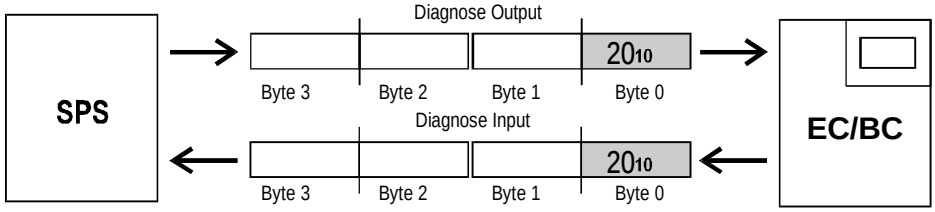
The parameters are reflected onByte 2 of the diagnose input data.

See also service function 9 and diagnosis on the PROFIBUS-DP on page 141 and 175.

10.19 Function 20 Delete error messages

Function 20 deletes the error message which is displayed on the bus coupler. The current error bits are also deleted.

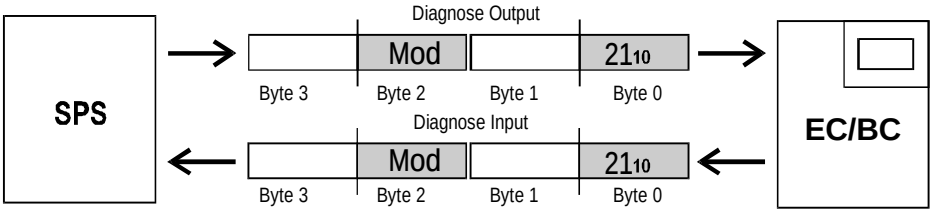
The functions carried out are the same as if you were deleting error messages using the OK key on the BC bus coupler.



10.20 Function 21 Save/delete bus node configuration

EC and BC bus couplers from software version 01xx only

The current bus node configuration can be saved as the specified configuration. If the current configuration is changed (e.g. if a slide contact is opened accidentally) error E012, flashing code 4, will be displayed when you switch the bus coupler on.



Diagnose Output

Byte 2 MOD (mode)

><1	Delete specified configuration and do not check anymore
1	Save current configuration as specified configuration

Default setting: 0

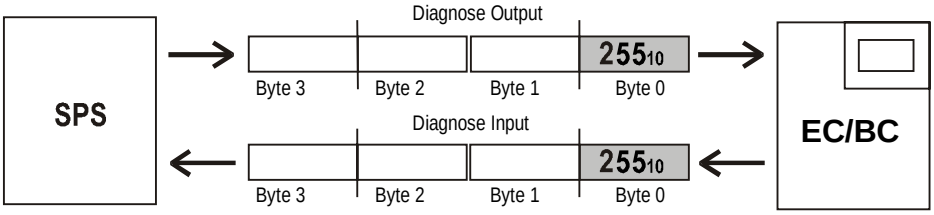
Diagnose Input

Byte 2 MOD (mode)

The parameters are reflected on Byte 2 of the diagnose input data.

10.21 Function 255 Reset

Reset resets all error messages as if you were deleting error messages using the OK key on the BC bus coupler. No functions are executed.



11 Technical data

Climatic conditions	
Ambient operating temperature	0 ... +55°C (class KV to DIN 40040), vertical installation, free air circulation
Storage temperature	-25 ... +70°C (class HS to DIN 40040)
Relative humidity	30 ... 95% (class F, DIN 40040), no condensation
Air pressure in operation	860 ... 1060 hPa

Mechanical strength	
Vibration	DIN IEC 68-2-6 10 ... 57Hz constant amplitude 0.075mm 57 ... 150Hz constant acceleration 1g

Electrical safety	
Protection class	IP 20 to EN 60529
Clearance/creepage distance	DIN EN 61131-2 and DIN EN 50178 between electrical circuits and objects as well as between electrically isolated circuits in accordance with overload category II, contamination level 2
Test voltage	350VAC/50Hz for rated equipment voltage 24VDC

Electromagnetic compatibility	
Electrostatic discharge	EN 61000-4-2: 4kV contact discharge
Electromagnetic fields	EN 61000-4-3: Field intensity 10V/m, 80 ... 1000MHz
Burst	EN 61000-4-4: 2KV on DC supply lines, 1KV on I/O signal and serial interface lines
Interference emissions	EN 55011: Class A, Group 1

Mechanical and installation	
Housing material	PA 6.0 GF20 black
Rail	DIN rail EN 50022-35

Connection system	
Connection	Spring terminal
Conductor size	Finely stranded*: 0.14-1.5mm^2 single-core: 0.5-2.5mm^2 *If a wire end ferrule is used it must be pressed air-tight.
Stripping length	10mm BC bus coupler, all I/O modules for modular system and compact RIO's 9mm EC bus coupler

11.1 Specifications Analog inputs/outputs

Analog inputs ±10 V

Parameter	Conditions	Min.	Typical	Max.	Unit
Measuring range		-10.000		+9.995	V
Resolution				12	Bit
Conversion time				2	ms
Common-mode range	To AGND	-12.1		+12.8	V
Input resistance	+input or -input to AGND		1		MΩ
Input current	+input to AGND -input to AGND		- 15 + 15		µA µA
Permissible source voltage range for two-way wire breakage detection:	Floating source - pole connected to AGND: + pole connected to AGND:	-10 -2.1 -2.,8		+9.9 +9.9 +9.9	V V V

Max. total error		±40 mV ±0.35% from measured value
Isolation	Only to bus, analog channels are not isolated from each other	

Analog inputs 20mA

Parameter	Conditions	Min.	Typical	Max.	Unit
Measuring range		0		19.995	mA
Resolution				12	Bit
Conversion time				2	ms

Input load	Current input to AGND	99.9	100.0	100.1	Ω
Permissible continuous input load				200	mW
Permissible continuous input current		-40		40	mA
Permissible continuous input voltage		-4		4	V
Dynamic input resistance	f > 2 kHz		95		Ω

Offset error		0.5	1	LSB
Channel crosstalk	f < 100Hz	-74		dB
Gain error		0.2	0.45	% FSR
Noise voltage		0.5	2	LSB

Max. total error	±40 µA ±0.35% from measured value
Isolation	Only to bus, analog channels are not isolated from each other

Analog outputs ±10 V

Parameter	Conditions	Min.	Typical	Max.	Unit
Resolution				12	Bit
Gain error			0.05	0.12	% FSR
Offset error			3	10	mV
Refresh rate			2		ms
Drift rate			2		mV / ms
Output current	Ua = -10 V ... +10 V, to AGND	-10		10	mA
Short-circuit current			20		mA
Short-circuit time				∞	

Max. total error	±40 mV ±0.35% from measured value
Isolation	Only to bus, analog channels are not isolated from each other

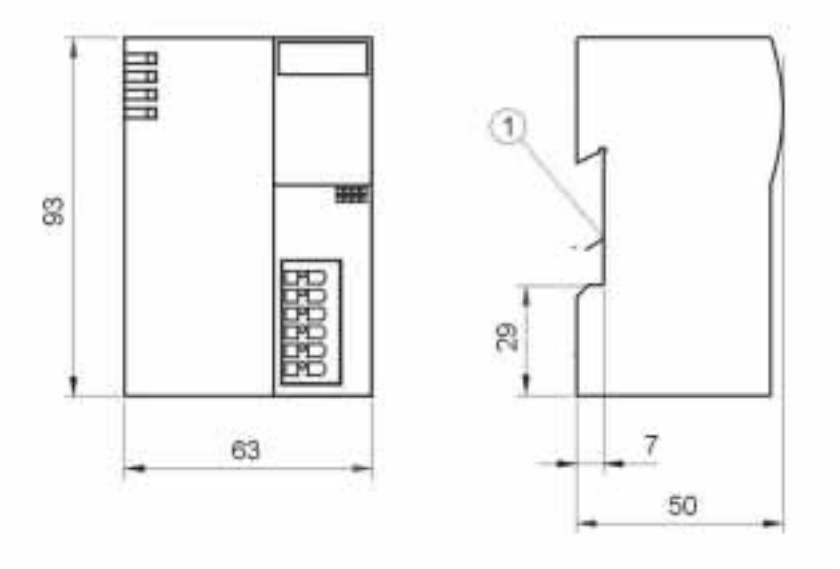
Analog outputs 20mA

Parameter	Conditions	Min.	Typical	Max.	Unit
Resolution				12	Bit
Gain error			0.2	0.5	% FSR
Offset error			10	20	µA
Refresh rate			2		ms
Drift rate			4		µA / ms
Load		0		500	Ω
Short-circuit current		0		20	mA
Short-circuit time				∞	
Output voltage		0		10	V

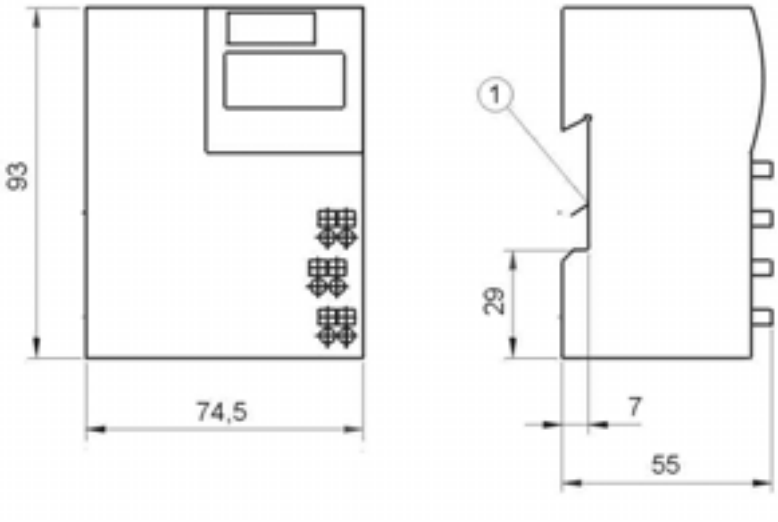
Max. total error	±40 µA ±0.35% from measured value
Isolation	Only to bus, analog channels are not isolated from each other

11.2 Dimensions

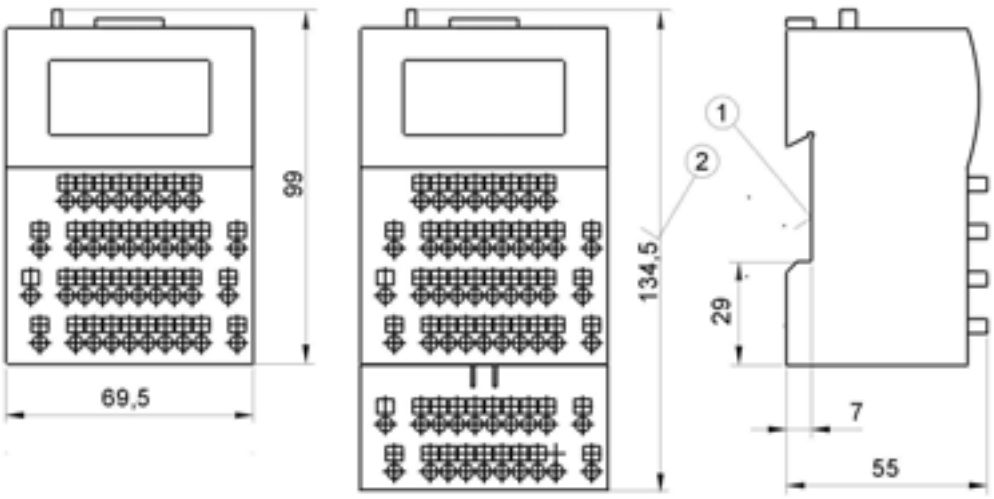
Dimensions
EC bus coupler



Dimensions
BC bus coupler



I/O modules for modular system and compact RIO's



(1) For DIN-rail EN 50022-35
(2) Height with potential distributor

12 Error messages

Error messages are output as flashing codes on the RUN LED of the EC bus coupler and as error messages on the numerical display of the BC bus coupler.

Flashing code Number of flashing codes on the RUN LED of the EC bus coupler	Error message Numerical display on the BC bus coupler	Explanation
6	**E001**	No expansion module connected.
7	**E002**	An expansion module with an ID not supported by the bus coupler was connected.
8	**E004**	Internal data transmission (bus coupler <---> expansion module) was interrupted (e.g. slide contact open).
9	**E005**	The bus coupler has identified a transgression of the maximum number of expansion modules.
3	**E006**	The field bus was interrupted or is no longer operated.
2	**E007**	Write access to the EEPROM in the bus coupler failed.
4	**E012**	Current I/O configuration of bus node does not match specified configuration. The specified configuration can be set on the EC bus coupler using parameterizing function 21 and on the BC bus coupler using parameterizing function 6.
5	**E014**	A PROFIBUS-DP master has sent an incorrect I/O configuration to the bus coupler.
	E016	BC bus coupler only. User lock-out violated on safety level 1.
	E017	BC bus coupler only. User lock-out violated on safety level 2.
	E018	More than 8 lock conditions set for analog channels.
2	**E019**	A module on the bus node has a 24V error.

Error messages 2,4,5:
All inputs/outputs are switched off, i.e. all outputs are set to zero and are no longer refreshed. Inputs are no longer sent to the PLC. The diagnosis continues to operate in the bus coupler, the diagnosis messages are transmitted.

The bus coupler continues to operate with all other error messages. The error message can be deleted on the bus couplers using diagnosis function 20.
On the BC bus coupler the message can also be deleted using the OK and Mode keys.

13 PROFIBUS-DP field bus

PROFIBUS was designed in 1983 as an open field bus, standardized in 1991 (DIN 19 245) and became a European standard in 1996 (EN 50 170).
PROFIBUS-DP has been specially designed for production automation with remote periphery.

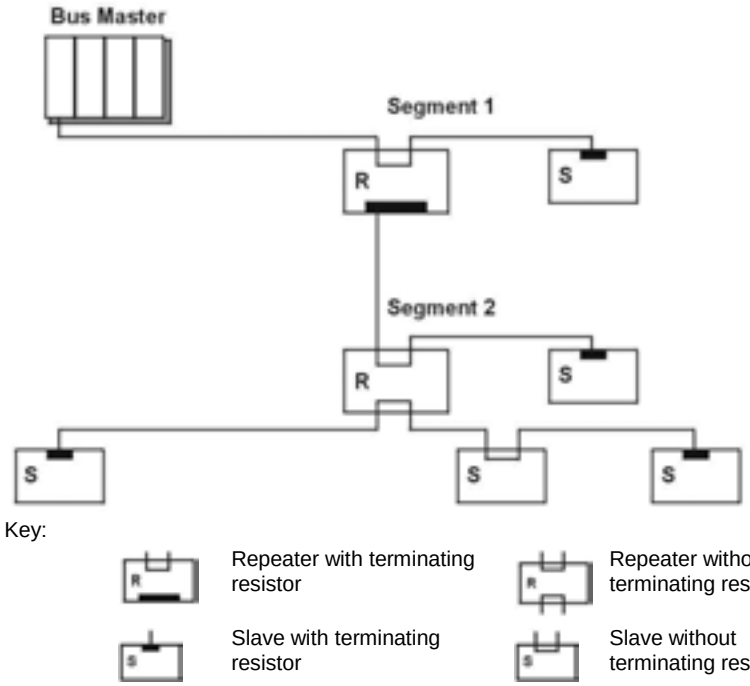
When planning a system not only local/building regulations must be met which mainly define the location of machines and field devices, but also physical regulations for a PROFIBUS system in accordance with EN 50 170.

Field-specific installation instructions of the various suppliers and safety-specific guidelines for a system remain in force.

13.1 PROFIBUS-DP bus topology

According to PROFIBUS-RS485 specification a maximum of 32 slaves can be connected to a bus segment. To operate more PROFIBUS-DP slaves the system must be segmented using repeaters.

Repeaters provide an electrical connections between bus segments and ensure that data signals are amplified and refreshed. Repeaters can be used in addition to isolating bus segments or bus part sections. A repeater adds another bus segment with full line length and the maximum number of field devices that can be connected to a PROFIBUS system. Repeaters will cause signal delays. This must be taken into account when the system is configured.



Max. number of slaves in full setup	126 (addresses from 0 ... 125)
Number of slaves per segment incl. repeater	32
Baud rates	9.6, 19.2, 45.45, 93.75, 187.5, 500, 1500, 3000, 6000, 12000 kBit/s
Number of segments in line (depending on repeaters and bus parameter settings)	3

Individual slaves may fail or shut off during bus operation. All other slaves will continue to operate.

The complete bus topology is configured in the master configuration.

Each slave has a unique manufacturer ID which is assigned by the PROFIBUS user organization (PNO).

13.2 Setup guidelines for PROFIBUS networks

Important steps for connecting and commissioning PROFIBUS networks are described in the Setup guidelines for PROFIBUS networks. The Setup guidelines are published by the PROFIBIS user organization (PNO).

In addition to the instructions given in this manual the Setup guidelines of the PROFIBUS user organization (PNO) must be observed.

The Setup guidelines can be ordered from the following address (please quote order no. 2111):

PROFIBUS-Nutzerorganisation e. V.
Haid-und-Neu-Straße 7
76131 Karlsruhe, Germany

Phone: +49 (0)721 / 96 58 590

Fax: +49 (0)721 / 96 58 589

www.profibus.com

PROFIBUS_International@compuserve.com

The following setup guidelines refer exclusively to transmission with copper lines (RS 485) according to EN 50 170.

The guidelines given in the Electrical installation chapter are in addition and for all bus couplers and must be observed.

13.3 PROFIBUS-DP bus cable parameters

The properties of the bus cable are specified in EN 50170 Part 8-2 as cable type A.

Parameter	Value
Surge impedance (Ω)	135 ... 165 (@ frequency from 3...20MHz)
Capacitance per unit length (pF/m)	< 30
Loop resistance (Ω/km)	<=110
Core diameter (mm)	>0.64*
Core cross-section (mm^2)	> 0.34*

* The core cross-sections must match the connections on the bus connector.

13.4 PROFIBUS-DP bus segment length

Baud rate in Kbit/s	Max. bus segment length in m
9.6	1200
19.2	1200
93.75	1200
187.5	1000
500	400
1500	200
12000	100

Only one baud rate can be selected in a PROFIBUS-DP system.

13.5 Pin configuration and wiring of PROFIBUS-DP

The two data wires for PROFIBUS are also called A and B. There is no rule which data wire color must be connected to which pin but it must be done consistently within the whole system (over several slaves and segments).

If a transmission cable with red and green data wires is used the cables should be wired as follows:

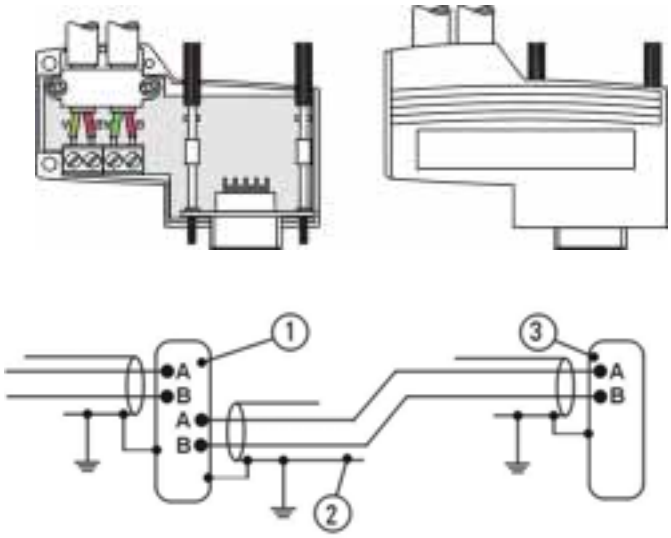
Data wire A - Green

Data wire B - Red

The names are the same for incoming and off-going data wires.

PROFIBUS interface connectors

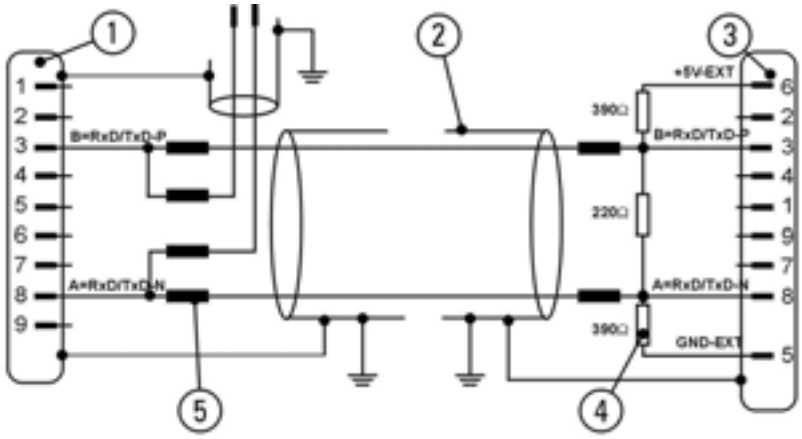
We recommend to use ERbic® PROFIBUS interface connectors from ERNI. The interface connectors can be used for the BC and EC bus couplers.



1 Erbic® PROFIBUS node (grey)
2 Shielded bus cable, for line parameters see below
3 Erbic® PROFIBUS terminator (yellow)
(with integrated terminating resistors)

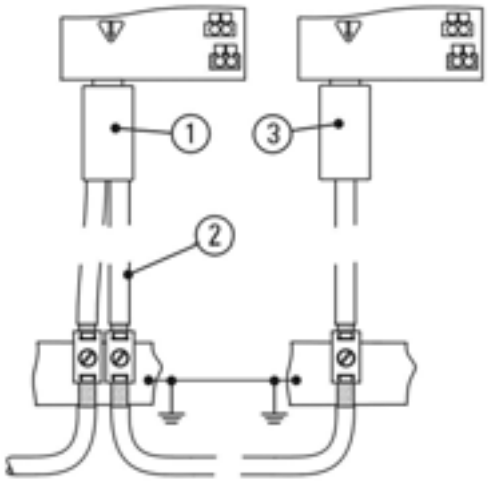
Subminiature connectors

If subminiature connectors are used connectors with a metal casing must be used. The shield of the bus cable must be connected to the metal casing. Bus nodes and bus terminators must be wired as follows:



1 PROFIBUS node, subminiature, 9-pin, male connector
2 Shielded bus cable
3 PROFIBUS terminator, subminiature, 9-pin, male connector
4 Terminating resistors (to be provided at both ends of the transmission line)
5 Direct-axis inductance of 110nH with baud rates > 1.5Mbaud must be provided.

The shields of the bus cables must have a broad-surface connection to the potential balance rail providing adequate conduction at the cabinet opening. The potential balance rail is connected to ground for each electronics cabinet and connected to the potential balance rails of other cabinets.



1 PROFIBUS node
2 Shielded bus cable
3 PROFIBUS terminator

The guidelines given in the Electrical installation chapter are in addition and for all bus couplers and must be observed.

13.6 Configuring PROFIBUS-DP

Perform the following steps:

- Load the GSD file using the configurator or programming system.
- Configure the PROFIBUS-DP master system,
  define the baud rate, highest L2 address etc.,
  specify the bus address for the PROFIBUS-DP master.
- Configure the I/O setup of the bus node and define the bus address.
- Define the input/output address of the bus node.
- Set the defined bus node address on the bus coupler.
- Transfer the configuration to the PROFIBUS-DP master.
- Program the PROFIBUS-DP master controller,
  read the PROFIBUS-DP input data,
  write the PROFIBUS-DP output data.
- Start up the system.

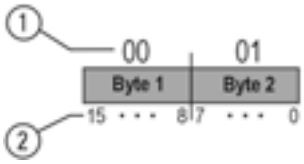
For further details, in particular regarding commissioning with STEP7 see the Commissioning notes for field bus systems description, order no. 322 152 48.

Alternatively you can download the GSD files free of charge from our web site at *www.sbc-support.ch*

13.7 Process data width and address configuration

Module type	Bytes Inputs		Bytes Outputs	
RIO BC DP	4 If diagnosis ON otherwise 0.		4 If diagnosis ON otherwise 0.	
RIO EC DP	4 If configured, otherwise 0.		4 If configured, otherwise 0.	
RIO 16 I	Byte 1	Byte 2		
SAIA-Flags 0..15 Pin configuration	15 ... 8 X2.15 ... X2.8	7 ... 0 X1.7 ... X1.0		
RIO 4I 120 VAC	Byte 1	Byte 2		
SAIA-Flags 0..15 Pin configuration	Not used	3 ... 0 X3.3/4.3 ... X3.0/4.0 (Bit 4 to 7 not used)		
RIO 4I 230 VAC	Byte 1	Byte 2		
SAIA-Flags 0..15 Pin configuration	Not used	3 ... 0 X3.3/4.3 ... X3.0/4.0 (Bit 4 to 7 not used)		
RIO 16 O			Byte 1	Byte 2
SAIA-Flags 0..15 Pin configuration			15 ... 8 X2.15 ... X2.8	7 ... 8 X1.7 ... X1.0
RIO 4 O R			Byte 1	Byte 2
SAIA-Flags 0..15 Pin configuration			Not used	3 ... 0 X3.3/4.3 ... X3.0/4.0 (Bit 4 to 7 not used)
RIO 8 I/O	Byte 1	Byte 2	Byte 1	Byte 2
SAIA-Flags 0..15 Pin configuration	Not used	7 ... 0 X1.7 ... X1.0	Not used	7 ... 0 X1.7 ... X1.0
RIO 8 I 8 I/O	Byte 1	Byte 2	Byte 1	Byte 2
SAIA-Flags 0..15 Pin configuration	15 ... 8X 2.7 ... X2.0	7 ... 0 X1.7 ... X1.0	Not used	7 ... 0 X1.7 ... X1.0
	Word* Inputs		Word* Outputs	
SAIA Register 0..3/5	0..3/5		0..3/5	
RIO 4AI ±10V	Word 1 to 4 (channel 0 to 3)			
RIO 4AI/4AO ±10V	Word 1 to 4 (channel 0 to 3)		Word 1 to 4 (channel 0 to 3)	
RIO 4AI 20mA	Word 1 to 4 (channel 0 to 3)			
RIO 4AI/4AO 20mA	Word 1 to 4 (channel 0 to 3)		Word 1 to 4 (channel 0 to 3)	
RIO T10-10	Word 1 to 4 (channel 0 to 3)			
RIO T20-10	Word 1 to 4 (channel 0 to 3)			
RIO C24-10	Word 1 to 5 or 1 to 3 depending on setting with service function 13.		Word 1 to 5 or 1 to 3 depending on setting with service function 13.	
RIO P24-10	Word 1 to 5 or 1 to 3 depending on setting with service function 13.		Word 1 to 5 or 1 to 3 depending on setting with service function 13.	

*1 word = 2 bytes



1 Byte start addresses

2 Bit numbering

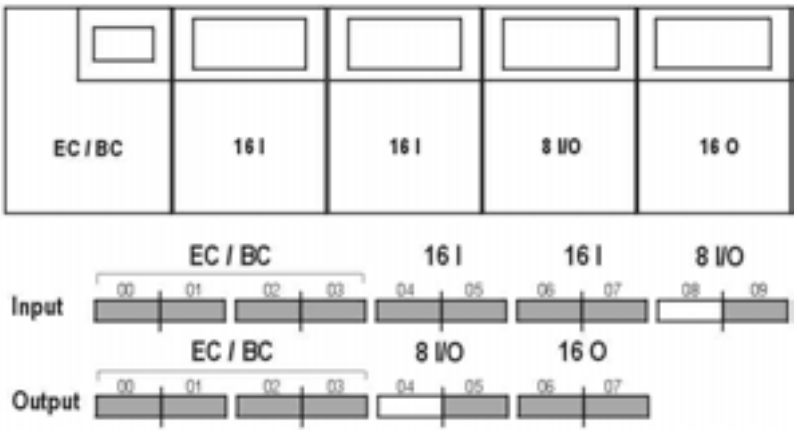
Up to 8 expansion modules can be operated on the DP bus coupler. Note that the maximum number of data bytes is 64 (input) and 64 (output).
The number of expansion modules may be restricted by their power consumption. See also the chapter **Bus node power consumption** on page 125.

The current process data width can be determined with **Service function 3** and **Service function 4** (page 141) or diagnosis **Function 3** (page 149). The Byte 1 / Byte 2 order can be changed using the byte swap mode, diagnosis **Function 18** (page 159) and

Service function 10 (page 141).

Examples of address configurations

Configuration of bus nodes and addresses:

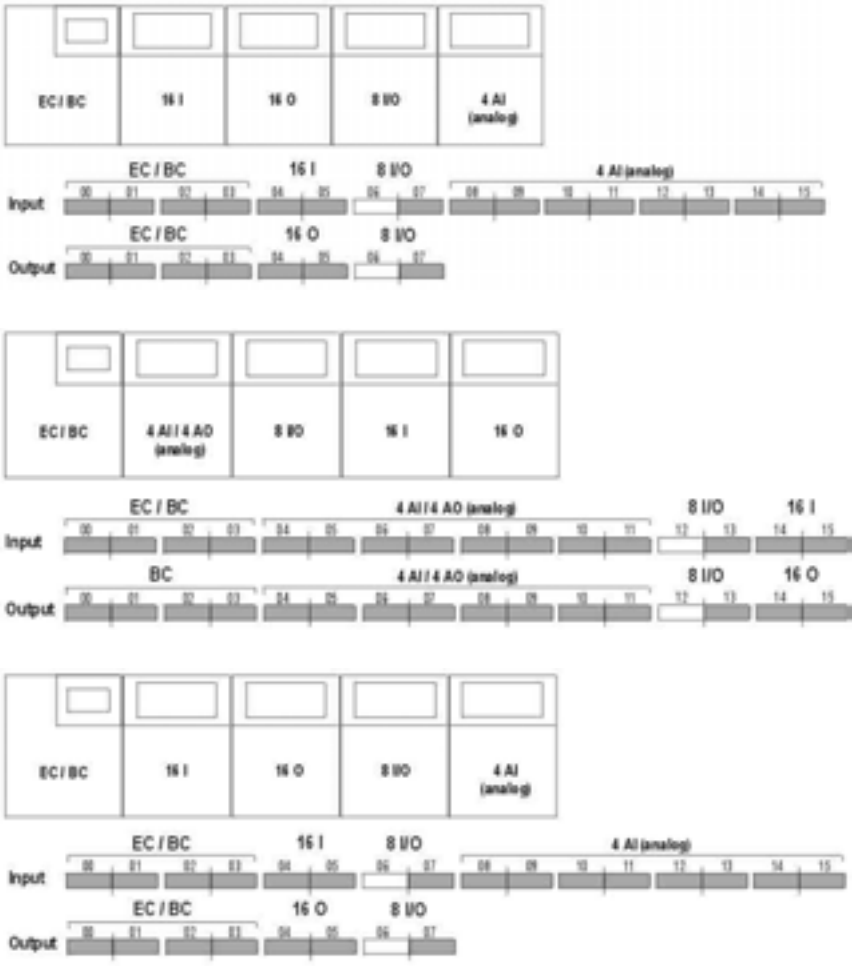


The 00 base addresses have been chosen as an example only and must be adapted to the respective PLC system.

In this example the bus coupler uses 4 bytes for diagnosis data because the diagnosis is switched on. If the diagnosis is switched off no address space is used.
The 8-fold expansion module (8I/O) always uses only the low byte. In this example bytes 08 and 04 are therefore not used.

Other examples

Diagnosis is switched on in all examples.



13.8 Commissioning PROFIBUS-DP

See the Profibus-DP manual, order no. 26/765 E.
All operating manuals can be downloaded free of charge at
www.sbc-support.ch .

13.9 Diagnosis on the PROFIBUS-DP

The bus coupler provides the PROFIBUS-DP standard diagnosis in octets* 1 to 6.
See also DIN 19245 Part 3 from page 40.

(*) In DIN 19245 a byte is called an octet. This is also the term that we use here.

Octet	Bit	Abbreviation	Description
1	0	non_exist	Slave does not exist (sets master)
	1	station_not_ready	Slave not ready for data exchange
	2	cfg_fault	Configuration data of master and slave does not match
	3	ext_diag	There are advanced diagnosis bytes
	4		
	5	invalid_slave_response	Always set to 0 by slave
	6	prm_fault	Parameterizing error
	7	master_lock	Slave parameterized by a master
2	0	prm_req	Slave must be re-parameterized
	1	stat_diag	Static diagnosis
	2		Always 1
	3	wd_on	Watchdog monitoring active
	4	freeze_mode	Freeze instruction active
	5	sync_mode	Sync instruction active
	6		Reserved
	7	slave_deactivated	1 if slave deactivated by master
3	0 ... 6		Reserved
	7	ext_diag_overflow	Diagnosis data overflow in master or slave

Octet	Description
4	Master address
5, 6	ID

Advanced diagnosis

Octet	Bit	Description	
7		Length of advanced diagnosis	
8	0 . . 7	Module 9 without power supply . . Module 15 without power supply	16 bit information module not supplied with 24V See diagnosis function 1
9	0 . . 7	Module 0 without power supply . . Module 7 without power supply	
10	0 . . 7	Module 9 output driver overload . . Module 15 output driver overload	16 bit information module overloaded See diagnosis function 2
11	0 . . 7	Module 0 output driver overload . . Module 7 output driver overload	
12		Error code (corresponds to error code display on the bus coupler)	

Switch advanced diagnosis ON and OFF using **Service function 9** on page 141 or parameterizing or diagnosis **Function 19** on page 160.

13.10 PROFIBUS-DP response times

The response time is defined as the total time of a message cycle between the master and an individual slave.
A message cycle consists of a request telegram to the slave, mandatory bus idle times and the response time of the slave.
The bus cycle time is the total of all the message cycles.

To calculate the response time:

12Mbaud	28µs + 1µs/data byte to be transmitted
1.5Mbaud	224µs + 7µs/data byte to be transmitted

Example:

10 bus nodes with 8 bytes of output data and 8 bytes of input data each

12Mbaud:

28 + 8 + 8 = 44µs	Response time
44 * 10 = 440µs	Bus cycle time

1.5Mbaud:

224 + (7*8) + (7*8) = 336µs	Response time
336 * 10 = 3.4ms	Bus cycle time

Add a manufacturer-specific run time in the DP master (typically 1 - 3ms).

Therefore the duration of a bus cycle in which all slaves are contacted once is approx. 2 - 4ms at 12Mbaud.

14 What if... ?

... error message 1 indicates that the bus coupler is operating without expansion modules?
The bus coupler will still work.
You can, for example, set and save the desired address for the next application via the PROFIBUS-DP bus coupler keypad.

... error message 2 indicates that an expansion module with an unknown ID has been detected?
The connected expansion modules include at least one whose ID is not supported by the existing firmware version in the bus coupler. I.e. one of the expansion modules is a new development which was unknown at the time when the bus coupler was manufactured.

... error message 4 indicates that the internal system bus has been interrupted?
During operation the orange slide contact has been opened and this has caused internal data communication to be interrupted. A monitoring function integrated in the expansion modules switches all existing 24V outputs to 0V after the watchdog time (t_w = 100ms).
The bus coupler is still active on the field bus but only operates its diagnosis interface.

... error message 5 indicates that too many expansion modules are connected to the bus coupler?
You must not exceed the maximum process data width of the bus coupler. See chapter Process data width.

error message 6 indicates that the field bus has been interrupted?
In this case either the field bus has been disconnected from the bus coupler or the relevant field bus master is no longer operating the bus. The reason for this error can also be a failure of the bus cable over a short time or a cable break.
A pre-defined preferred shut-off state (see parameterizing function 5) will now be activated by the bus coupler.
On PROFIBUS-DP part of the network may continue to operate depending on where the cable break occurred. If the connection is re-established the bus will automatically resume operation.

... error message 7 is displayed in LOCK *mode?*
A write instruction to the internal EEPROM of the bus coupler could not be carried out. If this errors is displayed repeatedly the hardware is defective. Despite this error the system can continue to be operated normally. Only saving *new* parameterizing data such as a new PROFIBUS-DP address or a modified LOCK mask is no longer available.

... error message 12 is displayed when I switch the system on?
After you have switched the system on the bus coupler has detected that the bus node configuration is different from the specified configuration.
Either you have forgotten to close one of the orange slide contacts (e.g. after a maintenance job) or the number or the order of the expansion modules has changed since the last time the system was switched on.
NOTE: If necessary, set the new specified configuration using service function 6 (BC bus coupler) or parameterizing function 21 (EC bus coupler).

... error message E016 or E017 indicates an active user lock-out? (BC bus coupler only)
Ensure that the desired operation does not produce an unauthorized operating state.
Press OK to confirm the error message. Cancel the user lock-out using service function 7 with parameter 0 or service function 8 with password.

... error message 14 is displayed?
The configuration in the PROFIBUS-DP master does not match the current I/O configuration. Also check the orange slide contacts and service function 6.

... you have pressed the Mode key on the BC bus coupler by mistake and pre-selected one of the commissioning modes?
The pre-selected mode indicated by the flashing LED will automatically stop flashing after 8s.

... diagnosis function 2 or 0 signals overloaded output drivers for one or more modules although none of the relevant outputs are connected?
There is no 24V supply to the output drivers on the relevant expansion modules. Diagnosis function 2 only works correctly if the expansion module has a 24V supply.

... you cannot operate the BC bus coupler?
Either the local operation of the bus node has been locked by the master control via diagnosis function 6 or the bus coupler is not ready for operation because of an error message.

If you need any further help please contact your local SAIA-Burgess Electronics representation.

15 Appendix

15.1 Input signal delay

Input signal delay	
Typical (any bus coupler with 3 digital I/O modules)	2 - 7ms

The input signal delay is longer:

- If you use analog I/O modules on the same bus coupler (approx. 7 - 14ms with 2 x analog, 1 x digital)
- When you press individual keys on the BC bus coupler (approx. 4ms)
- When you use the advanced operating modes on the BC bus coupler (e.g. LOCK 3ms)

15.2 Analog module data formats

The data formats are set using the parameterizing and diagnosis function of the respective bus coupler (e.g. RIO BC or EC) or Master PLC (e.g. PCD2.M..). For a description of the parameterizing and diagnosis functions refer to the respective operating manual.

The following data formats can be set:

Parameter	Data format	Suitable for
0	±10 V in two's complement (-2048 .... +2047)	RIO 4AI ±10V RIO 4AI/4AO ±10V
1	±10 V in mV (-10000 .... +10000)	RIO 4AI ±10V RIO 4AI/4AO ±10V
2	0...20 mA in two's complement (0...4095)	RIO 4AI 20mA RIO 4AI/4AO 20M RIO 4AI 4-20mA (*1) RIO 4AI/4AO 4-20mA (*1)
3	0...20 mA in µA (0...20000)	RIO 4AI 20mA RIO 4AI/4AO 20mA RIO 4AI 4-20mA (*2) RIO 4AI/4AO 4-20mA (*2)
4	4...20 mA in S5 format	0 ... 20 mA module RIO 4AI 20mA RIO 4AI/4AO 20mA
5	0...10 V in mV (0 ... 10000)	RIO 4AI 0-10V RIO 4AI/4AO 0-10V
7	4...20 mA in S7 format	4...20 mA modules
8	4...20 mA in S5 format	RIO 4AI 4-20mA RIO 4AI/4AO 4-20mA

(*1) = the range 0..4095 will be divided in the whole range of the 4-20mA module (0..22.81 mA)
(*2) = the range 0..20000 will be divided in the whole range of the 4-20mA module (0..22.81 mA)

15.2.1 Voltage input/output data formats

±10 V in two's complement (-2048 ... +2047)																		
Measured value	Binary																Dec.	Hex.
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0		
10,000 V	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	2047	07FF
5,000 V	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1024	0400
0,000 V	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0000
-5,000 V	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	-1024	FC00
-10,000 V	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	-2048	F800

±10 V in mV (-10000...+10000)																		
Measured value	Binary																Dec.	Hex.
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0		
10,000 V	0	0	1	0	0	1	1	1	0	0	0	1	0	0	0	0	10000	2710
5,000 V	0	0	0	1	0	0	1	1	1	0	0	0	1	0	0	0	5000	1388
0,000 V	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-5,000 V	1	1	1	0	1	1	0	0	0	1	1	1	1	0	0	0	-5000	EC78
-10,000 V	1	1	0	1	1	0	0	0	1	1	1	1	0	0	0	0	-10000	D8F0

0...10 V in mV (0...10000)																		
Measured value	Binary																Dec.	Hex.
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0		
10,000 V	0	0	1	0	0	1	1	1	0	0	0	1	0	0	0	0	10000	2710
5,000 V	0	0	0	1	0	0	1	1	1	0	0	0	1	0	0	0	5000	1388
0,000 V	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

15.2.2 Current input/output data formats

0...20 mA in two's complement (module 4AI 0-20mA, 4AI/4AO 0-20mA)																		
Measured value	Binary																Dec.	Hex.
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0		
20 mA	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	4095	0FFF
10 mA	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1024	0400
0 mA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

0...20 mA in two's complement (0..4095) (module 4AI 4-20mA, 4AI/4AO 4-20mA)		
Measured value	Dec.	Hex.
22.81 mA	4095	0FFF
20 mA	3591	0E07
10 mA	1795	0703
4 mA	718	02CE
0 mA	0	0

0...20 mA in µA (0...20000) (module 4AI 0-20mA, 4AI/4AO 0-20mA)																		
Measured value	Binary																Dec.	Hex.
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0		
20 mA	0	1	0	0	1	1	1	0	0	0	1	0	0	0	0	0	20000	4E20
10 mA	0	1	0	0	1	1	1	0	0	0	0	1	0	0	0	0	10000	2710
0 mA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

0...20 mA in µA (0...20000) (module 4AI 4-20mA, 4AI/4AO 4-20mA)		
Measured value	Dec.	Hex.
22.81 mA	20000	4E20
20 mA	17536	4480
10 mA	8768	2240
4 mA	3507	0DB3
0 mA	0	0

From bus coupler s/w version 00.50 the display format can also be set to SIMATIC S5.

0...20 mA SIMATIC S5 format for inputs (module 4AI/4AO 20mA)																	
Measured value	Binary representation													A	E	O	Units
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
20,000 mA	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	2560
19,992 mA	0	1	0	0	1	1	1	1	1	1	1	1	1	0	0	0	2559
16,000 mA	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2048
4,000 mA	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	512
3,992 mA	0	0	0	0	1	1	1	1	1	1	1	1	1	0	0	0	511
3,000 mA	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	384
1,179 mA	0	0	0	0	0	1	0	0	1	0	1	1	1	0	0	0	151
1,171 mA	0	0	0	0	0	1	0	0	1	0	1	1	0	0	0	1	150
0,000 mA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0

A Activity bit always = 0
E Error bit always = 0
O Overflow bit < 1.179 mA = 1 und >= 20 mA = 1

The measuring range 4 ... 20 mA is divided into 2048 units in the interval 512 ... 2560.
The software generates an overflow message under 1,179 mA.

0...20 mA SIMATIC S5 format for outputs (module 4AI/4AO 20mA)																	
Measured value	Binary representation												x	x	x	x	Units
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
20,000 mA	0	1	0	0	0	0	0	0	0	0	0	0	x	x	x	x	1024
19,984 mA	0	0	1	1	1	1	1	1	1	1	1	1	x	x	x	x	1023
12,000 mA	0	0	1	0	0	0	0	0	0	0	0	0	x	x	x	x	512
4,016 mA	0	0	0	0	0	0	0	0	0	0	0	1	x	x	x	x	1
4,000 mA	0	0	0	0	0	0	0	0	0	0	0	0	x	x	x	x	0
3,984 mA	1	1	1	1	1	1	1	1	1	1	1	1	x	x	x	x	-1
0,000 mA	1	1	1	1	0	0	0	0	0	0	0	0	x	x	x	x	-256

x No meaning

The measuring range 4 ... 20 mA is divided into 1024 units.
This corresponds to a resolution of 10 bit or 0.015625 mA/digit.

4...20 mA in S7 format (module 4AI 4..20mA, 4AI/4AO 4..20mA)																		
Measured value	Binary																Dec.	Hex.
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0		
20.0 mA	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	27648	6C00
10.0 mA	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	10368	2880
4.1 mA	0	0	0	0	0	0	0	0	1	0	1	0	1	1	0	1	173	00AD
4.0 mA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.9 mA	1	1	1	1	1	1	1	1	0	1	0	1	0	0	1	1	-173	FF53
0.0 mA	1	1	1	0	0	1	0	1	0	0	1	0	0	0	0	0	-6880	E520

The measuring range 4 ... 20 mA is divided into 27648 units.

15.3 Module IDs

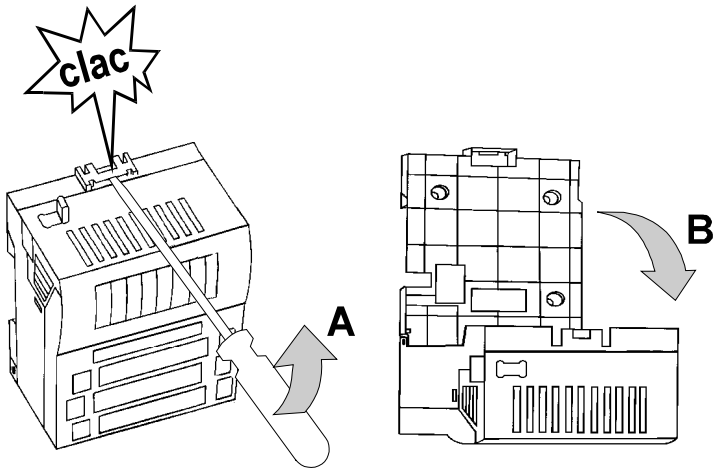
Module IDs	Module name
1	RIO 8 I/O
2	RIO 16 I
3	RIO 16 O
4	RIO 8I 8I/O
5	RIO 4AI/4AO ±10V
6	RIO 4AI ±10V
7	RIO 4AI/4AO 20mA
8	RIO 4AI 20mA
14d / 0Eh	RIO T10-10
10d / 0Ah (6 I/O bytes) 11d / 0Bh (10 I/O bytes)	RIO C24-10
12d / 0Ch (6 I/O bytes) 13d / 0Dh (10 I/O bytes)	RIO P24-10
16d / 10h	RIO 4AI/4AO 4-20mA
17d / 11h	RIO 4AI 4-20mA
19d / 13h	RIO 4 O R
20d / 14h	RIO T20-10
24d / 18h	RIO 4 I 120 VAC
25d / 19h	RIO 4 I 230 VAC

15.4 Replacing electronic parts in the module

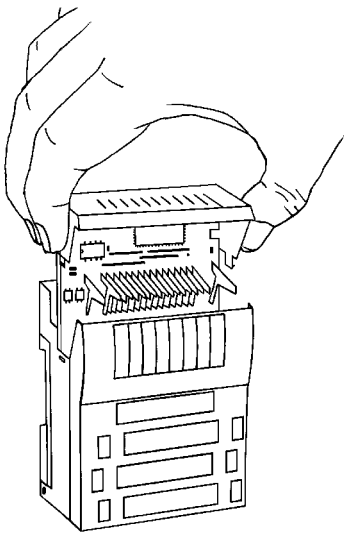
Always switch the module off before replacing parts.

All cables can be left on the module.

1. Open the contact slide
2. Tilt the module forward.



3. Hold module on textured areas, press together and remove electronic parts.



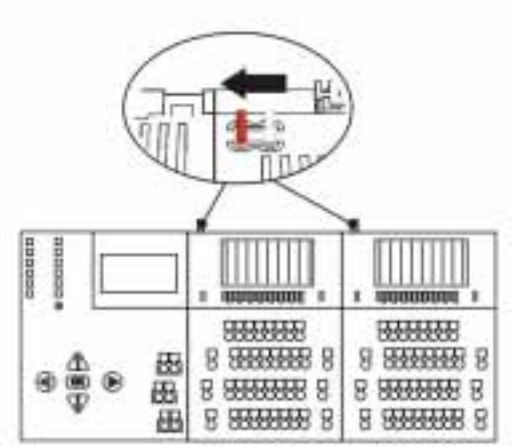
16 Glossary

Combination channels

I/O channels which can be used as inputs or outputs. I.e. an input address space and an output address space are reserved for the process map.

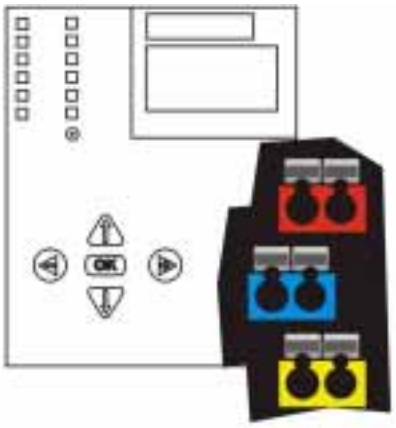
Slide contacts

The orange slide contacts on top of the module connect the modules to the bus coupler.



Terminals for relaying the power supply

Spring terminals which can be used to relay the power supply from one module to the next in order to reduce the number of terminal contacts.



17 Trademarks

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18 Safety-related information

The term automation system as used in this manual includes controls, their components (modules), other parts (such as racks, cables), operator panels, and the software used for programming, commissioning and operating the controls. This operating manual can only describe a fraction of the automation system (e.g. modules).

The technical design of SAIA-Burgess Controls automation systems is based on the EN 61131-2 (IEC 61131-2) product standard for programmable logic controls. The systems and devices have CE marking according to the EMC directive 89/336/EEC and, if applicable, the low-voltage directive 73/23/EEC.

The machinery directive 89/392/EEC is not applicable because the safety objectives of the directive are covered by the low-voltage and EMC directives.
When SAIA-Burgess Controls automation systems are part of the electrical equipment of a machine, the manufacturer must include them in the conformity evaluation process. In this case the DIN EN 60204-1 standard must be observed (safety of machines, general requirements for electrical equipment of machines).

When an automation system is properly used and serviced for its intended purpose it will not normally cause damage to property or present health hazards. However, improper configuration, installation, maintenance or operation of the system or machine, ignoring the instructions in this manual, or intervention by insufficiently qualified personnel may result in connected actuators (such as motors, hydraulic units, etc.) becoming a source of danger.

18.1 Correct use of the system

SAIA-Burgess Controls automation systems are state-of-the-art products and manufactured to recognized safety requirements. Their use can, however, cause danger to the health and safety of operators and others, or damage machines, systems or other property.

The automation system must only be used in perfect technical condition for its intended purpose, with attention given to safety and danger, and observing the operating manual. Correct transport, storage, installation, operation and maintenance of the system are all prerequisites for smooth and safe operation of the control. Malfunctions, in particular those which may affect safety, must be immediately resolved.

Automation systems are designed exclusively to control machines and systems. Automation systems are not intended for any other use than the above. The manufacturer will therefore accept no liability for any damages resulting from the incorrect use of the systems.

When using automation systems, all instructions given in this manual regarding mechanical and electrical setup, commissioning and operation must be observed.

18.2 Selection and qualification of personnel

All configuring, programming, installation, commissioning, operation and servicing work on the automation system must be carried out by trained personnel such as electricians or electrical engineers.

Personnel responsible for configuring and programming the system must be familiar with all safety-related issues in automation technology.

System operators must be instructed on the operation of the control and be familiar with the relevant operating instructions.

All personnel responsible for installing, commissioning and servicing the system must have had appropriate training qualifying them to work on automation systems.

18.3 Configuration, programming, installation, commissioning and operation

The automation system will in most cases be a part of a larger system in which machines or systems are controlled. When configuring, installing and commissioning automation systems to control machines the machine manufacturer and the user must observe the safety regulations as defined in the machinery directive 89/392/EEC. For specific applications national accident prevention regulations such as VBG 4.0 will apply.

Safety-related components on the controlled machine must be designed such that they operate independently from the control. Emergency stop components must be effective in all operating modes of the control. In an emergency stop the power supply to all switching elements controlled by the control must be cut off. The power supply can be cut off using a safety relay.

Measures must be taken for restarting an interrupted control program following voltage dips or power failures. Operating states should never cause danger, not even for a short time. In the event of danger the emergency stop must be immediately triggered.
In order to prevent an open-circuit in the signal circuit causing non-controllable states in the control, the relevant hardware and software safety precautions must be taken for I/O interfacing. Control elements and their assigned control panel elements must be installed in a place where they are sufficiently protected against inadvertent use.

18.4 Maintenance and servicing

Measuring and testing on active devices must be carried out in accordance with the regulations and instructions of the VBG 4.0 accident prevention regulation. The appropriate power tools must be used.

Repairs on control components must be carried out at repair shops authorized by SAIA-Burgess Controls. Opening the components and repairs by unauthorized personnel may lead to personal injury or damage to property.

Always disconnect the device from the mains before opening it (either disconnect the mains plug or use the cut-out switch).

Control modules may only be replaced when the power is switched off. Disassembly and assembly must be carried out according to the directives for mechanical assembly.

Fuses may only be replaced with those types specified in Specifications.

Batteries may only be replaced with those types specified in Specifications. Batteries must always be disposed as hazardous waste.

18.5 High voltage

When the cabinet is opened or the housing removed from system components certain parts of the automation system are exposed. These parts may be subject to dangerous high voltages.

The user must prevent any unauthorized and incorrect access to the system (for example, by ensuring that the cabinet is locked).

Personnel must be familiar with all sources of danger and measures for commissioning and servicing the system in line with the instructions given in this manual.

18.6 Used batteries

When the batteries in the automation system have reached the end of their life they must be disposed of in a battery return system or through special public waste disposal facilities.

Batteries should be fully discharged before disposal. A battery is discharged when the function of the device is impaired due to insufficient battery capacity.

When batteries for disposal are not fully discharged precautions must be taken to prevent short circuits. This can be done by sticking tape over the poles of the battery.

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