

B-Nimis MC-I/O XR series



Order numbers:

S-01030207-0100 – B-Nimis MC-I/O XR01

S-01030207-0200 – B-Nimis MC-I/O XR02

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Notes about this handbook

This equipment handbook contains information which is specific to the product and valid at the time of printing.

This equipment handbook is only complete in conjunction with the product-related hardware and software manuals required for the specific application.

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Berghof Automation GmbH is certified to DIN EN ISO 9001:2015.

Revision log

Version	Date	Description
1.0	20.06.2013	First Version
1.1	25.04.2016	New corporate name "Berghof Automation GmbH" UL certification New version of the EC-COM Module included Variant EC-COM 01 removed Section "Conformity declaration" updated Section "Nameplate" updated
1.2	02.08.2021	Revised
1.3	01.03.2024	Synchronized with german version number

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1. General Information

This equipment manual is intended for qualified personnel and contains information regarding mounting, installation, commissioning and maintenance. The information contained in this manual is subject to change without prior notice.


1.1. About This Manual

This equipment manual is an integral part of the product. Make sure the equipment manual is always available near the product's point-of-employment. The manual contains information about the following topics:


- Areas of application;
 - Safety;
 - Mechanical construction;
 - Electrical construction;
 - Connections;
 - Commissioning;
 - Care and maintenance;
 - Decommissioning;
 - Disposal.
- ▶ Keep this user handbook available alongside the product at all times.

1.2. Symbols and visual depictions

The following symbols and visual depictions are used in this user handbook:

Symbol	Meaning
→ ...	List entry
▶ ...	Individual instruction or list of instructions which can be carried out in any order.
1. ... 2. ...	List of instructions which must be carried out in the order given.
	Additional product information

Structure of the warnings:

 WARNING	
Optional:	Type and source of the danger
More	Brief description and consequences
symbols	Preventive measures

1.3. Hazard categories and indications

The following indications are used for warning messages that must be observed to ensure your personal safety and avoid any damage to property.

The indications have the following meanings:

DANGER

Immediate danger

Failure to observe the information indicated by this warning will result in death, serious injury or extensive property damage

WARNING

Potential danger

Failure to observe the information indicated by this warning may result in death, serious injury or extensive property damage

CAUTION

Danger

Failure to observe the information indicated by this warning may result in injury or property damage

NOTICE

No hazard

Information indicated in this manner provides additional notes concerning the product
Take preventive measures.

1.4. Conformity Declaration

The EtherCAT I/O Modules comply with and make allowance for the following directives and standards

- **EMC Directive 2014/30/EU**
- **RoHS-2 – Directive 2011/65/EU**
- **IEC 61131-2:2007** Programmable controllers
Part 2: Equipment requirements and tests
- **UL 508:2013-10** Industrial Control Equipment
17th Edition / 1999-01-28

1.5. Qualified personnel

Only qualified personnel may install, operate and maintain the EtherCAT I/O Modules.

Within the context of this documentation and the safety information it contains, qualified personnel constitutes trained specialists who have the authority to mount, install, commission, ground and identify equipment, systems and power circuits in accordance with the standards of safety technology, and who are familiar with the safety concepts of automation technology.

1.6. Duty of care

The operator, or the processor (OEM) must ensure that

- the EtherCAT I/O Modules are only used for the purpose for which they are intended;
- the EtherCAT I/O Modules are only operated in impeccable full working order;
- the user manual is always available in full and in a legible condition;
- only specialists with sufficient qualification and authorisation mount, install, commission and maintain the controller module;
- these specialists are regularly instructed in all relevant questions of occupational health and safety and environmental protection and that they also know the contents of the user manual and especially of the safety notes therein;
- the device markings, identifications, safety and warning notes attached to the EtherCAT I/O Modules are not removed and are always kept in a legible state;
- the national and international regulations for controlling machines and systems which apply at the relevant usage site are observed;
- the relevant information about the EtherCAT I/O Modules and their application and operation is always available to the users

1.6.1. Working on the controller module

Before carrying out work on the EtherCAT I/O Modules you must always

- first ensure that the controller and the system are in a secure state;
- only then switch off the controller and the system and
- only now disconnect the EtherCAT I/O Modules from the system.

WARNING

Before starting any work on the device, disconnect all inputs, including any connected peripherals.

Inappropriate handling (installation and movement), while the device is powered on, may result in damage and / or data loss.

1.7. Use as Prescribed

This is a modular automation system based on the CANbus, intended for industrial control applications within the medium to high performance range.

The automation system is designed for use within Overvoltage Category I (IEC 364-4-443) for the controlling and regulating of machinery and industrial processes in low-voltage installations in accordance with the following general parameters:

- maximum rated supply voltage of 1,000 VAC (50/60 Hz) or 1,500 VDC;
- for use in maximum category 2 pollution environment (EN 60950);
- for use up to a maximum altitude of 2,000 m above msn;
- max. ambient temperature inside and outside the control cabinet is within the technical specifications (see section "Technical data")

Qualified project planning and design, proper transport, storage, installation, use and careful maintenance are essential to the flawless and safe operation of the automation system.

The automation system may only be used within the scope of the data and applications specified in the present documentation and associated user manuals.

The automation system is to be used only as follows

- as prescribed,
- in technically flawless condition,
- without arbitrary or unauthorized changes and
- exclusively by qualified users

The regulations of the German professional and trade associations, the German technical supervisory board (TÜV), the VDE (Association of German electricians) or other corresponding national bodies are to be observed.

Safety-oriented (fail-safe) systems

Particular measures are required in connection with the use of PLCs in safety-oriented systems. If a PLC is to be used in a safety-oriented system, the user ought to seek the full advice of the PLC manufacturer in addition to observing any standards or guidelines on safety installations which may be available.

WARNING

As with any electronic control system, the failure of particular components may result in uncontrolled and/or unpredictable operation.

All types of failure and the associated fuse systems are to be taken into account at system level.

The advice of the PLC manufacturer should be sought if necessary.

2. Product description

2.1. Overview of the B-Nimis MC-I/O modules (MC-I/O XR01 – MC-I/O XR02)

The Type B-Nimis MC-I/O XR multifunctional I/O modules combine digital and analog inputs and outputs in one module. The digital inputs also have a counter function which is also suitable for encoders. The EtherCAT connection and affiliation to the MC-I/O family round off the function. The portfolio comprises six different hardware configurations.

From the functional point of view the B-Nimis MC-I/O XR modules correspond to the XR-I/O expansion cards from the DC1000 display controller family. The MC-I/O-XR modules thus not only complete the EtherCAT I/O system but also give DC1000 users the option to change with compatible I/O level from the DC1000 system to the CANtrol EC family and the CODESYS V3 controller EC1000.

The automation solution adopted by the MC-I/O XR family manages with as few different I/O modules as possible. In this way users can optimise the effort and expenditure involved in construction, production and storage.

Digital I/O

The digital signal mix comprises 8 inputs and 8 outputs. The outputs can also be used as digital inputs. Each input can count up to a frequency of 10 kHz. They can count forwards and backwards as well as process 24 V encoder signals.

Analog I/O

Except in the purely digital modules there are always at least four power inputs (+/- 10 V). Depending on the configuration of the module an additional 4 connections can function as inputs or outputs. Here the range of analog I/O functions includes +/- 10 V as well as +/- 20 mA, with the very high resolution of up to 22 bit.

Performance features – an overview

The great flexibility of the MC-I/O XR01 module requires its own library to configure the functions. Modules E-XR02 to E-XR06 have a fixed presetting.

Technical data - Multifunctional digital and analog I/O					
	Digital input	Digital in-/output	Analog input	Analog output	Analog in-/output
MC-I/O XR01	8 – singly configurable with counter function or for encoder connection	8 – usable either as in- or output	4 inputs ±10 V	-	4 - singly configurable as in- or output either as ±10 V or ±20 mA
MC-I/O XR02	4 inputs with counter function, 4 inputs for encoder connection	8 – usable either as in- or output	-	-	-
MC-I/O XR03	4 inputs with counter function, 4 inputs for encoder connection	8 – usable either as in- or output	8 inputs ±10 V	-	-
MC-I/O XR04	4 inputs with counter function, 4 inputs for encoder connection	8 – usable either as in- or output	4 inputs ±10 V 4 inputs ±20 mA	-	-
MC-I/O XR05	4 inputs with counter function, 4 inputs for encoder connection	8 – usable either as in- or output	4 inputs ±10 V	2 inputs ±10 V 2 inputs ±20 mA	-
MC-I/O XR06	4 inputs with counter function, 4 inouts for encoder connection	8 – usable either as in- or output	4 inputs ±10 V	-	-

Scope of supply

The scope of supply consists of:

→ MC-I/O XR module (without connecting plug)

Accessories

→ MC-I/O 36-PIN two-rowed plug; order no.: 204800300

2.2. Technical data

B-Nimis MC-I/O XR01 to XR06	
Module data	
Versions (item no.)	MC-I/O XR01 ENC/C DAIO 8/8/4/4 S-01030207-0100 MC-I/O XR02 ENC/C DIO 8/8 S-01030207-0200 MC-I/O XR03 ENC/C DAIO 8/8/8 S-01030207-0300 MC-I/O XR04 ENC/C DAIO 8/8/8 S-01030207-0400 MC-I/O XR05 ENC/C DAIO 8/8/4/4 S-01030207-0500 MC-I/O XR06 ENC/C DAIO 8/8/4 S-01030207-0600
Termination technique	204800300 36-pin connector for supply and I/O in common (not scope of supply)
Dimensions WxHxD [mm]	122 x 82 x25
Weight	Approx. 150 g
Operating temperature range	0 °C to 50 °C (non-condensating), convection cooling ensured
EMC, protection class, insulation test, protection type	
Emitted interference	EN 61000-6-4, industrial sector
Immunity to interference	EN 61000-6-2, industrial sector (connection cable inputs/outputs < 30 m)
Protection class	III
Insulation strength	EN 61131-2; DC 500 V test voltage
Protection type	IP 20
Supply voltage, current consumption	
Module electronics power supply (connection voltage)	SELV DC +24 V (-15 % / +20 %) (EN 61131-2) part of alternating voltage max. 5 %
Module electronics supply	Typ. 125 mA E-BUS load
I/Os power supply	Separate feeding with 36-pin connector
Current consumption	Unwired approx. 140 mA at 24 V fusing according to load of the I/Os max. 12 A
Protection against supply voltage pole reversal	Yes
Potential isolation	No
Digital inputs/outputs (DIO)	
Number of inputs	8, limiting frequency for counter / encoder function < 10 kHz per input
Number of inputs/outputs	8
Output current	0.5 A per output / total max. 2.0 A
Short circuit protection	Yes

B-Nimis MC-I/O XR01 to XR06

Potential isolation No

Analog inputs/outputs

Inputs 4 analog inputs ± 10 V

Inputs/outputs 4 analog inputs/outputs ± 10 V or ± 20 mA (according to the variant)

Resolution 22 bits (inputs), 16 bits (outputs)

2.3. Module view and pin assignment

2.3.1. Pin assignment MC-I/O XR01 ENC/C DAIO 8/8/4/4

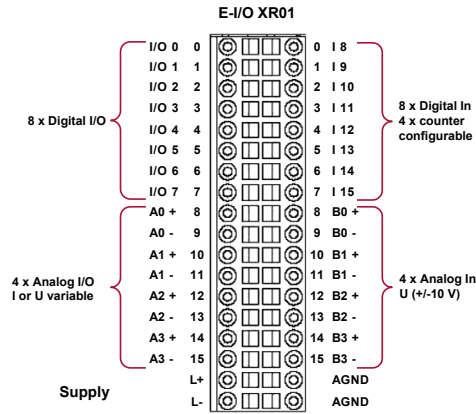


Figure 1: pin assignment XR01

Pin no. X1 (left)	Function	Description	Additional function
0	I/O 0	Digital I/O +24 V	Configurable as capture input
1	I/O 1	Digital I/O +24 V	Configurable as capture input
2	I/O 2	Digital I/O +24 V	Configurable as capture input
3	I/O 3	Digital I/O +24 V	Configurable as capture input
4	I/O 4	Digital I/O +24 V	
5	I/O 5	Digital I/O +24 V	
6	I/O 6	Digital I/O +24 V	
7	I/O 7	Digital I/O +24 V	
8	A0+	Analog IN / OUT	Configurable as in- / output (+/-10 V or +/-20m A)
9	A0-	Analog IN / OUT	Configurable as in- / output (+/-10 V or +/-20m A)
10	A1+	Analog IN / OUT	Configurable as in- / output (+/-10 V or +/-20 mA)
11	A1-	Analog IN / OUT	Configurable as in- / output (+/-10 V or +/-20 mA)
12	A2+	Analog IN / OUT	Configurable as in- / output (+/-10 V or +/-20 mA)
13	A2-	Analog IN / OUT	Configurable as in- / output (+/-10 V or +/-20 mA)
14	A3+	Analog IN / OUT	Configurable as in- / output (+/-10 V or +/-20 mA)
15	A3-	Analog IN / OUT	Configurable as in- / output (+/-10 V or +/-20 mA)
L+		+24 V	Supply I/O
L-		GND	Supply I/O

Pin no. X2 (right)	Function	Description	Additional function
0	In 8	Digital IN +24 V	Configurable as counter or encoder input
1	In 9	Digital IN +24 V	Configurable as counter or encoder input
2	In 10	Digital IN +24 V	Configurable as counter or encoder input
3	In 11	Digital IN +24 V	Configurable as counter or encoder input
4	In 12	Digital IN +24 V	Configurable as counter or encoder input
5	In 13	Digital IN +24 V	Configurable as counter or encoder input
6	In 14	Digital IN +24 V	Configurable as counter or encoder input
7	In 15	Digital IN +24 V	Configurable as counter or encoder input
8	B0+	Analog IN +/-10 V	
9	B0-	Analog IN +/-10 V	
10	B1+	Analog IN +/-10 V	
11	B1-	Analog IN +/-10 V	
12	B2+	Analog IN +/-10 V	
13	B2-	Analog IN +/-10 V	
14	B3+	Analog IN +/-10 V	
15	B3-	Analog IN +/-10 V	
AGND			Analog Ground
AGND			Analog Ground

2.3.2. Pin assignment MC-I/O XR02 ENC/C DIO 8/8

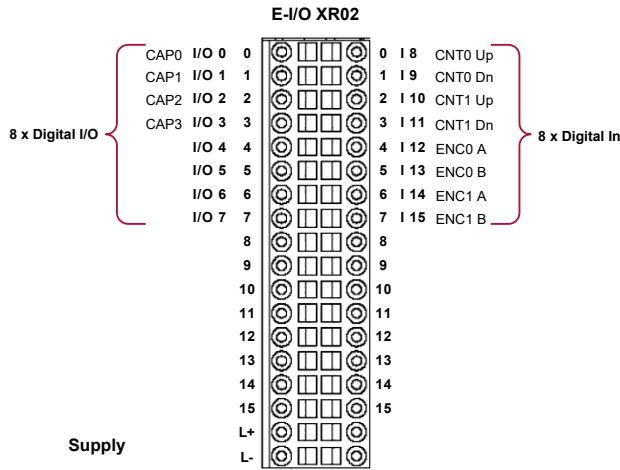


Figure 2: pin assignment XR02

Pin no. X1 (left)	Function	Description	Additional function
0	I/O 0	Digital I/O +24 V	Capture CNT0
1	I/O 1	Digital I/O +24 V	Capture CNT1
2	I/O 2	Digital I/O +24 V	Capture CNT2
3	I/O 3	Digital I/O +24 V	Capture CNT3
4	I/O 4	Digital I/O +24 V	
5	I/O 5	Digital I/O +24 V	
6	I/O 6	Digital I/O +24 V	
7	I/O 7	Digital I/O +24 V	
8		Not used	
9		Not used	
10		Not used	
11		Not used	
12		Not used	
13		Not used	
14		Not used	
15		Not used	
L+		+24 V	Supply I/O
L-		GND	Supply I/O

Pin no. X2 (right)	Function	Description	Additional function
0	In 8	Digital IN +24 V	Counter (CNT0 UP)
1	In 9	Digital IN +24 V	Counter (CNT0 DOWN)
2	In 10	Digital IN +24 V	Counter (CNT1 UP)
3	In 11	Digital IN +24 V	Counter (CNT1 DOWN)
4	In 12	Digital IN +24 V	Encoder0 (CNT2 A)
5	In 13	Digital IN +24 V	Encoder0 (CNT2 B)
6	In 14	Digital IN +24 V	Encoder1 (CNT3 A)
7	In 15	Digital IN +24 V	Encoder1 (CNT3 B)
8		Not used	
9		Not used	
10		Not used	
11		Not used	
12		Not used	
13		Not used	
14		Not used	
15		Not used	

2.3.3. Pin assignment MC-I/O XR03 ENC/C DAIO 8/8/8

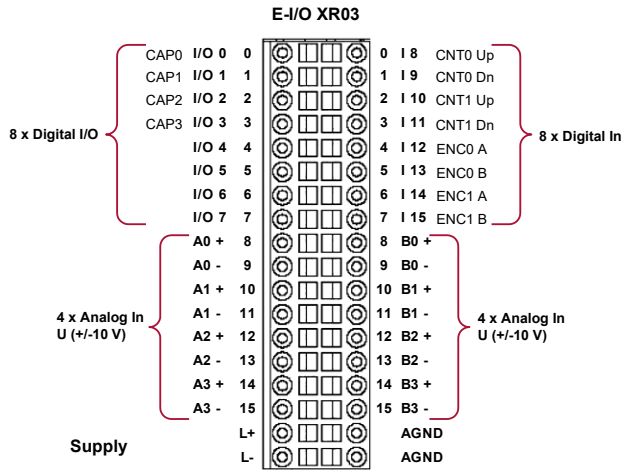


Figure 3: pin assignment XR03

Pin no. X1 (left)	Function	Description	Additional function
0	I/O 0	Digital I/O +24 V	Capture CNT0
1	I/O 1	Digital I/O +24 V	Capture CNT1
2	I/O 2	Digital I/O +24 V	Capture CNT2
3	I/O 3	Digital I/O +24 V	Capture CNT3
4	I/O 4	Digital I/O +24 V	
5	I/O 5	Digital I/O +24 V	
6	I/O 6	Digital I/O +24 V	
7	I/O 7	Digital I/O +24 V	
8	A0+	Analog IN +/-10 V	
9	A0-	Analog IN +/-10 V	
10	A1+	Analog IN +/-10 V	
11	A1-	Analog IN +/-10 V	
12	A2+	Analog IN +/-10 V	
13	A2-	Analog IN +/-10 V	
14	A3+	Analog IN +/-10 V	
15	A3-	Analog IN +/-10 V	
L+		+24 V	Supply I/O
L-		GND	Supply I/O

Pin no. X2 (right)	Function	Description	Additional function
0	In 8	Digital IN +24 V	Counter (CNT0 UP)
1	In 9	Digital IN +24 V	Counter (CNT0 DOWN)
2	In 10	Digital IN +24 V	Counter (CNT1 UP)
3	In 11	Digital IN +24 V	Counter (CNT1 DOWN)
4	In 12	Digital IN +24 V	Encoder0 (CNT2 A)
5	In 13	Digital IN +24 V	Encoder0 (CNT2 B)
6	In 14	Digital IN +24 V	Encoder1 (CNT3 A)
7	In 15	Digital IN +24 V	Encoder1 (CNT3 B)
8	B0+	Analog IN +/-10 V	
9	B0-	Analog IN +/-10 V	
10	B1+	Analog IN +/-10 V	
11	B1-	Analog IN +/-10 V	
12	B2+	Analog IN +/-10 V	
13	B2-	Analog IN +/-10 V	
14	B3+	Analog IN +/-10 V	
15	B3-	Analog IN +/-10 V	
AGND			Analog Ground
AGND			Analog Ground

2.3.4. Pin assignment MC-I/O XR04 ENC/C DAIO 8/8/8

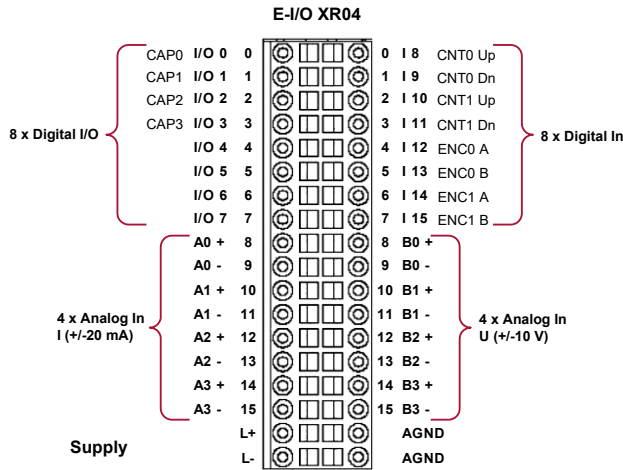


Figure 4: pin assignment XR04

Pin no. X1 (left)	Function	Description	Additional function
0	I/O 0	Digital I/O +24 V	Capture CNT0
1	I/O 1	Digital I/O +24 V	Capture CNT1
2	I/O 2	Digital I/O +24 V	Capture CNT2
3	I/O 3	Digital I/O +24 V	Capture CNT3
4	I/O 4	Digital I/O +24 V	
5	I/O 5	Digital I/O +24 V	
6	I/O 6	Digital I/O +24 V	
7	I/O 7	Digital I/O +24 V	
8	A0+	Analog IN +/-20 mA	
9	A0-	Analog IN +/-20 mA	
10	A1+	Analog IN +/-20 mA	
11	A1-	Analog IN +/-20 mA	
12	A2+	Analog IN +/-20 mA	
13	A2-	Analog IN +/-20 mA	
14	A3+	Analog IN +/-20 mA	
15	A3-	Analog IN +/-20 mA	
L+		+24 V	Supply I/O
L-		GND	Supply I/O

Pin no. X2 (right)	Function	Description	Additional function
0	In 8	Digital IN +24 V	Counter (CNT0 UP)
1	In 9	Digital IN +24 V	Counter (CNT0 DOWN)
2	In 10	Digital IN +24 V	Counter (CNT1 UP)
3	In 11	Digital IN +24 V	Counter (CNT1 DOWN)
4	In 12	Digital IN +24 V	Encoder0 (CNT2 A)
5	In 13	Digital IN +24 V	Encoder0 (CNT2 B)
6	In 14	Digital IN +24 V	Encoder1 (CNT3 A)
7	In 15	Digital IN +24 V	Encoder1 (CNT3 B)
8	B0+	Analog IN +/-10 V	
9	B0-	Analog IN +/-10 V	
10	B1+	Analog IN +/-10 V	
11	B1-	Analog IN +/-10 V	
12	B2+	Analog IN +/-10 V	
13	B2-	Analog IN +/-10 V	
14	B3+	Analog IN +/-10 V	
15	B3-	Analog IN +/-10 V	
AGND			Analog Ground
AGND			Analog Ground

2.3.5. Pin assignment MC-I/O XR05 ENC/C DAIO 8/8/4/4

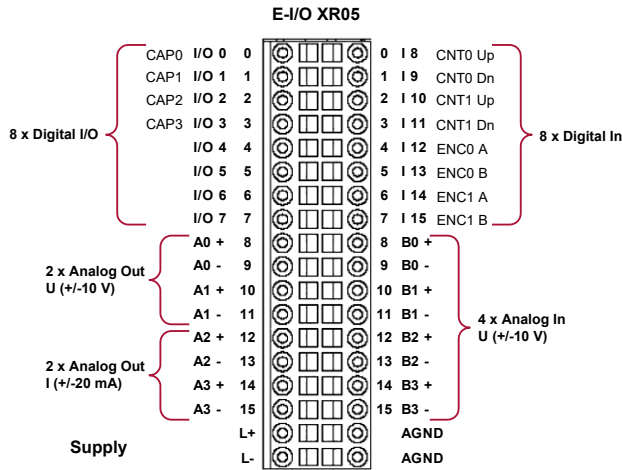


Figure 5: pin assignment XR05

Pin no. X1 (left)	Function	Description	Additional function
0	I/O 0	Digital I/O +24 V	Capture CNT0
1	I/O 1	Digital I/O +24 V	Capture CNT1
2	I/O 2	Digital I/O +24 V	Capture CNT2
3	I/O 3	Digital I/O +24 V	Capture CNT3
4	I/O 4	Digital I/O +24 V	
5	I/O 5	Digital I/O +24 V	
6	I/O 6	Digital I/O +24 V	
7	I/O 7	Digital I/O +24 V	
8	A0+	Analog OUT +/-10 V	
9	A0-	Analog OUT +/-10 V	
10	A1+	Analog OUT +/-10 V	
11	A1-	Analog OUT +/-10 V	
12	A2+	Analog OUT +/-20 mA	
13	A2-	Analog OUT +/-20 mA	
14	A3+	Analog OUT +/-20 mA	
15	A3-	Analog OUT +/-20 mA	
L+		+24 V	Supply I/O
L-		GND	Supply I/O

Pin no. X2 (right)	Function	Description	Additional function
0	In 8	Digital IN +24 V	Counter (CNT0 UP)
1	In 9	Digital IN +24 V	Counter (CNT0 DOWN)
2	In 10	Digital IN +24 V	Counter (CNT1 UP)
3	In 11	Digital IN +24 V	Counter (CNT1 DOWN)
4	In 12	Digital IN +24 V	Encoder0 (CNT2 A)
5	In 13	Digital IN +24 V	Encoder0 (CNT2 B)
6	In 14	Digital IN +24 V	Encoder1 (CNT3 A)
7	In 15	Digital IN +24 V	Encoder1 (CNT3 B)
8	B0+	Analog IN +/-10 V	
9	B0-	Analog IN +/-10 V	
10	B1+	Analog IN +/-10 V	
11	B1-	Analog IN +/-10 V	
12	B2+	Analog IN +/-10 V	
13	B2-	Analog IN +/-10 V	
14	B3+	Analog IN +/-10 V	
15	B3-	Analog IN +/-10 V	
AGND			Analog Ground
AGND			Analog Ground

2.3.6. Pin assignment MC-I/O XR06 ENC/C DAIO 8/8/4

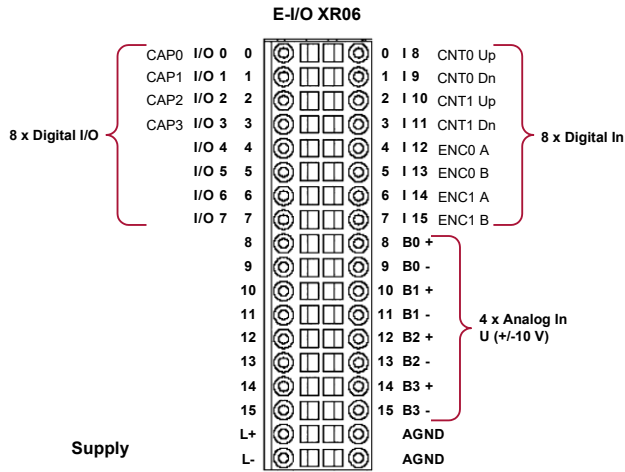


Figure 6: pin assignment XR06

2VF100590DG00.VSD

Pin no. X1 (left)	Function	Description	Additional function
0	I/O 0	Digital I/O +24 V	Capture CNT0
1	I/O 1	Digital I/O +24 V	Capture CNT1
2	I/O 2	Digital I/O +24 V	Capture CNT2
3	I/O 3	Digital I/O +24 V	Capture CNT3
4	I/O 4	Digital I/O +24 V	
5	I/O 5	Digital I/O +24 V	
6	I/O 6	Digital I/O +24 V	
7	I/O 7	Digital I/O +24 V	
8		Not used	
9		Not used	
10		Not used	
11		Not used	
12		Not used	
13		Not used	
14		Not used	
15		Not used	
L+		+24 V	Supply I/O
L-		GND	Supply I/O

Pin no. X2 (right)	Function	Description	Additional function
0	In 8	Digital IN +24 V	Counter (CNT0 UP)
1	In 9	Digital IN +24 V	Counter (CNT0 DOWN)
2	In 10	Digital IN +24 V	Counter (CNT1 UP)
3	In 11	Digital IN +24 V	Counter (CNT1 DOWN)
4	In 12	Digital IN +24 V	Encoder0 (CNT2 A)
5	In 13	Digital IN +24 V	Encoder0 (CNT2 B)
6	In 14	Digital IN +24 V	Encoder1 (CNT3 A)
7	In 15	Digital IN +24 V	Encoder1 (CNT3 B)
8	B0+	Analog IN +/-10 V	
9	B0-	Analog IN +/-10 V	
10	B1+	Analog IN +/-10 V	
11	B1-	Analog IN +/-10 V	
12	B2+	Analog IN +/-10 V	
13	B2-	Analog IN +/-10 V	
14	B3+	Analog IN +/-10 V	
15	B3-	Analog IN +/-10 V	
AGND			Analog Ground
AGND			Analog Ground

2.3.7. Power supply

The digital and analog I/Os must be supplied from an external source. An input voltage of 24 VDC (-15 % / +20 %) is permissible. The I/Os are equipped with a built-in pole reversal protection. The supply is made by L+ (24 VDC) and L- (GND) at the 36-pin connector.

The power cord and the external power supply must be equipped with an external short circuit and overload protection with an activation current of max. 12 A (depending on the number of I/Os).

All digital and analog I/Os have a joint supply and operate at the same potential. It is not possible to switch individual I/O areas on or off selectively.

i NOTE

The I/O cards possess a monitoring function for the supply voltage or function monitoring (represented by the data word "LifeGuarding_CNT" in the EtherCAT process data image).

⚠ CAUTION

The "LifeGuarding_CNT" is a counter that in normal operation is increased by "1" once per millisecond. When the value limit (after around 55 days of permanent operation) is reached, or after a power-on reset, the counter returns to "0".

If the external supply voltage (24 VDC) of the I/O card is cut off during operation, or if the 36-pole connector is removed, the counter value is no longer increased. In this case the process data of the I/O card is to be regarded as invalid. In order to guarantee the reliability of the control environment it is therefore recommended to monitor "LifeGuarding_CNT" permanently in the SPS program.

2.3.8. 8/8-0.5 digital inputs/outputs

Input / Output supply

The I/Os are supplied together with the module electronics. The supply must come directly (unswitched) from the power supply unit.

⚠ WARNING

Feedback may cause the destruction of the module and / or of the sensors.

Sensors, limit switches and other equipment leading to a digital I/O of the module must be fed by the same power supply unit as the module itself.

If unobserved, feedback effects can occur via the output transistors, which can lead to destruction of the I/O channel and/or sensors.

The digital inputs are positive-switching type 1 inputs (IEC61131-2). They are designed for nominal 24 V input voltages. The inputs are transferred internally to the core of the CPU in cycles. An open input is interpreted as static 0 (LOW).

Pulse identification and interference suppression

Inputs are read-in cyclically. The internal scanning time is fixed at 1 ms. A new value can therefore be sampled via the EtherCAT bus once per millisecond at the most.

Principal input circuit diagram, positive switching

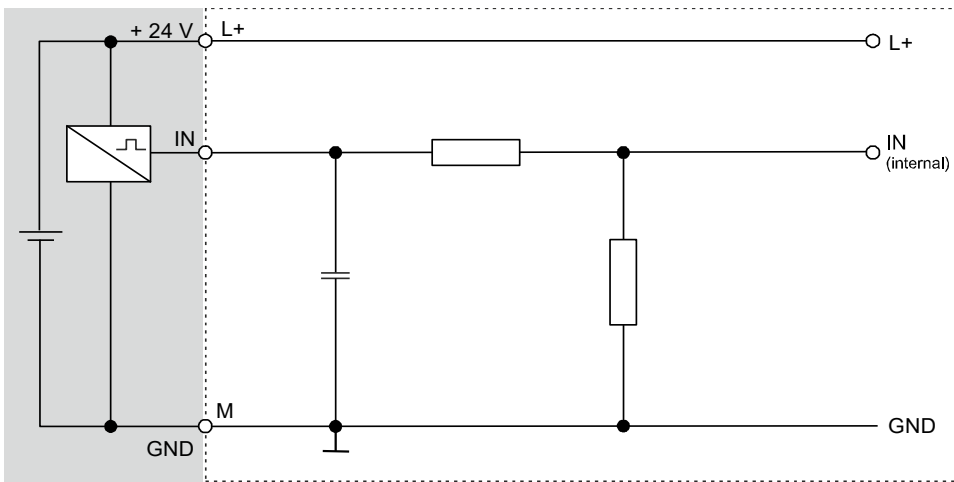


Figure 7: circuit diagram

Digital input data	
Module data	
Line lengths:	Connector cable < 30 m
In the switchgear cabinet	Select conductor cross-section making allowance for the voltage drop; otherwise no restrictions of practical relevance.
Field wiring	Meet all the relevant local regulations and the requirements in compliance with EN 61131-2.
Load nominal voltage L+	DC 24 V (SELV)
Polarity reversal protection	Yes
Potential isolation	No
Status display	Yes, green LED per input on the plug-in connector.

Operating ranges of the digital inputs

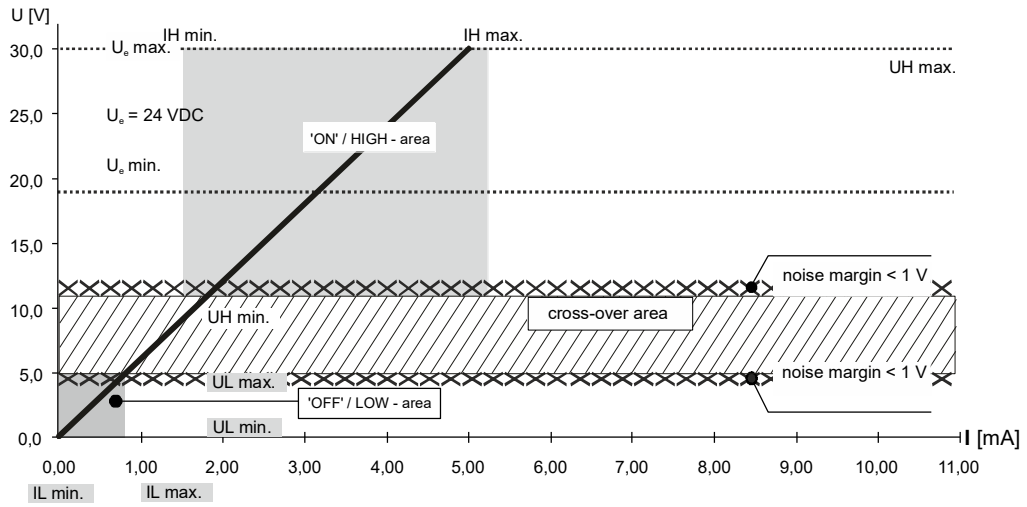


Figure 8: digital inputs

Input voltage (DC) of external power supply

U_e	24 V	rated voltage
$U_e \text{ max.}$	30 V	upper limit
$U_e \text{ min.}$	19.2 V	lower limit

Limit for '1' signal for the 'ON'-condition

$U_H \text{ max.}$	30.0 V	upper voltage limit
$I_H \text{ max.}$	5.2 mA	upper current limit
$U_H \text{ min.}$	11.0 V	lower voltage limit
$I_H \text{ min.}$	1.5 mA	lower current limit

Limit for '0' signal of the 'OUT'-condition

$U_L \text{ max.}$	5.0 V	upper voltage limit
$I_L \text{ max.}$	0.8 mA	upper current limit
$U_L \text{ min.}$	0 V	lower voltage limit
$I_L \text{ min.}$	0 mA	lower current limit

Digital inputs with counter-encoder functions

The digital inputs I 8 - I 15 can also be used as counter / encoder inputs. Each counting unit is connected by means of two 24-V inputs. The digital status information of the inputs used as counters continues to be available to the CODESYS PLC program.

For each counter not only the pure counter value exists but also a capture value (CAPT0 – CAPT3) and a capture event value (CAPT0_EventCounter – CAPT3_EventCounter). With a separate input the current counter status in the capture value can be transferred and thus buffered. The capture event value is increased by “1” (decimal) with every capturing event.

i NOTE

The number and order of the COUNTER / Capture inputs can freely be configured by the MC-I/O XR01 module!

Counting units

Number	4 counting units
Usage	Two counters are used as a quadrature decoder (CNT2 and CNT3) and two as an upward or downward counter (CNT0 and CNT1).
Capture input	For each counting unit a digital in-/output is specified which triggers capturing.
Maximum signal frequency	10 kHz (with a quadrature encoder this results in a 40 kHz counting frequency). At the maximum counting frequency the signal generator must be able to guarantee an edge steepness of at least 20 V/μs at the counting input.
Minimum pulse width	50 μs
Counter width	32 bits

i NOTE

Behaviour in the event of a fault:

If the components are permanently disconnected from the supply voltage (longer than 10 ms) or if they are operated at low voltage (signalled by status byte), all counter, capture and capture event values return to the value “0”.

If only communication to the controller (EtherCAT) is broken off (disconnection of the data link or SPS Stop) the counter and its values continue. The current values are transferred to the controller once communication has resumed.

⚠ WARNING

If overvoltage > 32 V and / or energetic recovery occur, the module may be destroyed.

This is a fire hazard!

Outputs

The outputs are positive-switching, 24-V outputs. Output current max. 500 mA per output. The outputs have a common reference potential (GND). Power is supplied together with the supply for the module electronics (refer to 'Terminal Assignment').

If there is no data connection to the EtherCAT or if the internal supply of the module is inadequate, the outputs automatically switch to '0' (LOW).

Protected output

In case of overload the current is limited (typically 7 A). After the overload has been eliminated, the output is again available. Fast de-excitation by means of a 41 V terminal voltage in relation to L+ protects all outputs against induced peak voltages with inductive loads.

If thermal loads occur owing to energetic recovery or fast de-excitation, the overload protection may react prematurely even in the case of outputs which are not involved.

⚠ CAUTION

The maximal output current is 0.5 A.

The output stage is protected against overload, which must be taken into account for high inrush currents from lamps, for example.

Basic output circuit diagram, positive-switching

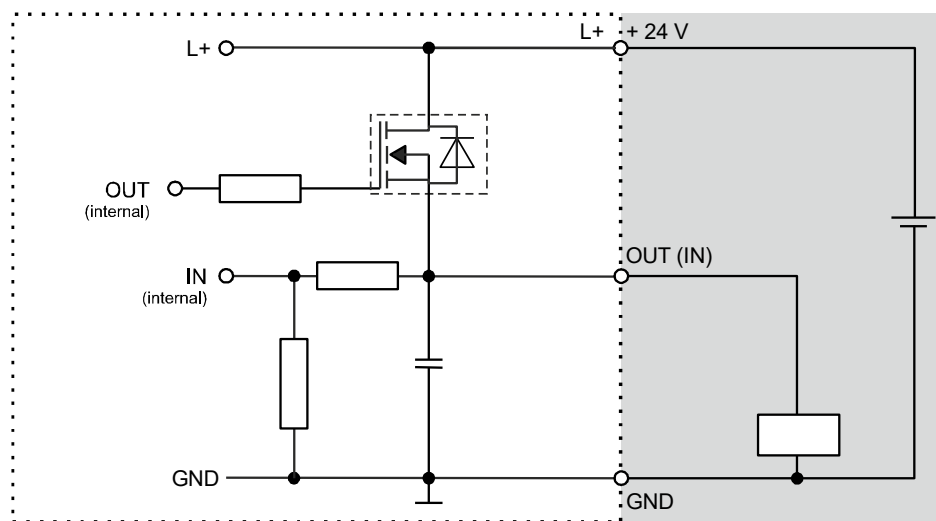


Figure 9: basic output circuit diagram

2VF100465DG00.cdr

Digital output data	
Module data	
Type of outputs	semiconductor, non-storing
Protection circuit for inductive loads	fast de-excitation (shall be provided externally) 41 V terminal voltage (typ.) around +24 V
Status display	Yes, green LED per input.
Overload protection	Yes, under thermal overload.
Short circuit protection ¹⁾²⁾³⁾ Response threshold	Yes, electronic current limitation typ. 7 A.
<p>1) Current is limited electronically. Triggering the short circuit protection causes thermal overload and the thermal overload protection is tripped.</p> <p>2) Starting from cold, maximally 10,000 permissible short circuits.</p> <p>3) Total duration of the short circuits max. 500 hours.</p>	
Output delay	
At '0' after '1'	typ. 1 ms
At '1' after '0'	typ. 1 ms
Output capacity	< 20 nF
Rated voltage	DC +24 V
Voltage drop (with rated current)	< 0.1 V
Rated current with '1' signal	0.5 A
Total current of all outputs	max. 2 A
Two outputs switched in parallel for logic link for increased output	permissible permissible up to 1 A

2.3.9. Analog inputs/outputs

CAUTION

Plugging the analog connections during operation may cause the destruction of the module.

Depending on the variant the module is equipped with 8 analog channels. They are divided into 4 A channels and 4 B channels.

Functions of the A channels:

- Voltage measurement AI-U ± 10 V
- Voltage measurement AI-I ± 20 mA
- Voltage transmitter AO-U ± 10 V
- Current transmitter AO-I ± 20 mA

Functions of the B channels:

- Voltage measurement AI-U ± 10 V

Analog input parameters (AI)

General characteristics

Method of transformation	Delta-sigma transformation according to multiplexer
Operating modes	Self-scanning
Common points between the channels	AGND reference
Calibration to maintain the accuracy class	12 months
Terminal arrangement	Shields on joint AGND pins

Scanning of measured data

Scanning time	10 μ s
Scanning rate	The scanning rate of each measuring channel depends on the number of configured measuring channels.
Assignment	Mode AI-U: 1 measuring channel AI-I mode: 1 measuring channel BI-U mode: 1 measuring channel AO-U mode: 2 measuring channels AO-I mode: 1 measuring channel - unless the user additionally monitors the voltage (AI-I active)
Measuring channels	1-5 active channels: Scanning rate 1 ms 6-11 active channels: Scanning rate 2 ms 12 active channels: Scanning rate 3 ms (Revertive readability of the A-channels)

Analog input parameters (AI)

Digital filtering

Filtering (only XR01)	Adjustable digital post-filtering facilitates constant signal movements. Low-pass of the 2 nd order 1 Hz (-6 dB at 1 Hz, 10 Hz, 100 Hz or 200 Hz). Digital filtering takes place every 1ms.
Scanning rate	If the scanning rate is above 1 ms the digital filtering ensures constant value curves instead of delivering the same value repeatedly.

Wiring information for analog channels

The high degree of measuring accuracy of the card makes specific demands on the connecting technique for the analog sensors:

- Use an analog cable with a braided shield.
- Lay the analog cable separate from the power cable. If necessary create a metallic shield in cable channels.
- Earth the shield with a clamp at the point of entry in the switch cabinet.
- Make a short connection from shield to AGND.
- Lines must be shorter than 30 m.
- Do not plug in while in operation.

Voltage input (AI-U) mode

Connections per output + and -, connect shield to AGND

Static characteristics

Differential measuring range	-10...+10 V
Input impedance in the signal range	500 kΩ (between + und -)
Greatest error at 25° C	±1000 ppm (±20 mV)
Temperature coefficient	±20 ppm/°K (±0,4 mV/°K)
Digital resolution	22 bits
Data format in the application program	32 bits Real (24 bits payload)
Maximum permitted continuous overload	Max. voltage on A+ or A- is ±14 V to AGND.
Digital value output during overload	If a voltage differential of 10 V is exceeded, the accuracy of this channel may be impaired; measured values are limited. If a voltage differential of 15 V is exceeded, the card reports an error which must be remedied.
Input type	Differential voltage measurement
Status display (signal)	Green - OK Red - Overvoltage

Voltage input (AI-U) mode	
Even range	-12 V < A+ < +12 V, -12 V < A- < +12 V
Common-mode rejection	60 dB (direct current); 20 dB at 50 Hz
Reference potential	AGND
Dynamic characteristics	
Analog filtering	Low-pass of the 1 st order, time constant T = 513 μs (-3 dB bei 310 Hz)
Greatest temporary differential during electrical interference test in compliance with IEC 61131-2	1.5 % of the measuring range

Typical example of external connections

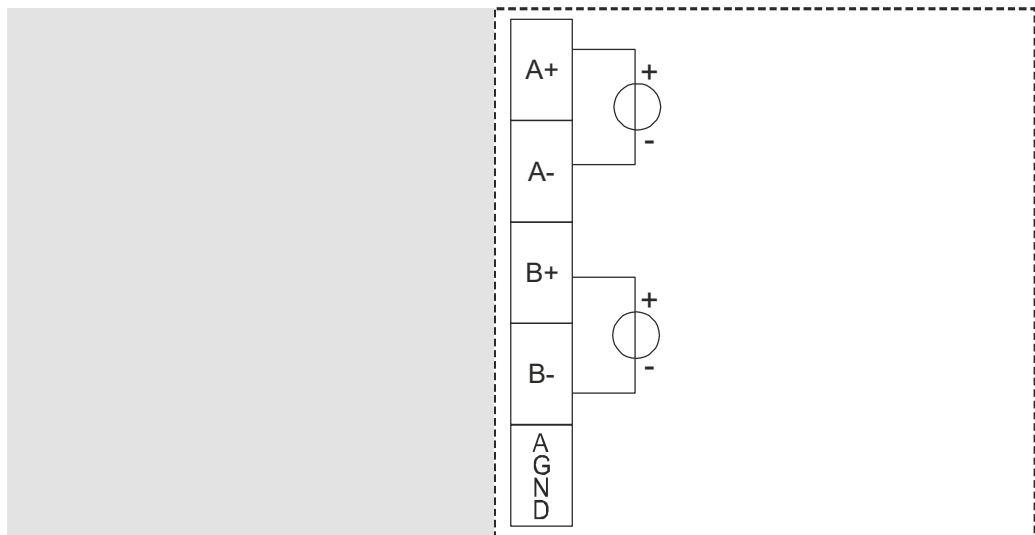


Figure 10: external connections 1

⚠ CAUTION

The module is damaged at input voltages of more than ±14 V..

Current input (AI-I) mode

Connections per output Current between A+ and AGND,
connect shield to joint AGND.
Do no connect A- pin.

Protective equipment Cuts off under overload

Static characteristics

Measuring range -20 mA...+20 mA
Technical direction of current into A+.

Load Typ. 110 Ω

Status display (signal) Green – OK
Red - Overcurrent

Measuring errors

Greatest error at 25° C ±1000 ppm (±40 µA)

Temperature coefficient ±20 ppm/°K (±0,8 µA/°K)

Noise-free resolution

Digital resolution 22 bits

Data format in the application
program 32 bits Real (24 bits payload)

Maximum permitted continu-
ous overload ±22 mA

Digital value output during
overload Values are correctly returned up to ±40 mA. The application of currents
over ±24 mA will lead in the long-run, however, to destruction of the
channel and should not occur in normal operation!

Input type Current measurement to AGND

Reference potential AGND

Dynamic characteristics (refer also to dynamic characteristics of the analog inputs)

Greatest temporary differential
during electrical interference
test in compliance with IEC
61131-2 1.5 % of the measuring range

Analog filtering Low-pass of the 1st order, time constant T = 16 µs (-3 dB bei 10 kHz)

Typical example of external connections

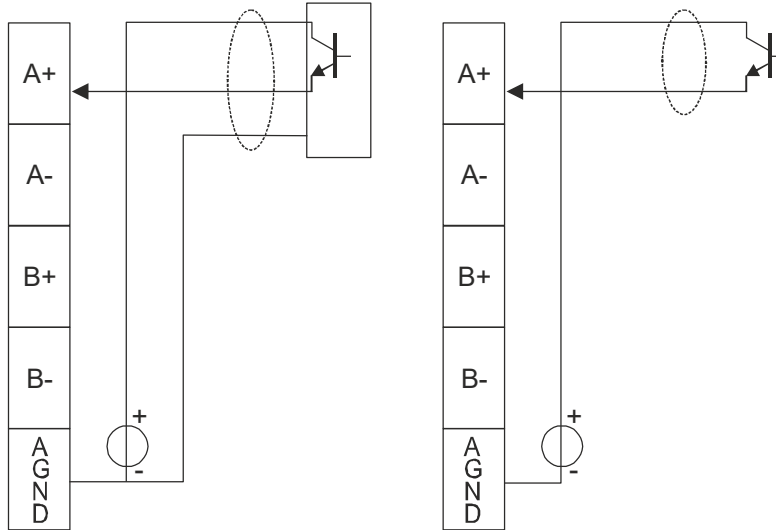


Figure 11: external connections 2

⚠ CAUTION

The module is damaged at input current in excess of ± 24 mA.

Analog output parameters (AO)

General characteristics

Type of protective equipment	Electronic switch
Insulation voltage between channel and other power circuits	None
Status display (signal)	Green – OK Once red flashing – short circuit 3 times red flashing – wire break

Voltage output (AO-U) mode

Overview

Signal range	-10 V to +10 V
Connections per output	A+ and A-, connect A- to AGND. Connect shield to AGND.

Static characteristics

Output impedance in signal range	1 Ω (by readjustment)
----------------------------------	-----------------------

Analog output errors

Greatest error at 25° C	±1000 ppm (±20 mV)
Temperature coefficient	±20 ppm/°K (±0,4 mV/°K)
Value of lowest-value bit (LSB)	±15 ppm (±0,305 mV)
Digital resolution	16 bits
Data format in the application program	32 bits Real (24 bits payload)

Dynamic characteristics

Settling time if there is a reversal over the full range (95%) (filter only usable with XR01 Module)	
Filter -6 dB at 200 Hz	50 ms
Filter -6 dB at 100 Hz	50 ms
Filter -6 dB at 10 Hz	100 ms
Filter -6 dB at 1 Hz	1000 ms
Overshoot	±5 % of the offset altitude
Greatest temporary differential during electrical interference test in compliance with IEC 61131-2	±1.5 % of the measuring range

Voltage output (AO-U) mode

General characteristics

Type of protective equipment	Electronic switch
Insulation voltage between channel and other power circuits	None
Reference potential	AGND
Calibration to maintain the accuracy class	12 months
Permissible load types	Without reference point, earthed
Greatest capacitive load	100 nF
Load impedance range	$\geq 500 \Omega$
Overload protection	Short-circuit proof. Current limitation at around 24 mA. Interruption for 400 ms. Cyclical reattempt.

Typical example of external connections

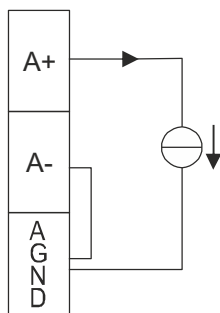


Figure 12: external connections 3

Voltage output (AO-U) mode

Output response to On/Off switching operations of power supply

Without supply voltage	High-impedance output: A+ to AGND > 300 k Ω A- to AGND > 300 k Ω A+ to A- > 300 k Ω
During booting routine of the controller	The analog output is not yet active during the booting routine of the controller. Differences to zero value when switched on and off is around < 2 %.
If there are brief interruptions	If there are interruptions of the supply voltage > 10 ms, the AOs are briefly switched to high impedance.

Voltage output (AO-U) mode

Behaviour in STOP mode

Voltage output 0 V

Usage of the AI during AO operation (with XR01 Module) The current that really flows can be indicated if the analog input is configured as **AI-I**. The voltage between A+ and A- can be displayed if the analog input is configured as **AI-U**. Readjustment is not required because it is readjusted internally.

With the XR05 module the current and voltage outputs are configured in the factory in such a way that the output values are displayed for checking (in each case at the associated current or voltage input).

Current output (AO-I) mode	
Overview	
Signal range	-20 mA to +20 mA
Connections per output	A+ and AGND. A- can be connected to AGND if the voltage is to be monitored. Connect shield to AGND.
Static characteristics	
Output impedance in signal range	> 300 kΩ (by readjustment)
Analog output errors	
Greatest error at 25 °C	±1000 ppm (±40 μA)
Temperature coefficient	±20 ppm/°K (±0.8 μA /°K)
Value of lowest-value bit (LSB)	±15 ppm (±0.610 μA)
Digital resolution	16 bits
Data format in the application program	32 bits Real (24 bits payload)
Dynamic characteristics	
Settling time if there is a reversal over the full range (95%)	
Filter -6 dB at 200 Hz	50 ms
Filter -6 dB at 100 Hz	50 ms
Filter -6 dB at 10 Hz	100 ms
Filter -6 dB at 1 Hz	1000 ms
Overshoot	±6.5 % of the offset altitude
Greatest temporary differential during electrical interference test in compliance with IEC 61131-2	±1.5 % of the measuring range

Current output (AO-I) mode

Overview

Signal range	-20 mA to +20 mA
Connections per output	A+ and AGND. A- can be connected to AGND if the voltage is to be monitored. Connect shield to AGND.

Static characteristics

Output impedance in signal range	> 300 kΩ (by readjustment)
----------------------------------	----------------------------

Analog output errors

Greatest error at 25 °C	±1000 ppm (±40 µA)
Temperature coefficient	±20 ppm/°K (±0.8 µA /°K)
Value of lowest-value bit (LSB)	±15 ppm (±0.610 µA)
Digital resolution	16 bits
Data format in the application program	32 bits Real (24 bits payload)

Dynamic characteristics

Settling time if there is a reversal over the full range (95%)	
Filter -6 dB at 200 Hz	50 ms
Filter -6 dB at 100 Hz	50 ms
Filter -6 dB at 10 Hz	100 ms
Filter -6 dB at 1 Hz	1000 ms
Overshoot	±6.5 % of the offset altitude
Greatest temporary differential during electrical interference test in compliance with IEC 61131-2	±1.5 % of the measuring range

Typical example of external connections

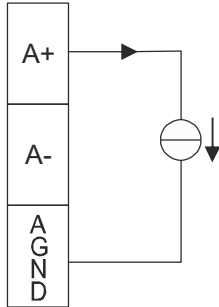


Figure 13: external connections 4

Current output (AO-I) mode	
Output response to On/Off switching operations of power supply	
Without supply voltage	High-impedance output 200 kΩ at 0 V
During booting routine of the controller	High-impedance analog output. Brief current peaks up to 2 % may occur when switching on and switching off.
If there are brief interruptions	If there are interruptions > 10 ms, the AOs are briefly switched to high impedance.
Current output (AO-I) mode	
Behaviour in STOP mode	
±20 mA	Current output: 0 mA
Effect of defective connection to the output terminals	
Usage of the AI during AO operation (with XR01 Module)	<p>The current that really flows can be indicated if the analog input is configured as AI-I. The voltage between A+ and A- can be displayed if the analog input is configured as AI-U. A- must be connected with AGND for monitoring the sensor. Readjustment is not required because it is readjusted internally.</p> <p>With the XR05 module the current and voltage outputs are configured in the factory in such a way that the output values are displayed for checking (in each case at the associated current or voltage input).</p>

3. Introduction EtherCAT I/O Modules

3.1. EtherCAT - Ethernet Control Automation Technology

EtherCAT is one of the most powerful Ethernet-based fieldbus systems. EtherCAT puts up the top speed mark, and its flexible topology and simple configuration make it the perfect means of controlling extremely fast processes.

Because of its high performance, the simple wiring and its open protocol support, EtherCAT is often used as a fast motion control and I/O bus driven by an industrial PC or in conjunction with control technology on a smaller scale. EtherCAT moves beyond the limits of conventional fieldbus systems. Its interconnections between the controller at one end and both the I/O modules and drives at the other are as fast as those of a backplane bus. EtherCAT controllers thus nearly act like centralized control systems, overcoming the issue of bus transfer times that conventional fieldbus systems are burdened with.

3.2. CANtrol - the automation platform

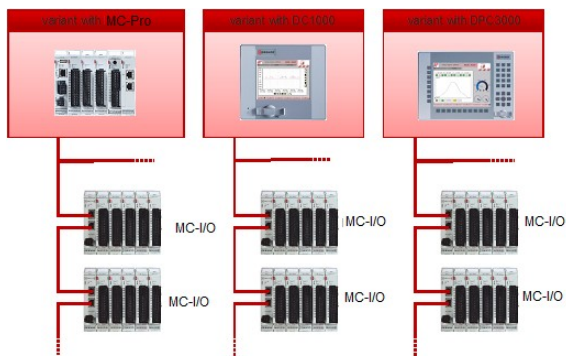
The automation platform CANtrol EC and CANtrol Dialog has been specifically engineered with applications near to the machine in mind. CANtrol provides flexible automation solutions including hardware and software PLCs based around industrial PCs, remote I/Os, PLCs with / without display and decentralized drives. EtherCAT, PROFINET, Bacnet, PROFIBUS-DP and CANopen are supported for networking. CANtrol controllers and industrial PCs used as EtherCAT masters feature a CoDeSys PLC.

3.3. MC-I/O - EtherCAT I/O-System

MC-I/O is a system of I/O modules for connecting the process signals to an EtherCAT network.

MC-I/O consists of the MC-I/O bus coupler and a range of I/O modules.

The MC-I/O bus coupler converts the physical transfer technology (twisted pair) to LVDS (E-bus) and generates the system voltages required by the LVDS modules. The standard 100 Base Tx lines used for office network communications connect to the one side, the MC-I/O Modules for the process signals connect to the other. This is how the Ethernet EtherCAT protocol is retained right through to the last I/O module. At the end of the modular device, the connection between the forward and return lines is automatically closed, the effect being that another 100 Base Tx line can be plugged in to connect the next EtherCAT unit to the second bus coupler port.



3.4. Electromagnetic compatibility

3.4.1. Definition

Electromagnetic compatibility is the ability of a device to function satisfactorily in its electromagnetic environment without itself causing any electromagnetic interference that would be intolerable to other devices in this environment.

Of all known phenomena of electromagnetic noise, only a certain range occurs at the location of a given device. It is defined in the relevant product standards.

The design and immunity to interference of programmable logic controllers are internationally governed by Standard IEC 61131-2 which, in Europe, has been the basis for European Standard EN 61131-2.

i NOTE

Refer to IEC 61131-4, User's Guideline, for general installation instructions to be complied with to ensure that hardware interface factors and the ensuing noise voltages are limited to tolerable levels.

3.4.2. Interference emission

Interfering emission of electromagnetic fields, HF compliant to EN 55011, limiting value class A, Group 1

i NOTE

If the controller is designed for use in residential areas, high-frequency emissions must comply with limiting value class B as described in EN 55011. Fitting the controller into earthed metal cabinets and in-stalling filters in the supply lines may produce a shielding compliant to the above standard.

3.4.3. General notes on installation

As component parts of machines, facilities and systems, electronic control systems must comply with valid rules and regulations, depending on their field of application.

General requirements concerning the electrical equipment of machines and aiming at the safety of these machines are contained in Part 1 of European Standard EN 60204 (same as VDE 0113).

For safe installation of our control system please observe the information given below.

3.4.4. Electrical immission safeguard

Connect the control system to the protective earth conductor to eliminate electromagnetic interference. Practice best cable routing.

Cable routing and wiring

Keep power circuits separate from control circuits:

- DC voltages 60 V ... 400 V
- AC voltages 25 V ... 400 V

Joint laying of control circuits is allowed for:

- shielded data signals
- shielded analogue signals
- unshielded digital I/O lines
- unshielded DC voltages < 60 V
- unshielded AC voltages < 25 V

Wire connection specifications: Use AWG wire size 16-22 or equivalent.

3.4.5. Location of installation

Exclude any and all impediments due to temperature, dirt, impact, vibration or electromagnetic interference.

Temperature

Consider heat sources such as general heating of rooms, sunlight, heat accumulation in assembly rooms or control cabinets.

Contamination

Use suitable casings to avoid possible negative influences due to humidity, corrosive gas, liquid or conducting dust.

Impact and vibration

Consider possible influences caused by motors, compressors, transfer lines, presses, ramming machines and vehicles.

Electromagnetic interference

Consider electromagnetic interference from various local sources: motors, switching devices, switching thyristors, radio-controlled devices, welding equipment, arcing, switched-mode power supplies, converters / inverters.

3.4.6. Particular sources of interference

Inductive actuators

Switching off inductances (such as from relays, contactors, solenoids or switching magnets) produces surge voltages. It is necessary to reduce these extra voltages to a minimum. Reducing elements may be diodes, Z-diodes, varistors or RC elements. To find the best adapted elements, we recommend that you contact the manufacturer or supplier of the corresponding actuators for the relevant information.

4. System description EtherCAT I/O Modules

MC-I/O is a system of I/O modules for connecting the process signals to any EtherCAT network station. MC-I/O consists of the MC-I/O bus coupler and a range of MC-I/O modules.

The MC-I/O bus coupler converts the physical transfer technology (twisted pair) to LVDS (E-bus) and generates the system voltages required by the LVDS modules. The standard 100 Base Tx lines used for office network communications connect to the one side, the MC-I/O modules for the process signals connect to the other. This is how the Ethernet EtherCAT protocol is retained right through to the last I/O module. At the end of the modular device, the connection between the forward and return lines is automatically closed, the effect being that another 100 Base Tx line can be plugged in to connect the next EtherCAT unit to the second bus coupler port.

If the bus coupler is the last station of the EtherCAT network, i.e. if its RJ45 "Out" socket remains unplugged, the connection between the forward and return lines is automatically closed.

4.1. Mechanical design

The figure shows the basic layout of the MC-I/O modules.

The bus coupler and the I/O modules differ in their connectors and indicators, however.

Module structure

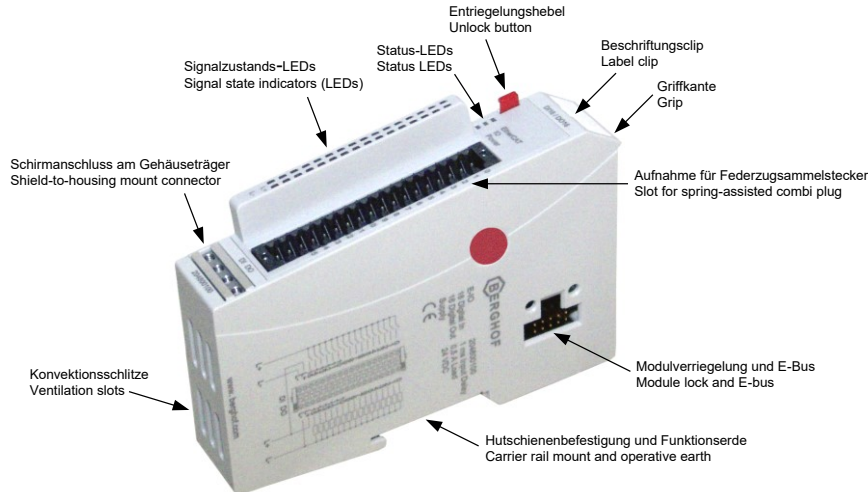


Figure 14: mechanical design

The housing mount consists of an aluminium profile with an integral snap-on device used to snap the module to a 35mm DIN rail.

The housing trough including the optical fibres for the status indicators, the side face and the front is made of plastic and contains the module.

The optical fibres for the signal state indicators (LEDs) are located next to the spring-assisted combi plug. They slightly protrude from the housing and allow a clear diagnosis at a glance.

4.1.1. Grounding

The CANtrol MC-I/O modules shall be earthed. Thereto the metal housing shall be attached to operative earth.

Since the operative earth connectors dissipate HF currents, it is of utmost importance for the module's noise immunity.

HF interference is dissipated from the electronics board to the metal housing. The metal housing therefore needs to be suitably connected to an operative earth connector.

You will normally have to ensure that

- the connection between module housing and DIN rail conducts well,
- the connection between DIN rail and switching cabinet conducts well,
- the switching cabinet is safely connected to earth.

In special cases you may attach the earth wire straight to the module.

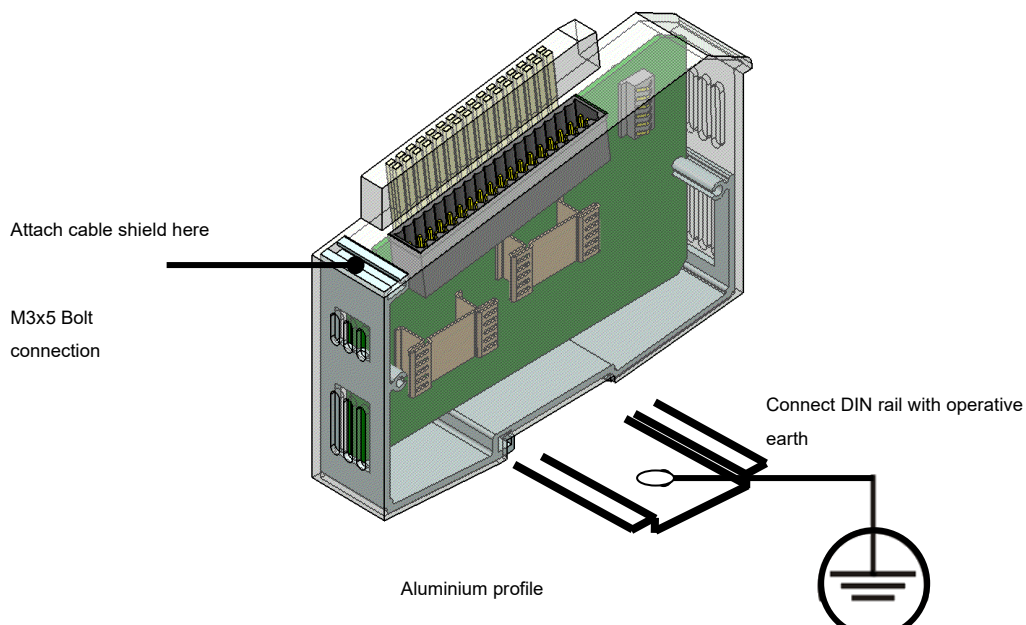


Figure 15: grounding

i NOTE

Earth wires should be short and have a large surface (copper mesh).

Further details has site [http://en.wikipedia.org/wiki/Ground_\(electricity\)](http://en.wikipedia.org/wiki/Ground_(electricity))

4.1.2. Installation

The MC-I/O modules are intended for mounting rail installation (DIN EN 50022, 35 x 7.5 mm).

The mounting rail is placed horizontally and the female connector strip of the modules face forward. For a sufficient ventilation of the convection slits the minimum distance must not fall below 20 mm upward and 35 mm to adjacent equipment and control cabinets. The lateral distance to external devices and cabinet controls must not fall below 20 mm.

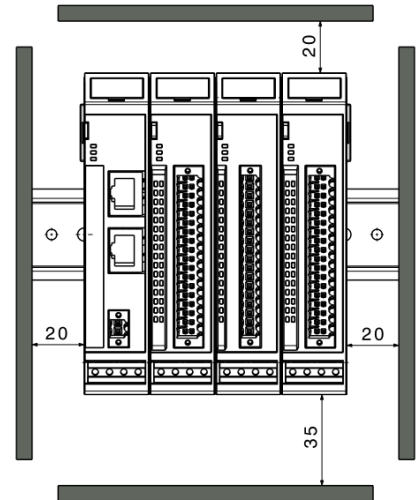


Figure 16: Installation position

Installation order within an MC-I/O system

i NOTE

To ensure smooth function of the entire MC-I/O system, the MC-I/O modules must be arranged based on their e-bus load. The modules with the biggest e-bus load are to be arranged directly next to the head modules (bus coupler or controller). Make sure that you note the maximum bus load of the head module.

- Push up the module against the mounting rail from below, allowing the metal spring to snap in between mounting rail and mounting area as illustrated.
- Push the module above against the mounting wall until it snaps in.

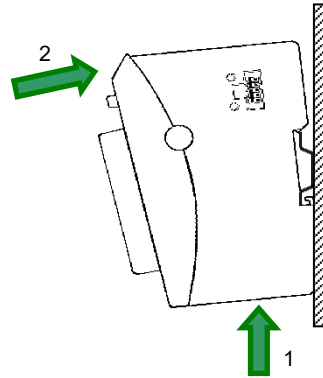


Figure 17: rail mounting of module

To interconnect two modules

After snapping on the first module to the rail, snap on the second module about 1cm away towards the right of the first module. Push the second module along the rail towards the first module until you hear the locking device snap in.

To disconnect two modules

Push down the unlock button (see figure below) of the module that you wish to disconnect from the module to the left of it. Push both modules away from one another until they are about 1 cm apart.

- Push the module up and against the metal spring located on the underside of the rail guide.
- Tip the module away from the rail as shown in the illustration.
- Pull the module down and out of the mounting rail.

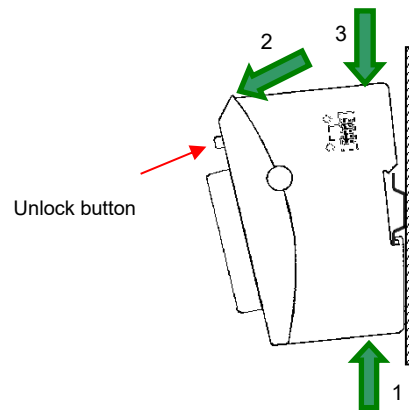


Figure 18: rail disassembly of the module

4.2. System power supply

4.2.1. General

General Spring-assisted blocks of sockets allow fast and simple wiring. A multiple socket connector densely packs the wires on a small footprint. Use the unlock button to easily disconnect the wires where there is little space.

Tool: 0.4 x 2.5 blade screwdriver

Cores: 0.20 - 1.0 mm² (IEC) / 28 - 18 ENC (UL)

Rated current: 5 A (CSA) / 10 A (UL)

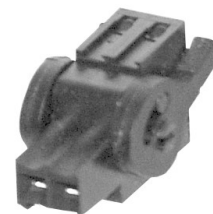
CAUTION

Do not connect the power supply lines through from one I/O power supply port to the next.

To ensure that there is as little interference as possible, install a central power supply point and establish a star topology of as short wires as possible between the central point and the I/O Modules.

4.2.2. Bus coupler

The system power supply connects to the bus coupler through a 2-pole plug-type terminal block. Since the bus coupler supplies power to both the E-bus and the logic circuits of the I/O modules, its power consumption depends on the number of I/O modules connected. Power to the I/O module outputs is supplied separately.



Spring-assisted connector and bus coupler unlock button
2VF100532DG00.cdr

4.2.3. I/O Modules

The I/O supply connects to the I/O module, normally together with the I/Os, using plug-type terminal blocks with different numbers of poles. Power to the I/O module logic circuits is supplied by the bus coupler.



Spring-assisted connector with I/O module unlock button
2VF100533DG00.cdr

4.3. Status LEDs

4.3.1. “EtherCAT” LED

An LED labeled “EtherCAT” is located on both the bus coupler and the I/O Modules. It indicates the state of the EtherCAT ASIC.

EtherCAT		
State	LED flash code	Explanation
Init	Red, on	Initializing, no data exchange
Pre-Op	Red/green, 1:1	Pre-operational, no data exchange
Safe-Op	Red/green, 5:1	Safe operation, inputs readable
Op	Green, on	Operational, unrestricted data exchange

4.3.2. “In” LED, “Out” LED

The “In” and “Out” LEDs are located on the bus coupler. They indicate the respective physical state of the Ethernet.

Ethernet		
State	LED flash code	Explanation
Not connected	Off	No Ethernet connection
Connected	Green, on	Connected to Ethernet
Traffic	Green, flashing	Exchanging telegrams

4.3.3. “I/O” LED

Every I/O Module has an LED labeled "IO". It indicates the state of the Module's I/Os. Refer to the I/O Module sections in this manual to know which states of a module are monitored and indicated.

4.3.4. “Power” LED

An LED labeled “Power” is located on every I/O Module that has a power supply connector (e.g. for digital outputs). It indicates the state of the I/O module's I/O power supply.

I/O power supply		
State	LED flash code	Explanation
On	Green, on	24 V DC supply ok
Off	Off	24 V DC supply not ok

4.4. Technical data (overview)

System properties CANtrol MC-I/O	
Fieldbus	EtherCAT 100Mbit/s
Dimensions	25 mm x 120 mm x 90 mm (W x H x D)
Housing mount	aluminium
Shield	connected straight to module housing
Installation	35 mm DIN rail (top-hat rail)
I/O connection	spring-assisted combi plug with mechanical ejector, 4 ... 36-pin
Signal indication	LED located next to the terminal
Diagnosis	LED: bus state, module state, broken wire/excessive current
Number of ports	up to 32 digital I/Os on every module, up to 8 analogue channels per module
Supply voltage	24 V DC -20% / +25%
Number of I/O modules	20 per bus coupler (total max. power consumption:3 A)
Electrical insulation	modules electrically insulated from one another and from the bus
Cable length analog signals	< 30 m
Storage temperature	-25 °C ... +70 °C
Operating temperature	0 °C ... +55 °C
Rel. humidity	5 % ... 95 %, non-condensing
Protection	IP20
Susceptibility to noise	zone B to EN 61131-2, installation on an earthed top hat rail in the earthed control

i NOTE

Exception

The dimensions of the Bus coupler DI16/DO16 amount to 42 mm x 120 mm x 90 mm (W x H x D).

5. BghExrlec.library (MC-I/O XR modules)

The functions and function blocks in the library's "Configuration" folder make the I/O configuration of the card possible by storing in the RAM components.

Reconfiguration is therefore always necessary after loss of power.

Two functions in the "Conversion" folder make conversion from DWORD to REAL and from REAL to UINT possible.

5.1. stEXRIO structure

The stEXRIO structure contains the information for the I/O configuration as DWORDs:

dwConfigAI : DWORD;

Contains the command and configuration values for the analog In channels AI0 to AI3. In these are determined (starting from the low-value nibbles) the respective type (Off, Voltage, Current) and filter.

dwConfigBI : DWORD;

Contains the command and configuration values for the analog In channels BI0 to BI3. In these are determined (starting from the low-value nibbles) the respective type (only Off and Voltage) and filter.

dwConfigCounter : DWORD;

Contains the command and the values for the counter units. They contain the type (forwards, backwards or quadrature counter), the counter unit (0 – 3) and the capture pin (0 – 15).

dwConfigAO : DWORD;

Contains the command and configuration values for the analog Out channels AO0 to AO3. In these are determined (starting from the low-value nibbles) the respective type (Off, Voltage, Current) and filter.

eStatus : eStatus;

As the condition for further processing of data the structure can be set at "eStatusIsInit" or "eStatusNotInit".

5.2. Functions for data transfer to the structure stEXRIO

SetCountMode

Declaration

```

FUNCTION SetCountMode : eError
VAR_INPUT
    eDirectionUPDown :    eDirection;
    eCntType :           eCounterType;
    eCapturePin :       eCounterCapture;
    eBlockID :          eCounterUnit;
END_VAR
VAR_IN_OUT
    EXRIO :    stEXRIO;
END_VAR
    
```

	Parameter	Value	Description
Input parameters	eDirectionUPDown		Determines whether the first pin of a channel counts forwards or backwards.
	eCntType		Determines whether device is configured as counter or quadrature encoder.
	eCapturePin		Determines the input (e.g. eCapturePinIn15) for the transfer of the counter reading.
	eBlockID		Defines the counter unit to be configured (eCountUnit0 – eCountUnit3).
In-/ Output parameter	EXRIO		Data are written in dwConfigCounter of the structure.
Output parameter	SetCountMode		eErrorOK or eErrParamOutOfRange where parameter is invalid

Description

SetModeChannelAI

Declaration

```

FUNCTION SetModeChannelAI : eError
VAR_INPUT
    eAnaChannel :    eAnalogChannels;
    eAnaType :      eAnalogType;
    eAnaFilter :    eAnalogFilter;
END_VAR
VAR_IN_OUT
    EXRIO:          stEXRIO;
END_VAR
    
```

	Parameter	Value	Description
Input parameters	eAnaChannel		Determines the channel number; eAnalogChannelA0 to eAnalogChannelA3 are possible.
	eAnaType		Determines the analog type; eOff, eVoltage and eCurrent are possible.
	eAnaFilter		Determines the input filter; eFilterNone, eFilter100Hz, eFilter10Hz and eFilter1Hz are possible.
In-/ Output parameter	EXRIO		Data are written in dwConfigAI of the structure.
Output parameter	SetModeChannelAI		eErrorOK or eErrParamOutOfRange where parameter is invalid.

Description

SetModeChannelBI

Declaration

```

FUNCTION SetModeChannelBI : eError
VAR_INPUT
    eAnaChannel :    eAnalogChannels;
    eAnaType :      eAnalogType;
    eAnaFilter :    eAnalogFilter;
END_VAR
VAR_IN_OUT
    EXRIO:    stEXRIO;
END_VAR
    
```

	Parameter	Value	Description
Input parameters	eAnaChannel		Determines the channel number; eAnalogChannelB0 to eAnalogChannelB3 are possible.
	eAnaType		Determines the analog type; eOff, eVoltage and eCurrent are possible.
	eAnaFilter		Determines the input filter; eFilterNone, eFilter100Hz, eFilter10Hz and eFilter1Hz are possible.
In-/ Output parameter	EXRIO		Data are written in dwConfigBI of the structure.
Output parameter	SetModeChannelBI		eErrorOK or eErrParamOutOfRange where parameter is invalid.

Description

SetModeChannelAO

Declaration

```

FUNCTION SetModeChannelAO : eError
VAR_INPUT
    eAnaChannel :    eAnalogChannels;
    eAnaType :      eAnalogType;
    eAnaFilter :    eAnalogFilter;
END_VAR
VAR_IN_OUT
    EXRIO:          stEXRIO;
END_VAR
    
```

	Parameter	Value	Description
Input parameters	eAnaChannel		Determines the channel number; eAnalogChannelA0 to eAnalogChannelA3 are possible.
	eAnaType		Determines the analog type; eOff, eVoltage and eCurrent are possible.
	eAnaFilter		Determines the output filter; eFilterNone, eFilter100Hz, eFilter10Hz and eFilter1Hz are possible.
In-/ Output parameter	EXRIO		Data are written in dwConfigAO of the structure.
Output parameter	SetModeChannelAO		eErrorOK or eErrParamOutOfRange where parameter is invalid.

Description

5.2.1. Examples of parameter setting of above functions

```

SetCountMode(eForward,eCountTypeQuadratur,eCapturePinIn0,eCountUnit0,EXRIO);
SetModeChannelAI(eAnalogChannelA1,eOff,eFilterNone,EXRIO);
SetModeChannelAO(eAnalogChannelA0,eCurrent,eFilterNone,EXRIO);
SetModeChannelBI(eAnalogChannelB0,eVoltage,eFilter1Hz,EXRIO);
    
```

5.3. Function blocks to use

DoConfigDevice

Declaration

```

FUNCTION_BLOCK DoConfigDevice
VAR_INPUT
    xExecute :   BOOL;
END_VAR
VAR_IN_OUT
    EXRIO:      stEXRIO;
END_VAR
VAR_OUTPUT
    xDone :     BOOL := FALSE;
    xBusy :     BOOL;
    xError:     BOOL := FALSE;
    eErr:      eError;
END_VAR
    
```

	Parameter	Value	Description
Input parameter	xExecute		The variable is edge-controlled. If the function block is recalled with xExecute := True the execution of the function block begins. Execution is terminated with xExecute := FALSE.
In-/ Output parameter	EXRIO		To write the configuration the data from this structure are used.
Output parameters	xDone	FALSE	Following successful execution of the function block the output variable Done = TRUE.
	xBusy		During execution the output variable xBusy = TRUE.
	xError	FALSE	In the event of an error the general error variable xError is set.
	eErr		Possible error returns are eErrNoInit, which relates to the stEXRIO structure, and eParamOutOfRange, if impermissible I/O parameters were transferred. Otherwise the eErrOK variable is assigned.
Description	Configures the analog I/Os and the card counters in which the configuration values are written in the component RAM.		

CheckDeviceConfig

Declaration

```

FUNCTION_BLOCK CheckDeviceConfig
VAR_INPUT
    xEnable :      BOOL;
END_VAR
VAR_IN_OUT
    EXRIO :      stEXRIO;
END_VAR
VAR_OUTPUT
    xDone :      BOOL;
    xBusy :      BOOL;
    xError:      BOOL;
    eError:      eError;
END_VAR
    
```

	Parameter	Value	Description
Input parameter	xEnable		Approval for execution of the function block.
In-/ Output parameter	EXRIO		Structure content for the current comparison of the hardware configuration.
Output parameters	xDone		After successful execution of the function block the output variable is xDone = TRUE.
	xBusy		During execution the output variable xBusy = TRUE (is not used in the current implementation).
	xError		In the event of error the general error variable xError is set.
	eError		Possible error return is eErrNoMatch if the structure and hardware comparison indicates at least one difference. Otherwise the eErrOK variable is assigned.
Description	Reads the I/O device configuration from the hardware and compares this with the content of the stEXRIO structure. The FB delivers a result with every call up, either XDone=TRUE or xError=TRUE.		

5.4. Start initialisation by using MC-I/O XR01

The analog channels and the counters of the multi-I/O MC-XR01 components are freely programmable. At the start of the SPS program with connected MC-XR01 a start initialisation must therefore be implemented. In doing so the structure must be charged with the required values (see 5.1 stEXRIO structure) one time only. After this the DoConfigDevice function block must be retrieved with the parameter of the stEXRIO structure. The I/O channels of the card are configured when the above xDone = TRUE function block is returned.

During operation with an SPS program the CheckDeviceConfig function block must be retrieved cyclically since the card configuration checks for consistency with the content of the stEXRIO structure. If the function block reports eError = eErrNoMatch, the target/performance of the card is no longer consistent. This can occur, for example, when the power supply to the EXR01 is briefly cut off. In this case the DoConfigDevice functional module must be retrieved once more and its xDone = TRUE waited for. The indirect addressing of the four input DWORDs and an output DWORD must be cancelled in VAR_CONFIG (see 5.6 Configuration of variables).

If several cards are to be configured an instance of the FBs and, if necessary, also one of the eEXRIO structures, must be applied. Individual I/O mapping in VAR_CONFIG must also be applied for each card. The library has no limitations regarding the maximum number of configurable cards.

5.5. Additional functions for converting

ConvertDWordToReal

Declaration

```
Function ConvertDWordToReal : REAL
VAR_INPUT
    dwValue :      DWORD;
    eModeType :    eAnalogType;
END_VAR
```

	Parameter	Value	Description
Input parameters	dwValue		DWORD of the analog input
	eModeType		Parameter values for conversion into voltage or current; permissible values: eOff, eVoltage or eCurrent
Output parameter	ConvertDWordToReal		Depending on the parameter eMode type mA or volt as REAL
Description	Reads an analog input as DWORD and returns this as floating-point number (e.g. for the display in a visualisation).		
Example of parameter setting	rAnalog0 := ConvertDWordToReal(dwValue:= M1_AI0, eModeType := eCurrent);		

ConvertRealToUInt

Declaration

```
Function ConvertRealToUInt : UINT
VAR_INPUT
    rValue :      REAL;
    eModeType :    eAnalogType;
END_VAR
```

	Parameter	Value	Description
Input parameters	rValue		The floating point value to be converted
	eModeType		Parameter values for conversion into voltage or current; permissible values: eOff, eVoltage or eCurrent
Output parameter	ConvertRealToUInt		Data for an analog output
Description	Converts a floating-point number into UINT. The result can be written direct into the hardware as an output value.		
Example of parameter setting	M1_AO0 := ConvertRealToUInt(rOutChannel0, eVoltage);		

5.6. Configuration of variables (under Globale_Variablen, VAR_CONFIG)

The In/Out addresses specified in the function blocks as indirect addresses must be specified in the application in VAR_CONFIG, including the function block path.

Example of Var_Config, if PLC_PRG function blocks are retrieved:

```
VAR_CONFIG
  (* Input addresses: *)
  PLC_PRG.DoConfigDevice.dwActConfigAI AT %IB2564 :      DWORD;
  PLC_PRG.DoConfigDevice.dwActConfigBI AT %IB2568 :      DWORD;
  PLC_PRG.DoConfigDevice.dwActConfigCounter AT %IB2572 :  DWORD;
  PLC_PRG.DoConfigDevice.dwActConfigAO AT %IB2576 :      DWORD;
  PLC_PRG.CheckDeviceConfig.dwActConfigAI AT %IB2564 :   DWORD;
  PLC_PRG.CheckDeviceConfig.dwActConfigBI AT %IB2568 :   DWORD;
  PLC_PRG.CheckDeviceConfig.dwActConfigCounter AT %IB2572 :  DWORD;
  PLC_PRG.CheckDeviceConfig.dwActConfigAO AT %IB2576 :   DWORD;
  (* Output address may exist once only, because the first address is
     overwritten by the second! *)
  PLC_PRG.DoConfigDevice.SendCtrlDword.dwCtrlDword AT %QB2564 :  DWORD;
END_VAR
```

5.7. Listing data types and structure of the library

```
TYPE eAnalogChannels :
(
  (* Analog-channels A0 - A3 and B0 - B3 *)
  eAnalogChannelA0 := 0,
  eAnalogChannelA1 := 1,
  eAnalogChannelA2 := 2,
  eAnalogChannelA3 := 3,
  eAnalogChannelB0 := 4,
  eAnalogChannelB1 := 5,
  eAnalogChannelB2 := 6,
  eAnalogChannelB3 := 7
);
END_TYPE
```

TYPE eAnalogFilter :

```
(
    eFilterNone := 0, (* No Filter (200 Hz) *)
    eFilter100Hz := 1, (* Filter 100 Hz *)
    eFilter10Hz := 2, (* Filter 10 Hz *)
    eFilter1Hz := 3 (* Filter 1 Hz *)
);
END_TYPE
```

TYPE eAnalogType :

```
(
    eOff := 0, (* Analog Off *)
    eVoltage := 1, (* Analog Type Voltage *)
    eCurrent := 3 (* Analog Type Current *)
);
END_TYPE
```

TYPE eCounterCapture :

```
(
    (* Capture-Pin-Values 0 to 15 *)
    eCapturePinIn0 := 0,
    eCapturePinIn1 := 1,
    eCapturePinIn2 := 2,
    eCapturePinIn3 := 3,
    eCapturePinIn4 := 4,
    eCapturePinIn5 := 5,
    eCapturePinIn6 := 6,
    eCapturePinIn7 := 7,
    eCapturePinIn8 := 8,
    eCapturePinIn9 := 9,
    eCapturePinIn10 := 10,
    eCapturePinIn11 := 11,
    eCapturePinIn12 := 12,
    eCapturePinIn13 := 13,
    eCapturePinIn14 := 14,
    eCapturePinIn15 := 15
);
END_TYPE
```

```

TYPE eCounterType :
(
    eCountTypeUpDown := 0, (* Up/Down-Counter *)
    eCountTypeQuadratur := 1 (* Quadrature encoder *)
);
END_TYPE

TYPE eCounterUnit :
(
    eCountUnit0 := 0, (* Value 0: IN8 + IN9 *)
    eCountUnit1 := 1, (* Value 1: IN10 + IN11 *)
    eCountUnit2 := 2, (* Value 2: IN12 + IN13 *)
    eCountUnit3 := 3 (* Value 3: IN14 + IN15 *)
);
END_TYPE

TYPE eDirection :
(
    eForward := 0,
    eBackward := 1
);
END_TYPE

TYPE eError :
(
    eErrOK := 0, (* No Error *)
    eErrConfigurationNotAllowed := 1, (* Configuration of the device is
                                        not allowed *)
    eErrParamOutOfRange := 2, (* Parameters are out of range *)
    eErrNoMatch := 3, (* No Match found *)
    eErrTimeOut := 4, (* Timeout in function *)
    eErrFilterNotAllowed := 5, (* Filtervalue not allowed *)
    eErrNotInit := 6 (* Not initialized *)
);
END_TYPE

TYPE eStatus :
(
    eStatusNotInit := 0, (* Status not yet initialized *)
    eStatusIsInit := 1 (* Status is now initialized *)
);
END_TYPE

```

```
TYPE stEXRIO :  
  STRUCT  
    (* Dwords that comprehend Byte Command and Dword value *)  
    dwConfigAI :      DWORD;  
    dwConfigBI :      DWORD;  
    dwConfigCounter :  DWORD;  
    dwConfigAO :      DWORD;  
    (* States init or not init *)  
    eStatus :         eStatus;  
  END_STRUCT  
END_TYPE
```

6. Environmental Protection

6.1. Emission

When used correctly, our modules do not produce any harmful emissions.

6.2. Disposal

At the end of their service life, modules may be returned to the manufacturer against payment of an all-inclusive charge to cover costs. The manufacturer will then arrange for the modules to be recycled.

6.3. Maintenance/Upkeep

WARNING

Do not insert, apply, detach or touch connections while in operation – risk of destruction or malfunction.

Disconnect all incoming power supplies before working on our modules; this also applies to connected peripheral equipment such as externally powered sensors, programming devices, etc. All ventilation openings must always be kept free of any obstruction.

-
- The modules are maintenance-free when used correctly.
 - Clean only with a dry, non-fluffing cloth.
 - Do not use detergents!

6.4. Repairs/Service

WARNING

Repair work may only be carried out by the manufacturer or its authorised service engineers.

6.4.1. Warranty

Sold under statutory warranty conditions. Warranty lapses in the event of unauthorised attempts to repair the equipment and/or product, or in the event of any other form of intervention.

6.5. Identification plate

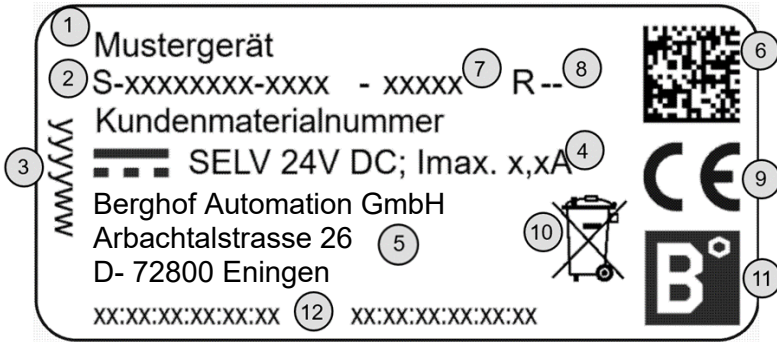


Figure 19: identification plate

2VF100080DG02.cdr

Item	Description	Item	Description
1	Device type description	7	Serial number of the device
2	Order number/part number	8	Version (delivery version; as-delivered condition)
3	Date of manufacture (year/calendar week)	9	CE marking
4	Supply voltage and maximum current	10	Disposal information
5	Manufacturer (manufacturer's address)	11	Manufacturer's logo
6	QR code (identification no.)	12	MAC addresses of the device

i NOTE

The 'Version' (supply version) panel specifies the design-level of the module as supplied ex-works.

When replacing a module, users, with the CNW (CANtrol Node Wizard) tool, can read off the current software version of the newly supplied module, and then reload their 'own' software version for a particular project if necessary.

With the latter in mind, before the download you should always keep a record of the existing software levels in your project documentation (software version, node IDs, baud rate, etc.).

7. Customer services / addresses

Repairs and corrective maintenance may only be carried out by the manufacturer or its authorised customer service centres.

7.1. Customer services

Berghof Automation GmbH
Arbachtalstrasse 26
72800 Eningen
Germany
T +49.7121.894-183
F +49.7121.894-100
email: support-controls@berghof.com
<https://www.berghof-automation.com>

7.2. Addresses

CAN in Automation; international manufacturer and user organisation for CAN users in automation:

CAN in Automation e.V. (CiA)
Am Weichselgarten 26
91058 Erlangen, Germany
headquarters@can-cia.de
www.can-cia.de

EtherCAT Technology Group
ETG Headquarters
Ostendstraße 196
90482 Nürnberg, Germany
info@ethercat.org
www.ethercat.org

Beuth Verlag GmbH, 10772 Berlin, Germany
or
VDE-Verlag GmbH, 10625 Berlin, Germany

VDE Verlag GmbH, 10625 Berlin, Germany
or
Internet research: www.iec.ch

7.3. Bibliography / Standards

Standard	Label
IEC61131-1 / EN61131-1	Programmable controllers Part 1: General information
IEC61131-2 / EN61131-2	Programmable controllers Part 2: Equipment requirements and tests
IEC61131-3 / EN61131-3	Programmable controllers Part 3: Programming languages
IEC61131-4 / EN61131B11	Programmable logic controllers Supplementary Sheet 1: User guidelines
IEC61000-6-4 / EN61000-6-4	German EMC Standard: Emitted interference
IEC61000-6-2 / EN61000-6-2	German EMC Standard: Noise immunity
ISO/DIS 11898	Draft International Standard: Road vehicles - Interchange of digital information - Controller Area Network (CAN) for high-speed communication
DIN EN ISO 13849-1	Safety of machinery: Safety-related parts of control systems (Part 1)
UL 508	Industrial Control Equipment 17 th edition / 1999-01-28

Notice: Our Technical Support team will be glad to provide other literature references on request.

8. Appendix

8.1. Notes on copyright and the software licence

The device's firmware contains free software. Parts of this software are available under the following and other open source licences:

- GNU General Public License (GPL)
- GNU Lesser General Public License (LGPL)
- Mozilla Public License (MPL)
- FreeType License (FTL)

The source code for the free software can be requested from Berghof Customer Services at cost price within three years of delivery of the device.

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