FAULHABER

Technical Manual

Motion Control System (MCS)

2232 BX4 IMC

2250 BX4 IMC

WE CREATE MOTION

EN

Imprint

Version:
1st edition, 15.04.2024

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Dr. Fritz Faulhaber GmbH & Co. KG cannot accept any liability for any errors in this document or for the consequences of such errors. Equally, no liability can be accepted for direct or consequential damages resulting from improper use of the equipment.

The relevant regulations regarding safety engineering and interference suppression as well as the requirements specified in this document are to be noted and followed when using the software.

Subject to change without notice.

The respective current version of this technical manual is available on FAULHABER's internet site:
www.faulhaber.com

Content

Content

1 About this document

1.1 Validity of this document

This document describes the installation and use of the following series:

- IMC RS
- IMC CO

This document is intended for use by trained experts authorized to perform installation and electrical connection of the product.

All data in this document relate to the standard versions of the series listed above. Changes relating to customer-specific versions can be found in the corresponding data sheet.

1.2 Associated documents

For certain actions during commissioning and operation of FAULHABER products additional information from the following manuals is useful:

Manual	Description
Motion Manager 7	Operating instructions for FAULHABER Motion Manager PC software
Quick start guide	Description of the first steps for commissioning and operation of FAULHABER Motion Control Systems
Drive functions	Description of the operating modes and functions of the drive
Accessories manual	Description of the accessories

These manuals can be downloaded in pdf format from the web page www.faulhaber.com/manuals.

1.3 Using this document

- Read the document carefully before undertaking configuration, in particular chapter “Safety”.
- Retain the document throughout the entire working life of the product.
- Keep the document accessible to the operating and, if necessary, maintenance personnel at all times.
- Pass the document on to any subsequent owner or user of the product.

1.4 List of abbreviations

Abbreviation	Meaning
AnIn	Analog input
AGND	Analog Ground
CAN	Controller Area Network
CAN_H	CAN-High
CAN_L	CAN-Low
CO	CANopen interface acc. to CiA 402
DigIn	Digital input
DigOut	Digital output
EFS	Electronics Filter Supply
EMC	Electromagnetic compatibility
ESD	Electrostatic discharge
GND	Ground
IMC	Integrated motion controller
MCS	Motion Control System
PLC	Programmable Logic Controller
PWM	Pulse Width Modulation
RS	Serial RS232 interface
RxD	Receive Data
TTL	Transistor Transistor Logic
TxD	Transmit data

1.5 Symbols and designations

⚠ DANGER!

Danger with high level of risk: if not avoided, death or serious injury will result.

- Measures for avoidance

⚠ WARNING!

Danger with medium level of risk: if not avoided, death or serious injury may result.

- Measures for avoidance

⚠ CAUTION!

Danger with low level of risk: if not avoided, minor or moderate injury may result.

- Measures for avoidance

NOTICE!

Risk of damage.

- Measures for avoidance

Instructions for understanding or optimizing the operational procedures

✓ Pre-requirement for a requested action

1. First step for a requested action
   ↳ Result of a step
2. Second step of a requested action

↳ Result of an action

- Request for a single-step action

2 Safety

2.1 Intended use

The Motion Control Systems described here consist of a combination of a base motor and an integrated Motion Controller.

The Motion Control Systems are intended for use as slaves, and are particularly suitable for positioning tasks in the following application fields:

- Robotics
- Toolbuilding
- Automation technology
- Industrial equipment and special machine building
- Medical technology
- Laboratory technology

When using the Motion Control Systems the following aspects should be observed:

- Motion Control Systems contain electronic components and should be handled in accordance with the ESD regulations.
- Do **not** use the Motion Control Systems in environments where it will come into contact with chemicals, **nor** in explosion hazard areas.
- The Motion Control Systems should be operated only within the limits specified in the corresponding data sheet.
- Please ask the manufacturer for information about use under individual special environmental conditions.

2.2 Safety instructions

In addition to the safety risks described in this technical manual, machine-specific dangers could arise that cannot be foreseen by the manufacturer of the Motion Control Systems (e.g., risk of injury from driven components). The manufacturer of the machine in which the Motion Control System is installed must perform a risk analysis in accordance with the regulations applicable to the machine and inform the end user of the residual risks.

2.2.1 Dangers in the event of damages and changes

Damage to the Motion Control Systems (MCS) can impair its functions. A damaged MCS can unexpectedly start, stop or jam. This can result in damage to other components and materials.

- Do **not** start up a drive system with a defective or damaged MCS.
- Appropriately mark a defective or damaged MCS.
- Do **not** replace defective or damaged components of the MCS.
- Make no changes (modifications, repairs) to the MCS.
- Have loose or defective connections immediately replaced by an electrician.
- After replacing a defective or damaged MCS, test and document the correct function.

2.2.2 Correct installation and commissioning

Errors during the installation and commissioning of the MCS could impair its function. An incorrectly installed MCS can unexpectedly start, stop or jam. This can result in damage to other components and materials.

- Follow the instructions for installation and commissioning given in these installation instructions exactly.
- Only have work on electrical operating equipment performed by an electrician.
- During all work on the electrical equipment, observe the 5 safety rules:
  a) Disconnect from power
  b) Secure against being switched on again
  c) Check that no voltage is present
  d) Ground and short-circuit
  e) Cover or block-off adjacent parts that are under voltage

Electrostatic discharges can damage the electronics.

- Store and transport the MCS in suitable ESD packaging.
- Handle the MCS in compliance with the ESD handling regulations (e.g. wear an ESD wristband, ground surrounding components).
- During installation, ensure that components in the surroundings cannot be electrostatically discharged.

Soiling, foreign bodies, humidity and mechanical influences can damage the electronics.

- Keep foreign objects away from the electronics.
- Install the MCS in a housing that protects it from mechanical influences and is adapted to the ambient conditions (protection class determination).

Installation and connection work whilst supply voltage is applied at the device can damage the electronics.

- Do **not** insert or withdraw connectors whilst supply voltage is applied at the MCS.
- Prior to all aspects of installation and connection work on the MCS, switch off the power supply.

Incorrect connection of the pins can damage the electronic components.

- Connect the wires as shown in the connection assignment.

2.2.3 Heat development

Active components may cause the MCS to heat up. If touched, there is a risk of burning.

- Protect the MCS against being touched and cool sufficiently.
- If necessary, affix a suitable warning sign in the immediate vicinity of the MCS.

Fig. 1: Suitable warning sign acc. to DIN EN ISO 7010

2.3 Environmental conditions

- Select the installation location so that clean dry air is available for cooling the MCS.
- Select the installation location so that the air has unobstructed access to flow around the MCS.
- When installed within housings and cabinets take particular care to ensure adequate cooling of the MCS.
- Select a power supply that is within the defined tolerance range.
- Protect the MCS against heavy deposits of dust, in particular metal dust and chemical pollutants.
- Protect the MCS against humidity and wet.

2.4 EC directives on product safety

- The following EC directives on product safety must be observed.
- If the Motion Control Systems are being used outside the EU, international, national and regional directives must be also observed.

Machinery Directive (2006/42/EC)
The controllers with attached motor described in this technical manual may be drive systems according to the Machinery Directive. They are therefore to be considered incomplete machines according to the Machinery Directive. Compliance is documented by the Declaration of Incorporation for the product and by the EC Declaration of the Conformity.

EMC Directive (2014/30/EU)
The directive concerning electromagnetic compatibility (EMC) applies to all electrical and electronic devices, installations and systems sold to an end user. In addition, CE marking can be undertaken for built-in components according to the EMC Directive. Conformity with the directive is documented in the Declaration of Conformity.

Applied standards
Various harmonized standards were applied to the products described in this technical manual; these standards are documented in the EC Declaration of Conformity. You can find the Declaration of Incorporation for the product and the EC Declaration of Conformity in chap. 8, p. 37.

WEEE Directive (2012/19/EU)
The directive on the disposal of electrical and electronic devices prescribes the separate collection of old electrical and electronic devices. The products described in this technical manual fall within the scope of this directive.

3 Product description

3.1 General product description

The drive systems integrate a brushless DC servomotor, a high-resolution actual value encoder and a Motion Controller in a compact, complete drive unit.

The motor commutation is achieved electronically so that the service life of a FAULHABER Motion Control Systems depends mainly on the service life of the motor bearings. FAULHABER uses high-precision, preloaded ball bearings in all of its systems with integrated Motion Controller. The following factors influence the service life of the bearings:

- Static, dynamic, axial and radial bearing loads
- Thermal environmental conditions
- Speed
- Vibrational and shock loads
- Level of precision to which the shaft is coupled to the given application

For highly dynamic servo applications requiring very high torque in the most compact dimensions, the FAULHABER BX4 Series 4-pin DC-Servomotors are integrated. They have the following features:

- Robust design
- Adhesive-free construction
- Long service life
- Ideal for hostile ambient conditions (e.g. extreme temperatures and high vibrational and shock loads)

Thanks to their robust construction and their compact design, the FAULHABER Motion Control Systems of the V3.0 generation are ideal for use in the markets described in chap. 2.1, p. 8.

As an option, a common power supply for motor and control electronics is possible.

Additional programming adapters and connection aids are available.

Special preconfiguration of the modes and parameters is possible on request.

3.2 Product information

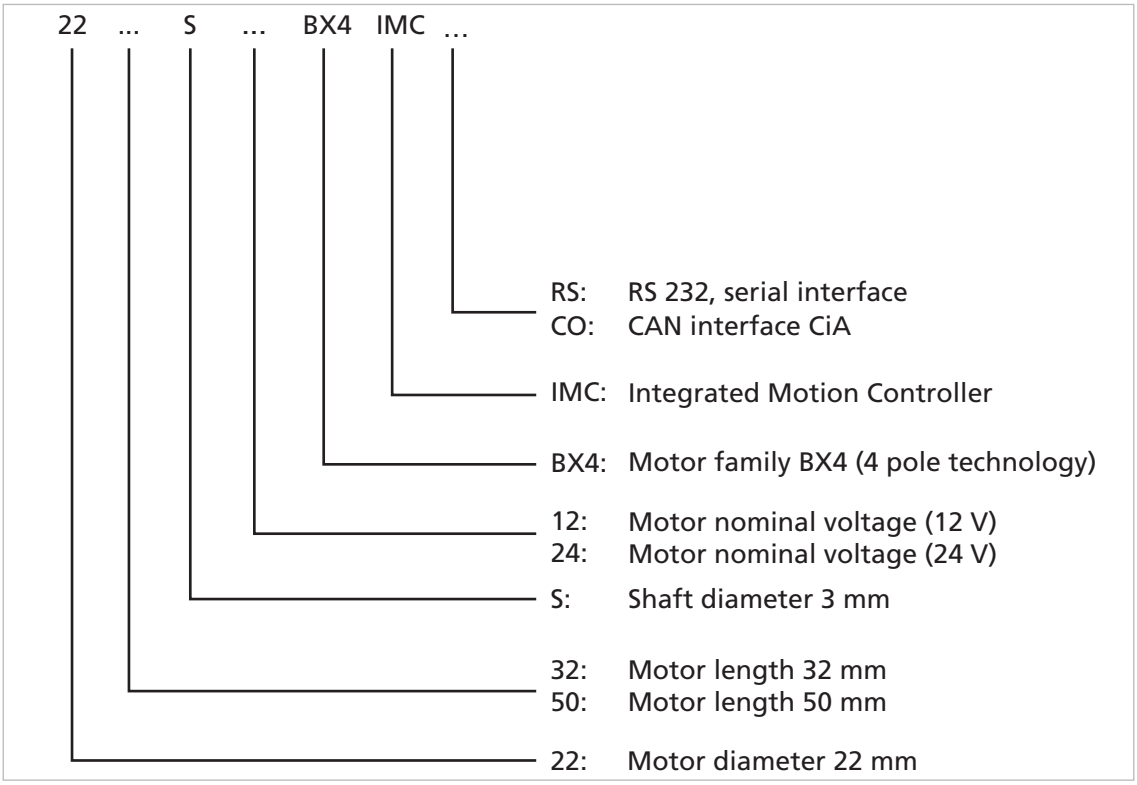


Fig. 2: Designation key for motor series 22xx

3.3 Product variants

Tab. 1: Product variants – Motion Control Systems

Motion Control System	Sensors	Speed range (min^{-1}) [a]	Power supply Electronics/motor (V DC) [b]	Peak current (A) [c]
2232 BX4 IMC	Sin/Cos	1…13,400	6…30	2.5
2250 BX4 IMC	Sin/Cos	1…8,500	6…30	3.5

a) Speed range depends on the power supply.

b) A shared power supply is available as an option (option 7431).

c) Depending on the cooling factor, operating point and ambient temperature, the current limitation parameter can be adapted using the FAULHABER Motion Manager. The specified values apply in the case of 22 °C ambient temperature and max. 60 °C MCS temperature and the nominal voltage for motor and electronics. Operating mode S2 for max. 1 s at 12 V nominal motor voltage and max. 2 s at 24 V nominal motor voltage.

4 Installation

Only trained experts and instructed persons with knowledge of the following fields may install and commission the MCS:

- Automation technology
- Standards and regulations (such as the EMC Directive)
- Low Voltage Directive
- Machinery Directive
- VDE regulations (DIN VDE 0100)
- Accident prevention regulations

This description must be carefully read and observed before commissioning.

Also comply with the supplementary instructions for installation (see chap. 2.3, p. 10).

4.1 Mounting

4.1.1 Mounting instructions

⚠ CAUTION!

The Motion Control System can become very hot during operation.

- Place a guard against contact and warning notice in the immediate proximity of the Motion Control System (see chap. 2.2.3, p. 10).

NOTICE!

Installation and connection of the MCS when the power supply is applied can damage the device.

- Prior to all aspects of installation and connection work on the MCS, switch off the power supply.

NOTICE!

The MCS can be damaged if mounted incorrectly.

- Observe the maximum screw-in depth of the fastening screws (see Tab. 2).

NOTICE!

Excessive loads on the motor shaft can cause irreparable damage to the MCS.

- When attaching parts to the motor shaft, observe the maximum permissible load values (see the product data sheet) of the shaft.

NOTICE!

Excessive radial loads on the servomotor or excessively tightened fastening screws can cause irreparable damage to the mounting flange.

- Observe the maximum permissible radial load on the motor (see Tab. 2).
- Make sure that the screws are tightened in accordance with Tab. 2.

4.1.2 Mounting the motor

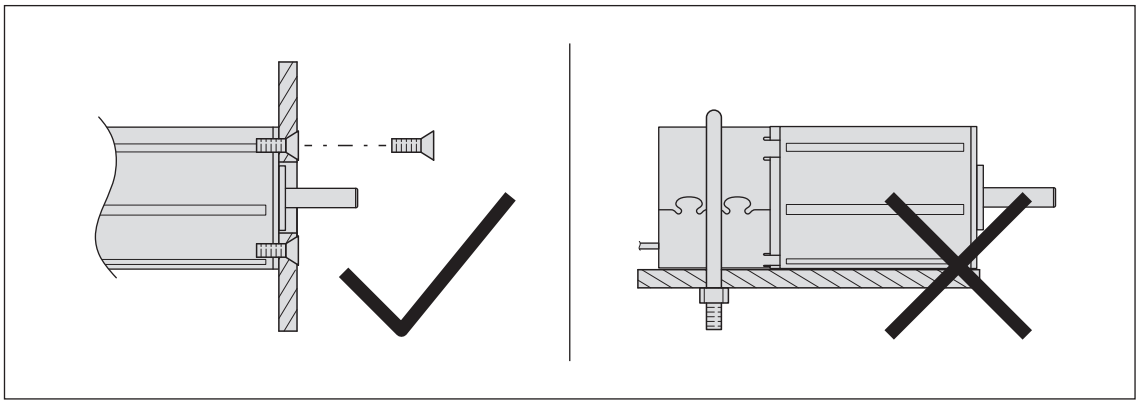


Fig. 3: Mounting example – 22xx BX4 IMC series

1. Secure the front flange of the MCS to a suitable surface using fastening screws (for the screw size and torque, see Tab. 2).
2. Protect the fastening screws to prevent displacement due to the effect of heat.
3. If necessary, attach parts to the motor shaft.

Information on the used flange can be found in the product data sheet.

Tab. 2: Attachment specifications

Motion Control System	Screw type	Thread depth (mm)	Max. tightening torque (Ncm)	Radial motor load, max. (N)
22xx BX4 IMC	M2	3.0	50	30

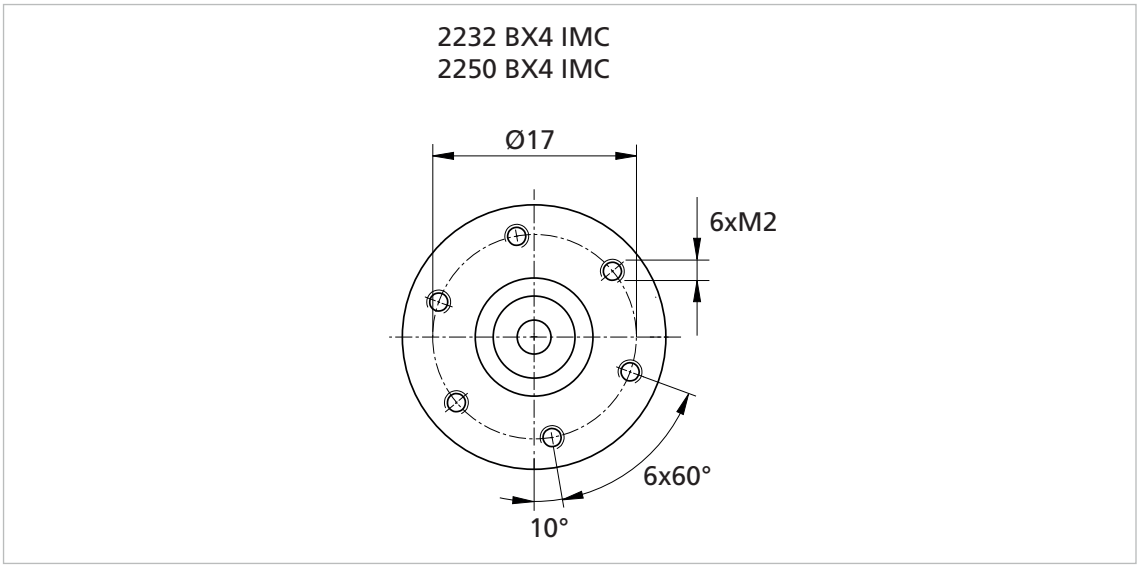


Fig. 4: Flange details (example)

4.2 Electrical connection

4.2.1 Notes on the electrical connection

NOTICE!

Electrostatic discharges to the MCS connections can damage the electronic components

- Observe the ESD protective measures.
- Carry out work only at ESD-protected workstations.
- Connect the connections as per the pin assignment (see chap. 4.2.3.1, p. 19)

NOTICE!

Risk of damage caused by back-induced voltage.

If the motor shaft is driven externally, the motor acts as a generator. The generated voltage can damage the electronics of the IMC. The generated DC voltage (U_{mot}) corresponds to the product of speed (n) and electromotive force constant (k_n).

- Connect the electronics supply of the MCS to a power supply unit during installation or connect the U_{mot} and GND connections to each other.
- Do not drive the MCS above the specified maximum and nominal speed, even if a gear-head is used.
- Use an EMC suppressor circuit (see chap. 4.3, p. 26).

NOTICE!

Extreme static or dynamic loads on the connection cable can cause the cable to be damaged.

- Make sure that the connection cable is not subjected to abrasion, crushing or excessively tight bending radii during installation and operation.
- Do not bend the cable at temperatures < –10 °C.
- Comply with permissible loads (see Tab. 3).

Tab. 3: Permissible loads of the connection cables

Motion Control System	Cable type	Permissible loads
22xx BX4 IMC	8 x AWG26	Maximum tensile load: 30 N
	1.27 mm	Continuous tensile load: <17 N
	Ribbon cable	Bending radius with repeated installation: >10 mm
		Bending radius with one-off installation: >1.2 mm

4.2.2 Electrical connection of motor

NOTICE!

Risk of damage caused by inadequately dimensioned power supply unit.

Using an inadequately dimensioned power supply unit can result in malfunctions.

- Make sure that the power supply unit is adequately dimensioned.

✓ The connection cables are <3 m

1. Take the appropriate EMC protective measures (see chap. 4.3, p. 26).
2. Take the appropriate ESD protective measures.
3. Connect the ribbon cable as per the pin assignment (see chap. 4.3, p. 26).
4. Connect the power supply as described in the explanation below.

There are 2 options for supplying power to the motor and the FAULHABER MCS:

Power supply with separate electronics supply (standard)

In the case of power supply with separate electronics supply, the motor supply can be switched off (e.g. by means of a safety relay) in the event of a fault while the controller continues to be supplied. As a result, the reference run does not need to be performed again after a fault because the sensor supply of the motor was maintained during the fault.

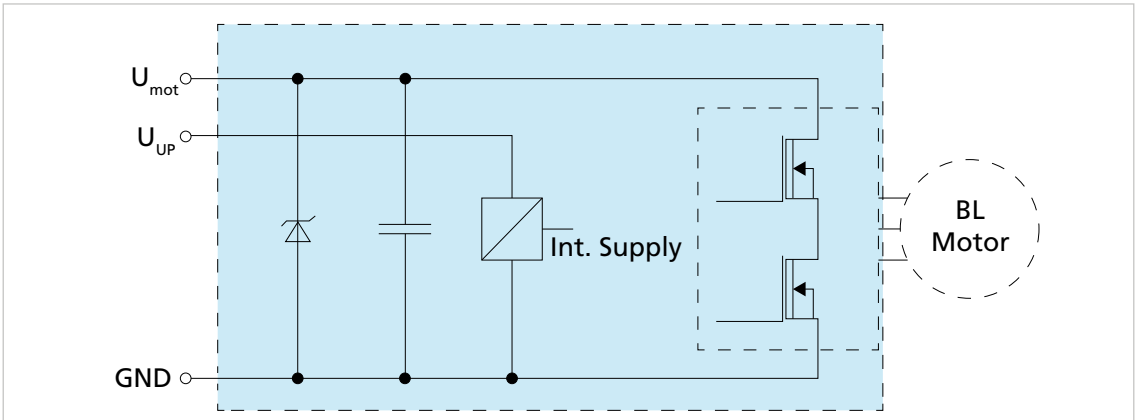


Fig. 5: Circuit diagram – separate electronics supply

Power supply with common electronics supply (option 7431)
In the case of power supply with common electronics supply, the controller and motor are switched off simultaneously if a fault occurs. After interruption of the power supply, the reference run must be performed again.

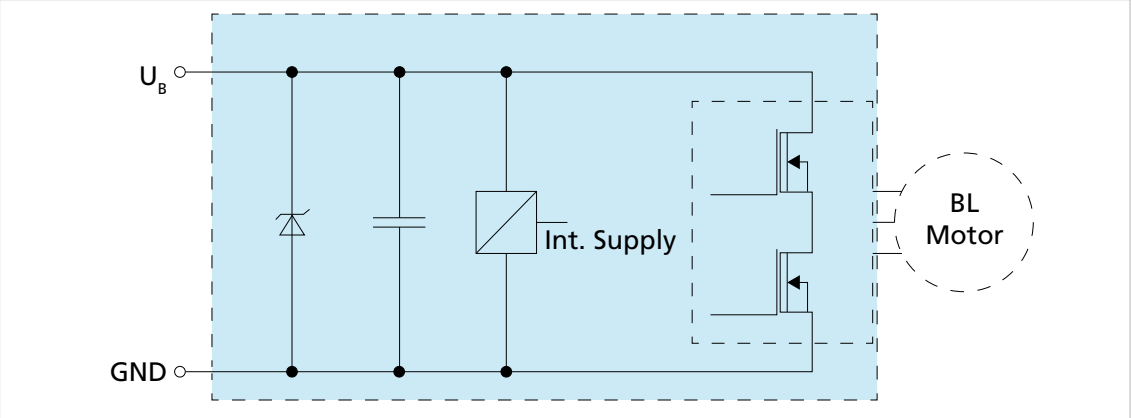


Fig. 6: Circuit diagram – common electronics supply

4.2.3 Supply connections

4.2.3.1 Pin assignment

NOTICE!

Incorrect polarity can cause irreparable damage to the electronics

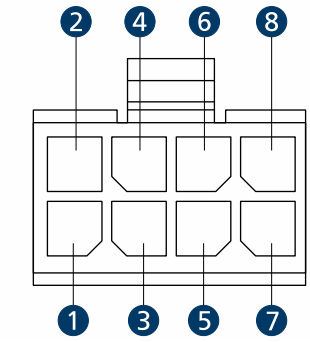
- Connect the MCS in accordance with the pin assignment.

The signal level of the digital inputs can be reconfigured to TTL via the interface.

- PLC level: low < 7 V / high >11,5 V
- TTL level: low < 0.5 V, high > 3.5 V_B

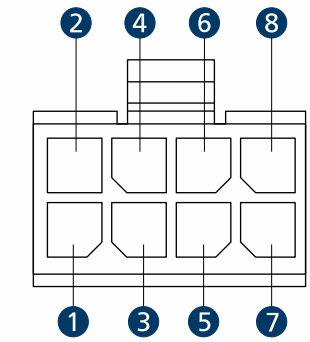
The resolution of the internal encoder is preset to 4096 lines per revolution.

Tab. 4: Pin assignment of ribbon cable with plug connector (option 3830)



Wire	Designation	Meaning
1	U_P	Supply connection for the electronics
2	U_{mot}	Supply connection for the motor
3	GND	Common ground
4	DigIn1 / DigOut2 / AnIn1	Digital input / digital output / analog input
5	DigIn2 / AGND	Digital input / analog GND
6	DigIn3 / DigOut1	Digital input / digital output
7	RS232 RXD / CAN_L	RS232 RxD/CAN-Low
8	RS232 TXD / CAN_H	RS232 TxD/CAN-High

Tab. 5: Pin assignment of ribbon cable with plug connector (options 3830 and 7431)



Wire	Designation	Meaning
1	AnIn2	Analog input
2	U_B	Supply connection for the controller
3	GND	Common ground
4	DigIn1/ DigOut2 / AnIn1	Digital input / digital output / analog input
5	DigIn2 / AGND	Digital input / analog GND
6	DigIn3 / DigOut1	Digital input / digital output
7	RS232 RXD / CAN_L	RS232 RxD/CAN-Low
8	RS232 TXD / CAN_H	RS232 TxD/CAN-High

Tab. 6: Electrical data 22xx BX4 IMC

Wire	Designation	Meaning	Value
1	U_P	Power supply of the electronics	6…30 V DC
	AnIn2 a)	Analog input	Voltage signal 0…10 V Ground reference GND
2	U_{mot}	Power supply of the motor	6…30 V DC
	U_B a)	Power supply of the MCS	6…30 V DC
3	GND	Common ground	Ground reference
4	DigIn1 / DigOut2 / AnIn1	Digital input	0…30 V 27 kΩ <1 MHz
		Digital output	Low = GND High = high resistance 27 kΩ Max. 0.7 A
		Analog input	Voltage signal 0…10 V b) Reference potential: AGND
5	DigIn2 / AGND	Digital input	0…30 V 27 kΩ <1 MHz
		Reference potential to AnIn1	
6	DigIn3 / DigOut1	Digital input	0…30 V 27 kΩ <1 MHz
		Digital output	Low = GND High = high resistance 27 kΩ Max. 0.7 A
7	RS232 RXD / CAN_L c)	Communication	RS232 RxD / CAN-L
8	RS232 TXD / CAN_H b)	Communication	RS232 TxD / CAN-H

a) *Option 7431 (shared power supply)*

b) *For a voltage signal +/- 10 V, the potential at AGND must be raised to such an extent that there is no negative potential at AnIn1 in relation to GND. Example: 0 V < AnIn1 < 20 (see Fig. 10).*
Option 7630 must be selected for voltage signals of up to –10 V relative to GND. The DigOut2 function is then not applicable.

c) *Wiring depends on the selected product IMC RS/CO*

4.2.3.2 I/O circuit diagrams

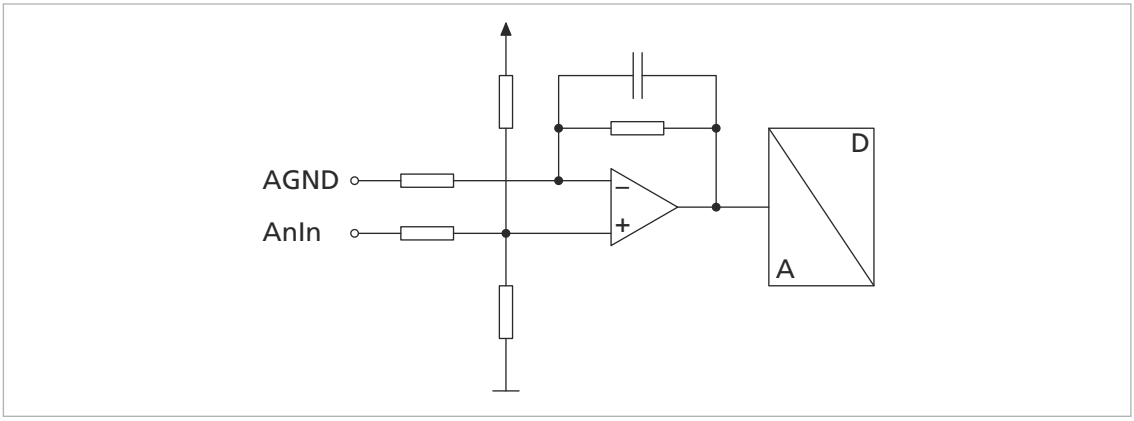


Fig. 7: Analog input circuit diagram (internal)

So that the voltage drop on the supply side does not affect the speed specification value, connect the analog input ground (AGND) to the power supply ground (GND).

The analog inputs are executed as differential inputs. Both inputs use the same reference input.

The analog inputs can be used flexibly:

- Specification of set-points for current, speed or position
- Connection of actual value encoders for speed or position
- Use as a free measurement input (queried via the interface)

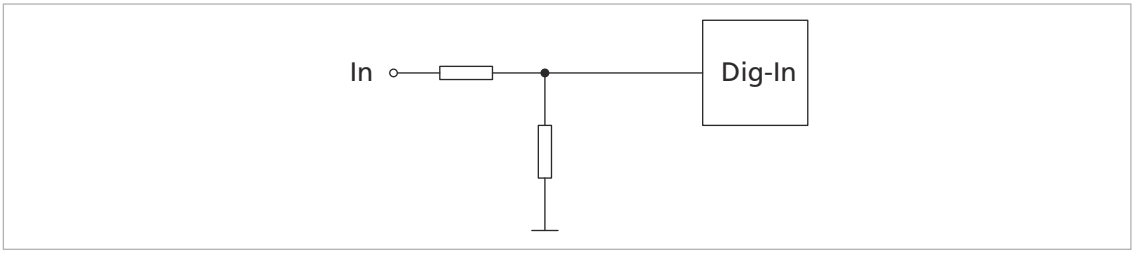


Fig. 8: Digital input circuit diagram (internal)

The digital inputs are switchable from the input level (PLC/TTL). The digital inputs can be configured for the following purposes (see the Drive Functions):

- Digital input for reference and limit switches
- Connection of an external encoder
- PWM (Pulse Width Modulation) set-point specification for current, speed and position

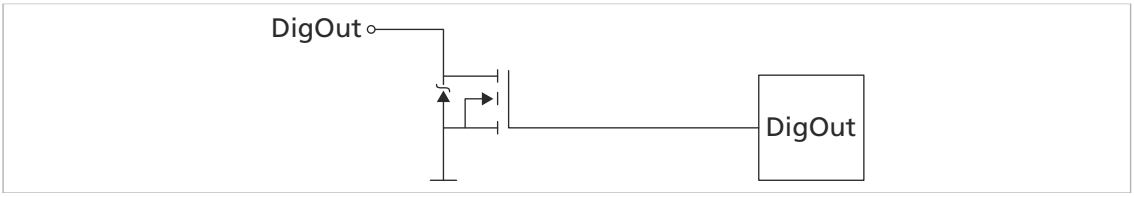


Fig. 9: Digital output circuit diagram (internal)

The digital output has the following properties:

- Open collector switch to ground
- Monitored output current (switch opens in the event of an error)

The digital output can be configured for the following purposes:

- Fault output
- Actuation of an externally installed brake
- Digital output (freely programmable)

4.2.3.3 External circuit diagrams

Bipolar analog set-point specification via potentiometer

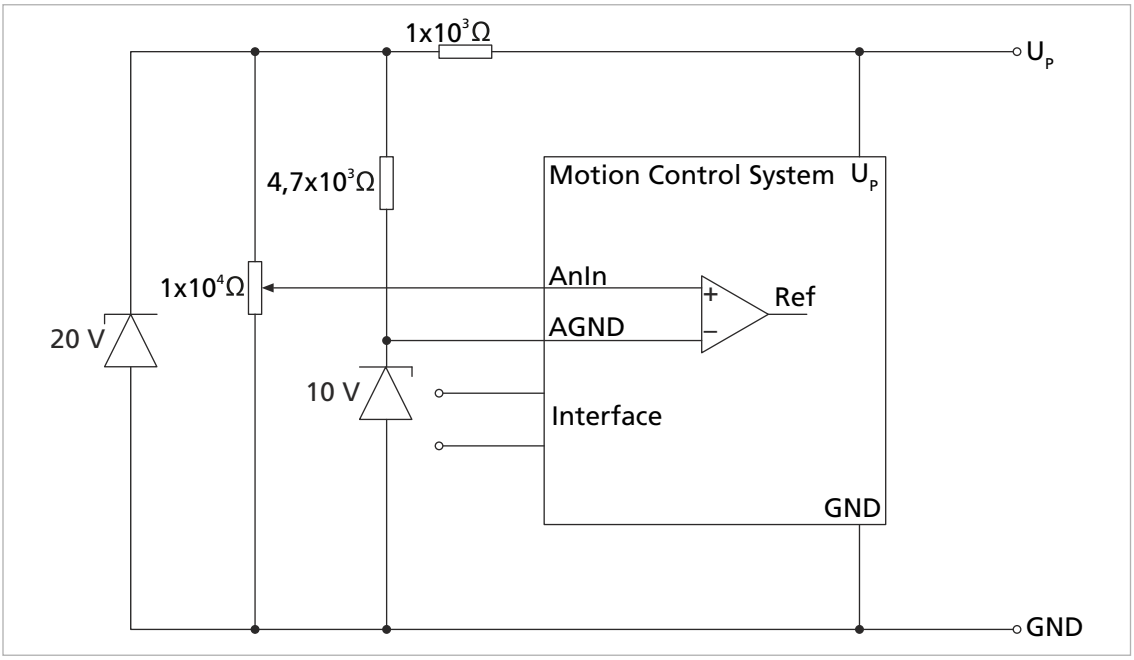


Fig. 10: Bipolar analog set-point specification via potentiometer

Analog set-point specification via potentiometer with internally set offset and scaling

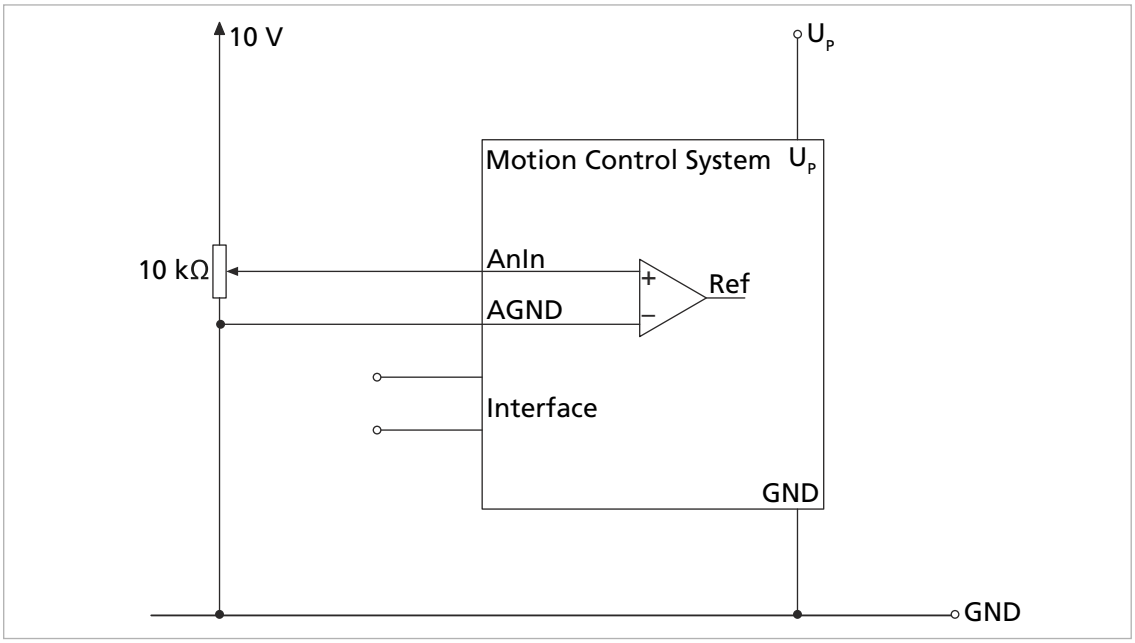


Fig. 11: Analog set-point specification via potentiometer with internally set offset and scaling

Connection of reference and limit switches

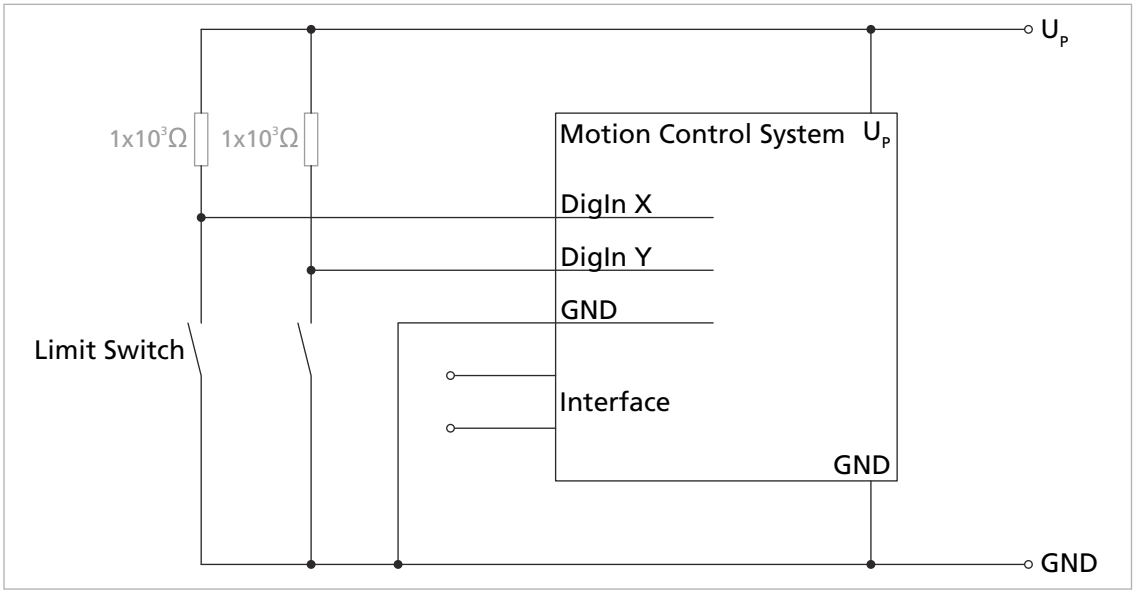


Fig. 12: Connection of reference and limit switches

Depending on the type of switch it may be necessary to use additional pull-up resistors. No internal pull-up resistors are incorporated in the Motion Control System.

Connection of an external incremental encoder

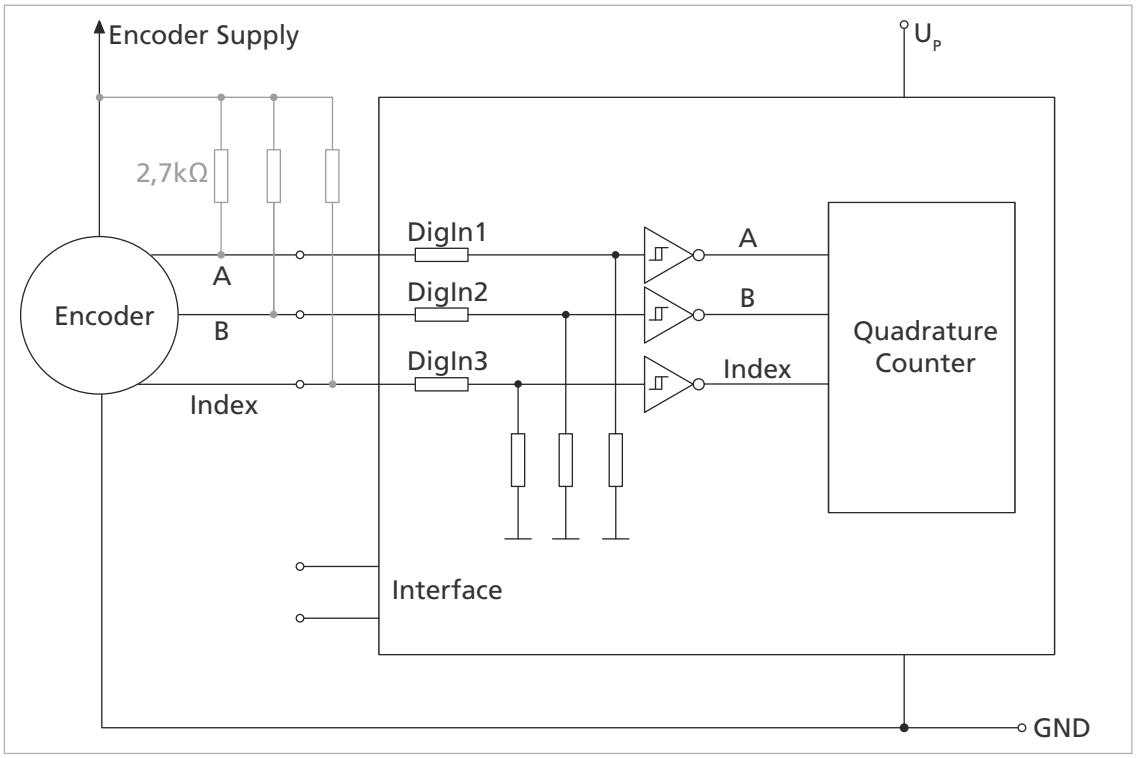


Fig. 13: Connection of an external incremental encoder

Depending on the type of encoder it may be necessary to use additional pull-up resistors. No internal pull-up resistors are incorporated in the Motion Control System.

Wiring between PC/controller and a MCS (example: RS232 operation)

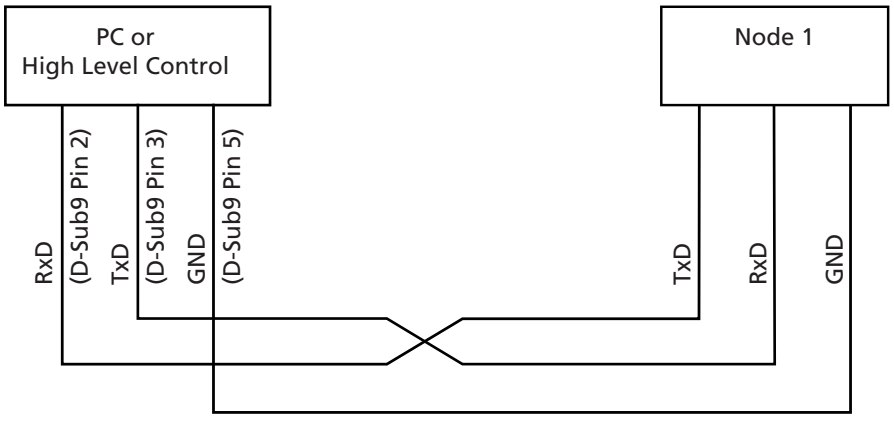


Fig. 14: Wiring between PC/controller and a drive (example: RS232 operation)

Wiring with several Motion Control Systems in RS232 network operation

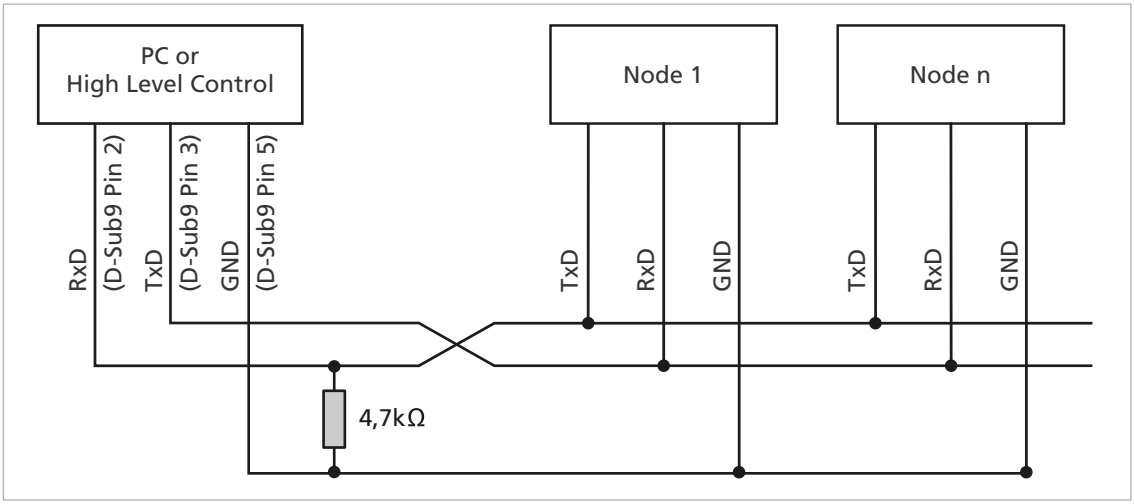


Fig. 15: Wiring with several Motion Control Systems in RS232 network operation

Depending on the number of networked Motion Control Systems, a smaller value may be necessary for the pull-down resistor.

Connection to the CANopen network

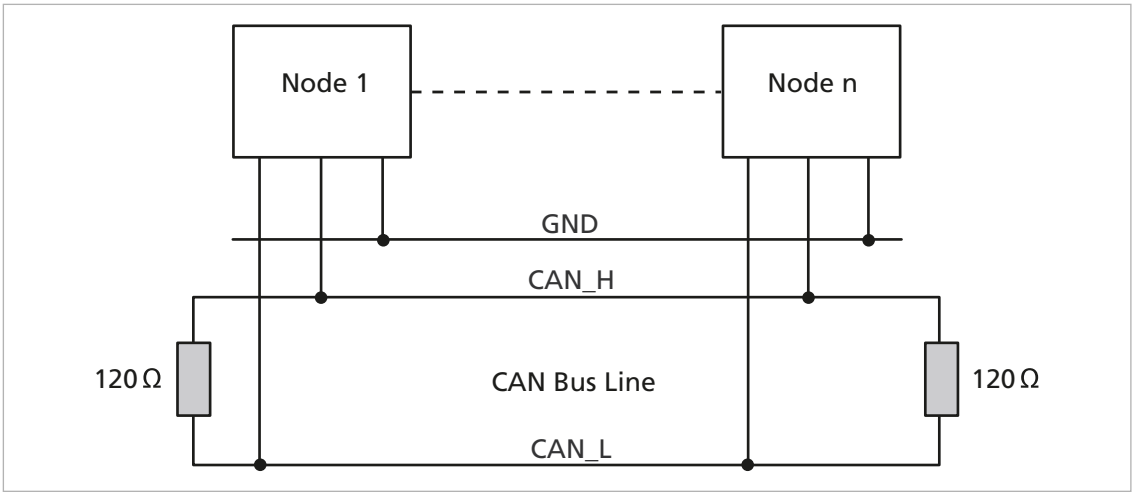


Fig. 16: Connection to the CANopen network

If the CAN wiring is not laid in a straight line it may be necessary to individually optimize the amount and location of the terminating resistors. For instance in a star network a central 60 Ohm terminating resistor may be more suitable. When the optimum arrangement of terminating resistors is fitted, no accumulation of error frames should be evident.

4.3 Electromagnetic compatibility (EMC)

- Follow the instructions in the following chapters to perform an EMC-compliant installation.

⚠ WARNING!

The MCS can cause high-frequency interference which can affect the function of electronic implants and other electronic devices.

- Take appropriate interference suppression measures, particularly during use in residential environments.
- Observe the notices for EMC-compliant setup.

NOTICE!

Drive electronics with qualified limit values in accordance with EN-61800-3: Category C2 can cause radio interference in residential areas.

- For these drive electronics, take additional measures to limit the spread of radio interference.

4.3.1 Functional earthing

⚠ DANGER!

Danger to life through ground leakage currents ≥3.5 mA

- Check the grounding of the devices for proper installation.

The grounding system is essential for discharging parasitic current and for a potential distribution in the system that is as uniform as possible. The most efficient systems have a star or mesh shape. A star-shaped connection is easier to implement.

- Ensure an adequate cross section and a very good electrical ground connection so that the contact resistances are low not only for the low-frequency currents.

  The ground connection can be improved, e.g., by removing the oxide layers from the ends of conductors with fine sandpaper.

For electrical safety:

- Ground in accordance with current standards and guidelines.
- Use separate protective conductors (PE) for all necessary parts (e.g., mains supply, motor, controller).
- Keep grounding cable as short as possible.

For functional earthing:

- Use a braided shield that is meshed as tightly as possible.
- Direct contact with the grounding plate is to be preferred.

  Therefore, avoid contact with the controller and then with the grounding plate.
- Connections made over a large surface area are to be preferred.

4.3.2 Cable routing

⚠ WARNING!

Voltages >25 V AC are generated and transmitted in the drive system.

- Set up the wiring of the drive system in a touch-proof manner.
- Only operate the drive system on an SELV or PELV power supply network.

The cable routing depends on various factors, such as:

- Is the cable shielded, twisted?
- Were interference-reducing measures taken?
- What material and what cable routing are used in the cable duct?
- Over what surface is the cable routed?

Observe the following when laying the cables:

- Use a full-surface, u-shaped and, if possible, metal cable duct.
- Lay the cables near the corners of the cable duct.
- Separate the cables by function where possible.
- Maintain distances when laying the cables.

  The distances may vary depending on the zone in the switching cabinet.
- If possible, all cables should be twisted pairs or twisted and shielded in function groups (e.g., motor phases together, Hall sensors and supply together).

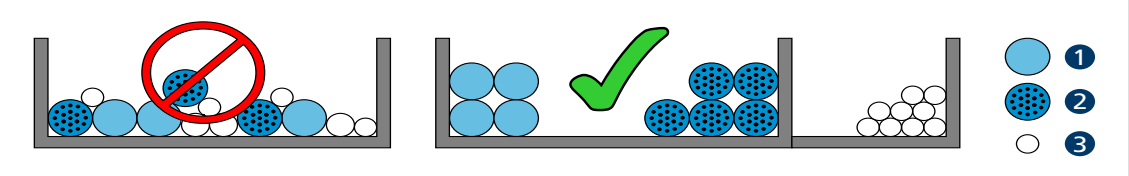


Fig. 17: Laying in the cable duct

1 High-current cable
2 Digital cable
3 Sensor cable

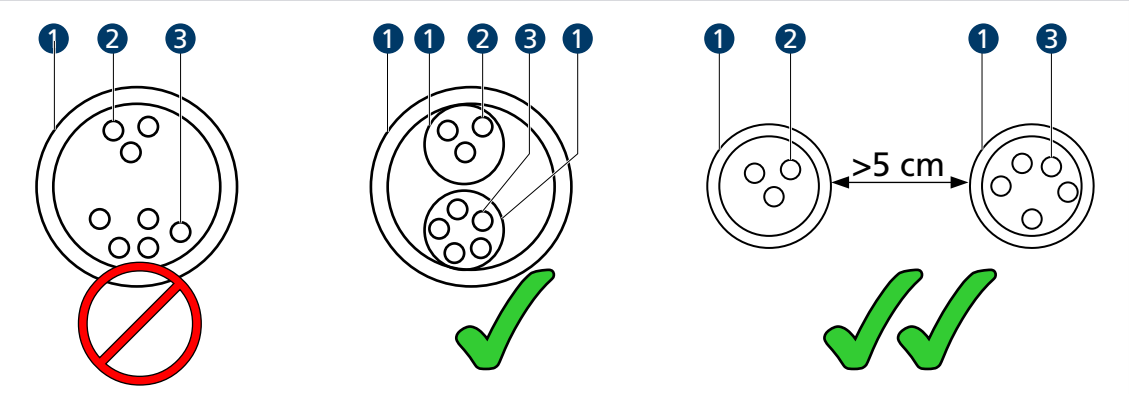


Fig. 18: Grouping and shielding of the cables

1 Shielding
2 Motor phase
3 Hall sensor

4.3.3 Shielding

- Shield cables in all cases.

  Shield cables that are longer than 3 m with tightly meshed copper braiding.

- Shield all supply lines according to current guidelines/standards (e.g., IPC-A-620B) and connect using (round) shield clamp.

  In special cases (e.g., with pigtail) or after qualification, the shield can be omitted for the following cables:

  - Cables with length <50 cm
  - Cables with low power supplies (e.g., <20 V)
  - Sensor cables

- Connect shield clamps to a low-impedance (<0.3 Ω) grounding bar or grounding plate.

  A connection to the controller housing should only be made if no grounding bar is available.

- Establish a star-point ground connection.

- Lay the motor phases in a shield, separate from the sensor or encoder signals, and connect on at least the motor side (see 1 or 2 in Fig. 19).

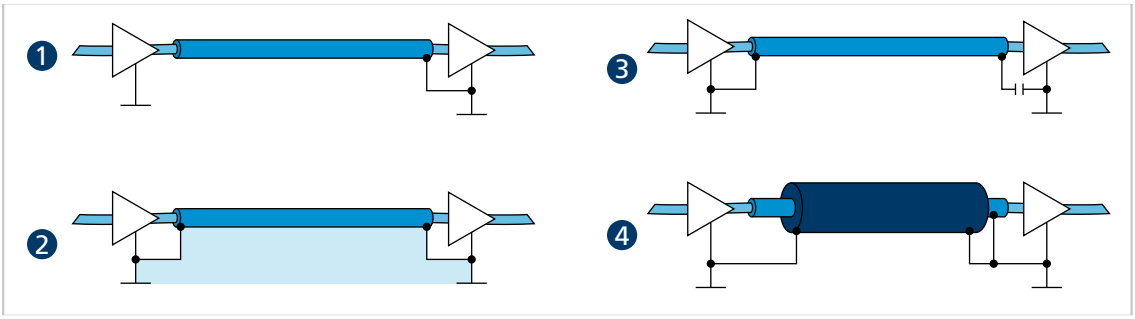


Fig. 19: Various possibilities for the shield connection

1 Suppressing electrical fields
2 Alternating magnetic field
3 Interruption of the ground loop for direct currents or low-frequency currents
4 Discharging parasitic currents to the reference potential

The sensor signals can optionally be laid with the motor phases in a shared cable/insulation hose using another outer braided shield. This outer braided shield must be connected at both ends (e.g., 4 in Fig. 19). A solution such as 2 in Fig. 19 is not functional in every case for this configuration. If this is not possible by means of a ground offset, establish the RF connection via specially suited capacitors (e.g., safety capacitors such as Y1/Y2/X1/X2, see 3 in Fig. 19). In this case, do not connect the shield multiple times except at the motor connection and controller side.

4.3.3.1 Establishing the shield connection

The best results when establishing a shield connection on the cable are achieved in the following way:

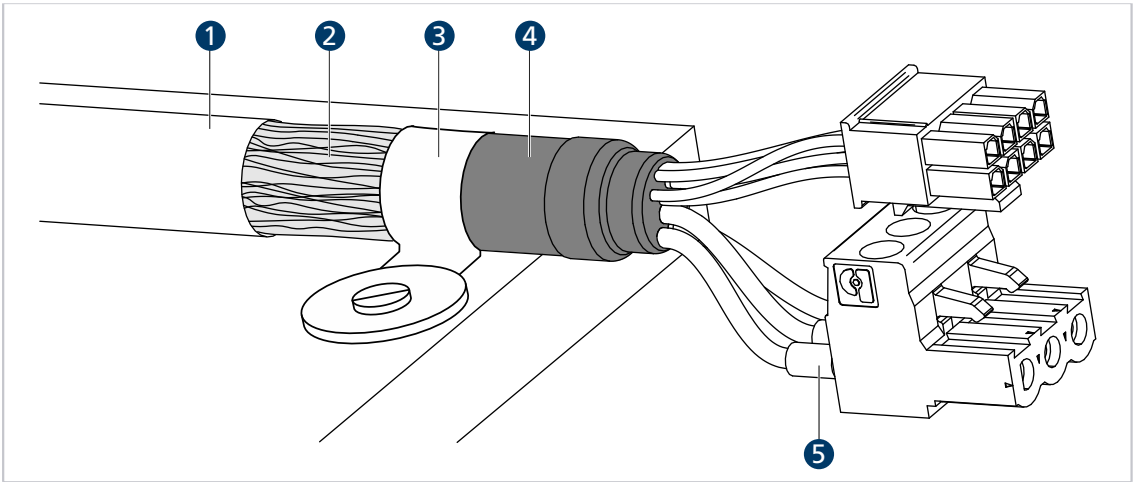


Fig. 20: Motor cable shield connection

1 Outer cable shield
2 Braided shield
3 Shield clamp
4 Heat-shrink tubing
5 Crimp-sleeve

1. Remove approx. 50-100 mm from the outer cable shield (1). Make certain that none of the fibers of the braided shield (2) are destroyed.
2. Either push back the shield or roll it up and fasten with heat-shrink tubing (4).
3. Optionally fit crimp-sleeves on the cable ends (5) and attach to the plug connectors.
4. Fasten the shield and the fixed end of the heat-shrink tubing with a cable tie (3).

4.3.3.2 Establishing shield connection with cable lug

A shield connection with cable lug should be avoided whenever possible. If it is necessary, however, the connection should be established as follows.

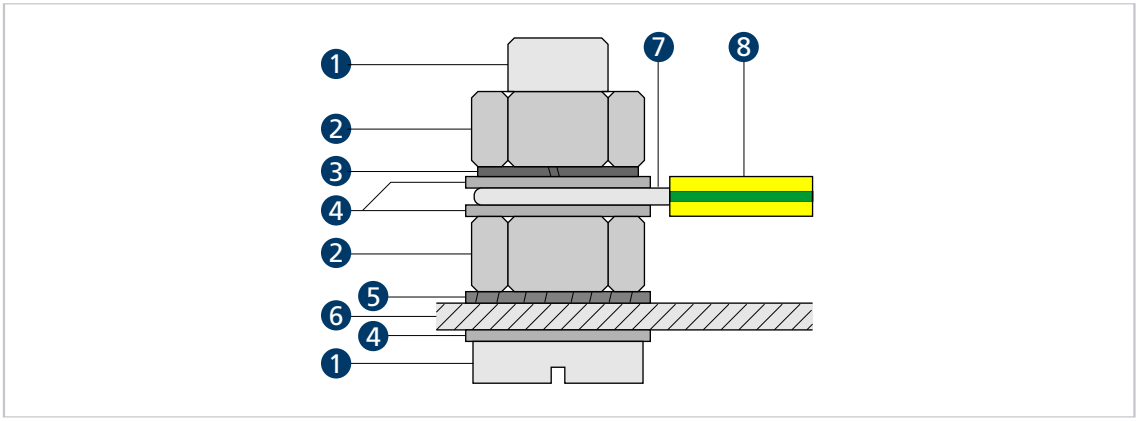


Fig. 21: Shield connection with cable lug

1	*Screw*	*5*	*Lock washer*
2	*Nut*	*6*	*Wall*
3	*Spring washer*	*7*	*Wire eyelet*
4	*Washer*	*8*	*Protective conductor*

1. Scrape the surface around the hole to remove as much of the oxide layer as possible.
2. Guide screw with washers through the cable lug.
3. Place lock washer on the screw.

   Depending on the screw length, also position the lock washer against the roughened surface.
4. Fix screw with nut on the bottom side or screw into the thread.

4.3.4 Using filters

The filters are divided into various function and current ranges.

The use of an input-side filter, i.e. a filter on the power supply side, is possible.

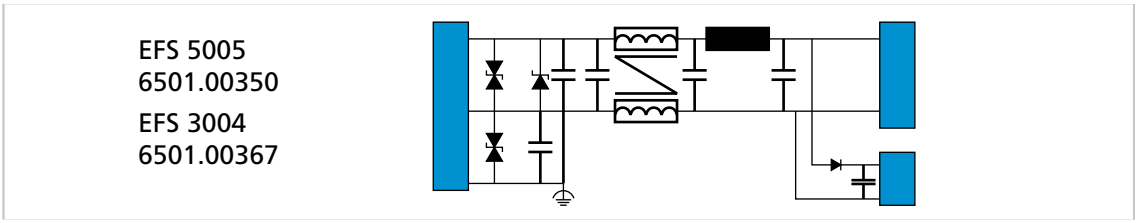


Fig. 22: Input-side filter from FAULHABER

4.3.4.1 Input-side filters

These filters are for applications that either cannot use the motor filter (e.g., integrated controllers) or in which the filtering by the motor filters is not sufficient. In this case, two filtering measures are used:

- Measure comparable to large capacitors (approx. >100 µF) as close as possible to the controller and, where possible, low-ESR capacitances
- Discharge of common-mode interference with a common-mode choke, a low-pass filter and capacitors between functional earth and DC power supply

4.3.4.2 Insulation resistance

The filters from FAULHABER are not intended for an insulation resistance test. Discharging of the common-mode interference with capacitors prevents a meaningful result from an insulation resistance test.

4.3.4.3 Coiling ferrite ring

Ideally, ferrites made of manganese-zinc material are used that are active in the 1…10 MHz range. Typical diameters are between 25 and 35 mm onto which two to three windings with all 3 motor phases are wound simultaneously.

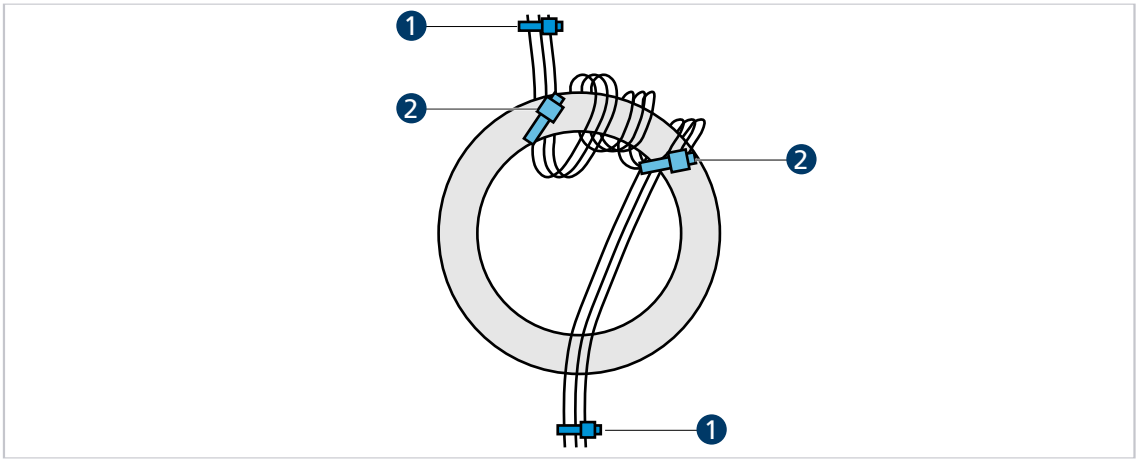


Fig. 23: Coiling ferrite ring

1 Fastening the motor phase cables *2 Fastening on the ferrite ring (optional)*

1. Fasten motor phase cables, e.g., with cable ties (1), so that the motor side end of the cable points away from the user and the plug end of the cable points toward the user.

2. Simultaneously guide all three phases through the ferrite ring from below.
3. Guide the wound stranded wires back through the ring clockwise next to the first stranded wires so that a winding is created.
4. Wrap 2 further windings directly next to the existing windings in the same way.
   ↳ There are 9 stranded wires in the ferrite ring.
5. Again secure the motor phase cables, e.g., with cable ties (2), on the ferrite ring.

4.3.5 Error avoidance and troubleshooting

1. Can the problem clearly be traced back to the FAULHABER drive system?
   a) Switch the output stage off and on.

      The voltage controller mode is suitable here.

   b) Unplug controller supply voltages or operate controller via a separate external power supply used solely for this purpose.
   c) If present, switch off unnecessary system components.
2. Have the measures shown in chap. 4.3.1, p. 26 been performed and tested?
   a) Can a uniform ground potential be ensured, e.g., by using large cable cross sections?
   b) Is the RF quality of the connections ensured?
      - Establish connection through metal-to-metal connection elements.
      - Remove paints or other insulating materials. Check that the shield connection is correct.
3. Were the recommended cables used?
   a) Select motor cables in the accessory catalog.
   b) Motor cables must be shielded as they otherwise act as an antenna.

      Unshielded cables could cause interference in the surrounding area. If uncertain, the shield can be doubled; for further information, see FAULHABER accessories catalog and chap. 4.3.3, p. 28.
4. Are the contacts correctly screwed down or properly plugged in?
5. Are the cables laid in accordance with the standards/directives (e.g., IPC-A-620B-2013)?
   a) Sensor cables and encoders are to be laid at least 10 cm from the motor phases.
   b) Lay sensor cables at least 10 cm from all other signal cables that are not also sensor cables. Alternatively, use absolute encoders and/or line drivers.
   c) Keep cables away from high-voltage current and mains cables.
   d) Only cross cables at an angle of 90°.
6. Is it necessary to use filters?
   a) Use filters in the case of poor signal quality or if interference occurs/is to be expected.
   b) Note the product listing in chap. 4.3.4, p. 31.

Conformity measurements

The following points must be observed during the conformity measurement:

Conducted interference voltage measurement	Radiated interference voltage measurement
▪ When laying cables, remove all loops. ▪ Lay the cables with a meandering shape.	▪ Where possible, lay cables over a grounding plate.
▪ Connect the shield of the motor cable on the motor side and as close as possible on the controller side. ▪ The shield is to be connected over a large area, ideally with a round connection.	▪ The connection of the motor cable shield is to be as short as possible ▪ Keep the motor cable as short as possible.
▪ Use an input filter. When selecting, pay attention to the difference of filter attenuation between 50 Ω and realistic values 1/100 Ω or 100/1 Ω measurement.	▪ Use a motor filter and keep the connection as short as possible.
▪ If possible, secure cable with shield clamps or with adhesive tape.	

5 Maintenance

5.1 Maintenance instructions

NOTICE!

Damage to the MCS caused by contact with solvents.

- During operation and maintenance protect the housing against contact with solvents or substances containing solvents.

5.2 Maintenance tasks

The MCS is generally maintenance-free. Where the device is mounted in a cabinet, depending on the deposition of dust the air filter should be regularly checked and cleaned if necessary.

5.3 Troubleshooting

If unexpected malfunctions occur during operation according to the intended use, please contact your support partner.

6 Accessories

A contact adapter for direct connection to a CAN or RS232 network is available under the article number 6501.00391.

For IMC RS, a contact adapter with integrated USB-RS232 converter for direct connection to the USB is available under the article number 6500.00392.

Details on configuration can be found in the Motion Manager manual (see chap. 1.2, p. 5).

Details on the connection sequence can be found in the product data sheet of the respective contact adapter.

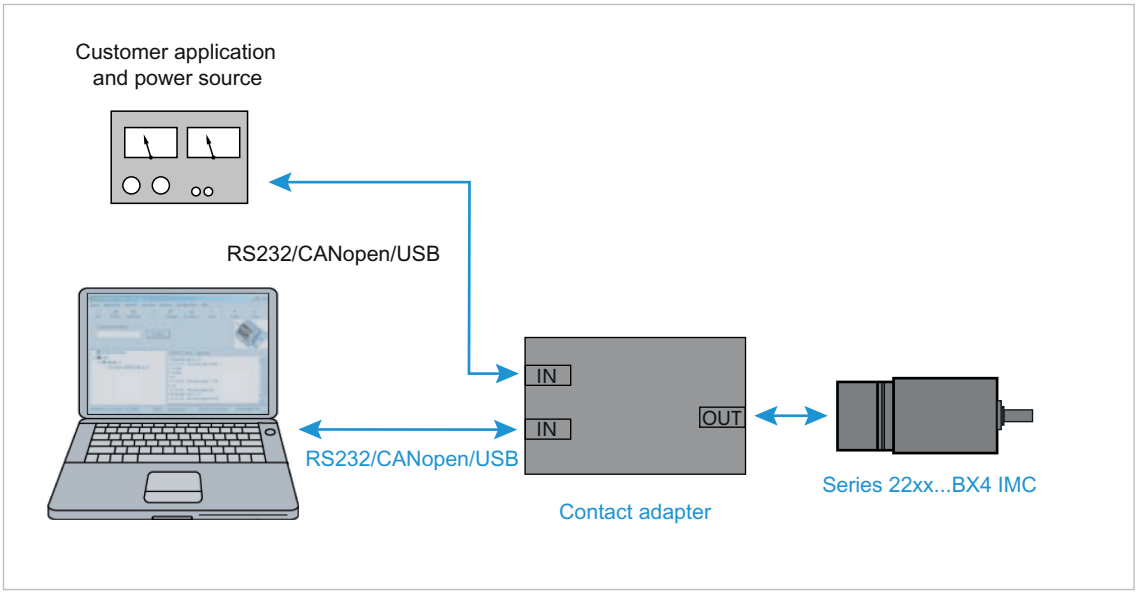


Fig. 24: Setup with contact adapter

Information on other accessories can be found in the accessories manual.

7 Warranty

Products of the company Dr. Fritz Faulhaber GmbH & Co. KG are produced using the most modern production methods and are subject to strict quality inspections. All sales and deliveries are performed exclusively on the basis of our General Conditions of Sale and Delivery which can be viewed on the FAULHABER home page www.faulhaber.com/en/contact/gtc and downloaded from it.

8 Additional documents

8.1 Declaration of Conformity 22xx...BX4 IMC

EG–Konformitätserklärung
EC Declaration of Conformity
mit gefordertem Inhalt gemäß ISO/IEC 17050-1
with required content in accordance with ISO / IEC 17050-1

Dokument-Nr. / Monat, Jahr: *Document-no. / month, year:*	EG-00052-001 / 03.2024
Der Hersteller: *The manufacturer:*	**Dr. Fritz Faulhaber GmbH & Co. KG** Faulhaberstraße 1 D-71101 Schönaich Germany

erklärt hiermit, dass das folgende Produkt
declares that the following product

Produktbezeichnung: *Product designation:*	**2232 ... BX4 IMC** **2250 ... BX4 IMC**
Produkttyp: *Product type:*	**Motor mit integriertem Motion Controller** ***Motor with integrated Motion Controller***

den grundlegenden Anforderungen entspricht, die in den nachfolgend bezeichneten Harmonisierungsrechtsvorschriften festgelegt sind:
complies with the essential requirements of the following harmonization legislations:

- Richtlinie 2011/65/EU des Europäischen Parlaments und des Rates vom 8.Juni 2011 zur Beschränkung der Verwendung bestimmter gefährlicher Stoffe in Elektro- und Elektronikgeräten – **kurz: RoHS-Richtlinie**
  Directive 2011/65 / EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment – ***short: RoHS directive***

- Richtlinie 2014/30/EU des Europäischen Parlaments und des Rates vom 26.Februar 2014 zur Angleichung der Rechtsvorschriften der Mitgliedstaaten über die elektromagnetische Verträglichkeit – **kurz: EMV Richtlinie**
  Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility – ***short: EMC directive***

Die Einhaltung dieser Richtlinie(n) setzt die Umsetzung aller in der technischen Dokumentation genannten Maßnahmen voraus.
The measures indicated in all technical documents must be fulfilled in order to meet the requirements of this directive.

DFF/FO_0408 – 01– 17.04.2018

Additional documents

Die Konformität wird in Bezug auf folgende angewandte harmonisierte Normen erklärt:
The declared conformity relates to the following harmonized standards:

Die Übereinstimmung mit den genannten EG-Richtlinien wurde durch Überprüfung gemäß folgender Fachgrundnormen nachgewiesen:
The conformity with the EC guidelines was proven according to the following references to the relevant harmonized standards used:

Richtlinienbezug *Related to directive*	Fundstelle *Document*	Titel *Title*
RoHS-Richtlinie RoHS Directive	EN 50581:2012	Technische Dokumentation zur Beurteilung von Elektro- und Elektronikgeräten hinsichtlich der Beschränkung gefährlicher Stoffe
EMV Richtlinie EMC directive	EN 61800-3:2018-09	Drehzahlveränderbare elektrische Antriebe — Teil 3: EMV-Anforderungen einschließlich spezieller Prüfverfahren

Bevollmächtigter im Sinne des Anhangs II Nr. 1.A Nr. 2, 2006/42/EG für die Zusammenstellung der technischen Unterlagen:
Entitled person within the meaning of Annex II, point 1.A, No 2, 2006/42 / EC, for the compilation of technical documentation:

Schönaich, 15.03.2024 (Datum) *(date)* — Dr. Andreas Wagener, Head of Systems Enegineering *(Name, position)* — (Unterschrift) *(signature)*

Die alleinige Verantwortung für die Ausstellung dieser Konformitätserklärung in Bezug auf die Erfüllung der grundlegenden Anforderung und die Anfertigung der technischen Unterlagen trägt der Hersteller / diese Erklärung wird verantwortlich für den Hersteller
Only the producer is responsible for providing this declaration of conformity, regarding essential requirements and providing technical documentation / this declaration is, responsible for the manufacturer

Dr. Fritz Faulhaber GmbH & Co. KG
Faulhaberstr. 1
D-71101 Schönaich
Germany

abgegeben durch
issued by

Schönaich, 20/3/2024 (Datum) *(date)* — Dr. Udo Haberland, Geschäftsführung *(Name, Management)* — (Unterschrift) *(signature)*

Diese Erklärung bescheinigt die Übereinstimmung mit den genannten Harmonisierungsrechtsvorschriften, beinhaltet jedoch keine Zusicherung von Eigenschaften.
This declaration assures conformity with the standards and directives cited, but does not represent any guarantee of specific features.

Additional documents

Zusatzangaben:
Additional information

Diese Erklärung gilt für alle Exemplare, die in verschiedenen Leistungsdaten in dieser Serie hergestellt werden.
This statement should be valid for all derivates produced according to the related construction drawings and electrical drawings, which are part of the technical documentation.

DFF/FO_0408 – 01– 17.04.2018

8.2 Declaration of Incorporation 22xx...BX4 IMC

Einbauerklärung nach Anhang II B,
EG-Maschinenrichtlinie 2006/42/EG
Installation Declaration according to Appendix II B,
EC Machinery Directive 2006/42/EC

Dokument-Nr./Monat.Jahr: *Document No./Month.Year:*	EG-00053-001 / 03.2024
Der Hersteller: *The manufacturer:*	**Dr. Fritz Faulhaber GmbH & Co. KG** Faulhaberstraße 1 D-71101 Schönaich Germany

erklärt hiermit, dass es sich beim nachfolgend bezeichneten Produkt um eine Einbaukomponente (siehe unten) handelt und diese zum Einbau in eine Maschine bestimmt ist. Die Inbetriebnahme dieser unvollständigen Maschine ist solange untersagt, bis festgestellt wurde, dass die Gesamtmaschine, in die diese Komponente eingebaut werden soll, den grundlegenden Schutzanforderungen der hier genannten EG-Maschinenrichtlinie 2006/42/EG entspricht.
herewith declares that the product designated below is an installable component (see below), and that it is intended for installation in a machine. It is prohibited to bring this incomplete machine into service until it has been proven that the machine as a whole in which this component is to be installed meets the basic safety requirements of the here mentioned EC Machinery Directive 2006/42/EC.

Einbaukomponente: *Installable component::*	**2232 ... BX4 IMC** **2250 ... BX4 IMC**
Produkttyp: *Product type:*	**Motor mit integriertem Motion Controller** ***Motor with integrated Motion Controller***

Gemäß Anhang VII Teil B der EG-Maschinenrichtlinie 2006/42/EG wurden spezielle technischen Unterlagen für diese unvollständige Maschine erstellt. Durch begründetes Verlangen einzelstaatlicher Stellen können diese in elektronischer Form übermittelt werden.
Pursuant to Appendix VII, Part B of the EC Machinery Directive 2006/42/EC, specific technical documents have been created for this incomplete machine. On reasoned request by national authorities these documents may be transmitted in machine-readable format.

Der Bevollmächtigte für die Zusammenstellung und Übermittlung der relevanten technischen Unterlagen ist:
The person responsible for the compilation and transmission of the relevant technical documents is:

Dr. Andreas Wagener, Dr. Fritz Faulhaber GmbH & Co. KG, Faulhaberstraße 1, 71101 Schönaich, Germany.

Schönaich,	22.03.2024 (Datum) *(Date)*	Dr. Udo Haberland, Geschäftsführung *(Name, Chairman)*	 (Unterschrift) *(Signature)*

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7000.05073, 1st edition, 15.04.2024