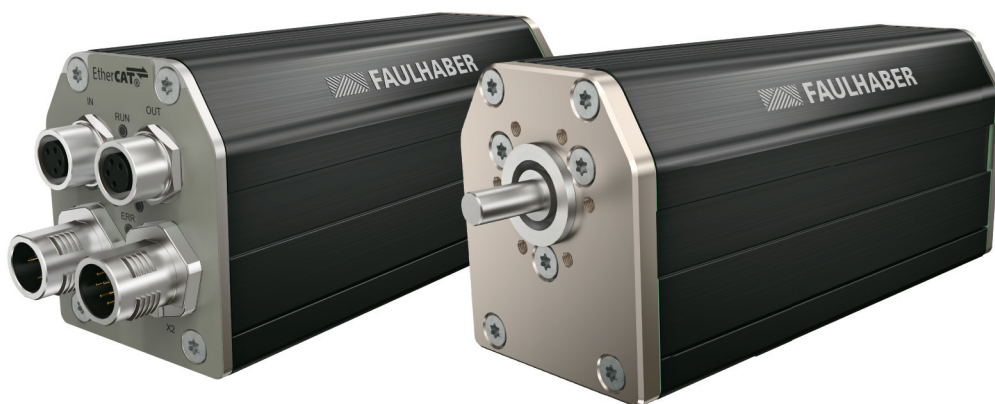


Technical Manual

MCS 3242 BX4

MCS 3268 BX4

MCS 3274 BP4



Imprint

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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:
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About this document

1 About this document

1.1 Validity of this document

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

- MCS 3242 BX4
- MCS 3268 BX4
- MCS 3274 BP4

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 6	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.

About this document

1.4 List of abbreviations

Abbreviation	Meaning
AC	Alternating Current
AnIn	Analog input
AGND	Analog Ground
CAN	Controller Area Network
CAN_L	CAN-Low
CAN_H	CAN-High
DC	Direct Current
DigIn	Digital input
DigOut	Digital output
EFS	Electronics Filter Supply
EGND	Electronic Ground
EMC	Electromagnetic compatibility
ESD	Electrostatic discharge
ET	EtherCAT (Ethernet for Control Automation Technology)
GND	Ground
I/O	Input/Output
PLC	Programmable Logic Controller
PWM	Pulse Width Modulation
RxD	Receive Data
TTL	Transistor Transistor Logic
TxD	Transmit data

About this document

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 within a common housing with standard protection class IP 54.

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.

Safety

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 Controller (e.g., risk of injury from driven components). The manufacturer of the machine in which the Motion Controller 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 Controller can impair its functions. A damaged Motion Controller 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 Motion Controller.
- ▶ Appropriately mark a defective or damaged Motion Controller.
- ▶ Do **not** replace defective or damaged components of the Motion Controller.
- ▶ Make no changes (modifications, repairs) to the Motion Controller.
- ▶ Have loose or defective connections immediately replaced by an electrician.
- ▶ After replacing a defective or damaged Motion Controller, test and document the correct function.

2.2.2 Correct installation and commissioning

Errors during the installation and commissioning of the Motion Controller could impair its function. An incorrectly installed Motion Controller 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 Motion Controller in suitable ESD packaging.
- ▶ Handle the Motion Controller 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.

Safety

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

- ▶ Keep foreign objects away from the electronics.
- ▶ Install the Motion Controller 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 Motion Controller.
- ▶ During all aspects of installation and connection work on the Motion Controller, 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 Motion Controller to heat up. If touched, there is a risk of burning.

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



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 Motion Control System.
- ▶ When installed within housings take particular care to ensure adequate cooling of the Motion Control System.
- ▶ Select a power supply that is within the defined tolerance range.
- ▶ Protect the Motion Control System against chemical pollutants.
- ▶ Motion Control Systems satisfy protection class IP54 acc. to DIN EN 60259.



Depending on the application, additional shaft seals may optionally be installed in the base drive, which have to be maintained at regular intervals.

When combined with attachments (e.g., gearboxes) or for enhanced motor protection an additional seal (O-ring) to enhance the protection class is optionally available (see chap. 3.4.3, p. 15, chap. 4.1.2, p. 18 and chap. 5.2, p. 40).

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. 44.

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 FAULHABER Motion Control Systems described here are intended for controlled operation of various integrated base motors. They offer different functions and operating modes, allowing complex drive tasks to be performed. Thanks to their compact design and flexible connection options, the units can be used in a wide variety of applications and require only basic wiring.

The Motion Control System can offer the following communication interfaces:


- RS232
- CANopen
- RS232 and EtherCAT

Connections are also available for common or separate voltage supplies between motor and controller, and also for a wide variety of inputs and outputs. Configuration of the Motion Control System is performed using the FAULHABER Motion Manager V6.

The drives can be operated in the network via the CANopen or EtherCAT fieldbus interface. In smaller setups, networking can also be performed via the RS232 interface. The Motion Control Systems operate in the network in principle as a slave; master functionality for actuating other axes is not provided. After basic commissioning via Motion Manager, the Motion Control Systems can alternatively also be operated without communication interface.

Motion Control Systems are normally secured using the tapped holes of the front panel. Where cabling is connected axially, optionally the drive can be secured from below on a flat base plate (see chap. 4.1, p. 17).

Analog Hall sensors are used as feedback components.

 Motion Control Systems with RS232, CANopen or EtherCAT interfaces can also be operated independently of the communication interface, if a function or a sequence program has been programmed previously without digital command control.

Product description

3.2 Product information

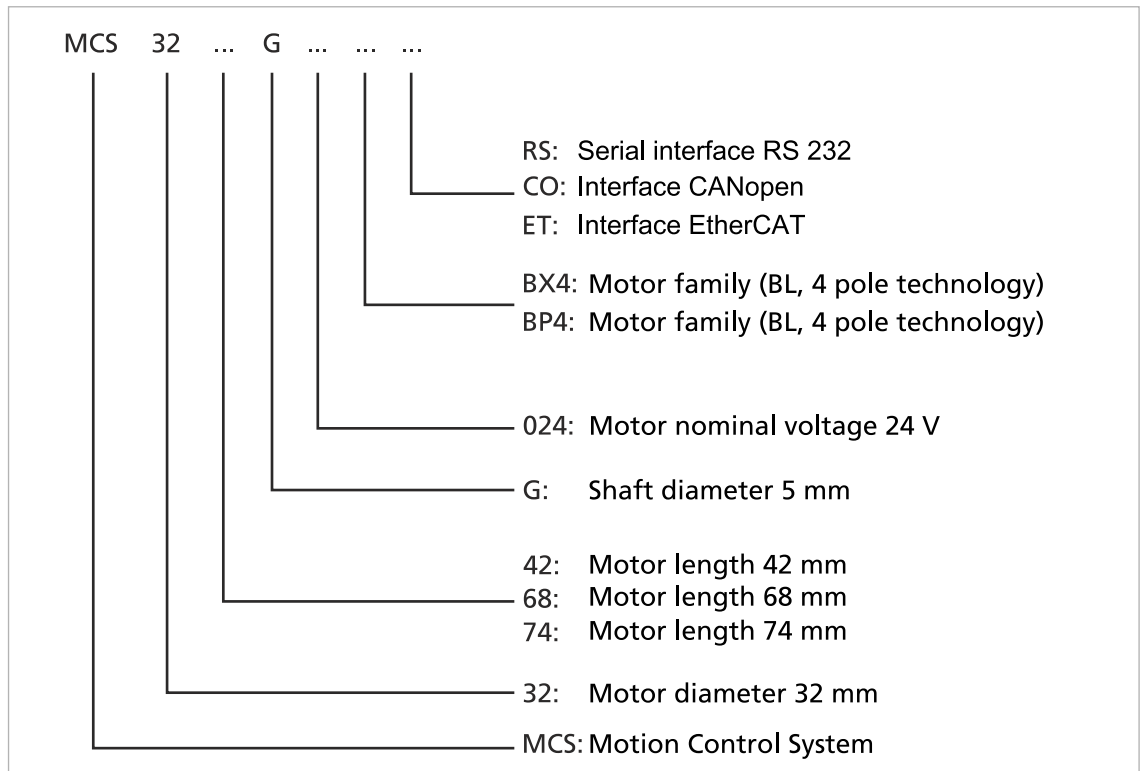


Fig. 2: Designation key

3.3 Product variants

The following product variants are possible:

- Motion Control System with axial cable outlet
- Motion Control System with radial cable outlet

In addition to the cable outlet, the following communication interfaces can be selected:

- RS232
- CANopen
- RS232 and EtherCAT

The following motors are available for selection for each product variant:

- 3242 BX4
- 3268 BX4
- 3274 BP4

i Depending on the motor, interface and cable outlet selected, the installed length and/or height of the MCS will vary. Details can be found on the respective product data sheet or in the relevant dimensional drawing.

Product description

i Depending on the application, additional shaft seals may optionally be installed in the base drive, which have to be maintained at regular intervals.

When combined with attachments (e.g., gearboxes) or for enhanced motor protection an additional seal (O-ring) to enhance the protection class is optionally available (see chap. 3.4.3, p. 15, chap. 4.1.2, p. 18 and chap. 5.2, p. 40).

3.4 Cable outlet of the Motion Control System

3.4.1 Axial cable outlet (standard)

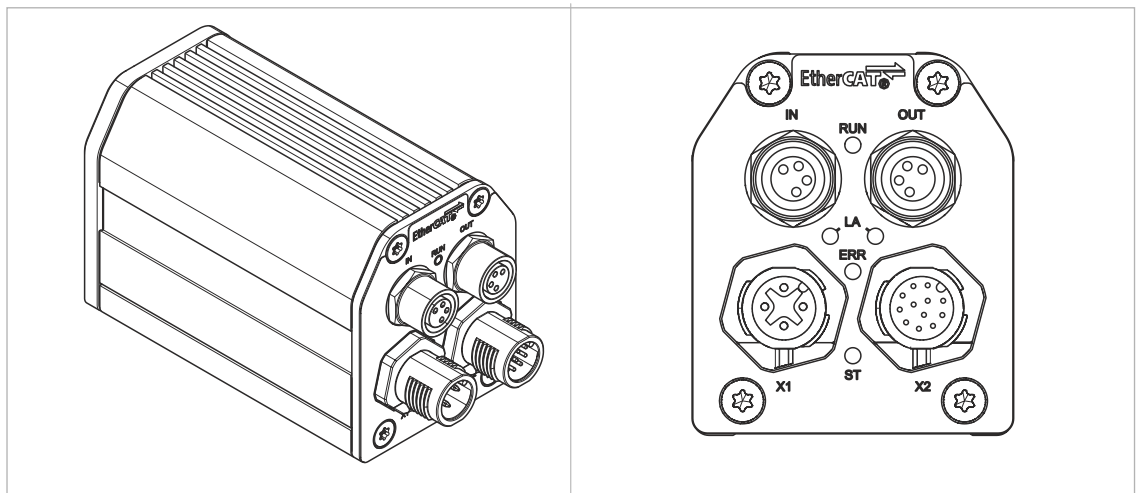


Fig. 3: Isometric view (left) and connector view (right) for axial cable outlet

3.4.2 Radial cable outlet (option 5451)

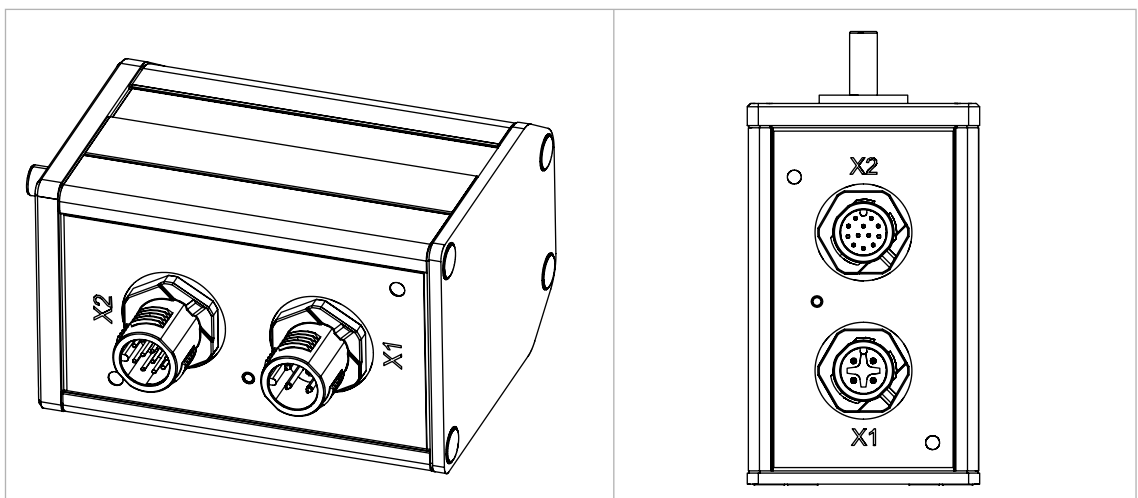


Fig. 4: Isometric view (left) and connector view (right) for radial cable outlet

Product description

3.4.3 Gearhead combination

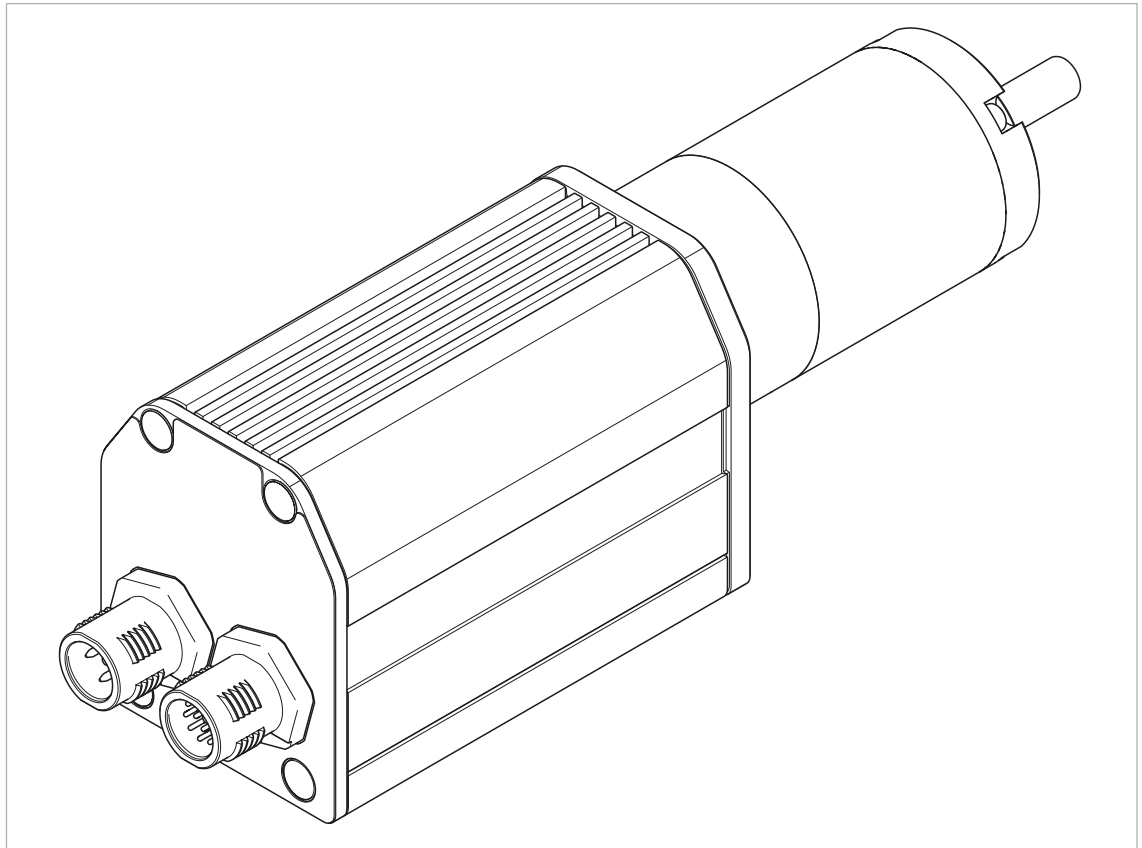


Fig. 5: Combination example with gearhead 32A

i Using option 5657 and when the base drive is directly flange-mounted or in combination with attachments (e.g. gearboxes), an additional seal (O-ring), to enhance the protection class of the complete system, may be installed between the drive and the attachment (see chap. 4.1.2, p. 18, and chap. 5.2, p. 40).

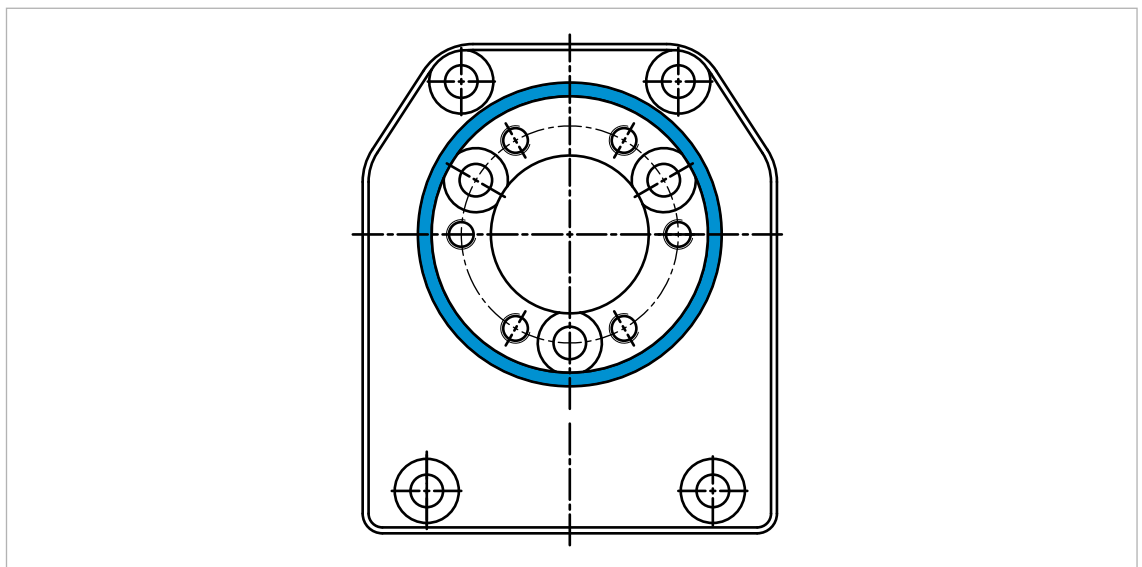


Fig. 6: Front view of the motor flange A-side with radial groove (blue)

Product description

3.5 Connector overview

Tab. 1: Connector overview of the Motion Control System

Designation	Function
IN/OUT	Connection of the EtherCAT communication
X1 (supply)	Power supply of the Motion Control System
X2 (I/O)	Interface connection RS232/CAN and inputs or outputs for external circuits

Tab. 2: LED overview

Designation	Interface	Function
State LED	all	<ul style="list-style-type: none"> Green (continuous light): Device active. Green (flashing): Device active. However the state machine has not yet reached the <i>Operation Enabled</i> state. Red (continuously flashing): The drive has switched to a fault state. The output stage will be switched off or has already been switched off. Red (error code): Booting has failed. Please contact FAULHABER Support.
RUN LED	EtherCAT	<ul style="list-style-type: none"> Green (continuous light): Connection present. Device is ready for use. Green (flashing): Device is in the <i>Pre-Operational</i> state Green (single flash): Device is in the <i>Safe-Operational</i> state Off: Device is in the <i>Initialisation</i> state.
ERR LED	EtherCAT	<ul style="list-style-type: none"> Red (flashing): Faulty configuration. Red (single flash): Local error. Red (double flash): Watchdog timeout. Off: No connection error
LA LED	EtherCAT	<ul style="list-style-type: none"> Green (continuous light): No data transfer. Connection to another participant established. Green (flashing): Data transfer active. Off: No data transfer. No connection to another participant.

Installation

4 Installation

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

- 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).

DANGER!

Incorrect handling and installation can cause the Motion Control System to perform uncontrolled movements.

A damaged Motion Control System can unexpectedly start, stop or jam. Depending on the use of the Motion Control System, this can lead to severe or fatal injury.

- ▶ Observe the safety information in the chap. 2.2.1, p. 9.
- ▶ Use suitable fastening material (see the following chapter).

Visual inspection

- ▶ After unpacking the Motion Control System, perform and document a visual inspection:
 - Motion Control System is undamaged?
 - Sticker with serial number is present?
 - Pin contacts in the connectors are OK (not oxidized, not bent)?

DANGER!

The function of the Motion Control System is not ensured if the visual inspection criteria are not satisfied.

If the function is not ensured, the drive may start unexpectedly. Depending on the use of the Motion Control System, this can lead to severe or fatal injury.

- ▶ Do not start up the Motion Control System.

Installation

DANGER!

During operation, the drive system produces mechanical forces and movements.

- ▶ Protect the drive system and components driven by the drive system from being touched.

4.1.2 Mounting on the front flange

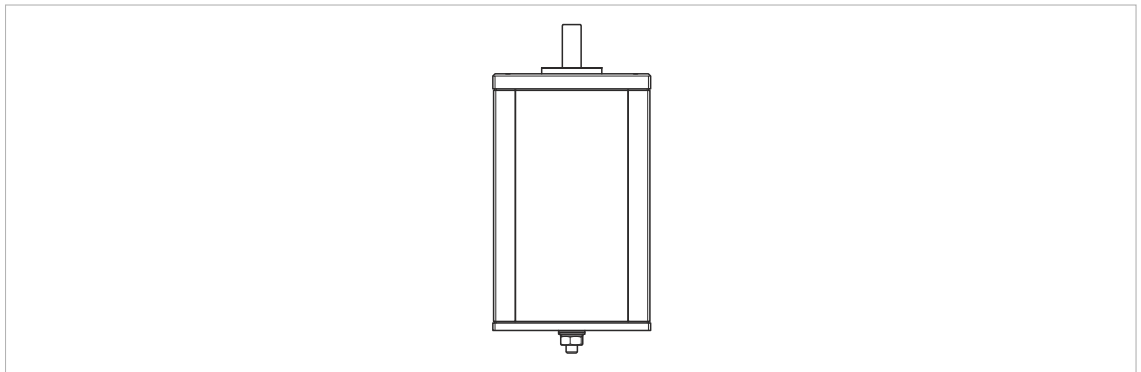


Fig. 7: V3 installation schematic diagram

NOTICE!

If the Motion Control System is installed with the shaft end facing upwards, liquids can accumulate on the upward-facing surface and damage the device.

- ▶ With V3 installation (see Fig. 7), make sure that no liquids can penetrate the bearings.
- ▶ Optional: Use a Motion Control System with an additional shaft seal. Fitting a shaft seal may reduce the motor performance (see chap. 4.1, p. 17)
- ▶ Secure the Motion Control System (1) with screws (2) using the tapped bore holes on the cover plate as shown in Fig. 8.
 - The maximum tightening torque of the screws is 130 Ncm.
 - The maximum screw-in depth is 4 mm.

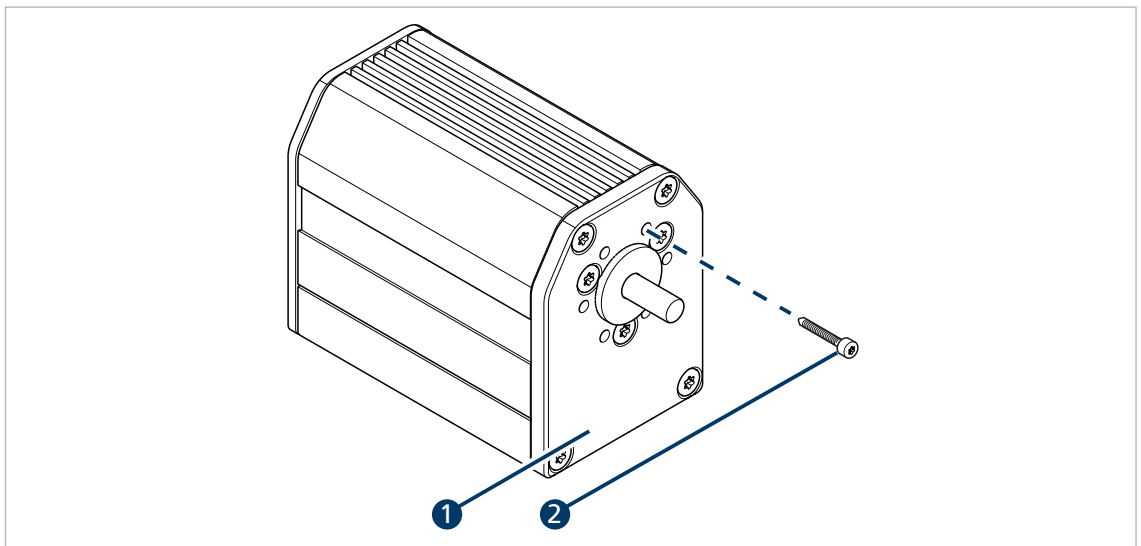


Fig. 8: Mounting on the front flange

Installation

i Using option 5657 and when the base drive is directly flange-mounted or in combination with attachments (e.g. gearboxes), an additional seal (O-ring), to enhance the protection class of the complete system, may be installed between the drive and the attachment (see chap. 5.2, p. 40).

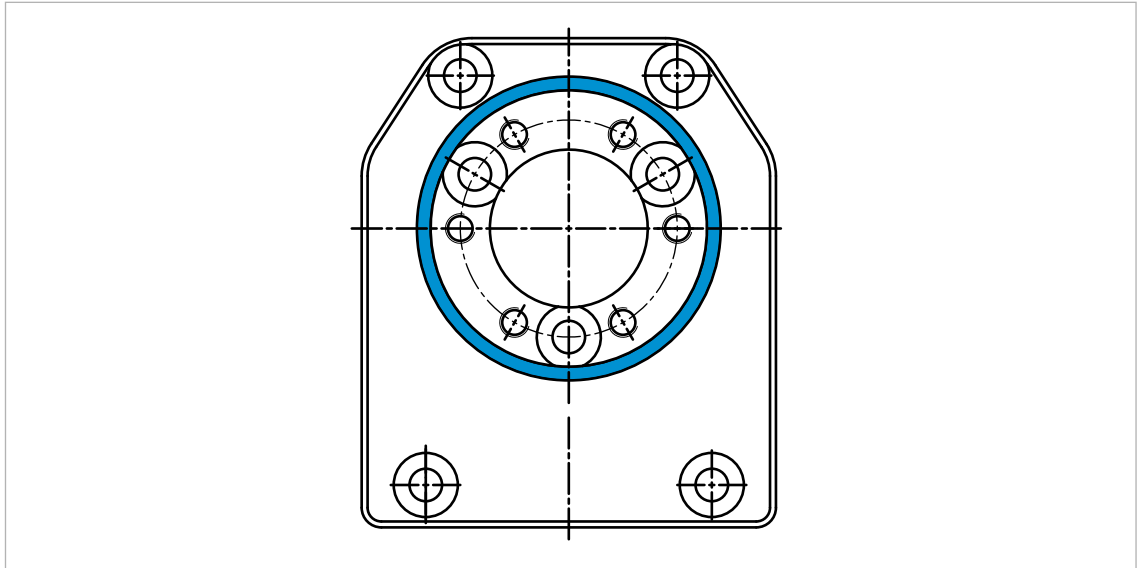


Fig. 9: Front view of the motor flange A-side with radial groove (blue)

Installation

4.1.3 Mounting with baseplate

i Screws and base plate are not part of the FAULHABER product portfolio and they must be provided by the user.

1. Secure the Motion Control System (1) with screws (3) to the base plate (2).
 - Screw type ST 2.2
 - The maximum tightening torque of the countersunk screws is 50 Ncm.
 - The maximum screw-in depth of the countersunk screws is 5 mm

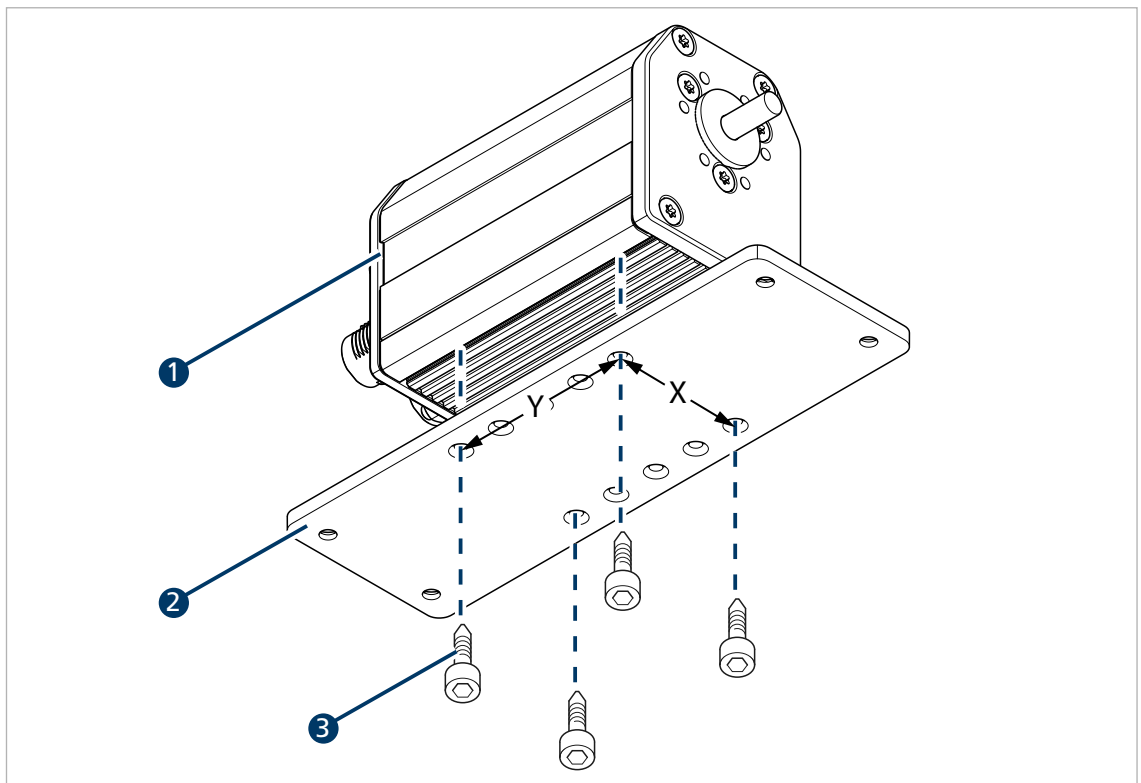


Fig. 10: Mounting with baseplate

Screw spacing	3274 BP4 RS/CO/ET	3268 BX4 RS/CO/ET	3242 BX4 RS/CO/ET
X	29 mm	29 mm	29 mm
Y	103 mm	94 mm	68 mm

Installation

4.2 Electrical connection

4.2.1 Notes on the electrical connection

NOTICE!

Electrostatic discharges to the Motion Control Systems connections can damage the electronic components

- ▶ Observe the ESD protective measures.

NOTICE!

Incorrect connection of the wires can damage the electronic components.

- ▶ Connect the wires as shown in the connection assignment.

NOTICE!

A short-term voltage peak during braking can damage the power supply or other connected devices.

- ▶ For applications with high load inertia, the FAULHABER Braking Chopper of the BC 5004 series can be used to limit overvoltages and thereby protect the power supply. For more detailed information see the data sheet for the Braking Chopper.

The Motion Control Systems contain a PWM output stage for controlling the motors. Power losses arising during operation and alternating electrical fields arising due to the pulsed control of the motors, must be dissipated and damped by appropriate installation.

- ▶ Connect the Motion Control System to an earthing system. This should be done preferably by mounting it on an earthed base plate, or alternatively by connecting it to an earthed flange. Alternatively the earthing can be achieved by shielding the connecting cables to the connection sockets.
- ▶ Make sure that potential equalization is present between all coupled parts of the system.
- ▶ If several electrical devices or controllers are networked by means of RS232 or CAN, make sure that the potential difference between the ground potentials of the various parts of the system is less than 2 V.
- ▶ The EGND connection, and if necessary the shielding around the supply connection, are available for potential equalization.

Installation

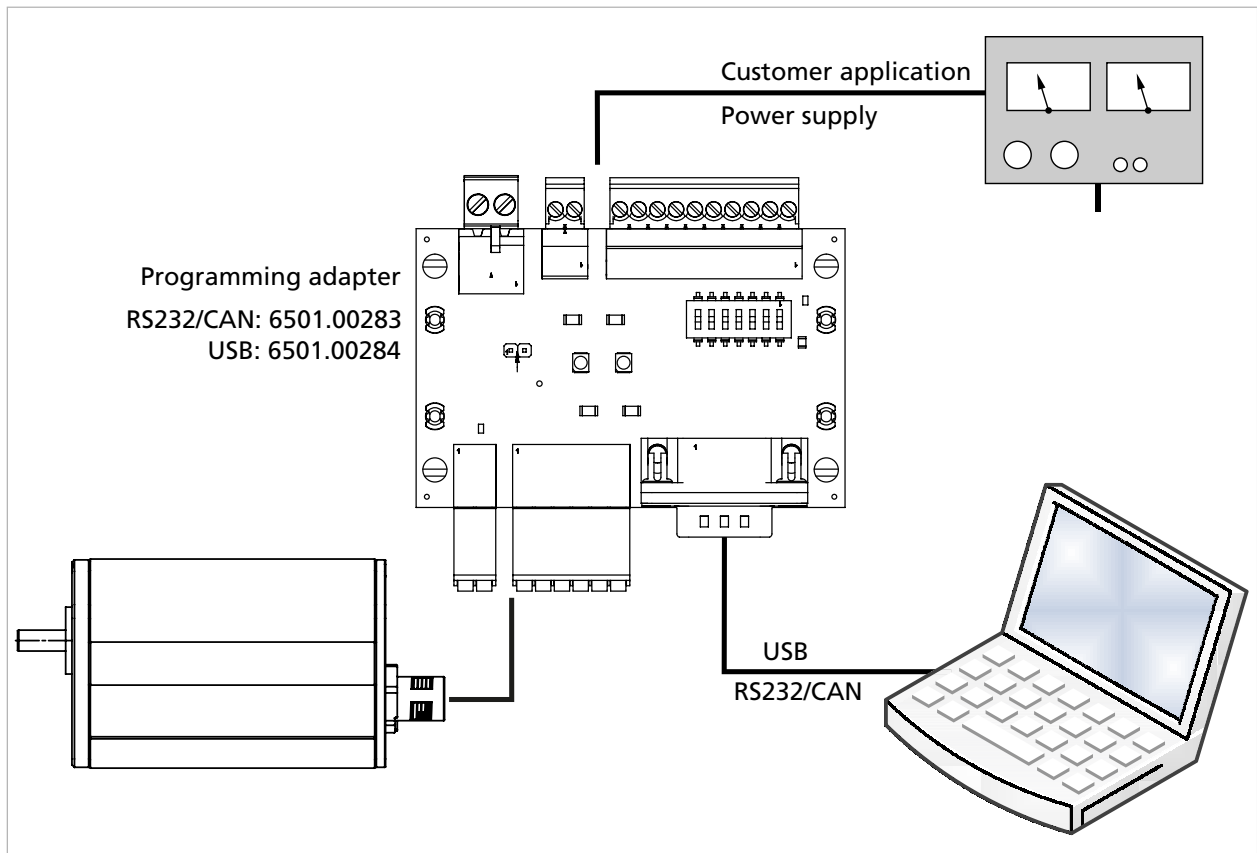


Fig. 11: Commissioning via programming adapter



For details on pin assignment and jumper settings of the programming adapter refer to the appropriate data sheets.

Installation

4.2.2 Connecting the Motion Control System

Connections of the Motion Control System:

- Discrete inputs and outputs (for instance for discrete set-point specification or for connection of limit switches and reference switches)
- Communication connections
- ▶ Make sure that the connection cables are not longer than 3 m.

To reduce the effects on the DC power supply network, ferrite sleeves (such as WE 742 700 790) can be used on the supply cables.

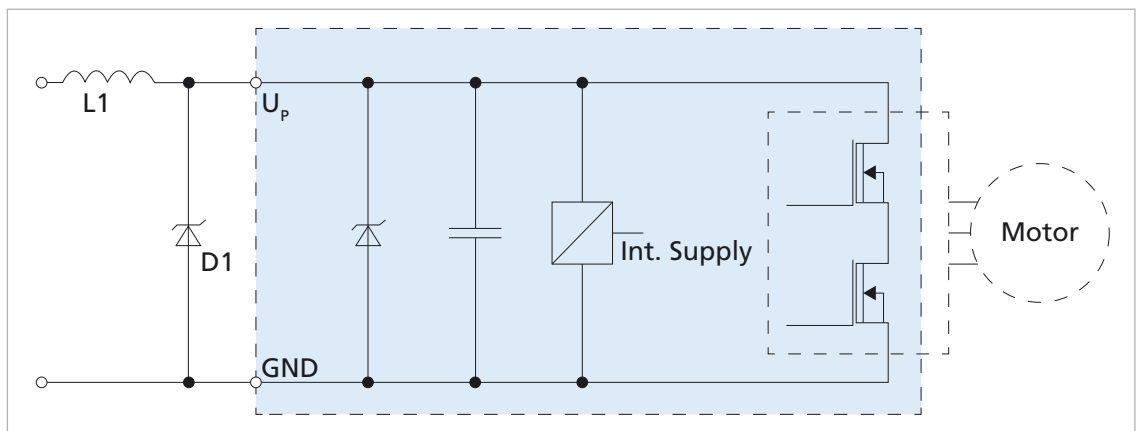


Fig. 12: EMC suppressor circuit

4.2.2.1 Power supply

- ▶ Connect the Motion Control System to a sufficiently dimensioned power supply unit.
- ▶ During acceleration procedures, current peaks with values up to the peak current limit setting of the motor can occur for multiples of 10 ms.
- ▶ During braking procedures, energy can be regenerated and fed back into the DC power supply network. If this energy cannot be taken up by other drives, the voltage in the DC power supply network will rise. A limit value for the voltage that can be fed back during regenerative braking can be set in the Motion Control System. Alternatively the overvoltage can be dissipated by an additional external brake chopper, see the data sheet for the brake chopper.

Installation

4.2.3 Connector pin assignment

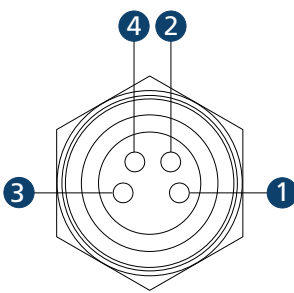
NOTICE!

Incorrect connection of the pins can damage the electronic components.

- ▶ Check the orientation of the pins in the diagram.

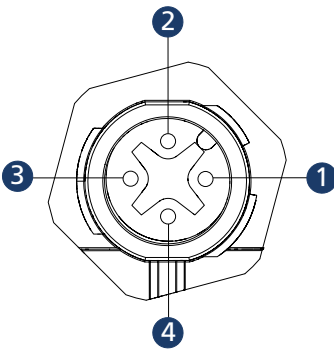
EtherCAT interface connection (IN/OUT)

Tab. 3: Pin assignment for the EtherCAT M8 connector, 4-pin, A-coded, viewed from the socket side

	Pin	Designation	Meaning
	1	Rx/Tx +	Rx/Tx positive connection
	2	Tx/Rx +	Tx/Rx positive connection
	3	Tx/Rx –	Tx/Rx negative connection
	4	Rx/Tx –	Rx/Tx negative connection

Supply connection (X1)

Tab. 4: Pin assignment for the M12 connector, 4-pin, A-coded, viewed from the pin side

	Pin	Designation	Meaning
	1	GND	Ground connection
	2	U_p	Supply connection for the electronics
	3	U_{mot}	Supply connection for the motor
	4	EGND	Housing ground connection

Tab. 5: Electrical data for the supply connection (X1)

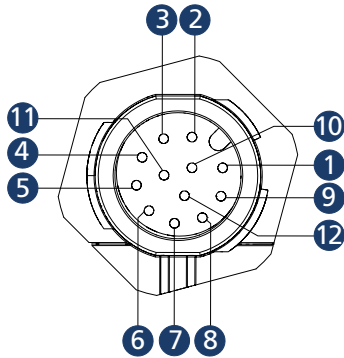
Designation	Value
Power supply for the electronics	12–50 V Reference potential to GND < 100 mA (without external consumer)
Motor power supply	<50 V Reference potential to GND

Installation

I/O connection (X2)

Tab. 6: Pin assignment for the M12 connector, 12-pin, A-coded, viewed from the pin side

Pin	Designation	Meaning
1	GND	Ground connection
2	CAN_L / RxD	CAN-Low interface
3	CAN_H / TxD	CAN-High interface
4	U _{DD}	Power supply for external consumer loads
5	DigOut 1	Digital output
6	DigOut 2	Digital output
7	DigIn 1	Digital input
8	DigIn 2	Digital input
9	DigIn 3	Digital input
10	AnIn 1	Analog input
11	AGND	Analog ground connection
12	AnIn 2	Analog input
Shielding	EGND	Housing ground connection



Tab. 7: Electrical data for the I/O connection (X2)

Pin	Value
External supply	5 V Current source < 100 mA
DigOut	Low = GND High = high resistance Integrated pull-up resistor = 33 kΩ Current sink < 0.7 A TTL level: low < 0.5 V, high > 3.5 V PLC level: low < 7 V, high > 11.5 V
DigIn	<50 V Input resistance > 10 kΩ Frequency < 1 MHz Reference potential = GND
AnIn	Input voltage = ±10 V Input resistance > 27 kΩ AGND

Installation

4.2.4 I/O circuit diagrams

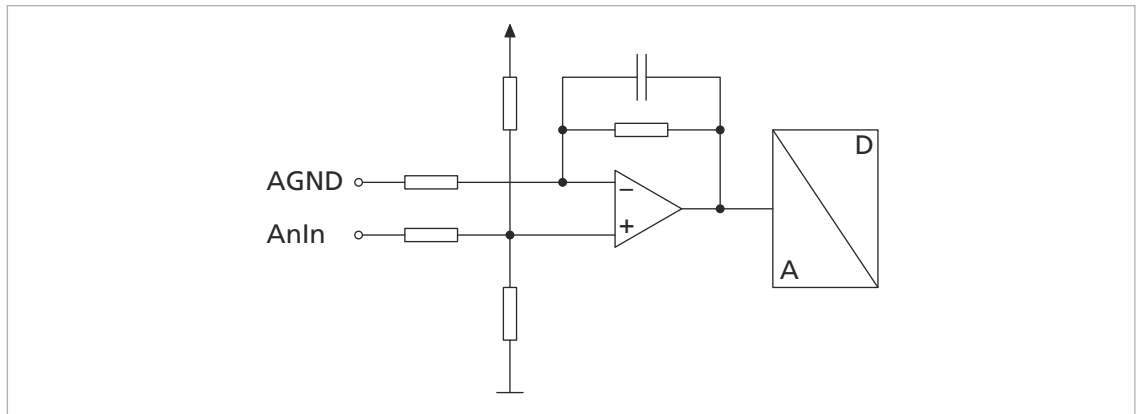


Fig. 13: Analog input circuit diagram (internal)

i 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)

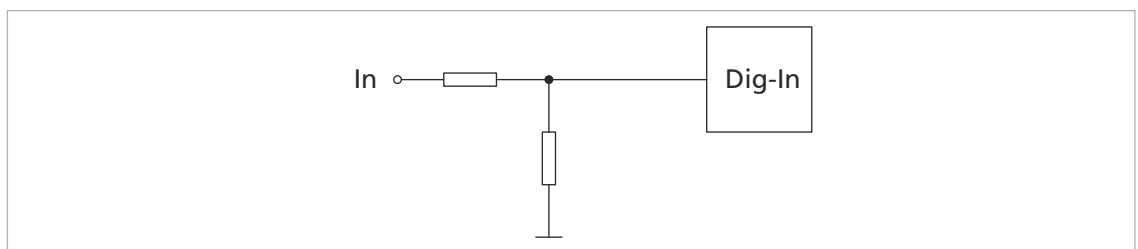


Fig. 14: Digital input circuit diagram (internal)

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

Installation

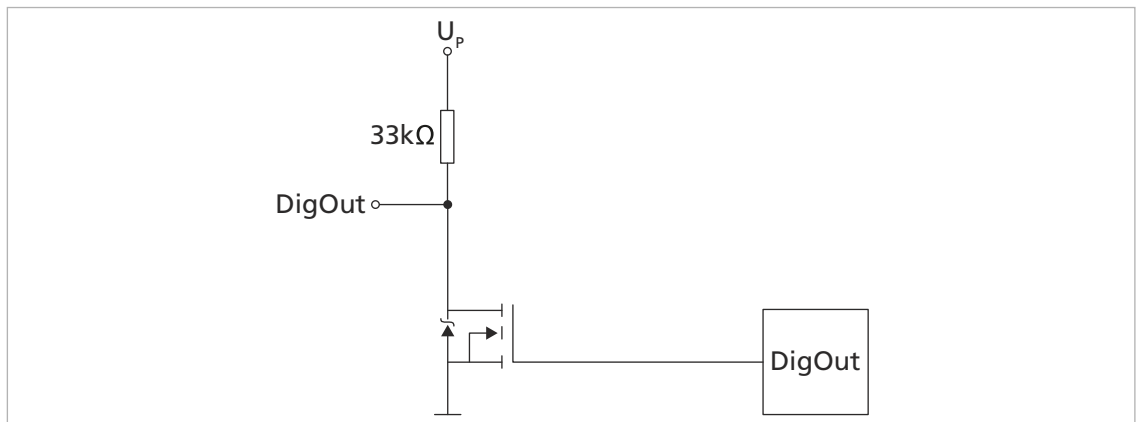


Fig. 15: Digital output circuit diagram (internal)

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)

4.2.5 External circuit diagrams

Bipolar analog set-point specification via potentiometer

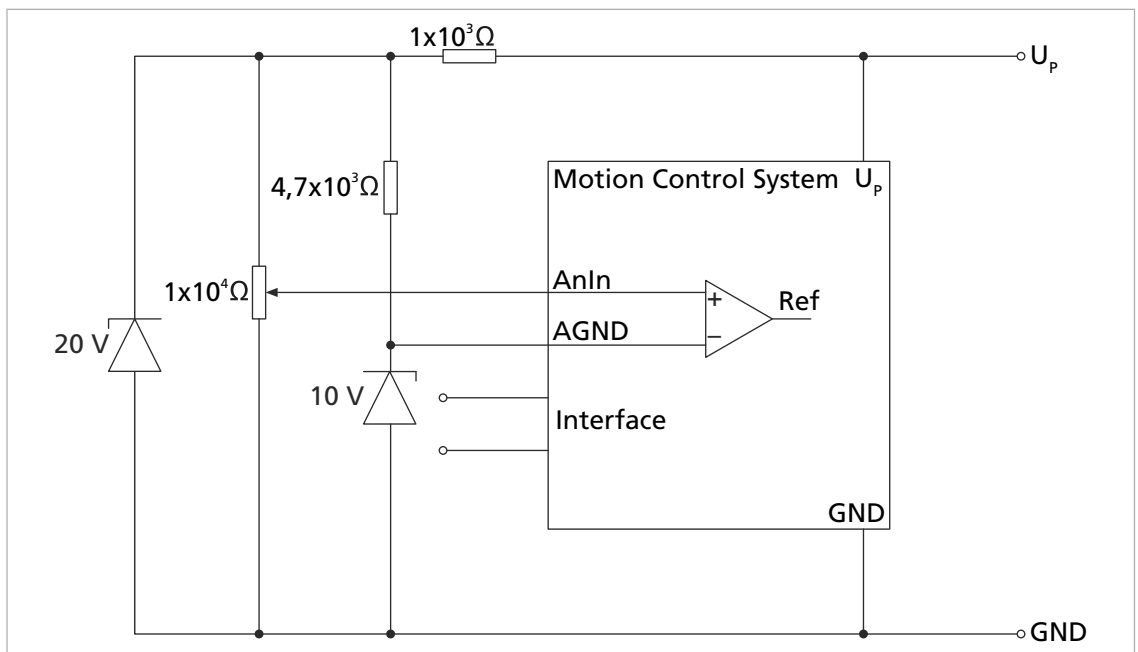


Fig. 16: Bipolar analog set-point specification via potentiometer

Installation

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

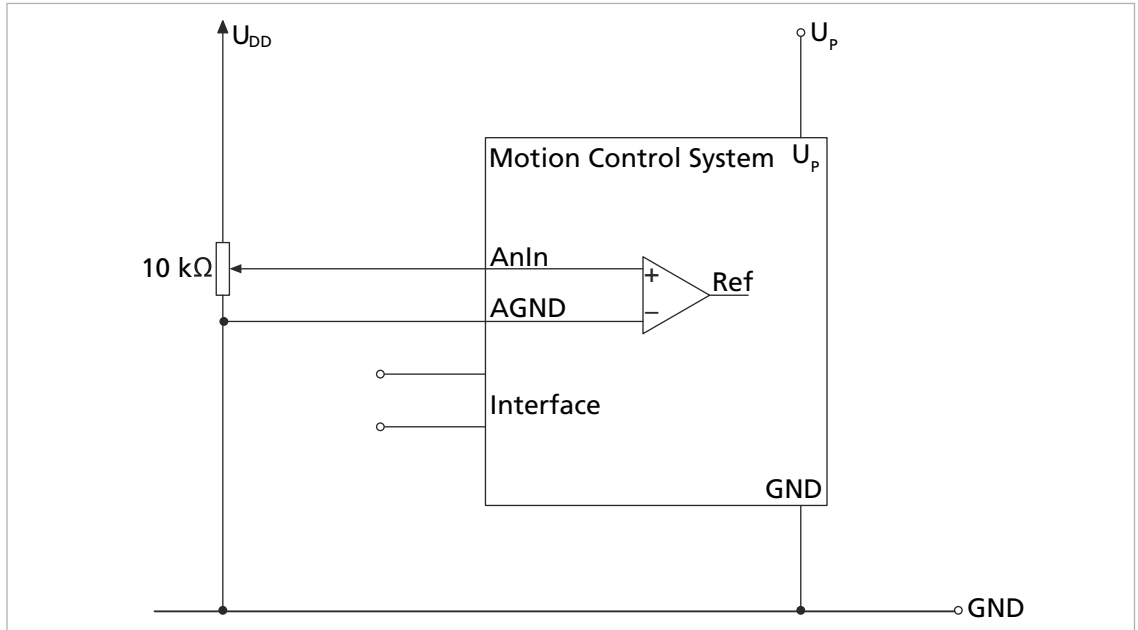


Fig. 17: Analog set-point specification via potentiometer with internally set offset and scaling

Connection of reference and limit switches

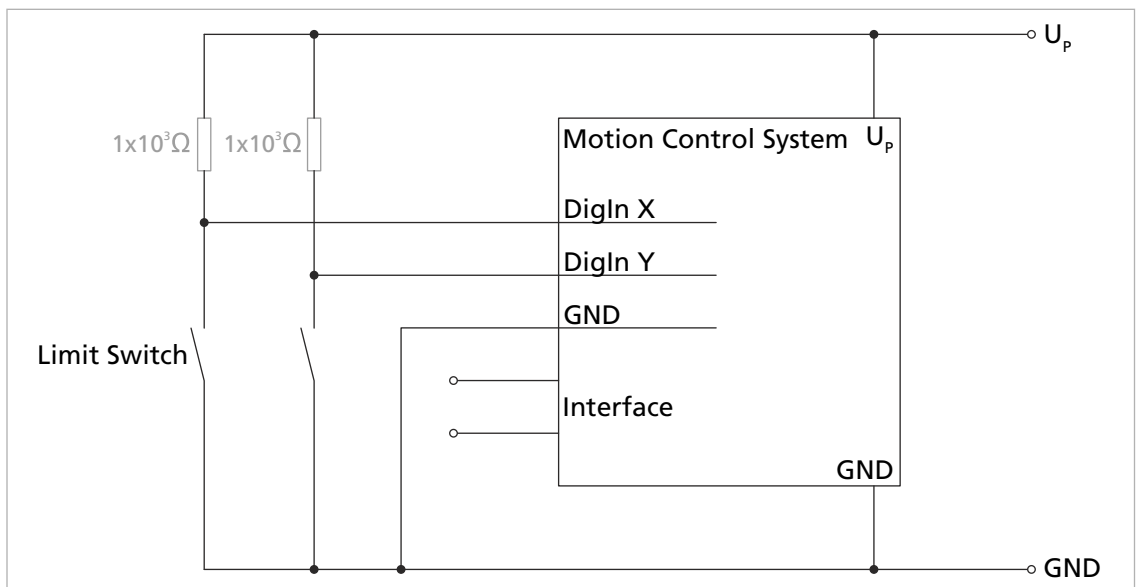


Fig. 18: Connection of reference and limit switches

i 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.

Installation

Connection of an external incremental encoder

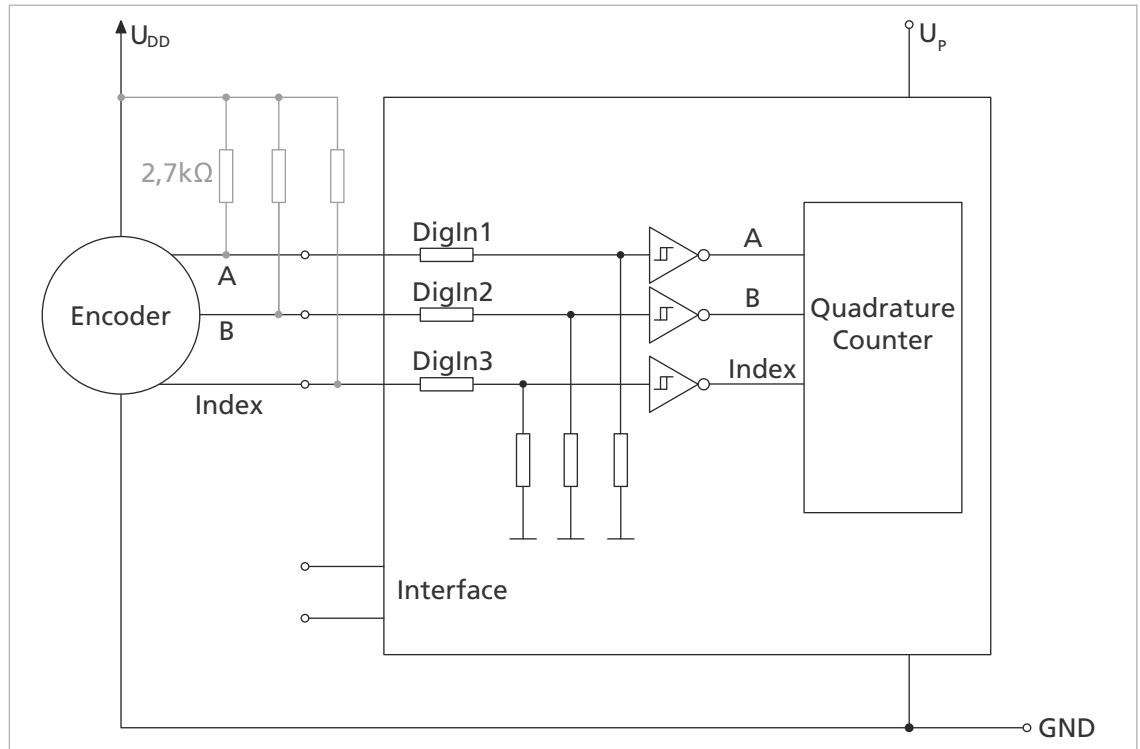


Fig. 19: Connection of an external incremental encoder

i 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 drive

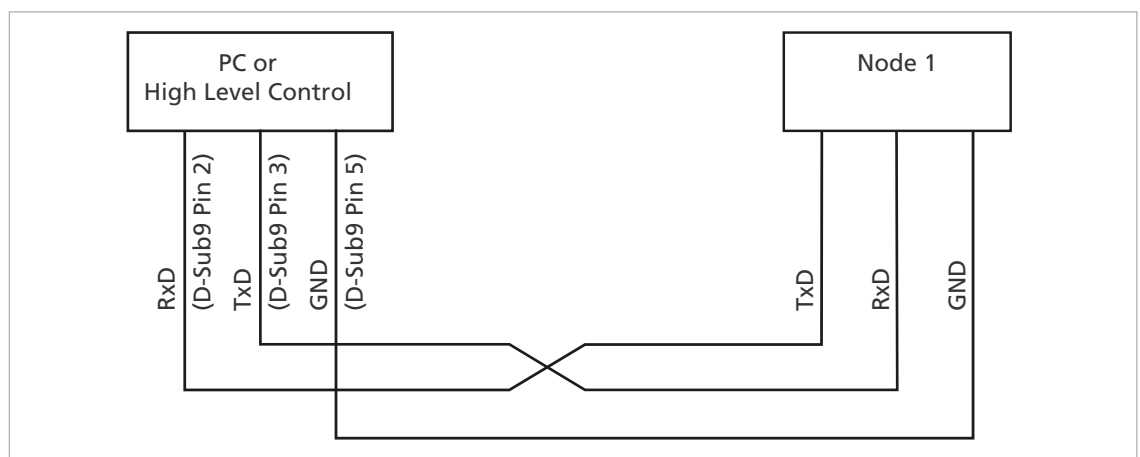


Fig. 20: Wiring between PC/controller and a drive

Installation

Wiring with several Motion Control Systems in RS232 network operation

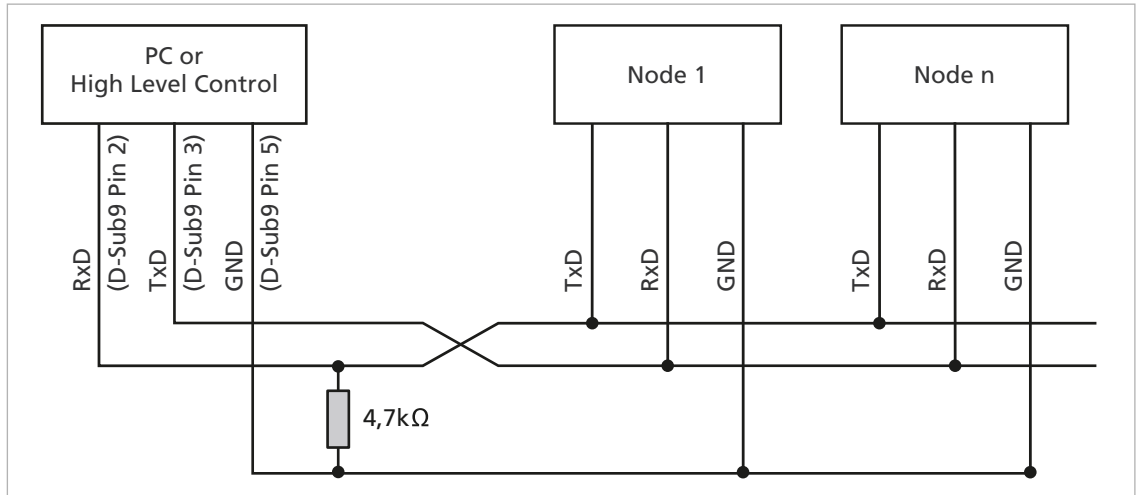


Fig. 21: Wiring with several Motion Control Systems in RS232 network operation

i 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

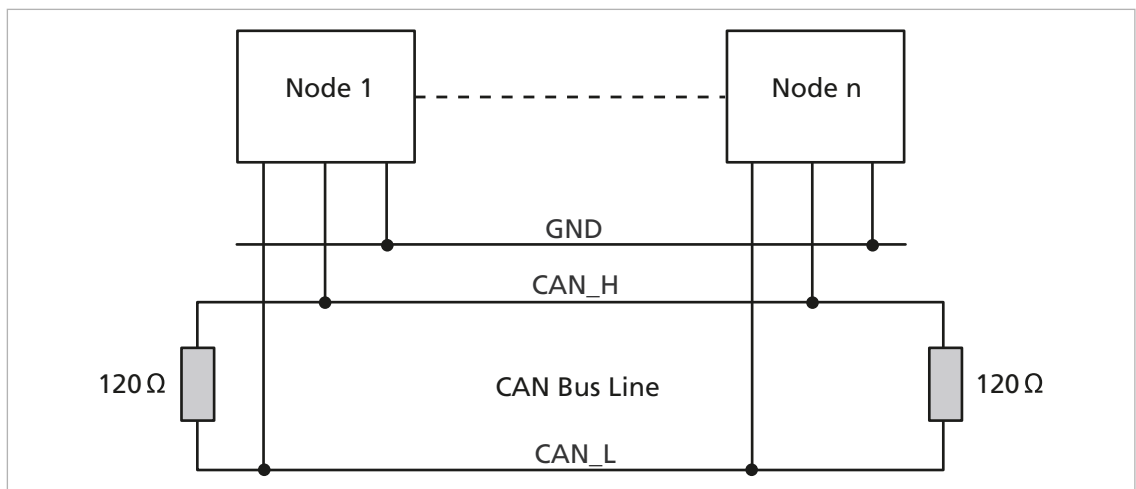


Fig. 22: Connection to the CANopen network

i 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.

Installation

4.3 Electromagnetic compatibility (EMC)

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

WARNING!

The Motion Controller 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 Considered systems

The following considerations assume installations that can be described with the following circuit diagrams.

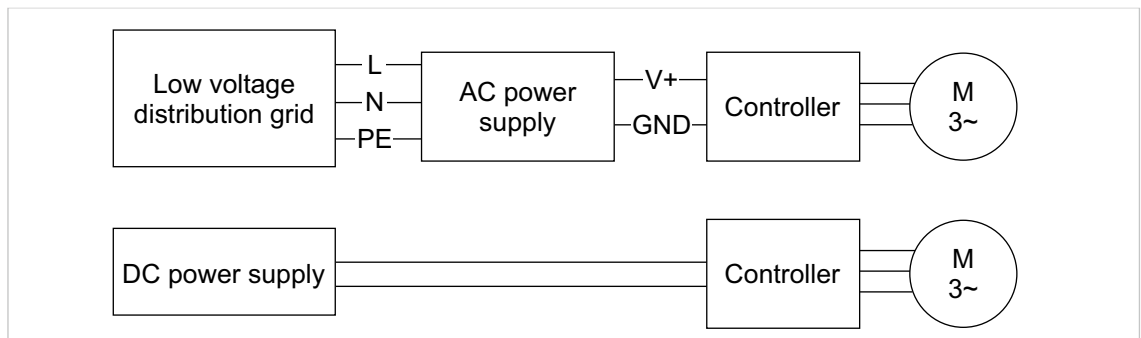


Fig. 23: Circuit diagrams of the considered systems

Installation

AC-mains system

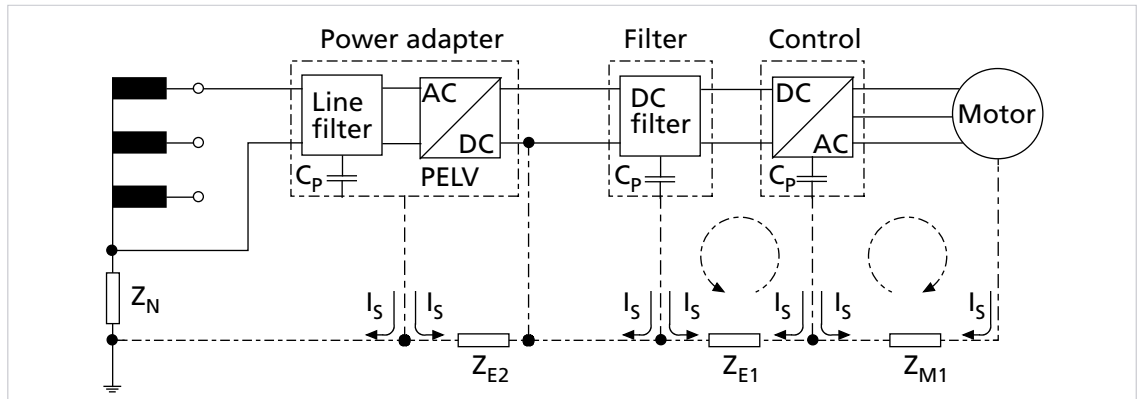


Fig. 24: Interference sources in an AC-mains system

- Z_N Mains impedance of mains transformer – power supply connection
- Z_{E1} Common-mode impedance of electronics on DC side
- Z_{E2} Common-mode impedance of electronics on AC side – power supply connection
- Z_{M1} Impedance of motor housing – controller
- I_s Parasitic current
- C_p Parasitic capacitance/filter capacitance

Parasitic current usually arises from the following components:

- Semiconductors
- Capacitive portion of the motor supply line
- Parasitic elements in the motor

Operating the motors with PWM is the cause here.

The DC-DC converter in the device and the used switching power supply also produce interference that could affect the mains. The created interference of the DC-DC converter in the device is, however, normally of little relevance due to the switched power (<5 W).

In contrast to this are the switching power supply, which supplies the controller with motor voltage or electronics voltage, and the PWM drive. Depending on the design, quality and effectiveness of the integrated filters (where present), the power supply can also cause interference.



The qualitative assessment of a power supply can be performed with an interference voltage test and a resistive load (e.g., fanless heater / hot plate).

DC-mains system

Prerequisite for connecting to the DC mains is that the switching interference of the power supply be negligible. A linear power supply can be used to reduce this interference.

Problem solutions

The interference may vary depending on load and installation.

Installation

Solution	Mode of action	Benefits	Disadvantages
3-phase common-mode choke / ferrite ring around all supply cables	Removes common-mode interference of the MCS	<ul style="list-style-type: none"> Removes RF common-mode interference Fast testing possible 	<ul style="list-style-type: none"> Does not remove all interference Fabrication necessary
Input filter upstream of the controller (e.g., EFS 5004 6501.00350)	Removes interference of the switching regulator and part of the motor interference on DC networks	Pass an interference voltage measurement with correct wiring	Does not remove interference on the motor side
Mains filter upstream of the switching power supply	Removes common-mode interference of the power supply	Very cost-effective solution	<ul style="list-style-type: none"> Often only effective for power supply Does not remove all interference

The mentioned variants are effective only if the following chapters are followed correctly.

4.3.2 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 earth conductors for all necessary parts (e.g., mains supply, 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.

Installation

4.3.3 Cable routing

WARNING!

Voltages >25VAC 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).

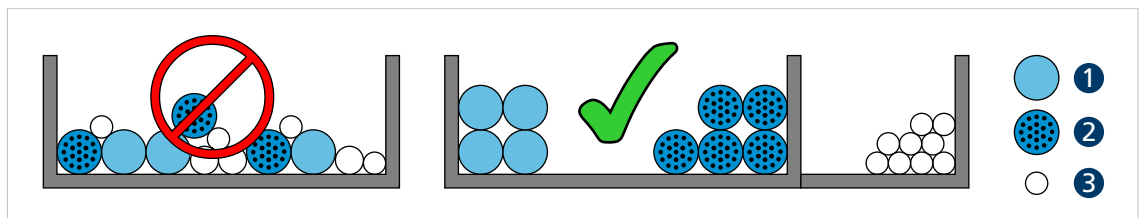


Fig. 25: Laying in the cable duct

- 1 High-current cable
2 Digital cable

- 3 Sensor cable

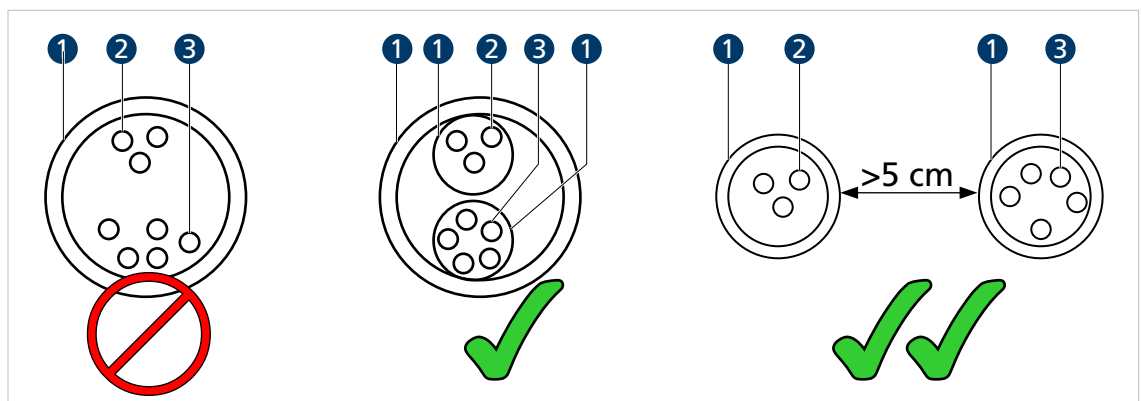


Fig. 26: Grouping and shielding of the cables

- 1 Shielding
2 Motor phase

- 3 Hall sensor

Installation

4.3.4 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.
- ▶ Establish a star-point earth connection (see chap. 4.3.2, p. 33).

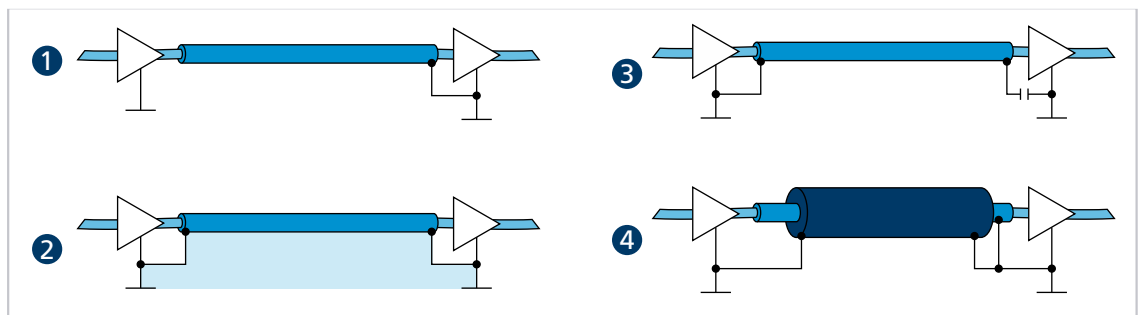


Fig. 27: Various possibilities for the shield connection

- 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. 27). A solution such as 2 in Fig. 27 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. 27).

Installation

4.3.4.1 Establishing the shield connection

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

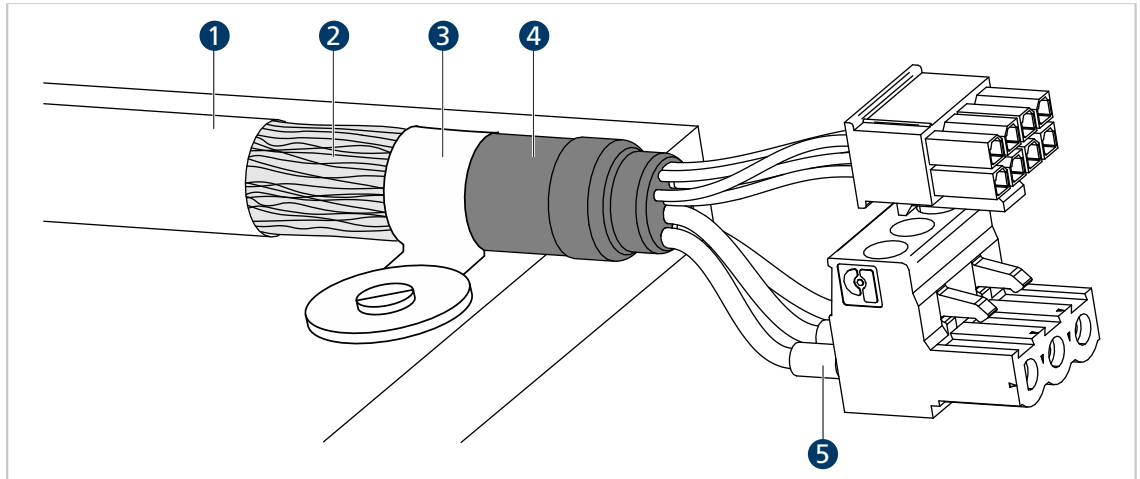


Fig. 28: Motor cable shield connection

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

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).

Installation

4.3.4.2 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.

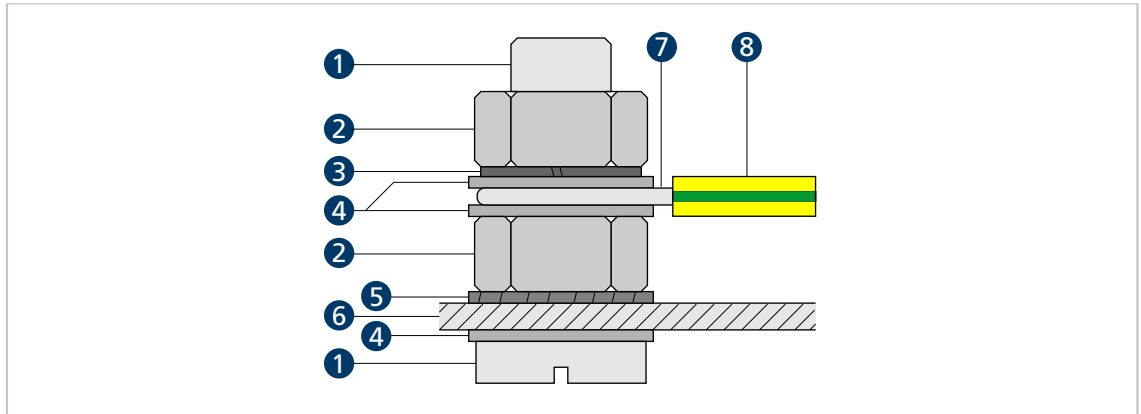


Fig. 29: Shield connection with cable lug

- | | |
|-----------------|------------------------|
| 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.

Installation

4.3.5 Using filters

The filters are divided into various function and current ranges.

Filter types:

- Input-side filters: filters on the power supply side
- Motor-side filters: filters that are connected between controller and motor in the motor phases



Filters on the motor side must not be used in the MCS.

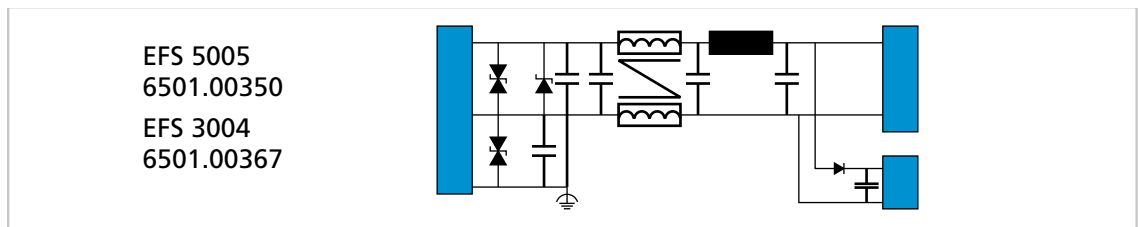


Fig. 30: Filter categories from FAULHABER

4.3.5.1 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. $>100 \mu\text{F}$) 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

4.3.5.2 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.

Installation

4.3.6 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. 4.3.2, p. 33 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 supply cables in the accessory catalog.
 - b) Supply 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. 4.3.4, p. 35.
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) 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.
 - b) Keep cables away from high-voltage current and mains cables.
 - c) 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.

Conformity measurements

The following points must be observed during the conformity measurement:

Conducted interference voltage measurement	Radiated interference voltage measurement
<ul style="list-style-type: none"> ▪ When laying cables, remove all loops. ▪ Lay the cables with a meandering shape. 	<ul style="list-style-type: none"> ▪ Where possible, lay cables over an earth plate.
<ul style="list-style-type: none"> ▪ The shield is to be connected over a large area, ideally with a round connection. 	
<ul style="list-style-type: none"> ▪ 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. 	
<ul style="list-style-type: none"> ▪ If possible, secure cable with shield clamps or with adhesive tape. 	

Maintenance and diagnostics

5 Maintenance and diagnostics

5.1 Maintenance instructions

NOTICE!

The housing of the Motion Control System is not resistant to solvents such as alcohols or acetone.

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

5.2 Maintenance tasks

In principle the drives are 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.

When using additional seals:

Option	Seal
5657	O-ring for sealing the motor flange in protection class IP54. After disassembling the drive from the flange or when replacing the attachment (e.g. gearhead) the O-ring has to be replaced.
5452	Rotary shaft seal for use in direct contact with oily substances Material: Nitrile rubber N7LM Lubrication: Self-lubrication depending on the ambient medium
5453	Shaft seal for sealing the motor shaft in protection class IP54 Material: Nitrile rubber N7LM Lubrication: Isoflex NB52 Lubrication interval: 500 operating hours Replacement: After 1000 operating hours



Using option 5452 or 5453 may reduce the motor performance. The lifetime generally depends on the installation and ambient conditions as well as on the given loading conditions.

Maintenance and diagnostics

5.3 Diagnosis

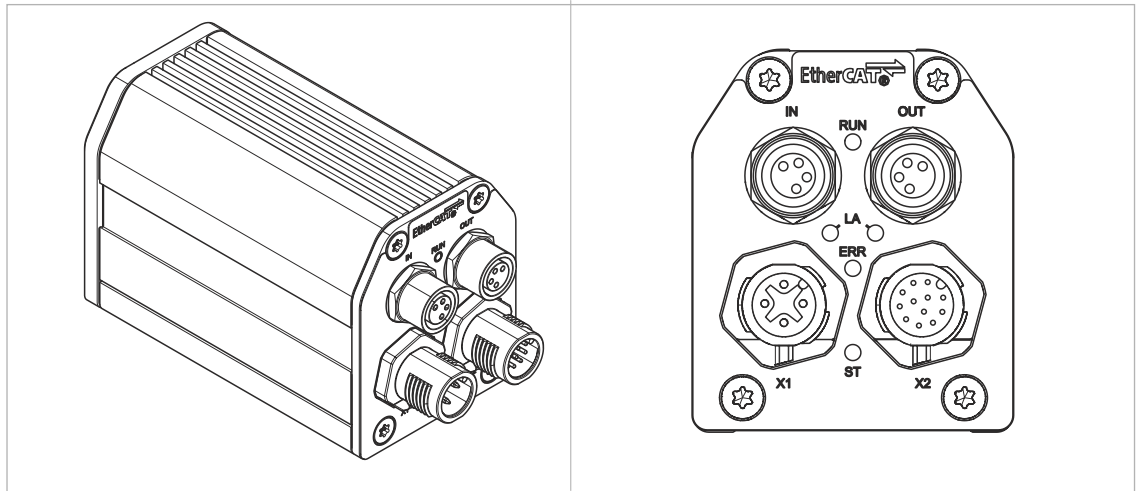


Fig. 31: Isometric view (left) and connector view (right) for axial cable outlet

Tab. 8: LED overview

Designation	Interface	Function
State LED	all	<ul style="list-style-type: none"> Green (continuous light): Device active. Green (flashing): Device active. However the state machine has not yet reached the <i>Operation Enabled</i> state. Red (continuously flashing): The drive has switched to a fault state. The output stage will be switched off or has already been switched off. Red (error code): Booting has failed. Please contact FAULHABER Support.
RUN LED	EtherCAT	<ul style="list-style-type: none"> Green (continuous light): Connection present. Device is ready for use. Green (flashing): Device is in the <i>Pre-Operational</i> state Green (single flash): Device is in the <i>Safe-Operational</i> state Off: Device is in the <i>Initialisation</i> state.
ERR LED	EtherCAT	<ul style="list-style-type: none"> Red (flashing): Faulty configuration. Red (single flash): Local error. Red (double flash): Watchdog timeout. Off: No connection error
LA LED	EtherCAT	<ul style="list-style-type: none"> Green (continuous light): No data transfer. Connection to another participant established. Green (flashing): Data transfer active. Off: No data transfer. No connection to another participant.

5.4 Troubleshooting

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

6 Accessories

Details of the following accessory parts can be found in the Accessories Manual:

- Connection cables
- Connectors
- Installation aids
- Additional equipment
- Programming adapter

Warranty

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/gtc and downloaded from it.

Additional documents

8 Additional documents

8.1 Declaration of Conformity

EG-Konformitätserklärung **EC Declaration of Conformity**

Dokument-Nr./Monat.Jahr:
Document-No./Month. Year:

EG-00026-001 / 06.2021

Der Hersteller:
The manufacturer:

Dr. Fritz Faulhaber GmbH & Co. KG
Daimlerstr. 23/25
D-71101 Schönaich
Germany

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

Produktbezeichnung:
Product designation:

MCS 32xx RS/CO
MCS 32xx ET

Produkttyp:
Product type:

Motor mit integriertem Motion Controller
Motor with integrated Motion Controller

den wesentlichen Schutzanforderungen entspricht, die in der/den nachfolgenden Richtlinie(n) festgelegt sind:
fulfills the essential protection requirements defined within the following directive:

EMV-Richtlinie 2014/30/EU
EMC-Directive 2014/30/EU

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.

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

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

- Anhang A / „Dokumentidentifikation“
- Annex A / Document identification

Die Anlage ist Bestandteil dieser Erklärung.
The annex is a component of this declaration.

Schönaich,

01.07.21
(Datum)
(date)

Dr. Thomas Bertolini,
Geschäftsführung
(Name, Chairman)


(Unterschrift)
(signature)

Additional documents

Anhang A zur Konformitätserklärung ***Annex A to Declaration of Conformity***

Dokument-Nr./Monat.Jahr:
Document-No./Month. Year:

EG-00026-001 / 06.2021

Die Übereinstimmung mit den genannten EG-Richtlinien wurde durch Überprüfung gemäß nach folgender Fachgrundnorm nachgewiesen:

The conformity with the EC guidelines was proven according to the following standards:

Fundstelle <i>Document</i>	Ausgabedatum <i>Date of issue</i>	Richtlinienbezug <i>Related to directive</i>
EN 61800-3	2018	EMV Richtlinie EMC directive

Additional documents

8.2 Declaration of Incorporation

**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-00027-001 / 06.2021

Der Hersteller:
The manufacturer:

Dr. Fritz Faulhaber GmbH & Co. KG
Daimlerstr. 23/25
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::

MCS 32xx RS/CO
MCS 32xx ET

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.

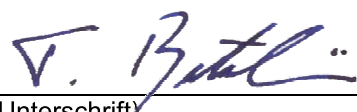
Der Bevollmächtigte für die Zusammenstellung und Übermittlung der relevanten technischen Unterlagen ist:
The person responsible for the compilation and transmission of the relevant technical documents is:

Dr. Andreas Wagener, Dr. Fritz Faulhaber GmbH & Co. KG, Daimlerstr. 23/25, 71101 Schönaich, Germany.

Schönaich,

01.07.21
(Datum)
(Date)

Dr. Thomas Bertolini,
Geschäftsführung
(Name, Chairman)


(Unterschrift)
(Signature)

