

# Technical Manual

MC 5010

MC 5005



## Imprint

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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:  
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## 1 About this document

### 1 About this document

#### 1.1 Validity of this document

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

- MC 5005
- MC 5010

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

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

#### 1.2 Associated documents

For certain operations during commissioning and operation of FAULHABER products, additional information can be found in the following manuals:

Manual	Description
Software Manual	Instruction Manual for FAULHABER Motion Manager PC software
Quick Start Manual	Description of the first steps for commissioning and operation of FAULHABER Motion Manager
DC Drive Functions	Description of the operating modes and functions of the drive
Accessories Manual	Description of the accessories articles

These manuals can be downloaded in pdf format from the Internet page [www.faulhaber.com/manuals/](http://www.faulhaber.com/manuals/).

#### 1.3 Using this document

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

## 1 About this document

### 1.4 List of abbreviations

Abbreviation	Meaning
AC	Alternating Current
AnIn	Analogue input
AnOut	Analogue output
AGND	Analogue ground
CAN	Controller Area Network
CAN_L	CAN-Low
CAN_H	CAN-High
CLK	Clock
CS	Command Specifier
DC	Direct Current
DigIn	Digital input
DigOut	Digital output
EMC	Electromagnetic compatibility
ESD	Electrostatic discharge
ET	EtherCAT
GND	Ground
PLC	Programmable Logic Controller
PWM	Pulse Width Modulation
RxD	Receive data
TTL	Transistor Transistor Logic
TxD	Transmit data
NMT	Network Management Object
RTR	Remote Request
OV	Object dictionary

## 1 About this document

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### 1.5 Symbols and markers



#### **CAUTION!**

**Hazards to persons. Disregard can lead to minor injuries.**

- ▶ Measures for avoidance



#### **CAUTION!**

**Hazards due to hot surfaces. Disregard can lead to burns.**

- ▶ Measures for avoidance



#### **NOTICE!**

**Risk of damage to equipment. Disregard can lead to damage to equipment.**

- ▶ Measures for avoidance



Instructions for understanding or optimising the operations

- ✓ Pre-requirement for a requested action
- ▶ Request for a single-step action
- 1. First step for a requested action
- 2. Second step of a requested action
- ↪ Result of an action

## 2 Safety

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## 2 Safety

### 2.1 Use for the intended purpose

The Motion Controllers described here are designed for use as slaves for control and positioning tasks for the following motors:

- DC-Motors
- Linear DC-Servomotors
- Brushless DC-Motors

The Motion Controller is suitable in particular for tasks in the following fields of application:

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

When using the Motion Controllers the following aspects should be recognised:

- The Motion Controller contains electronic components and should be handled in accordance with the ESD regulations.
- Do **not** install the Motion Controller in environments where it will come into contact with water, chemicals and/or dust, **nor** in explosion hazard areas.
- The Motion Controller is **not** suitable for use in combination with stepper motors.
- The Motion Controller should be operated only within the limits specified in the data sheet.
- Please ask the manufacturer for information about use under individual special environmental conditions.



## 2 Safety

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### 2.2 Safety instructions



**NOTICE!**

**Electrostatic discharges can damage the electronics.**

- ▶ Wear conductive work clothes.
- ▶ Wear an earthed wristband.



**NOTICE!**

**Penetration by foreign bodies can damage the electronics.**

- ▶ Do not open the housing.



**NOTICE!**

**Inserting and withdrawing connectors whilst the device is live can damage the electronics.**

- ▶ Do not insert or withdraw connectors whilst the device is live.

### 2.3 Environmental conditions

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

## 2 Safety

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### 2.4 EC directives on product safety

- ▶ The following EC directives on product safety must be complied with.
- ▶ If the Motion Controller is being used outside the EU, comply also with international, national and regional directives.

#### **Machines Directive (2006/42/EC)**

Because of their small size, no serious hazards to life and limb can normally be expected from small electric drives. Therefore the Machines Directive does not apply to our products. The products described here are not "incomplete machines". Therefore incorporation instructions are not normally issued by FAULHABER.

#### **Low Voltage Directive (2014/35/EU)**

The Low Voltage Directive applies to all electrical equipment with a rated voltage of 75 to 1500 V DC and 50 to 1000 V AC. The products described in this device manual do not fall within the scope of this directive, since they are intended for lower voltages.

#### **EMC Directive (2014/30/EU)**

The directive concerning electromagnetic compatibility (EMC) applies to all electrical and electronic devices, equipment and systems sold to an end user. In addition, individual components may be covered by a CE mark in respect of the EMC Directive. Conformity with the directive is documented in the Declaration of Conformity.

## 3 Product description

### 3 Product description

#### 3.1 General product description

The MC 5005 and MC 5010 products are housed versions of the FAULHABER Motion Controller and can control DC, LM or BL motors as required. Configuration of the Motion Controller is performed using the FAULHABER Motion Manager V6.

The drives can be incorporated into the network by means of the CANopen or EtherCAT field bus interfaces. In smaller installations networking can be performed using the RS232 interface. Within the network the Motion Controller operates principally as a slave. Master functionality for controlling other axes is not provided. Alternatively, after initial commissioning by the Motion Manager, the controller can also be operated without any communications interface.

The controller is mounted on a flat baseplate, using the installation holes. Optional accessories also permit the controller to be mounted on a top-hat rail.

The output stages are exchangeable and are matched to the various sizes and types of motors, i.e. DC, BL and LM motors from 12 – 44 mm, as listed in the FAULHABER product portfolio.

The following connections are available on the supply side:

- Communications interfaces
- Common or separate power supplies between motor and controller
- Various inputs and outputs

The following connections are available on the motor side, depending on the product combination:

- Motor phases
- Feedback components such as:
  - Digital/analogue Hall sensors
  - Incremental encoders with or without line driver.



Motion Controllers with RS232, CANopen or EtherCAT interfaces can also be operated independently of the communications interface if a pre-programmed function or operating program has been programmed without digital command controls.

## 3 Product description

### 3.2 Product information

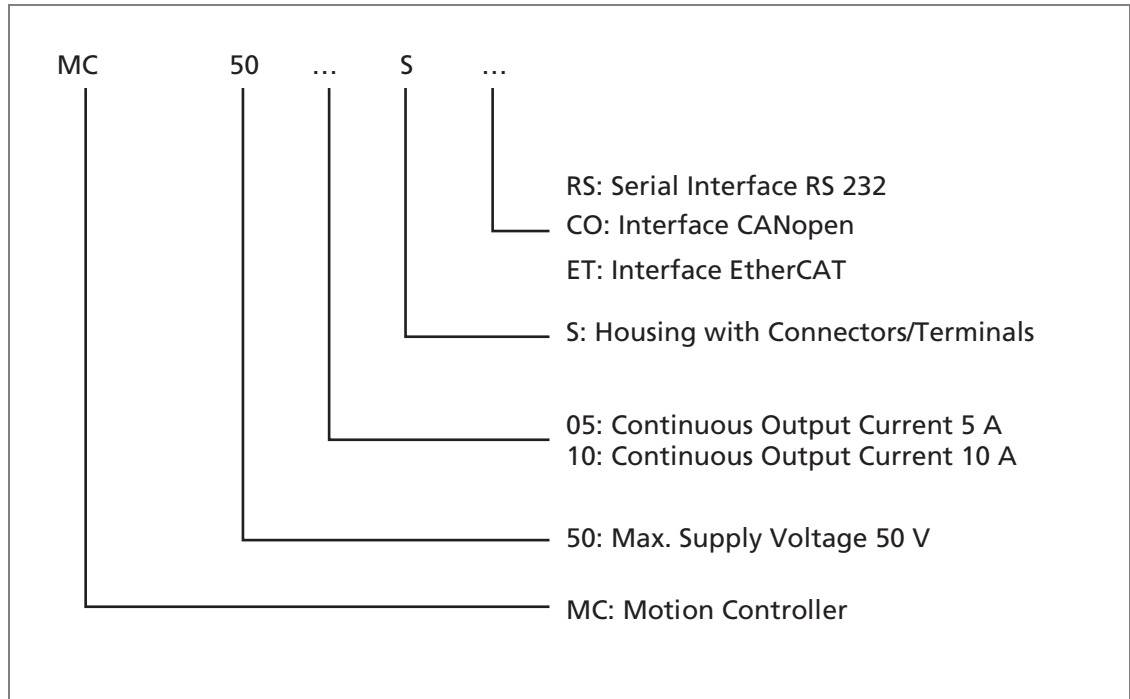


Fig. 1: Designation key

## 3 Product description

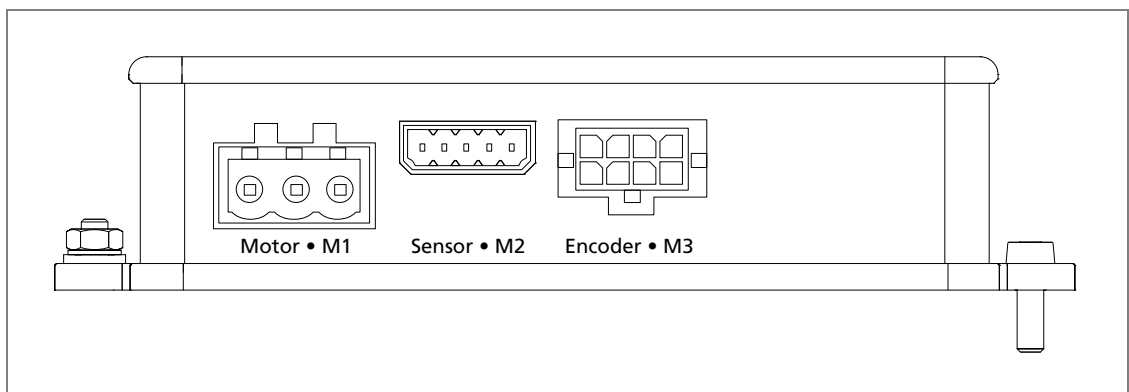
### 3.3 Product variants

The housed variant of the Motion Controller is available in 2 formats.

#### 3.3.1 Standard format

The standard format of the housed Motion Controller has a CANopen or RS232 interface. The USB interface is available in all devices.

##### 3.3.1.1 Motor side of the standard format



*Fig. 2: Motor side of the standard format*

*Tab. 1: Connector overview on the motor side*

Designation	Function
M1 (motor)	Connection of the motor phases
M2 (sensor)	Connection of the Hall sensors
M3 (encoder)	Connection of an incremental encoder with or without line driver. Alternatively an absolute encoder can be connected with or without line driver.

## 3 Product description

### 3.3.1.2 Supply side of the standard format

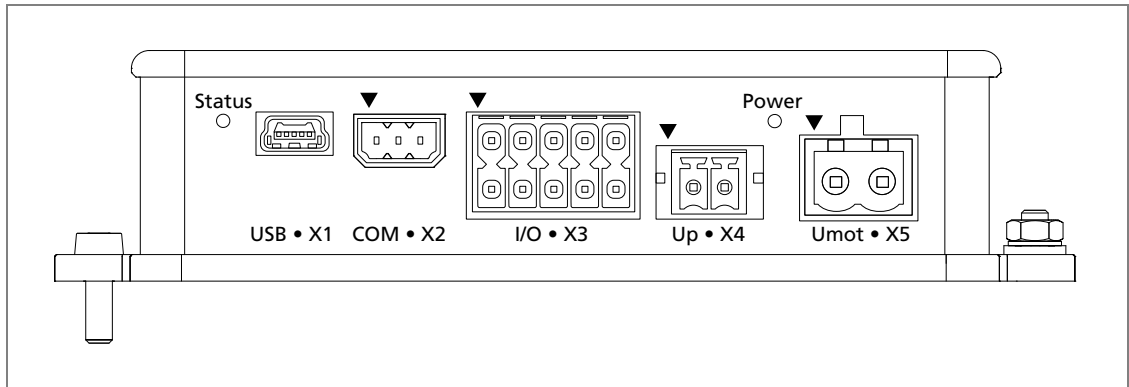


Fig. 3: Supply side of the standard format

Tab. 2: Connector overview on the supply side

Designation	Function
X1 (USB)	Connection of the USB communication
X2 (COM)	Interface connection RS232/CAN
X3 (I/O)	Inputs or outputs for external circuits
X4 ( $U_p$ )	Power supply of the controller
X5 ( $U_{mot}$ )	Power supply of the motor

Tab. 3: LED overview

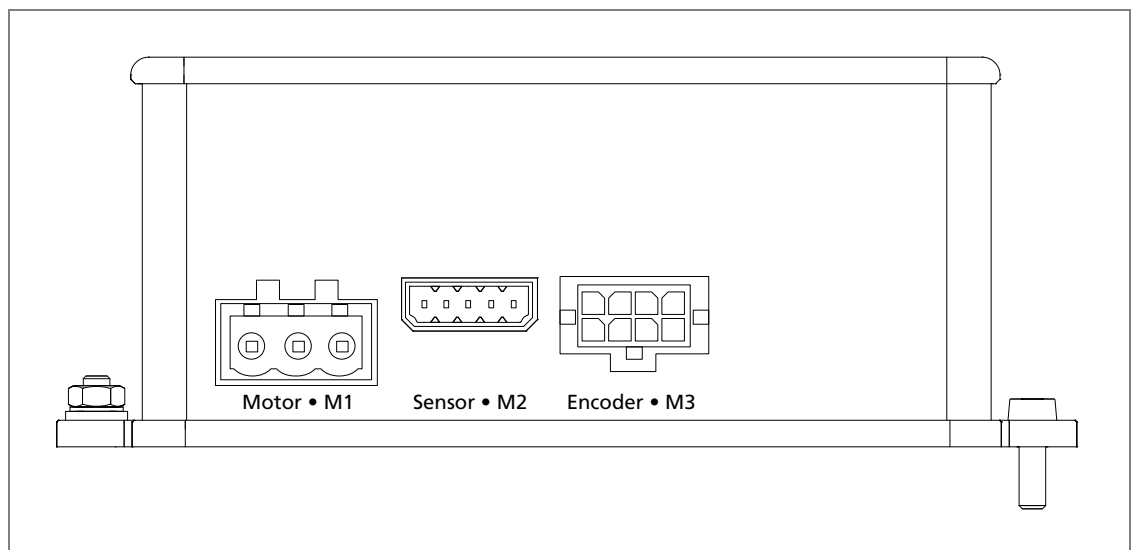
Designation	Function
Status LED	<ul style="list-style-type: none"> <li>Green (continuous): Device active.</li> <li>Green (flashing): Device active. However the state machine has not yet reached the state <i>Operation Enabled</i>.</li> <li>Red (continuously flashing): The drive has switched to a fault state. The output stage will be switched off or has already been switched off.</li> <li>Red (Error code): Boot procedure failed. Please contact FAULHABER Support.</li> </ul>
Power LED	<ul style="list-style-type: none"> <li>Green: Power supply within the permissible range.</li> <li>Off: Power supply not within the permissible range.</li> </ul>

## 3 Product description

### 3.3.2 Extended format

The extended format of the housed Motion Controller has a further EtherCAT port in addition to the standard format.

#### 3.3.2.1 Motor side of the extended format



*Fig. 4: Motor side of the extended format*

*Tab. 4: Connector overview on the motor side*

Designation	Function
M1 (motor)	Connection of the motor phases
M2 (sensor)	Connection of the Hall sensors
M3 (encoder)	Connection of an incremental encoder with or without line driver. Alternatively an absolute encoder can be connected with or without line driver.

### 3 Product description

#### Supply side of the extended format

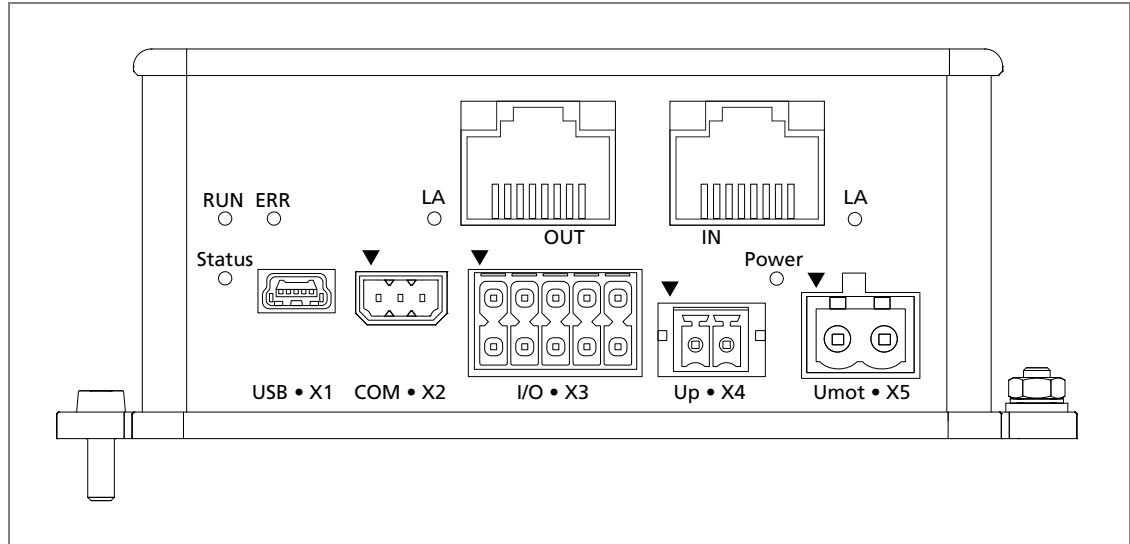


Fig. 5: Supply side of the extended format

Tab. 5: Connector overview on the supply side

Designation	Function
X1 (USB)	Connection of the USB communication
X2 (COM)	Interface connection RS232/CAN
X3 (I/O)	Discrete I/Os and sensor supply +5 V
X4 (U <sub>p</sub> )	Power supply of the controller
X5 (U <sub>mot</sub> )	Power supply of the motor
IN/OUT	Port for EtherCAT communication

Tab. 6: LED overview

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



## 4 Installation

### 4 Installation

#### 4.1 Installation

Only trained specialists and instructed persons with knowledge of the following fields may install and operate the Motion Controller:

- Automation technology
- Standards and regulations (such as the EMC Directive)
- Low Voltage Directive
- Machines Directive
- Local regulations concerning electrical installations
- Accident prevention regulations

This description must be carefully read and complied with before commissioning.

Please also comply with the supplementary instructions for installation (see chap. 2.3, p. 9).

##### 4.1.1 Installation instructions



##### CAUTION!

**When in operation the Motion Controller can become very hot.**

- ▶ Place a guard against contact and warning notice in the immediate proximity of the controller.



##### NOTICE!

**Improper installation or installation using unsuitable attachment materials can lead to the Motion Controller becoming damaged.**

- ▶ Comply with the installation instructions.



##### NOTICE!

**Installation and connection of the Motion Controller when the power supply is live can lead to the device becoming damaged.**

- ▶ During all aspects of installation and connection work on the Motion Controller, switch off the power supply.

## 4 Installation

### 4.1.2 Attachment via the side plates



#### NOTICE!

Installation of the Motion Controller on a surface that is not flat can lead to the Motion Controller becoming damaged.

- ▶ Install the Motion Controller on a flat surface.

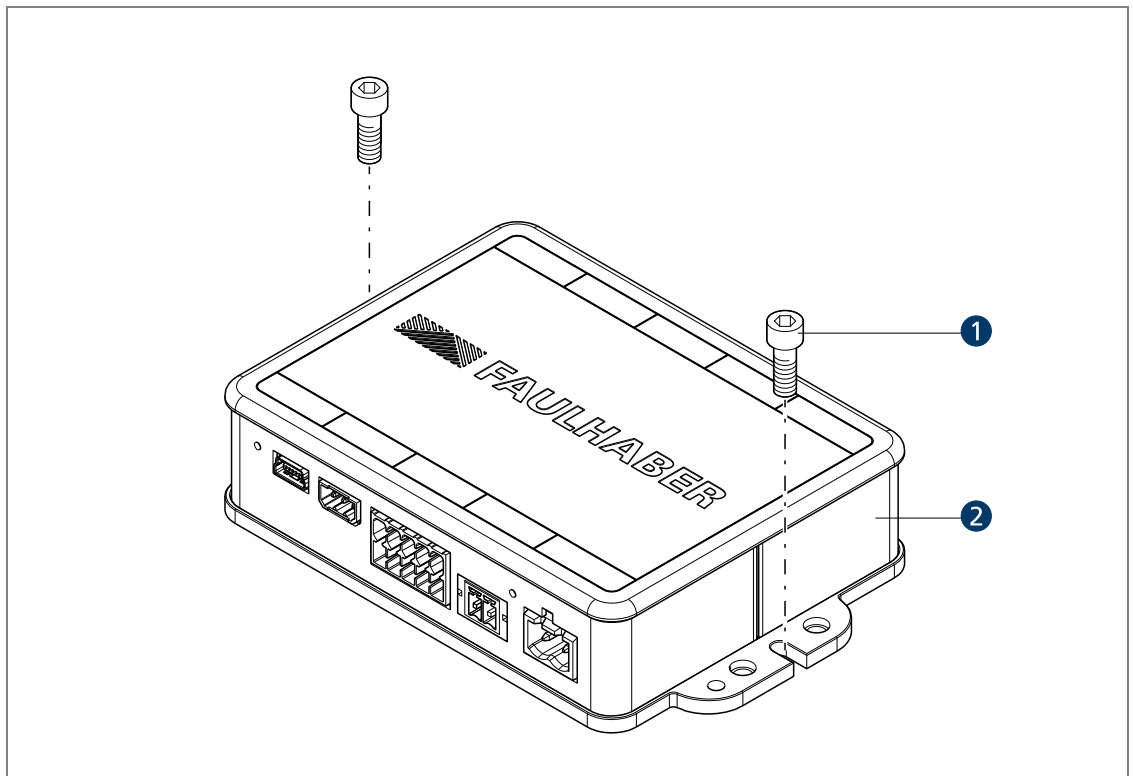


Fig. 6: Installation via the side plates

1 Screw

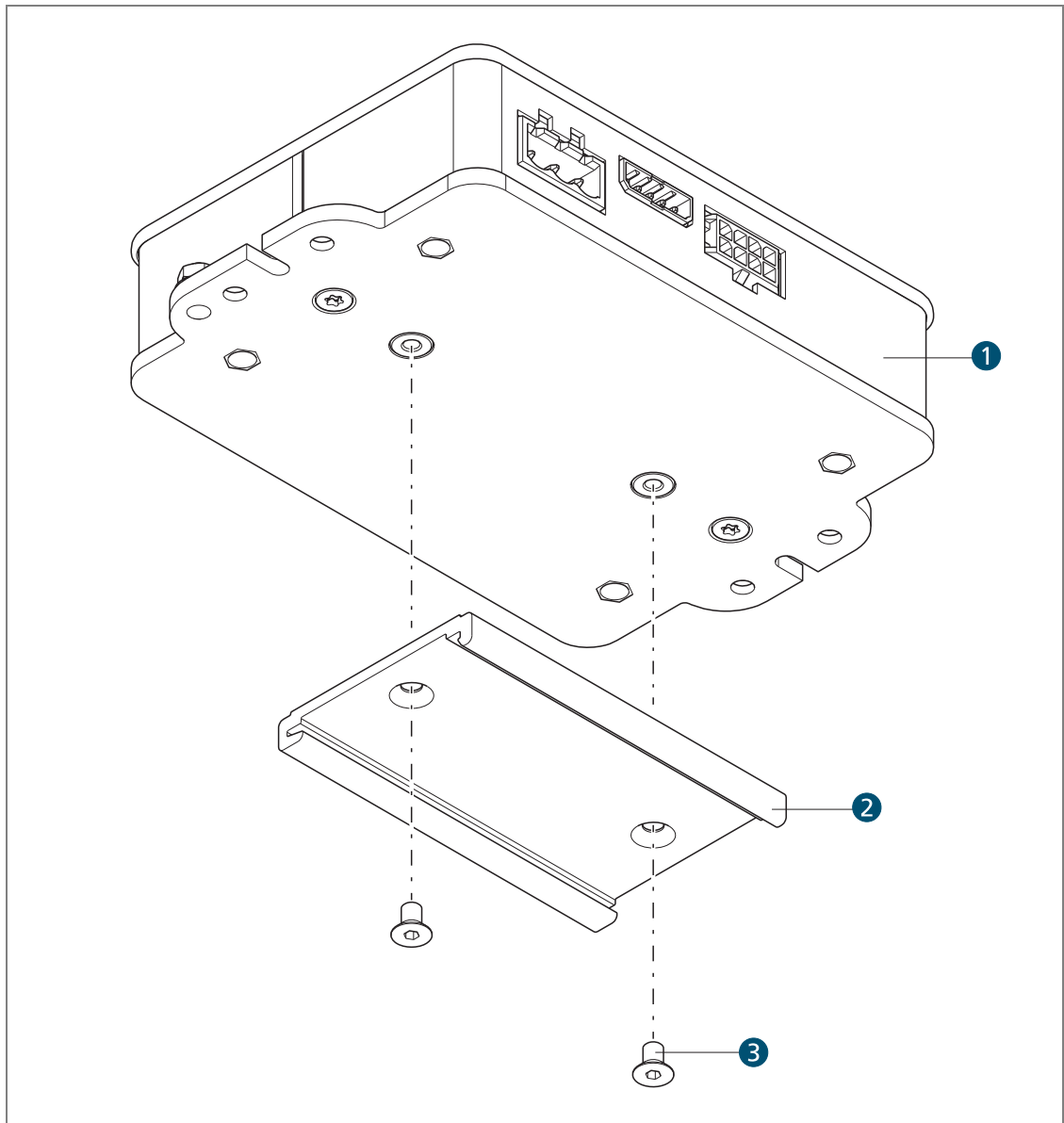
2 Motion Controller

- ▶ Attach the Motion Controller (2) to the mounting plate with screws (1) as described in Fig. 6, p. 18.

## 4 Installation

### 4.1.3 Installation on a top-hat rail

The top-hat rail adapter is available as an accessory, see the Accessories Manual.



*Fig. 7: Installation on a top-hat rail*

- |                        |                     |
|------------------------|---------------------|
| 1 Motion Controller    | 3 Countersunk screw |
| 2 Top-hat rail adapter |                     |

- Using countersunk screws (3), screw the top-hat rail adapter (2) on to the Motion Controller (1).
  - The tightening torque of the countersunk screws is max. 60 Nm.
- Click the Motion Controller with the top-hat rail adapter on to the top-hat rail.

## 4 Installation

### 4.1.4 Installation with top-hat rail clips

**i** Top-hat rail clips are not part of the FAULHABER product portfolio, they must be provided by the user (recommendation: Mounting foot, WAGO item number 209-188).

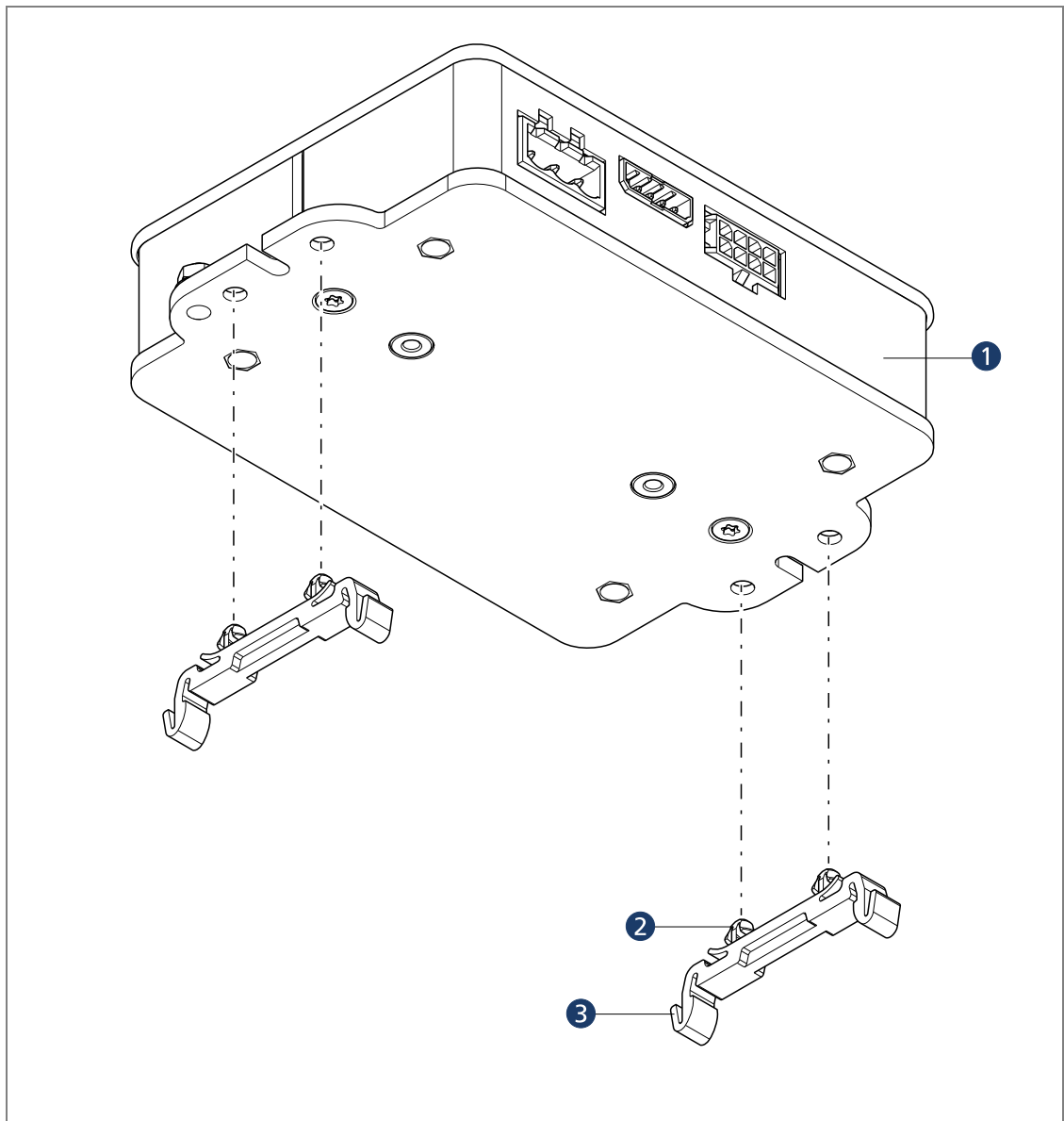


Fig. 8: Installation with top-hat rail clips

- |                     |                     |
|---------------------|---------------------|
| 1 Motion Controller | 3 Top-hat rail clip |
| 2 Clamping pin      |                     |

1. Push the clamping pins (2) for the two top-hat rail clips (3) into the side plates as far as they will go.
2. Click the top-hat rail clips on to the top-hat rail.

## 4 Installation

### 4.2 Electrical connection

#### 4.2.1 Instructions for the electrical connection



**NOTICE!**

Electrostatic discharges to the Motion Controller connections can damage the electronic components

- ▶ Comply with 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 voltage peak during braking can damage the power supply or other connected devices.

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

The Motion Controller contains a PWM output stage for controlling the motors. Thermal losses arise during operation and alternating electrical field arise due to the pulsed control of the motors. These must be dissipated and damped by appropriate installation.

- ▶ Connect the Motion Controller to an earthing system. This should be done preferably by mounting on an earthed baseplate, or alternatively by connection to an earth continuity conductor.
- ▶ Make sure that equal earth potential is maintained between all connected parts of the system. This applies even if the Motion Controller and motor are mounted separately.
- ▶ If several electrical devices or controllers are networked by means of RS232 or CAN, make sure that the potential difference between the earth potentials of the various parts of the system is less than 2 V.

 The cross-section of the potential equalisation conductors between the various parts of the system is specified in VDE 100 and must satisfy the following conditions:

- at least 6 mm<sup>2</sup>
- larger than half the cross-section of the supply conductor

## 4 Installation

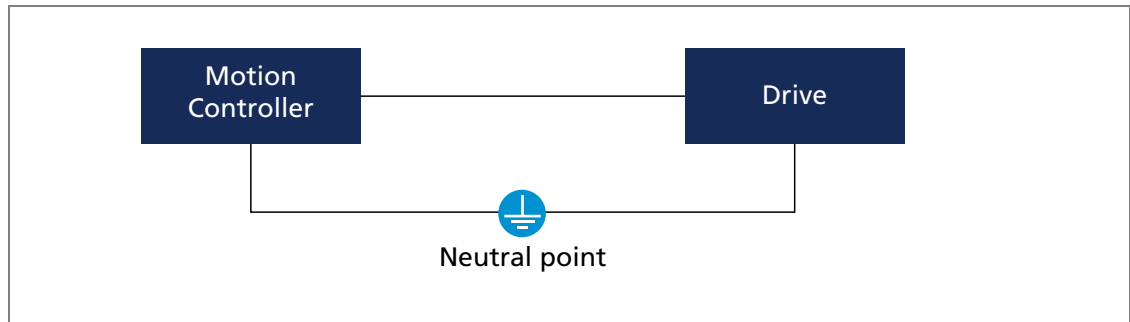


Fig. 9: Potential equalisation between electrically connected parts of the system

### 4.2.2 Connections at the motor side

The maximum length of the cable between the Motion Controller and motor depends on the sensor system used and the electrical and magnetic fields in the environment.

Tab. 7: Guide values for the cable length

Sensor type	Unscreened length	Screened length <sup>1)</sup>
Digital Hall sensors	0.5 m	2–5 m
Analogue Hall sensors	0.5 m	2–5 m
Incremental encoders without line driver	0.5 m	2–5 m
Incremental encoders with line driver	2 m	2–5 m
Absolute encoders without line driver	0.3 m	0.5 m
Absolute encoders with line driver	2 m	5 m

1) applies to cables separately screened from the motor phase power cables.

Longer cables are generally permissible, but must be validated for the target installation.

Optimisation of the behaviour in respect of transient emission and interference resistance may require additional EMC measures (see chap. 4.2.3, p. 23).

## 4 Installation

### 4.2.3 Screening

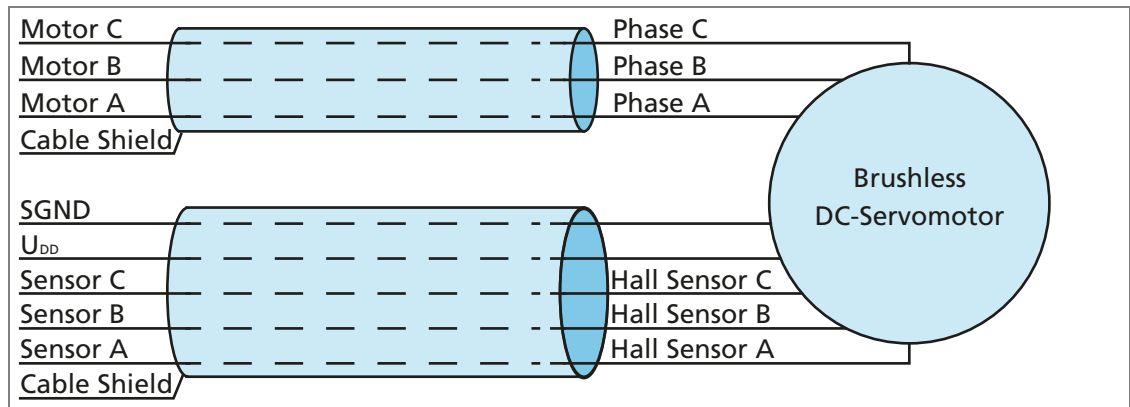


Fig. 10: MC 50xx connection of a BL servomotor

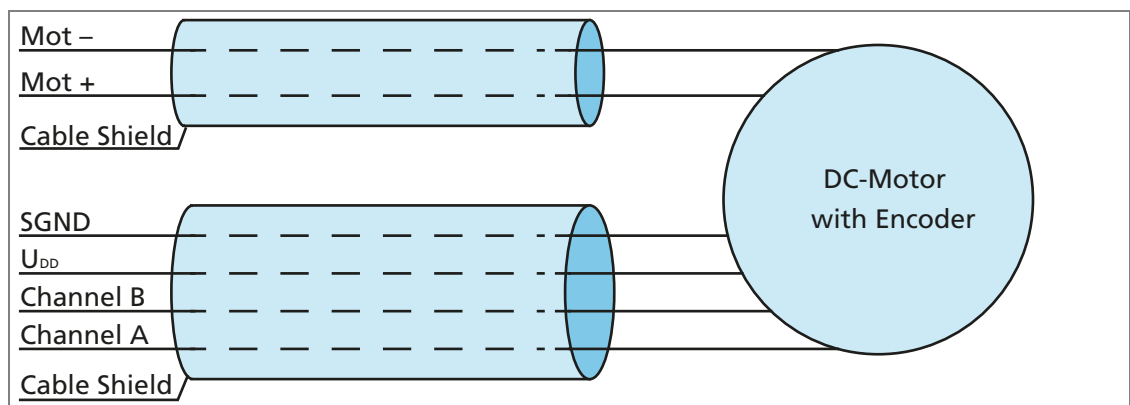


Fig. 11: MC 50xx connection of a DC motor with encoder

- ▶ Connect screen connections for the sensor systems and the motor cables to the Motion Controller to the earthed mounting plate or the screen connection screw on the Motion Controller by the shortest available route.

**i** The best screening effect is achieved if the braiding is laid flat for instance on a screen terminal.

**i** If the installation ensures potential equalisation, the braid can also be attached to an earthed surface on the motor.

Alternatively equalisation currents can also be suppressed by connected the cable screen at the motor end via a capacitor (approx.  $1\mu\text{F} \dots 2\mu\text{F} / 50\text{ V}$ ).

## 4 Installation

### 4.2.4 Connection at the supply side

Connections at the supply side:

- Discrete inputs and outputs (for instance for discrete target values preselection or for connection of limit switches / reference switches)
- Communication connections
- ▶ Make sure that the connection cables to the connection side are not longer than 3 m.
- ▶ Keep the screen connections for connection cables short and flat.

**i** The USB port is a pure configuration connection. A cable length of < 3 m also applies to the USB connection.

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

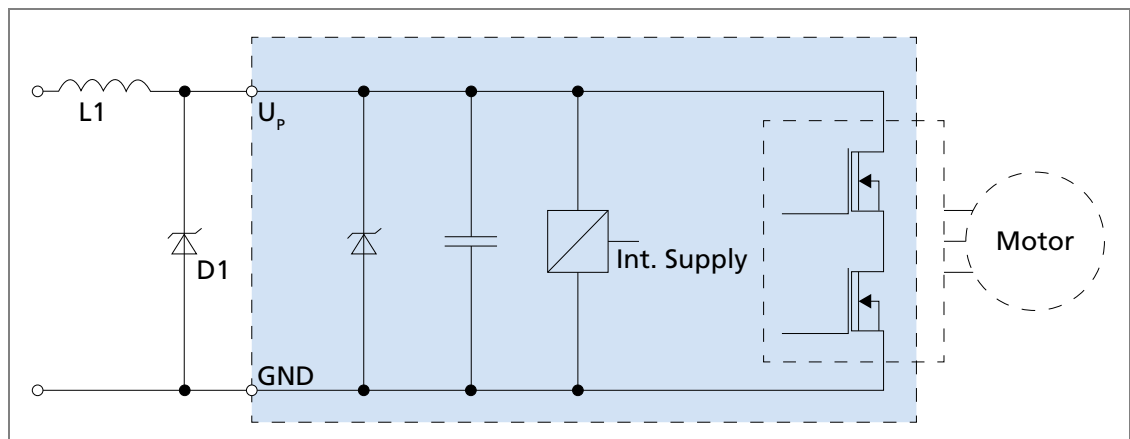


Fig. 12: EMC protective circuit

#### 4.2.4.1 Power supply

- ▶ Connect the Motion Controller to a sufficiently well 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 Controller. Alternatively the overvoltage can be dissipated by an additional external Brake Chopper, see the datasheet for the Brake Chopper.



## 4 Installation

### 4.2.5 Connector pin assignment

#### 4.2.5.1 Pin assignment at the motor side

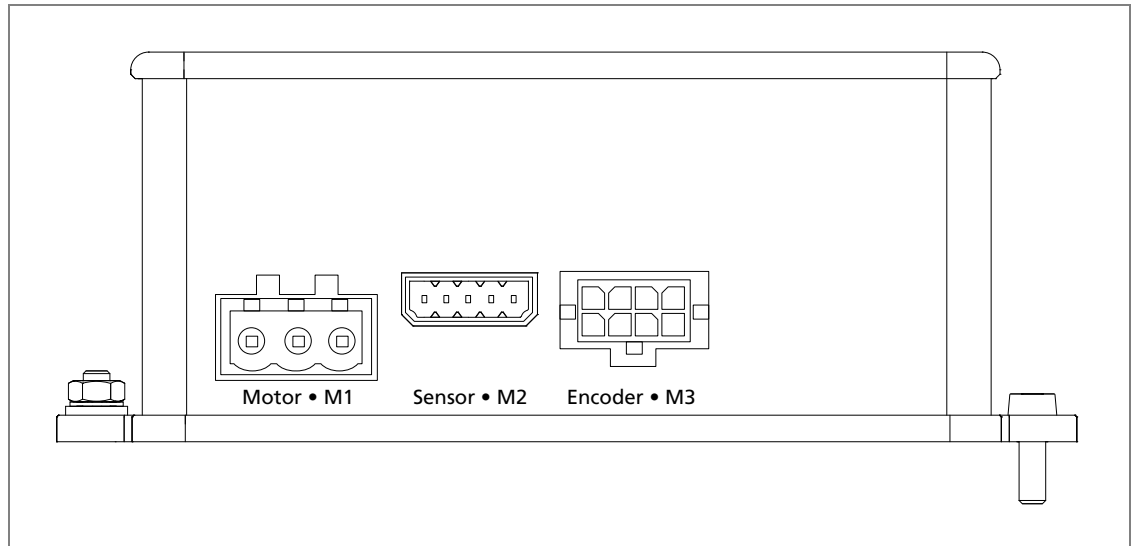
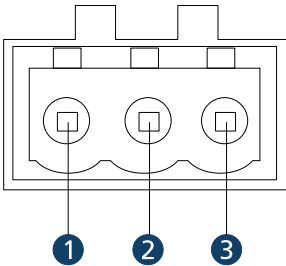


Fig. 13: Connector overview on the motor side

#### Motor connection (M1)

Tab. 8: Pin assignment at the BL motor connection (M1)

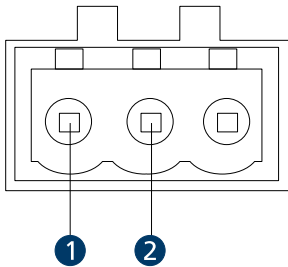
	Pin	Designation	Meaning
	1	Motor A	Connection to motor phase A
	2	Motor B	Connection to motor phase B
	3	Motor C	Connection to motor phase C

Tab. 9: Electrical data for the motor connection (M1)

Designation	Value
Power supply of the motor	$0 \dots U_{\text{mot}}$ max. 5/15 A (type MC 5005) or 10/30 A (type MC 5010) 100 kHz

## 4 Installation

Tab. 10: Pin assignment at the DC motor connection (M1)

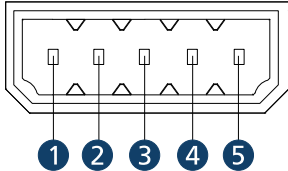
	Pin	Designation	Meaning
	1	Motor +	Connection to the motor plus pole
	2	Motor –	Connection to the motor minus pole

Tab. 11: Electrical data for the DC motor connection (M1)

Designation	Value
Power supply of the motor	$0 \dots U_{\text{mot}}$ max. 5/15 A (type MC 5005) or 10/30 A (type MC 5010) 100 kHz

### Sensor connection (M2)

Tab. 12: Pin assignment at the sensor connection (M2)

	Pin	Designation	Meaning
	1	$U_{\text{DD}}$	Power supply for the sensor
	2	GND	Ground
	3	Sensor A	Hall sensor A
	4	Sensor B	Hall sensor B
	5	Sensor C	Hall sensor C

Tab. 13: Electrical data for the sensor connection (M2)

Designation	Value
Power supply for sensor	5 V <100 mA
Connection port for sensor	<5 V

## 4 Installation

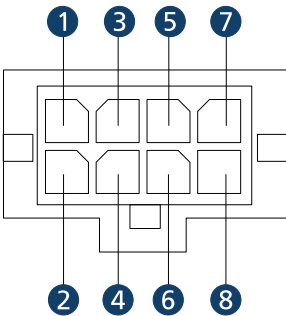
### Encoder connection (M3)



The pin assignment of the encoder connector varies depending on the encoder type.

- Incremental encoder with or without line driver
- Absolute encoder with or without line driver.

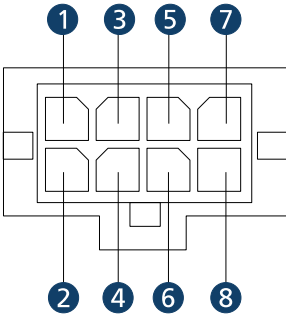
Tab. 14: Pin assignment for incremental encoders with line driver (M3)

	Pin	Designation	Meaning
	1	$U_{DD}$	Power supply for the incremental encoder
	2	GND	Ground
	3	$\overline{\text{Channel A}}$	Encoder channel A (logically inverted signal)
	4	Channel A	Encoder channel A
	5	$\overline{\text{Channel B}}$	Encoder channel B (logically inverted signal)
	6	Channel B	Encoder channel B
	7	$\overline{\text{Index}}$	Encoder index (logically inverted signal)
	8	Index	Encoder Index

Tab. 15: Electrical data for incremental encoders with line driver (M3)

Designation	Value
Power supply for incremental encoder	5 V <100 mA
Connection port for incremental encoder	<5 V <2 MHz 5 k $\Omega$

Tab. 16: Pin assignment for incremental encoders without line driver (M3)

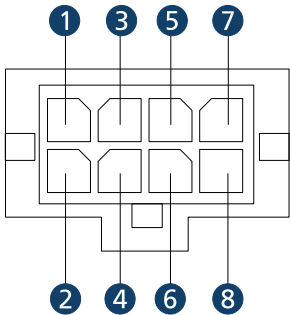
	Pin	Designation	Meaning
	1	$U_{DD}$	Power supply for the incremental encoder
	2	GND	Ground
	3	$\overline{\text{Channel A}}$	n.c.
	4	Channel A	Encoder channel A
	5	$\overline{\text{Channel B}}$	n.c.
	6	Channel B	Encoder channel B
	7	$\overline{\text{Index}}$	n.c.
	8	Index	Encoder Index

## 4 Installation

Tab. 17: Electrical data for incremental encoders without line driver (M3)

Designation	Value
Power supply for incremental encoder	5 V <100 mA
Connection port for incremental encoder	<5 V <2 MHz 5 k $\Omega$

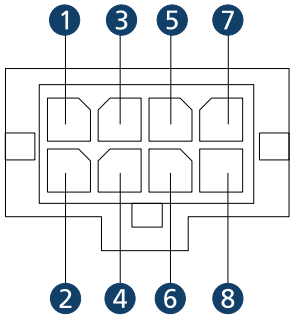
Tab. 18: Pin assignment for absolute encoders with line driver (M3)

	Pin	Designation	Meaning
	1	$U_{DD}$	Power supply for absolute encoders
	2	GND	Ground
	3	$\overline{CS}$	Command specifier for absolute encoders (logically inverted signal)
	4	CS	Command specifier for absolute encoders
	5	$\overline{Data}$	Data for absolute encoders (logically inverted signal)
	6	Data	Data for absolute encoders
	7	$\overline{CLK}$	Clock for absolute encoders (logically inverted signal)
	8	CLK	Clock for absolute encoders

Tab. 19: Electrical data for absolute encoders with line driver (M3)

Designation	Value
Absolute encoder power supply	5 V <100 mA
Command specifier connection port	5 V
Connection port for data	<5 V 5 k $\Omega$
Connection port for clock	5 V 1 MHz

Tab. 20: Pin assignment for absolute encoders without line driver (M3)

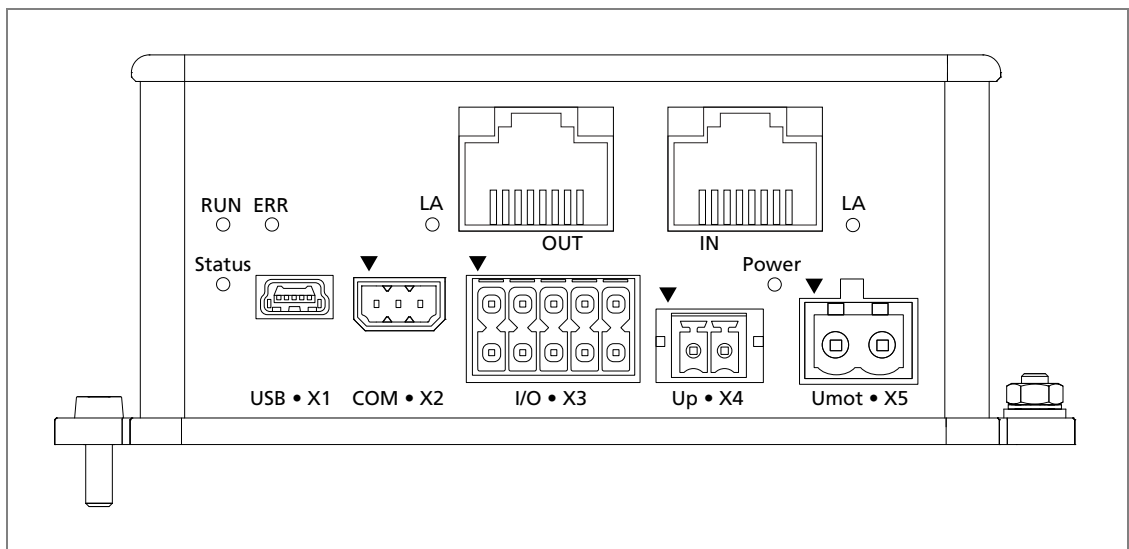
	Pin	Designation	Meaning
	1	$U_{DD}$	Power supply for absolute encoders
	2	GND	Ground
	3	$\overline{CS}$	n.c.
	4	CS	Command specifier for AES
	5	$\overline{Data}$	n.c.
	6	Data	Data for AES
	7	$\overline{CLK}$	n.c.
	8	CLK	Clock for AES

## 4 Installation

*Tab. 21: Electrical data for absolute encoders without line driver (M3)*

Designation	Value
Absolute encoder power supply	5 V <100 mA
Command specifier connection port	5 V
Connection port for data	<5 V 5 kΩ
Connection port for clock	5 V 1 MHz

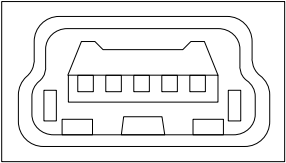
### 4.2.5.2 Pin assignment at the supply side



*Fig. 14: Connector overview on the supply side*

### USB port (X1)

*Tab. 22: Pin assignment at the USB port (X1)*

	Designation	Meaning
	USB	USB communication

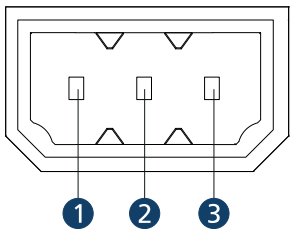
## 4 Installation

### COM port (X2)

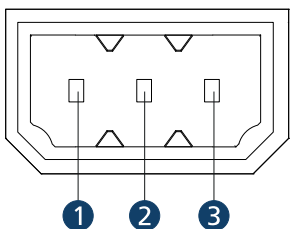
**i** The pin assignment at the COM port differs according to the type of communication. The distinction is made between the following types of communication:

- RS232
- CANopen

*Tab. 23: Pin assignment at the USB port (X2) for RS232*

	Pin	Designation	Meaning
	1	TxD	RS232 interface transmit direction
	2	RxD	RS232 interface receive direction
	3	GND	Ground

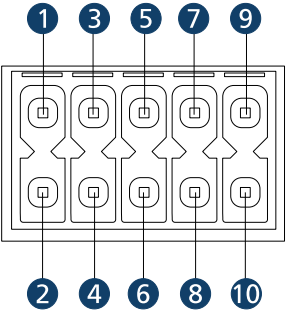
*Tab. 24: Pin assignment at the USB port (X2) for CANopen*

	Pin	Designation	Meaning
	1	CAN-H	CAN-High interface
	2	CAN-L	CAN-Low interface
	3	GND	Ground

## 4 Installation

### I/O port (X3)

Tab. 25: Pin assignment at the I/O port (X3)

	Pin	Designation	Meaning
	1	$U_{DD}$	Power supply for external consumer load
	2	GND	Ground
	3	DigOut 1	Digital output (open collector)
	4	DigOut 2	Digital output (open collector)
	5	DigIn 1	Digital input
	6	DigIn 2	Digital input
	7	DigIn 3	Digital input
	8	AnIn 1	Analogue input
	9	AnIn 2	Analogue input
	10	AGND	Group connection for analogue inputs

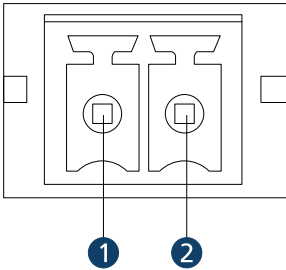
Tab. 26: Electrical data for the I/O port (X3)

Designation	Value
Power supply for external consumer load	5 V <100 mA
DigOut	low = GND high = high resistance 47 k $\Omega$ max. 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 47 k $\Omega$ <1 MHz
AnIn	$\pm 10$ V AGND

## 4 Installation

### Power supply of the controller (X4)

Tab. 27: Pin assignment for the power supply of the controller (X4)

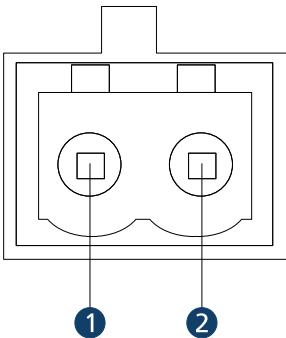
	Pin	Designation	Meaning
	1	GND	Ground
	2	$U_p$	Power supply of the controller

Tab. 28: Electrical data for the power supply (X4)

Designation	Value
Power supply for controller	12–50 V ≤100 mA (without external consumer load)

### Power supply of the motor (X5)

Tab. 29: Pin assignment for the power supply of the motor (X5)

	Pin	Designation	Meaning
	1	GND	Ground
	2	$U_{mot}$	Power supply of the motor

Tab. 30: Electrical data for the power supply (X5)

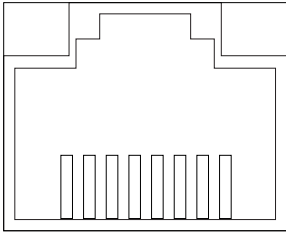
Designation	Value
Power supply of the motor	≤50 V



## 4 Installation

### EtherCAT port (IN/OUT)

*Tab. 31: EtherCAT pin assignment (IN/OUT)*

	Designation	Meaning
	IN/OUT	EtherCAT communication Pin 1: TxD+ Transmit data + Pin 2: TxD- Transmit data - Pin 3: RxD+ Receive data + Pin 6: RxD- Receive data -

## 4 Installation

### 4.2.6 Connection at the motor side

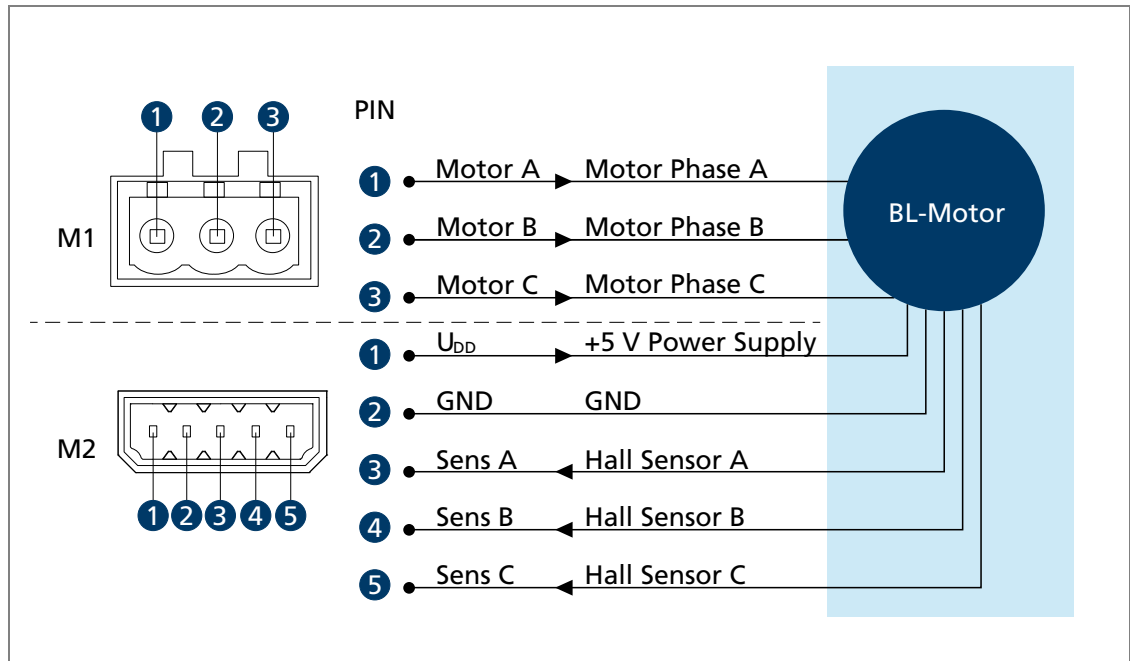


Fig. 15: BL/LM motor with Hall sensors

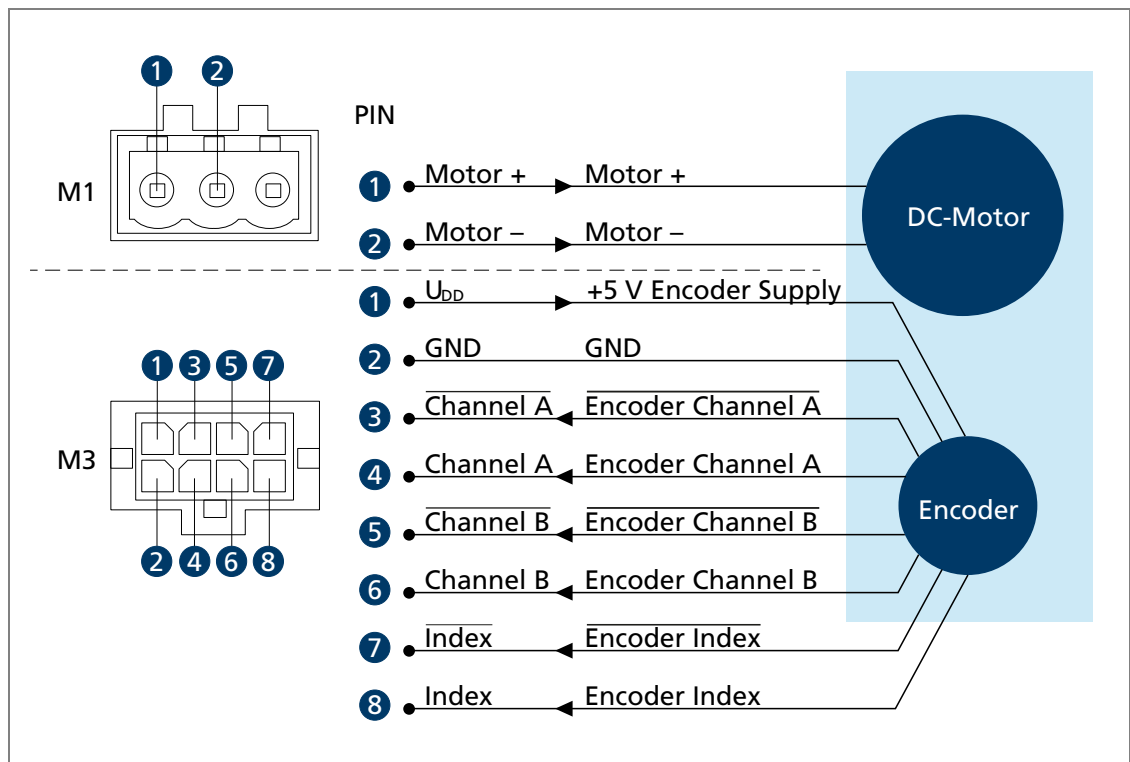


Fig. 16: DC motor with incremental encoder

## 4 Installation

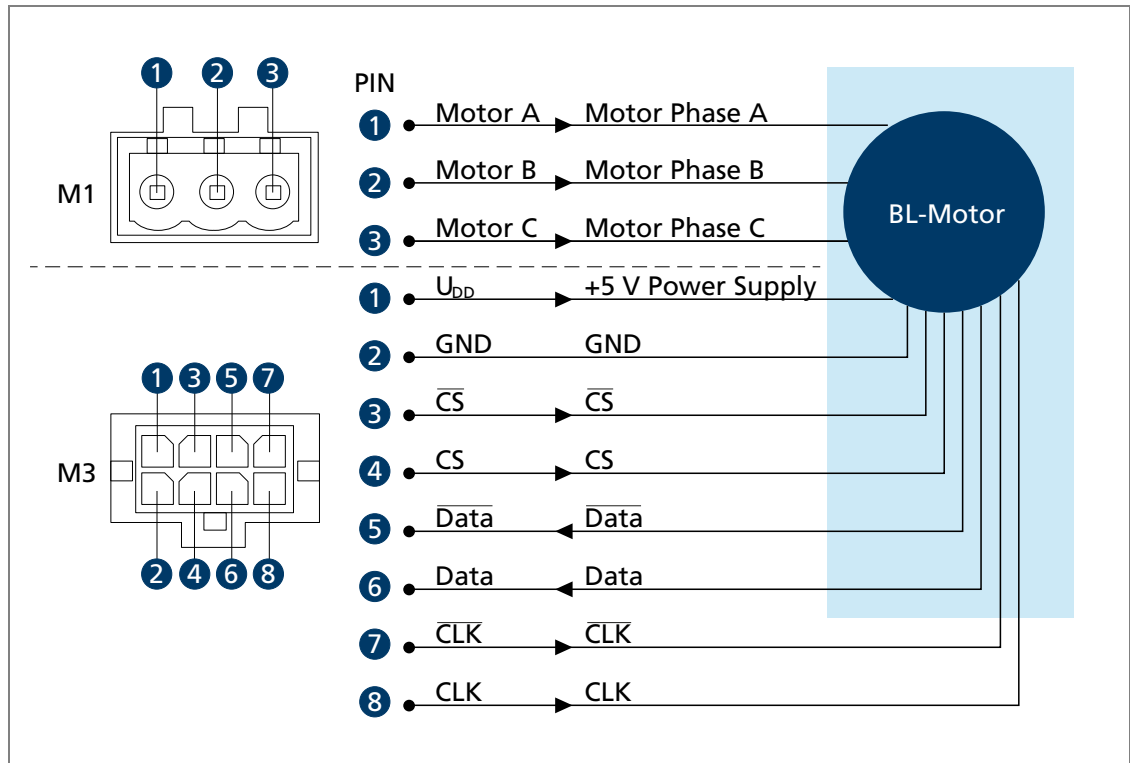


Fig. 17: BL motor with absolute encoder

## 4 Installation

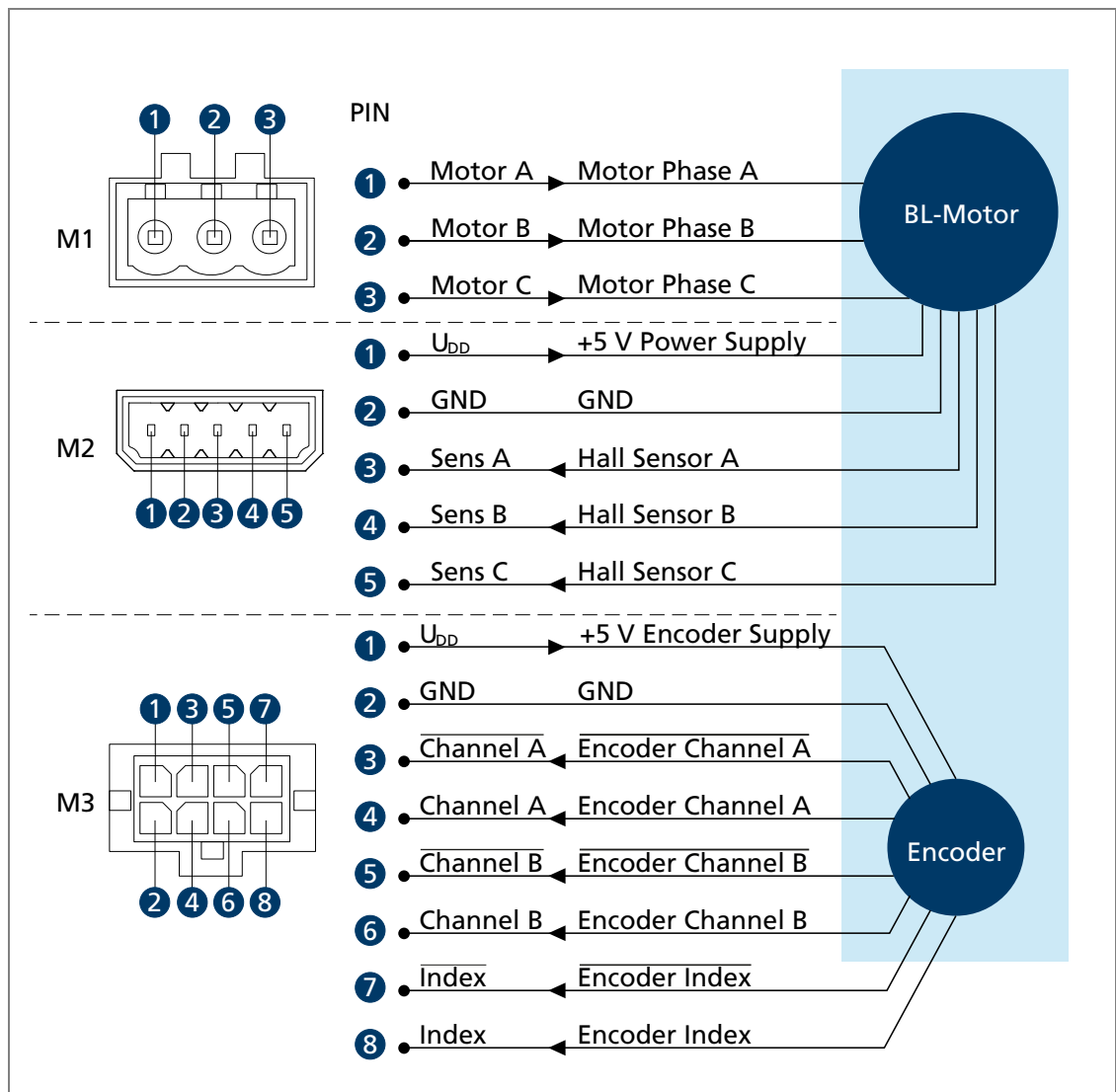


Fig. 18: BL motor with Hall sensors and incremental encoder

## 4 Installation

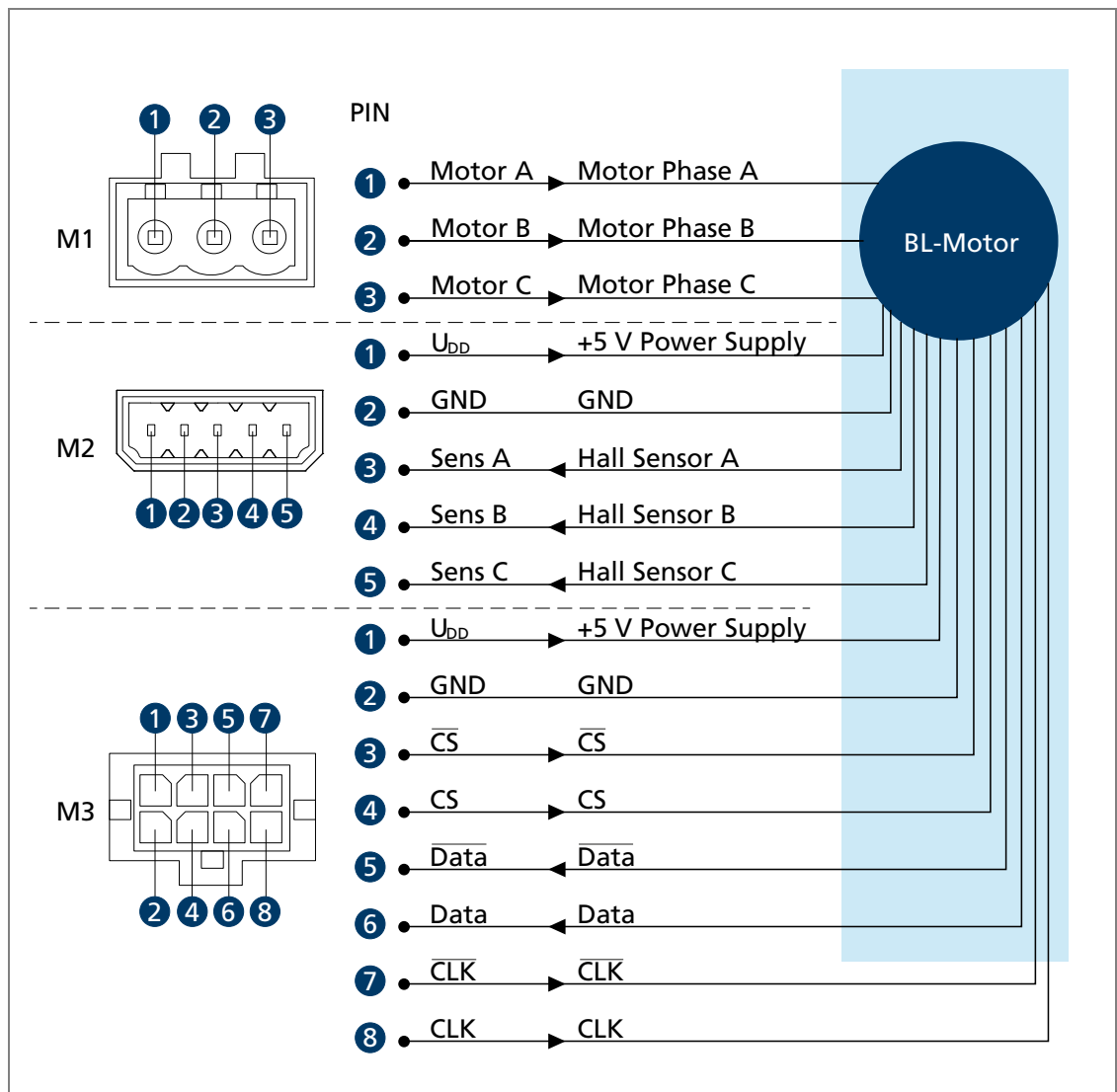


Fig. 19: BL motor with Hall sensors and absolute encoder

## 4 Installation

### 4.2.7 I/O circuit diagrams

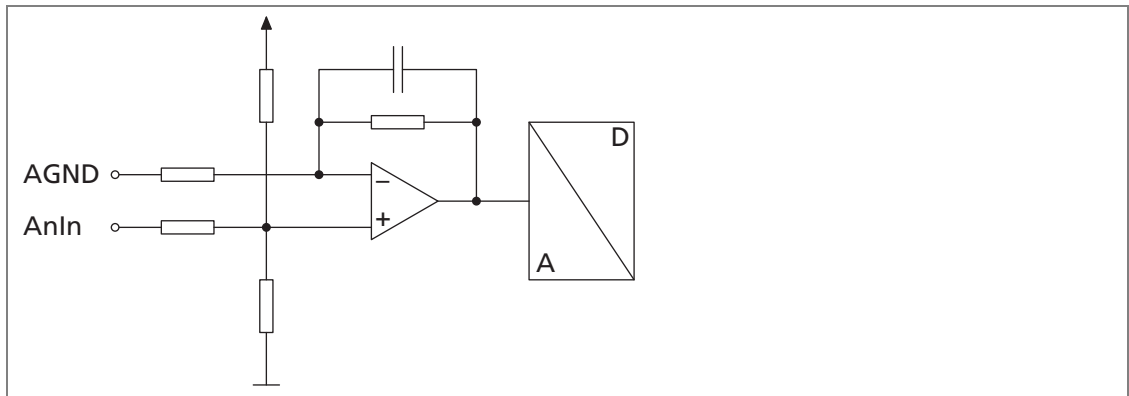


Fig. 20: Analogue input circuit diagram (internal)



So that the voltage drop on the supply side does not affect the setpoint velocity value, connect the analogue input ground (AGND) to the power supply ground (GND).

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

The analogue inputs can be used flexibly:

- Setpoint values for current, speed or position
- Connection of actual value sensors for speed or position
- Use as a free measurement input (monitored via the interface)

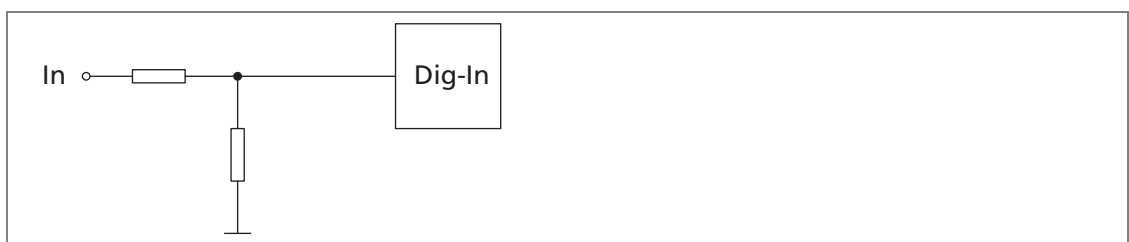
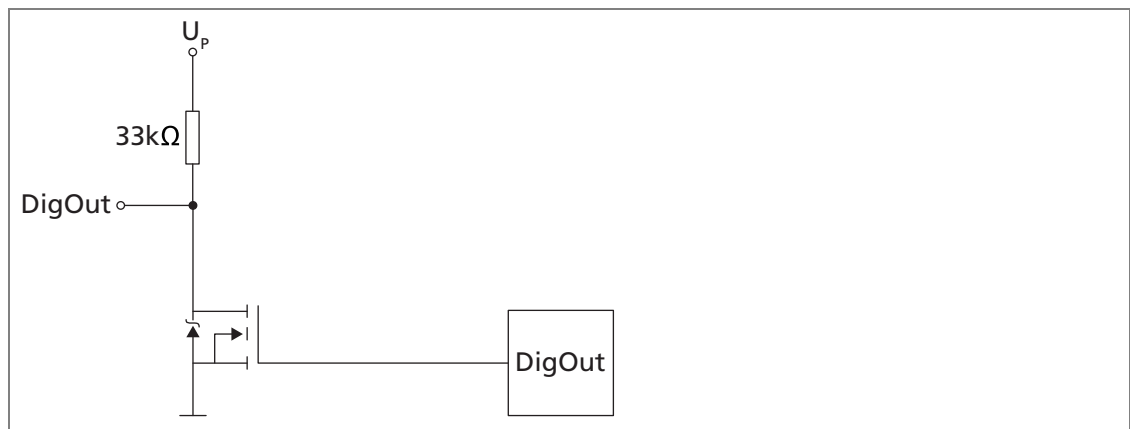


Fig. 21: Digital input circuit diagram (internal)

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

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

## 4 Installation



*Fig. 22: 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)

A digital output can be assigned to an error output. It can be configured for the following purposes:

- Pulsed output
- Digital output (freely programmable)

## 4 Installation

### 4.2.8 External circuit diagrams

#### Bipolar analogue setpoint value specification via potentiometer

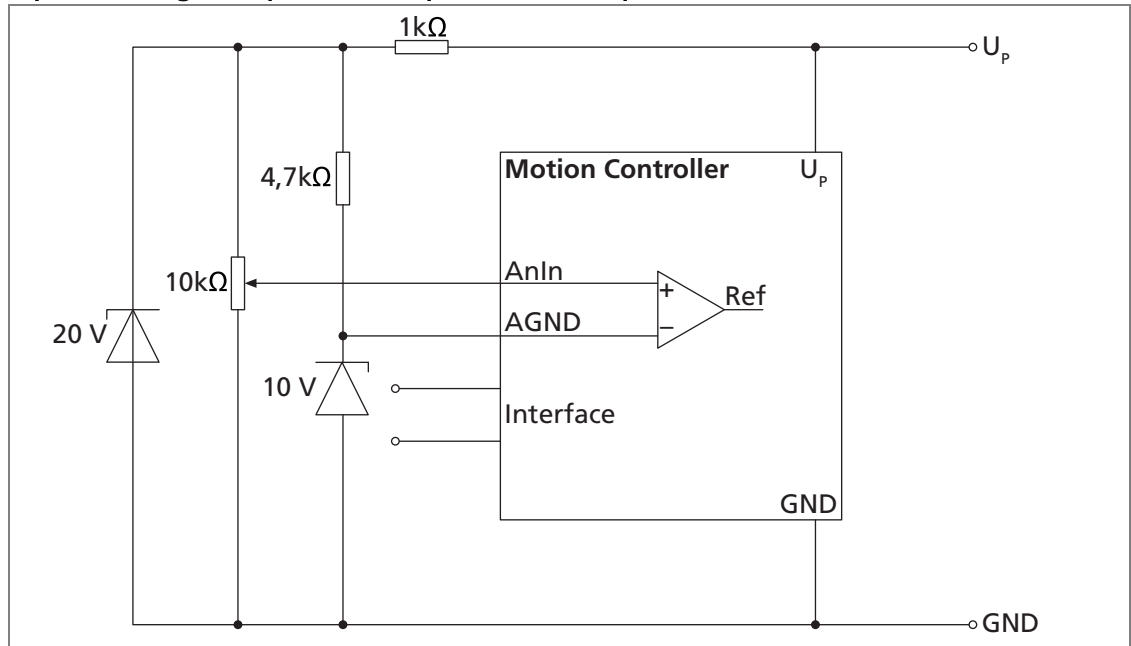


Fig. 23: Bipolar analogue setpoint value specification via potentiometer

#### Analogue setpoint value specification via potentiometer with internally set offset and scaling

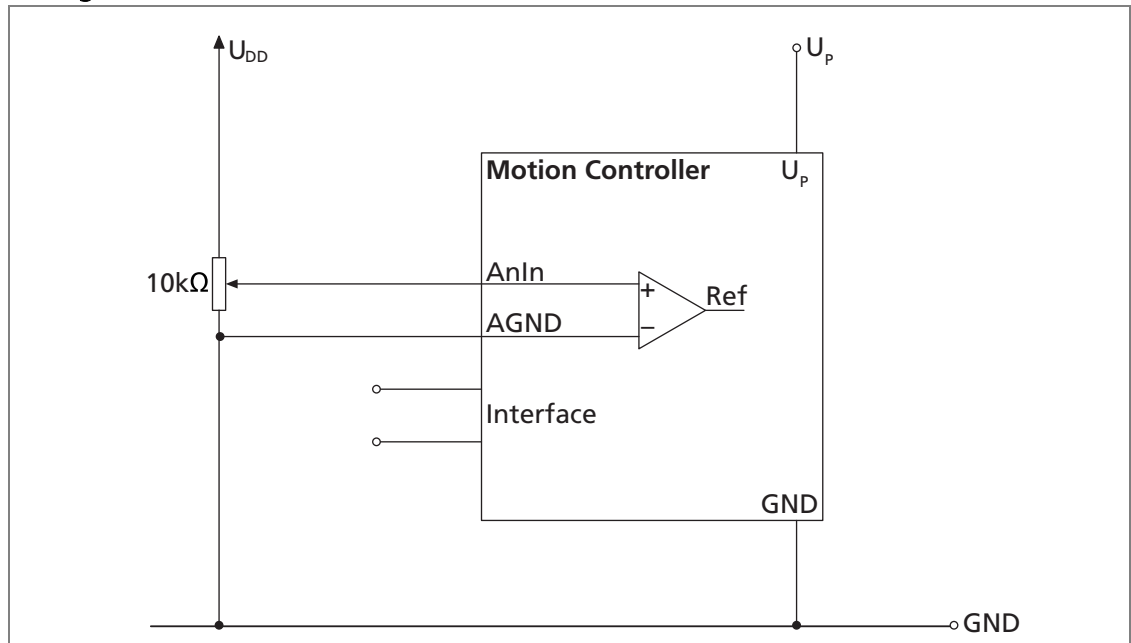


Fig. 24: Analogue setpoint value specification via potentiometer with internally set offset and scaling



## 4 Installation

### Connection of reference and limit switches

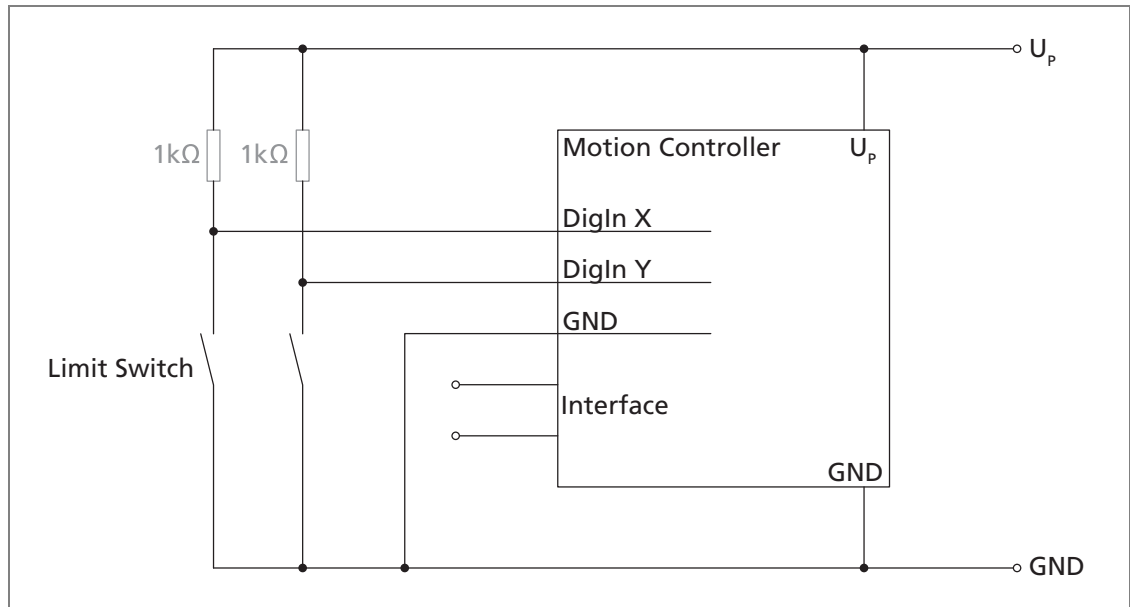


Fig. 25: Connection of reference and limit switches



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

### Connection of an external incremental encoder

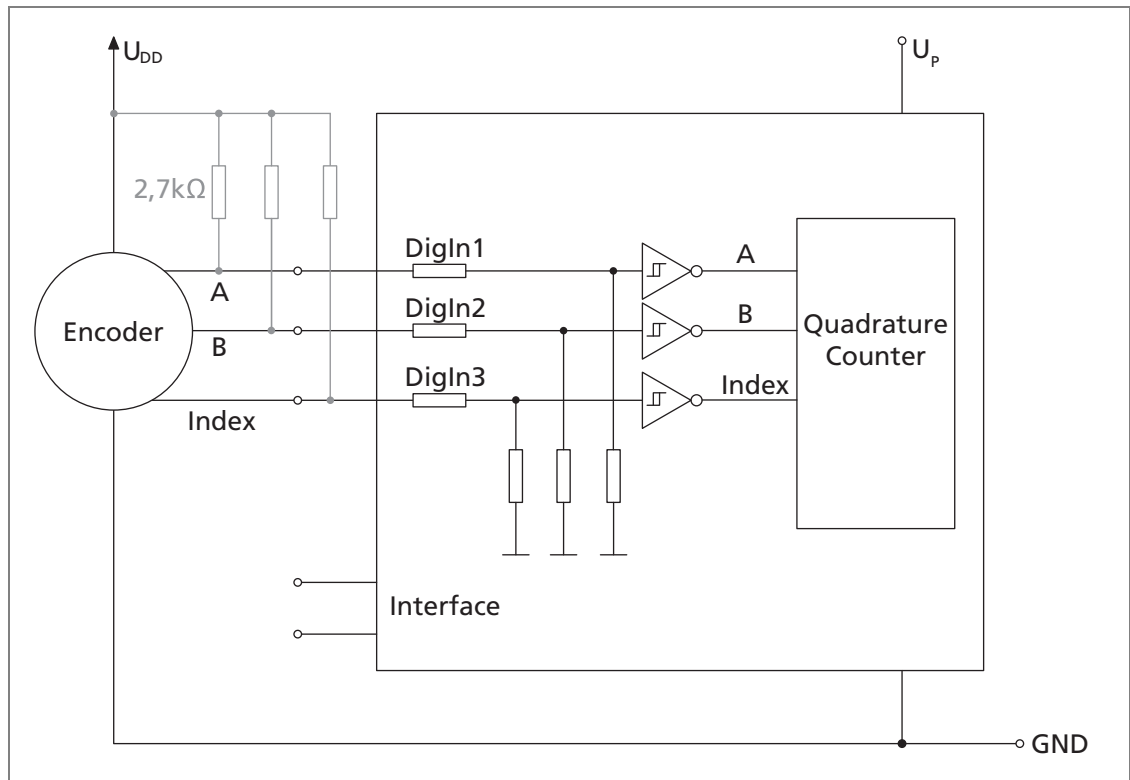


Fig. 26: Connection of an external incremental encoder

## 4 Installation

**i** Depending on the type of encoder it may be necessary to fit additional pull-up resistors. No internal pull-up resistors are incorporated in the Motion Controller.

### Wiring between PC/controller and a drive

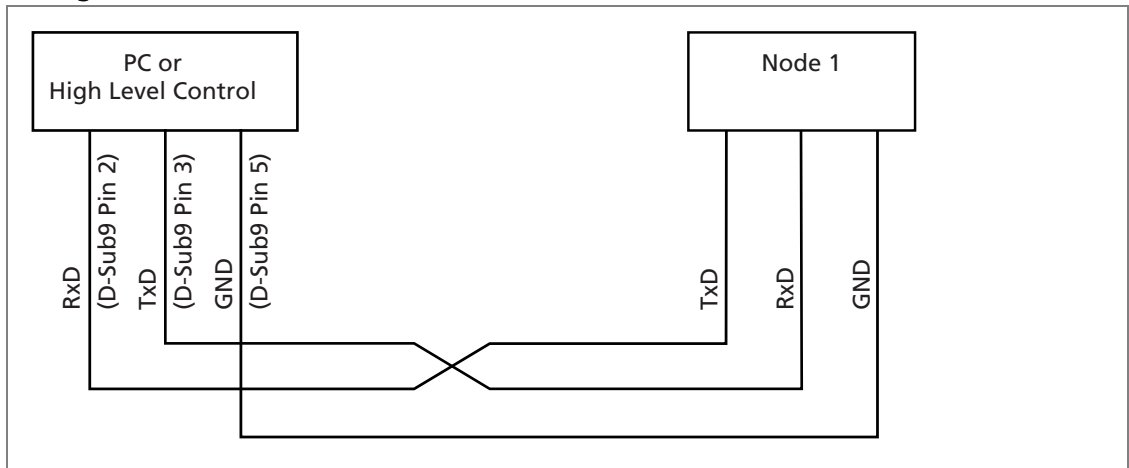


Fig. 27: Wiring between PC/controller and a drive

### Wiring with several Motion Control systems in RS232 network operation

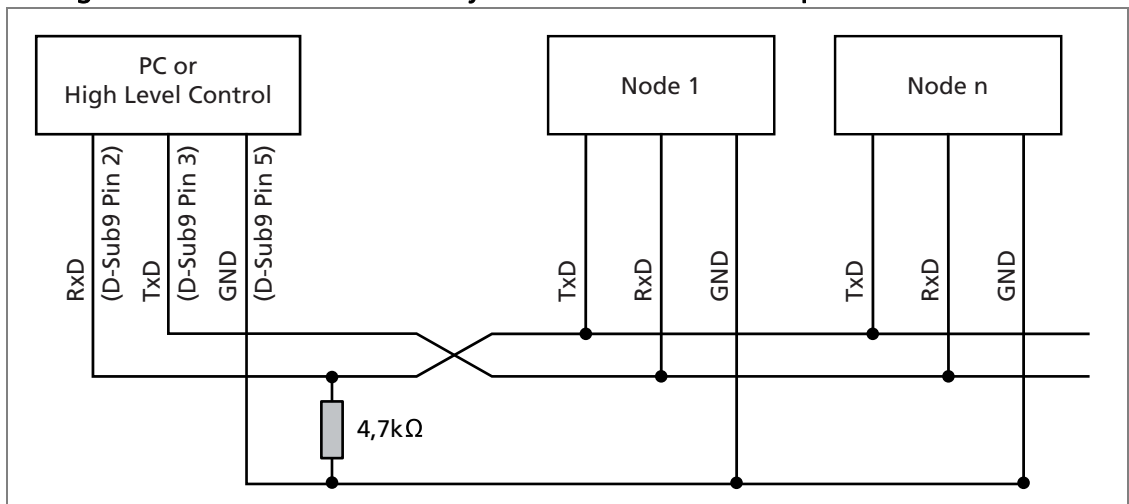


Fig. 28: Wiring with several Motion Control systems in RS232 network operation

**i** Depending on the number of networked controllers a smaller value may be necessary for the pull-down resistor.

## 4 Installation

Connection to the CANopen network

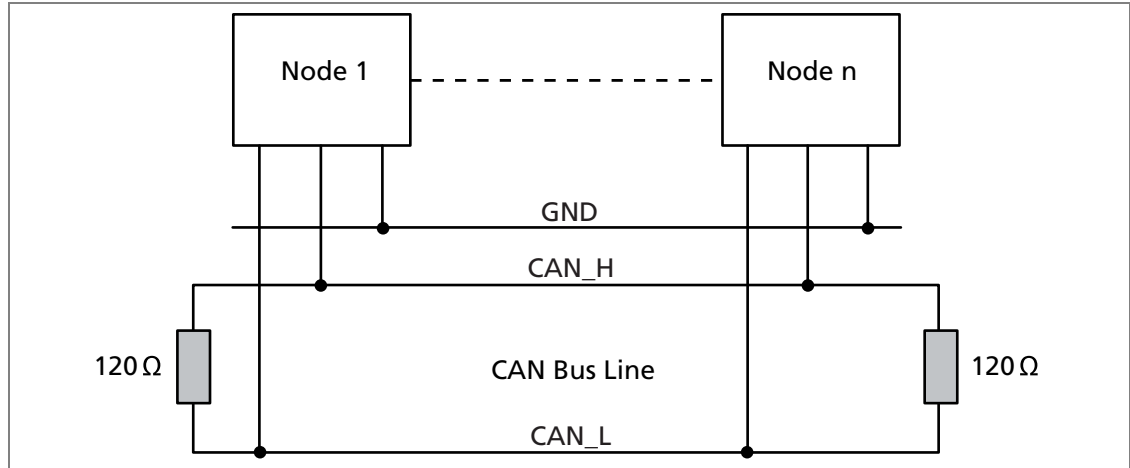


Fig. 29: Connection to the CANopen network

**i** If the CAN cabling is not laid in a straight line it may be necessary to optimise the value 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.

## 5 Maintenance and diagnostics

### 5 Maintenance and diagnostics

#### 5.1 Maintenance instructions



##### NOTICE!

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

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

#### 5.2 Maintenance activities

The drive 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 as necessary.

#### 5.3 Diagnostics

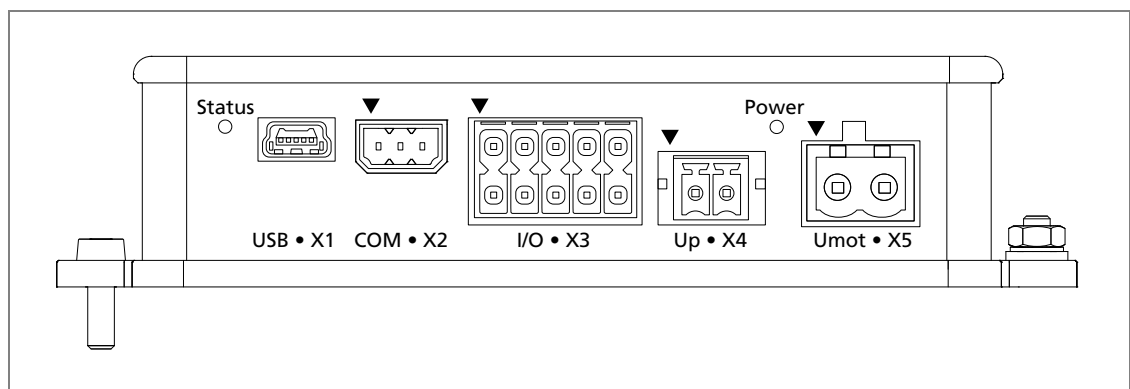


Fig. 30: LEDs on the supply side of the standard format

Tab. 32: LED overview

Designation	Function
Status LED	<ul style="list-style-type: none"> <li>Green (continuous): Device active.</li> <li>Green (flashing): Device active. However the state machine has not yet reached the state <i>Operation Enabled</i>.</li> <li>Red (continuously flashing): The drive has switched to a fault state. The output stage will be switched off or has already been switched off.</li> <li>Red (Error code): Boot procedure failed. Please contact FAULHABER Support.</li> </ul>
Power LED	<ul style="list-style-type: none"> <li>Green: Power supply within the permissible range.</li> <li>Off: Power supply not within the permissible range.</li> </ul>

## 5 Maintenance and diagnostics

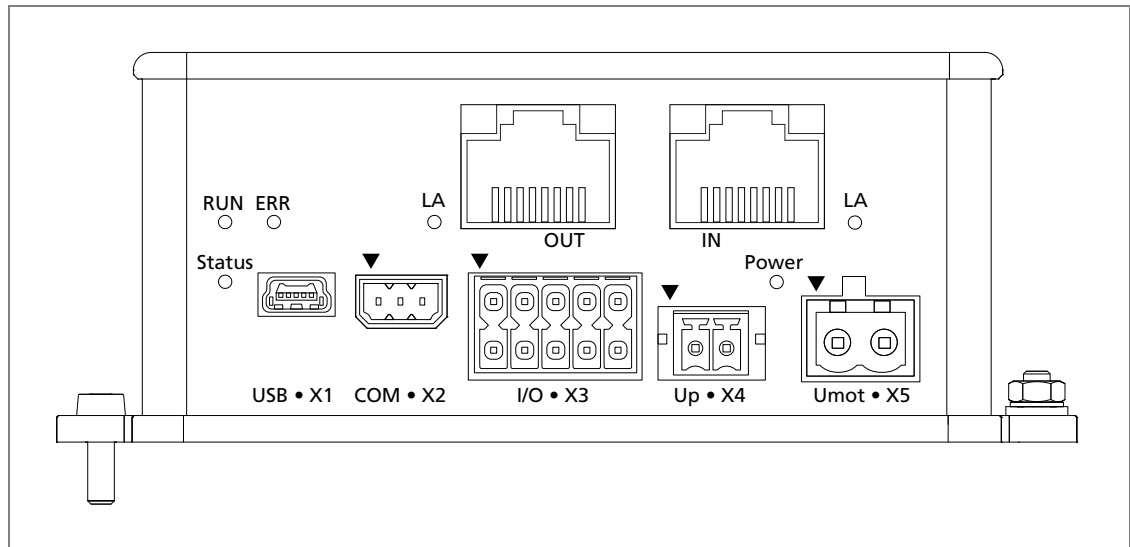


Fig. 31: LEDs on the supply side of the extended format

Tab. 33: LED overview

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

### 5.4 Troubleshooting

If despite the device being used properly nevertheless malfunctions occur, contact your responsible support partner.

## 6 Accessories

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### 6 Accessories

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

- Connection cables
- Connectors
- Connector sets
- Installation materials
- Additional equipment

## 7 Warranty

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### **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/agb](http://www.faulhaber.com/agb) and downloaded from it.

