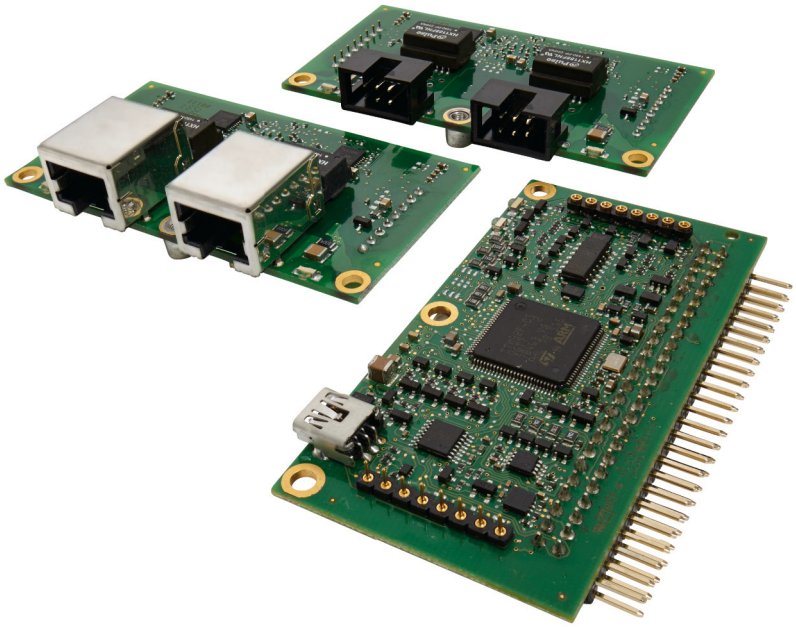
FAULHABER

Technical Manual

MC 5004



WE CREATE MOTION

EN

Imprint

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

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

Subject to change without notice.

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

FAULHABER

Content

1 About this document

1.1 Validity of this document

This document describes the installation and use of the MC 5004.

This document is intended for use by trained experts authorised 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 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 Controllers
Drive functions	Description of the operating modes and functions of the drive
Accessories manual	Description of the accessories

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

1.3 Using this document

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

1.4 List of abbreviations

Abbreviation	Meaning
AC	Alternating Current
AES	Absolute encoder
AGND	Analogue Ground
AnIn	Analogue Input
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
DIP	Dual In-Line Package
EMC	Electromagnetic compatibility
ESD	Electrostatic discharge
ET	EtherCAT (Ethernet for Control Automation Technology)
GND	Ground
I/O	Input/Output
LA	Status LED EtherCAT
MC	Motion Controller
Mot	Motor
n.c.	not connected
PWM	Pulse Width Modulation
RxD	Receive Data
SGND	Signal ground
TxD	Transmit data

1.5 Symbols and markers

CAUTION!
Hazards due to hot surfaces. Disregard may lead to burns.

- Measures for avoidance

NOTICE!
Risk of damage.

- Measures for avoidance

Instructions for understanding or optimising 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 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 micro motors
- Linear DC-Servomotors
- Brushless DC motors

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

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

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

- The Motion Controller contains electronic components and should be handled in accordance with the ESD regulations.
- Do **not** use 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.

2.2 Safety instructions

NOTICE!
Electrostatic discharges can damage the electronics.

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

NOTICE!
Foreign bodies can damage the electronics.

- Keep foreign bodies away from the electronics.

NOTICE!
Inserting and withdrawing connectors 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 device.

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

2.4 EC directives on product safety

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

Machinery Directive (2006/42/EC)
Because of their small size, no serious threats to life or physical condition can normally be expected from electric miniature drives. Therefore the Machinery Directive does not apply to our products. The products described here are not "incomplete machines". Therefore installation instructions are not normally issued by FAULHABER.

Low Voltage Directive (2014/35/EU)
The Low Voltage Directive applies for all electrical equipment with a nominal voltage of 75 to 1500 V DC and 50 to 1000 V AC. The products described in this technical 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, 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.

3 Product description

3.1 General product description

The MC 5004 products are unhoused 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. The Motion Controller operates within the network 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 can be connected to a motherboard by means of the 50-pin edge connector. FAULHABER offers a motherboard capable for connecting up to four MC 5004 controllers.

The built-in output stages with optimised current measurement can be configured for DC, BL and LM motors in the range 08 – 32 mm, as listed in the FAULHABER product portfolio.

The following connections are available on the edge connector:

- Communications interfaces
- Common or separate power supplies between motor and controller
- Various inputs and outputs
- Motor phases
- Feedback components such as:
  - Digital/analogue Hall sensors
  - Incremental encoders with or without line drivers.

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

3.2 Product information

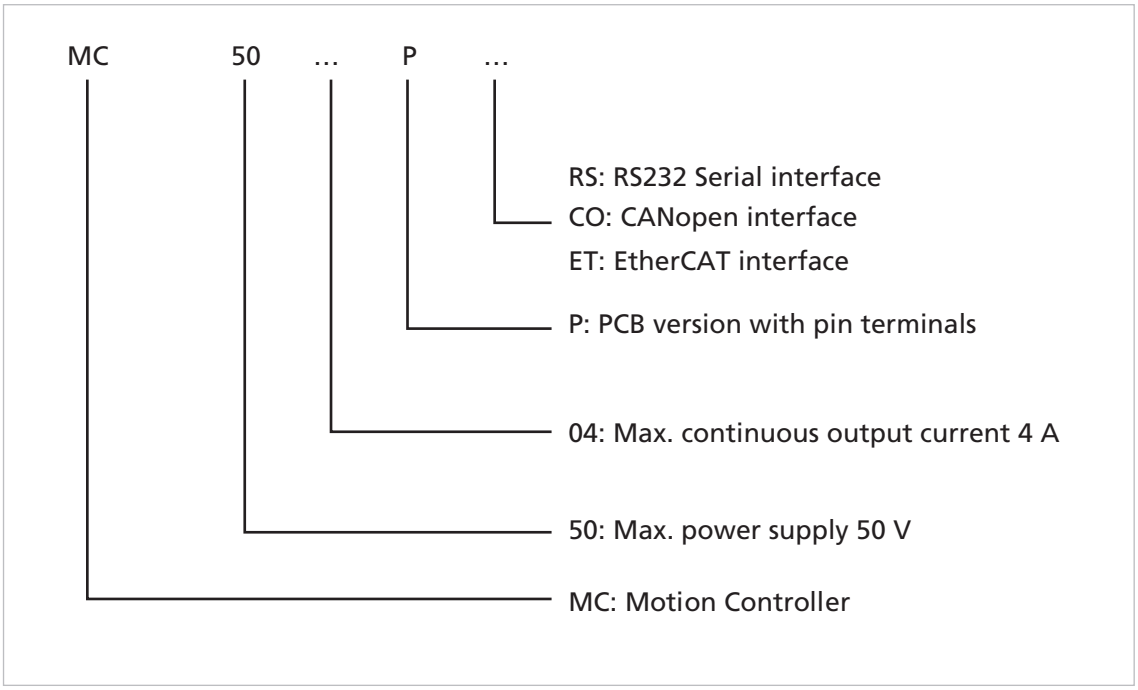


Fig. 1: Designation key

3.3 Product variants

The following product variants are available:

- MC 5004 P RS/CO
- MC 5004 P ET

The Motion Controller circuit boards can be plugged into a motherboard. The FAULHABER motherboard can accommodate up to four Motion Controller circuit boards.

3.3.1 Controller circuit boards

3.3.1.1 Standard circuit board

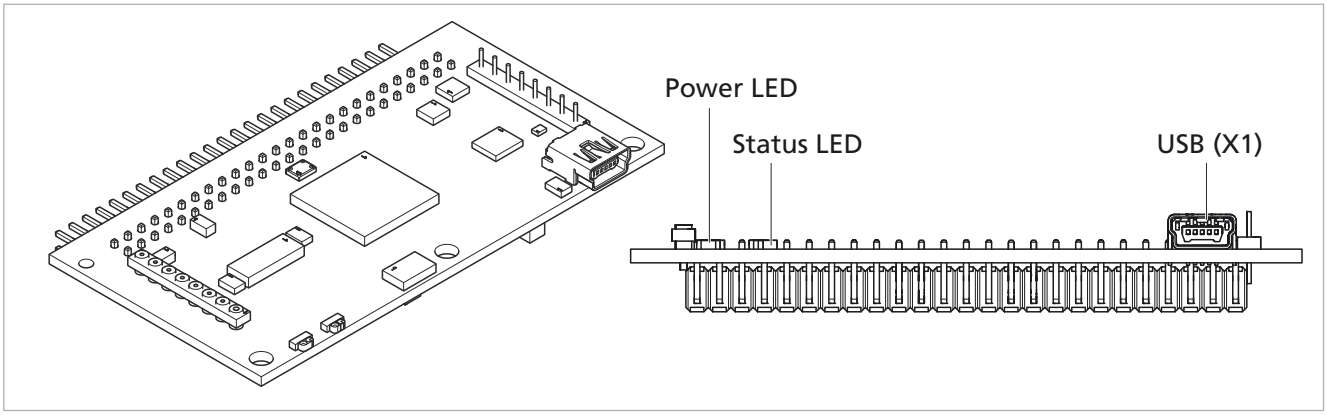


Fig. 2: ISO view (left) and front elevation (right) of the standard circuit board

Tab. 1: Connector overview

Designation	Function
USB (X1)	Connection of the USB communication

Tab. 2: LED overview

Designation	Function
Status LED	▪ Green (continuous): Device active. ▪ Green (flashing): Device active. However the state machine has not yet reached the *Operation Enabled* 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): Boot procedure failed. Please contact FAULHABER Support.
Power LED	▪ Green: Power supply within the permissible range. ▪ Off: Power supply not within the permissible range.

3.3.1.2 Circuit board with vertical plug connector (option 5621)

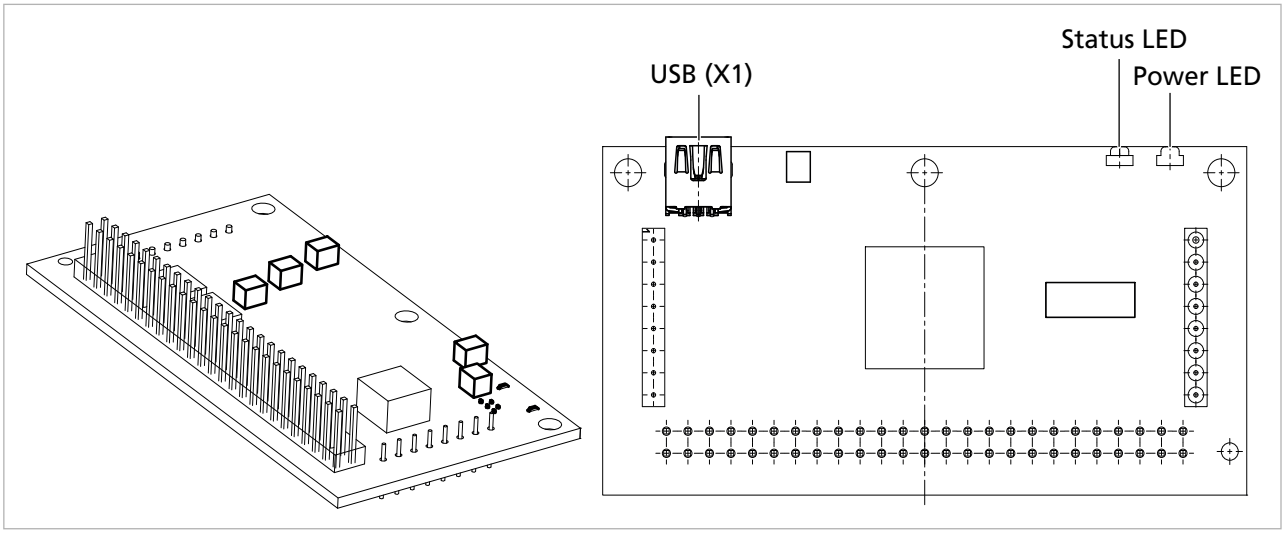


Fig. 3: ISO view (left) and plan view (right) of the circuit board with vertical plug connector

Tab. 3: Connector overview

Designation	Function
USB (X1)	Connection of the USB communication

Tab. 4: LED overview

Designation	Function
Status LED	▪ Green (continuous): Device active. ▪ Green (flashing): Device active. However the state machine has not yet reached the *Operation Enabled* 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): Boot procedure failed. Please contact FAULHABER Support.
Power LED	▪ Green: Power supply within the permissible range. ▪ Off: Power supply not within the permissible range.

3.3.1.3 EtherCAT circuit board

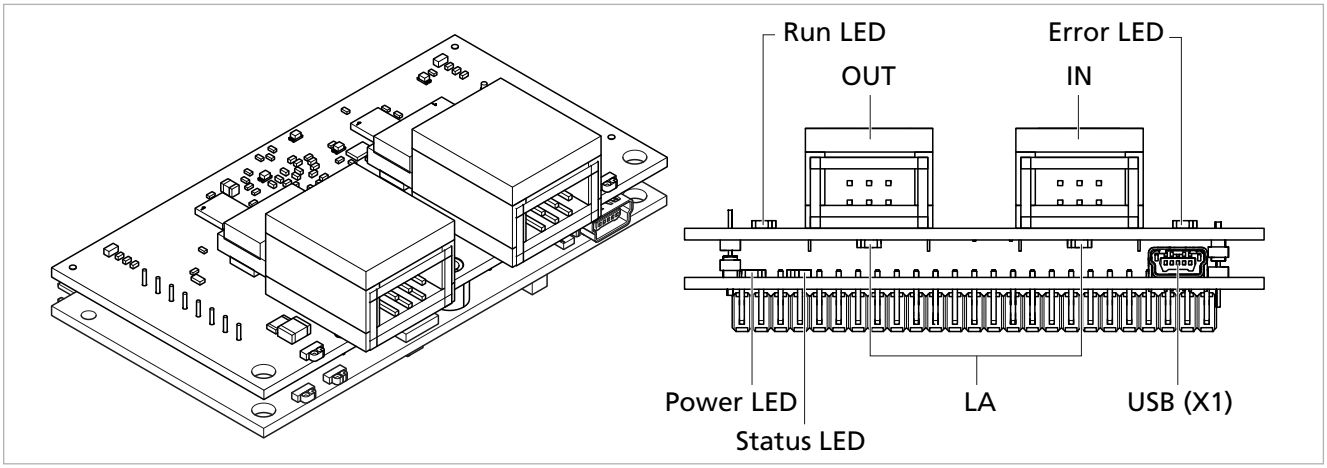


Fig. 4: ISO view (left) and front elevation (right) of the plugged-in EtherCAT circuit board

Tab. 5: Connector overview

Designation	Function
IN/OUT	Connection of the EtherCAT communication
USB (X1)	Connection of the USB communication

Tab. 6: LED overview

Designation	Interface	Function
Status LED	all	▪ Green (continuous): Device active. ▪ Green (flashing): Device active. However the state machine has not yet reached the *Operation Enabled* 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): Boot procedure failed. Please contact FAULHABER Support.
Power LED	all	▪ Green: Power supply within the permissible range. ▪ Off: Power supply not within the permissible range.
RUN LED	EtherCAT	▪ Green (continuous): Connection available. Device is ready for operation. ▪ Green (flashing): Device is in the *Pre-Operational* state. ▪ Green (single flash): Device is in the *Safe-Operational* state. ▪ Off: Device is in the *Initialisation* state.
ERR LED	EtherCAT	▪ Red (flashing): Defective configuration. ▪ Red (single flash): Local error. ▪ Red (double flash): Watchdog timeout. ▪ Off: No connection error
LA LED	EtherCAT	▪ Green (continuous): No data transfer. Connection to another participant has been established. ▪ Green (flashing): Data transfer active. ▪ Off: No data transfer. No connection to another participant.

3.3.2 Motherboard

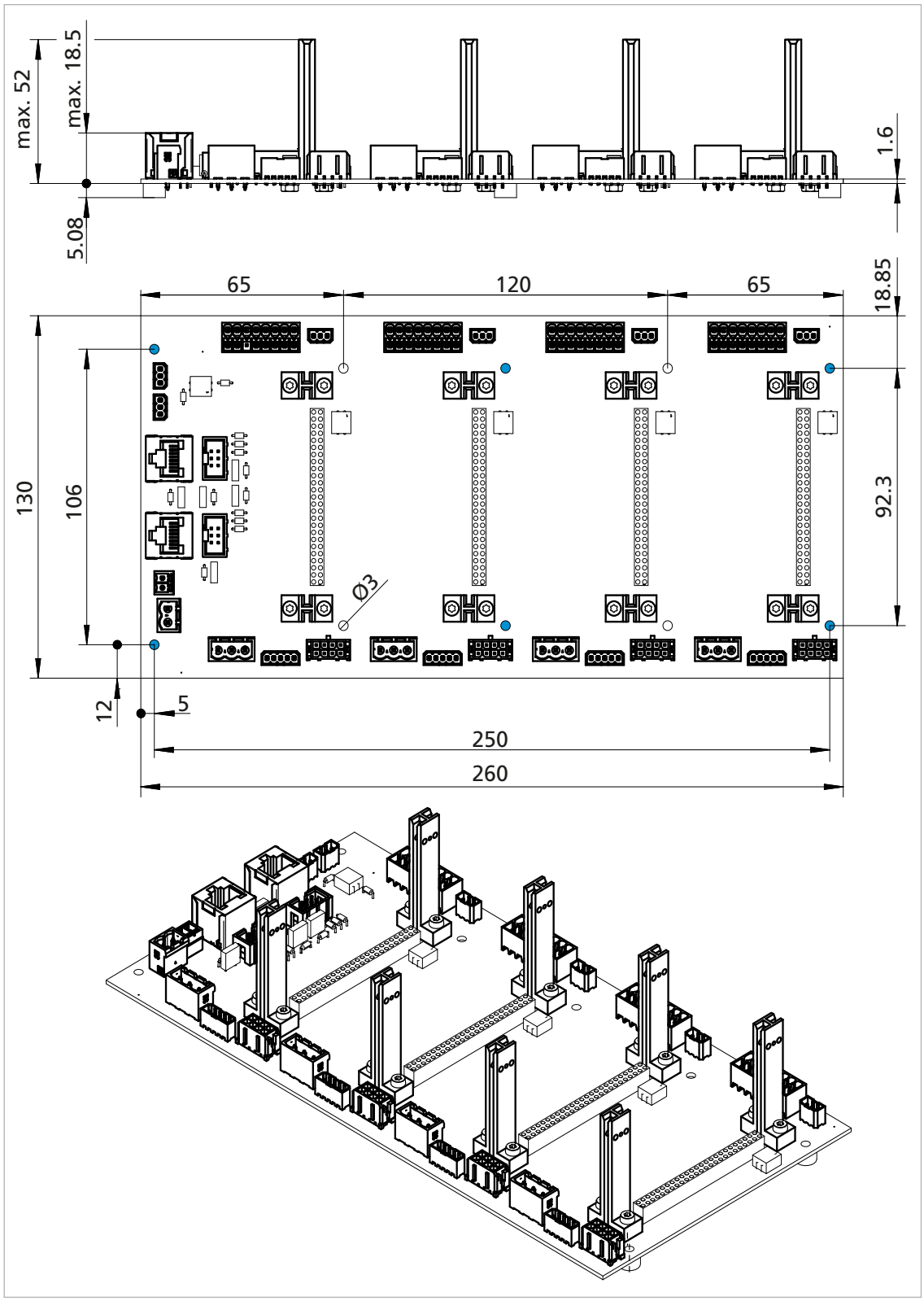


Fig. 5: Side view (top), plan view (middle) and ISO view (below) of the motherboard with vertical connectors

Product description

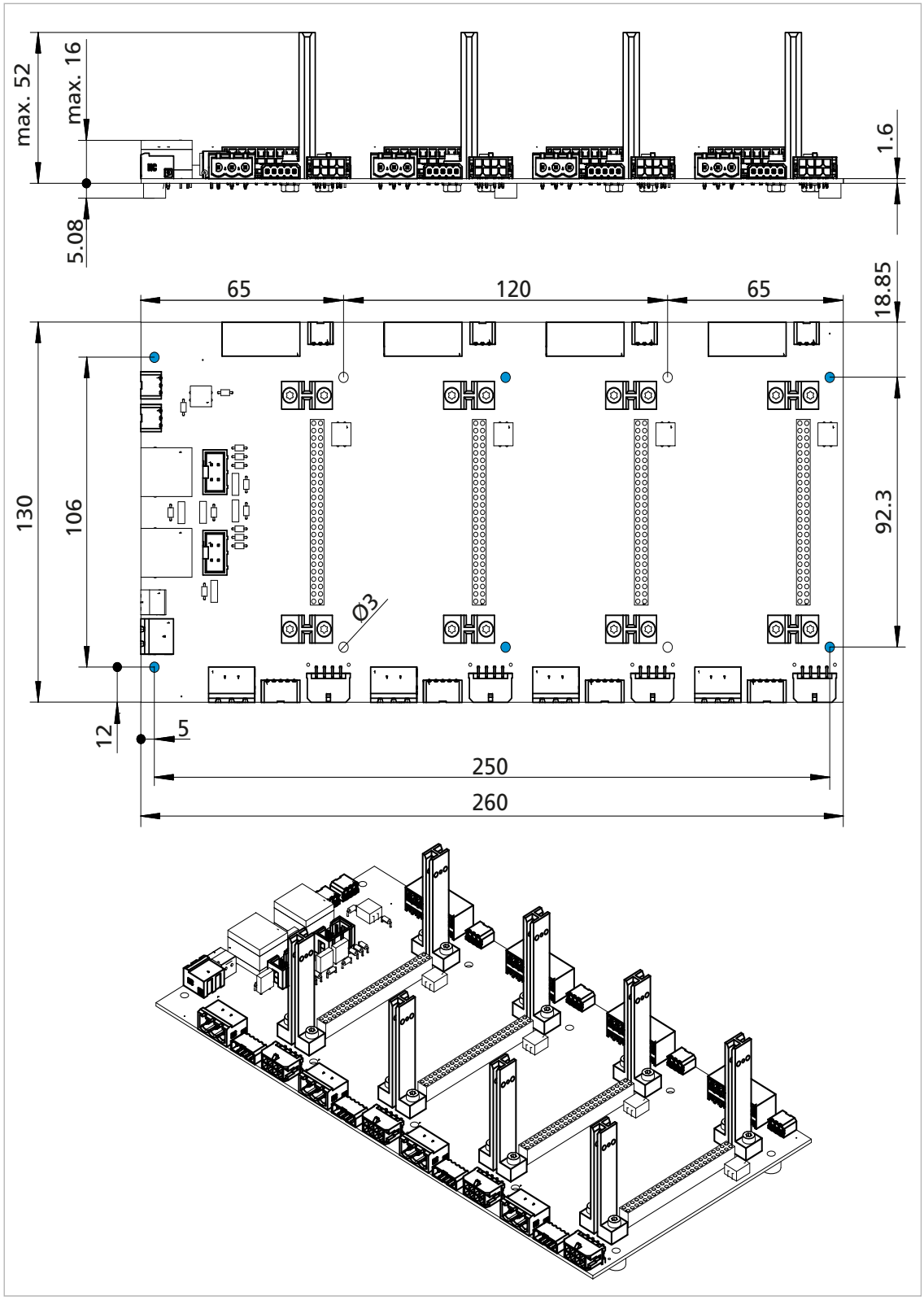


Fig. 6: Side view (top), plan view (middle) and ISO view (below) of the motherboard with horizontal connectors

In the delivery state there are rubber buffers in the outer and middle holes of the motherboard. In Fig. 5 and Fig. 6 these holes are marked in blue.

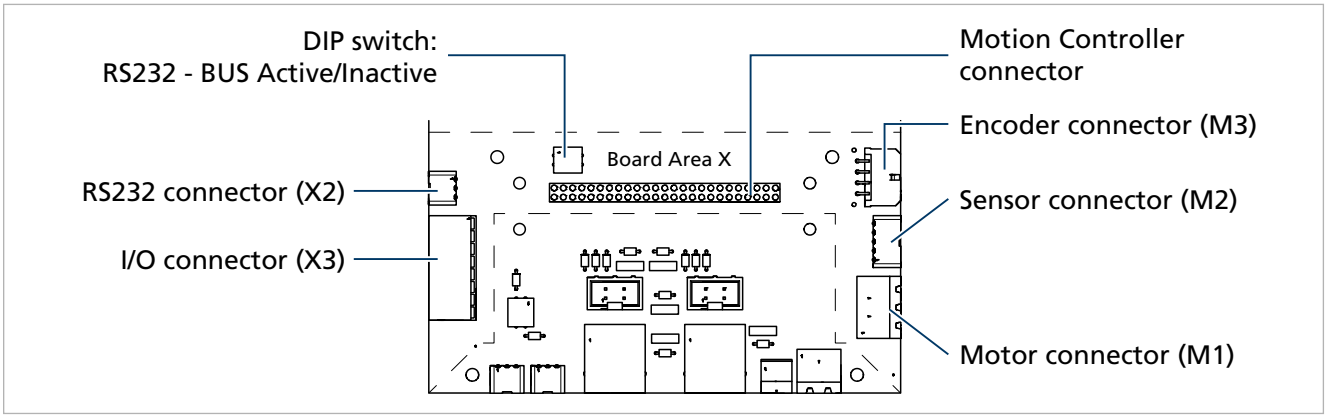


Fig. 7: Connector overview of the motherboard (board area)

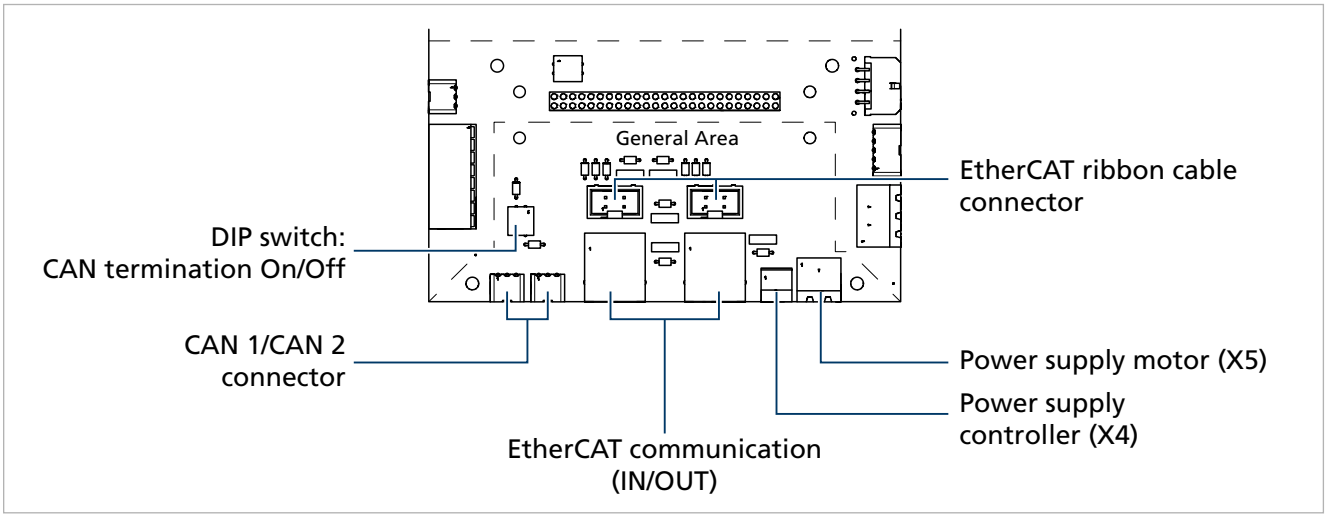


Fig. 8: Connector overview of the motherboard (general area)

Tab. 7: Motherboard connector overview

Designation	Function
Motion Controller connector	Connection of the Motion Controller circuit board
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
X2 (COM)	RS232 interface connection
CAN 1/CAN 2	CANopen interface connection
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
IN/OUT	Connection of the EtherCAT communication

Designation	Function
EtherCAT ribbon cable connector	Optional ribbon cable connection
DIP Switch CAN termination	CAN Termination resistor (On/Off): ▪ On: Termination resistor active ▪ Off: Termination resistor inactive
DIP switch RS232 active/inactive	RS232 net mode (On/Off): ▪ On: RS232 net mode active ▪ Off: RS232 net mode inactive

4 Installation

4.1 Mounting

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

- 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. 8).

4.1.1 Mounting instructions

CAUTION!
The Motion Controller can become very hot during operation.

- 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 damage the Motion Controller.

- Comply with the installation instructions.

NOTICE!
Installation and connection of the Motion Controller when the power supply is applied can damage the device.

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

CAUTION!
The Speed Controller can become very hot during operation.

- 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 damage the Speed Controller.

- Comply with the installation instructions.

NOTICE!
Installation and connection of the Speed Controller when the power supply is applied can damage the device.

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

4.1.2 Installation of Motion Controller circuit boards

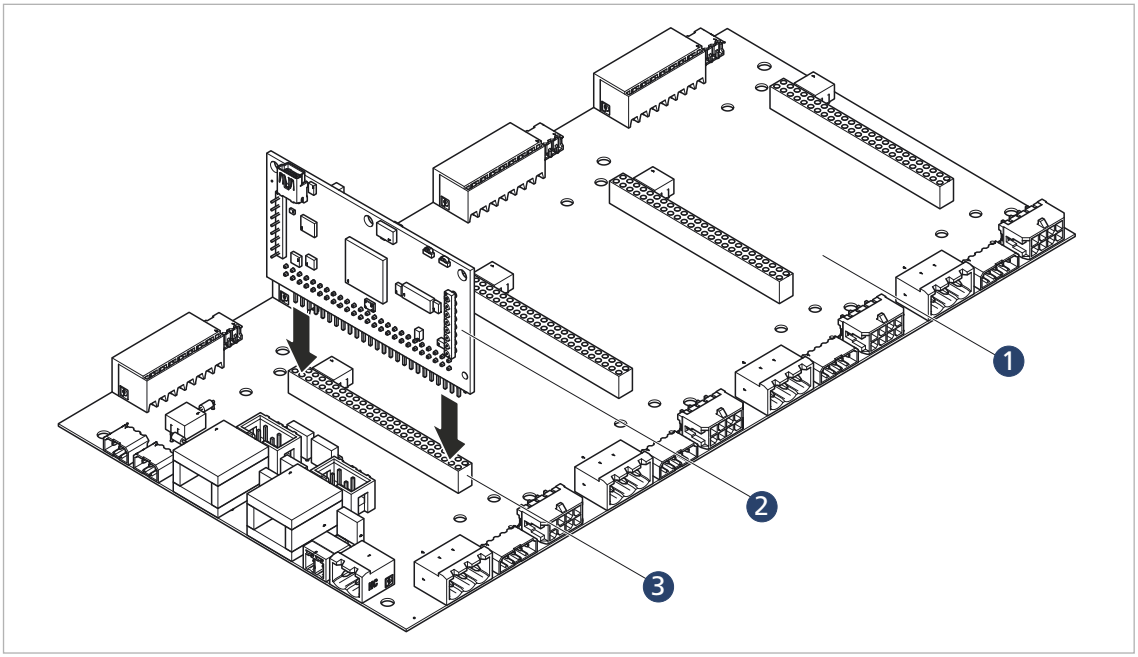


Fig. 9: Installation of a Motion Controller circuit board

NOTICE!
Incorrect installation can damage the Motion Controller.

- Orient the Motion Controller circuit board as shown in Fig. 9.
- Connect the Motion Controller circuit board (2) to the motherboard (1) via the connector (3).

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

- Observe the ESD protective measures.

NOTICE!
Electrostatic discharges to the Speed Controller 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 Controller contains 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 Controller to a grounding system. This should be done preferably by mounting it on an earthed baseplate, or alternatively by connecting it to an earthed mounting rail.
- Make sure that potential equalisation is present between all coupled 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 required 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^2
- Larger than half the cross-section of the supply conductor

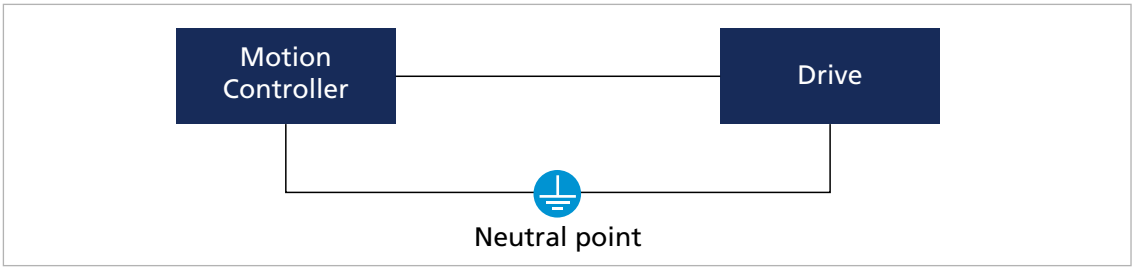


Fig. 10: Potential equalisation between electrically connected parts of the system

4.2.2 Connection of the drive

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. 8: Guide values for the cable length

Sensor type	Unscreened length	Screened length [a]
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

a) 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)

4.2.3 Screening

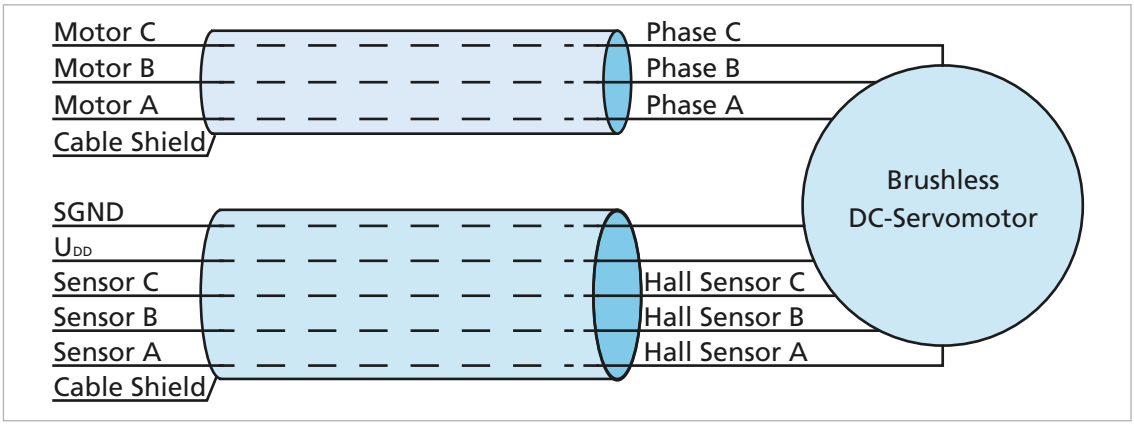


Fig. 11: MC 50xx connection of a BL servomotor

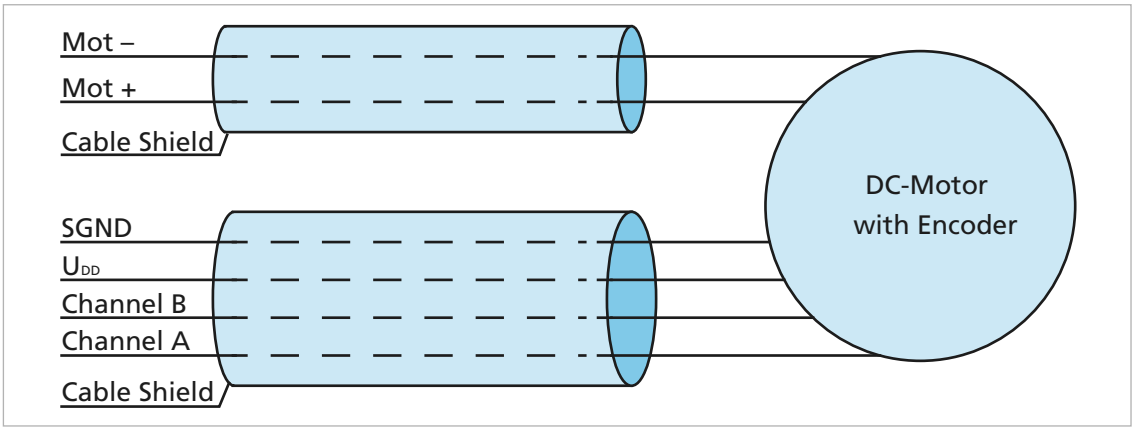


Fig. 12: MC 50xx connection of a DC motor with encoder

- 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.

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

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. 1µF … 2µF / 50 V).

4.2.4 Connection of the power supply

- 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.

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.

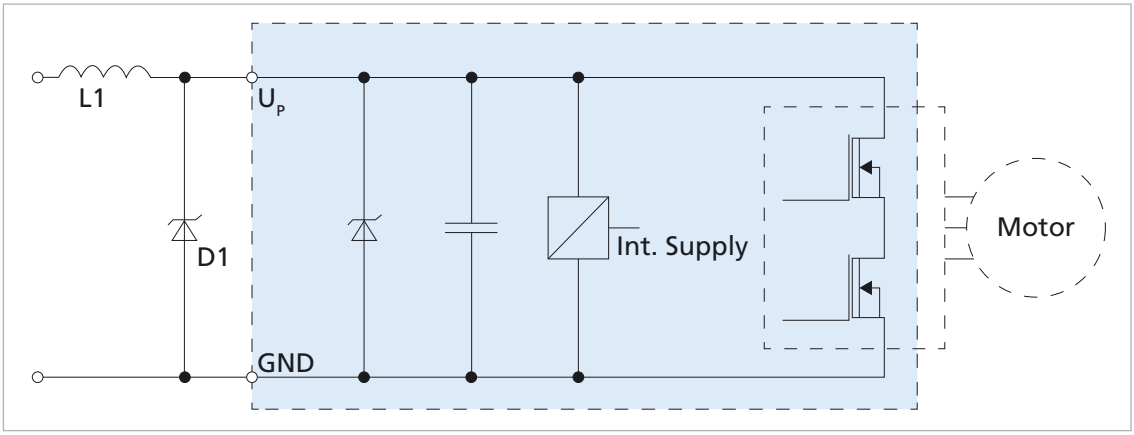


Fig. 13: EMC protective circuit

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.

4.2.5 Connector pin assignment

4.2.5.1 Pin assignment of the Motion Controller edge connector

Motion Controllers have an edge connector which enables the connection to be made between the Motion Controller and the motherboard or customer-specific peripherals.

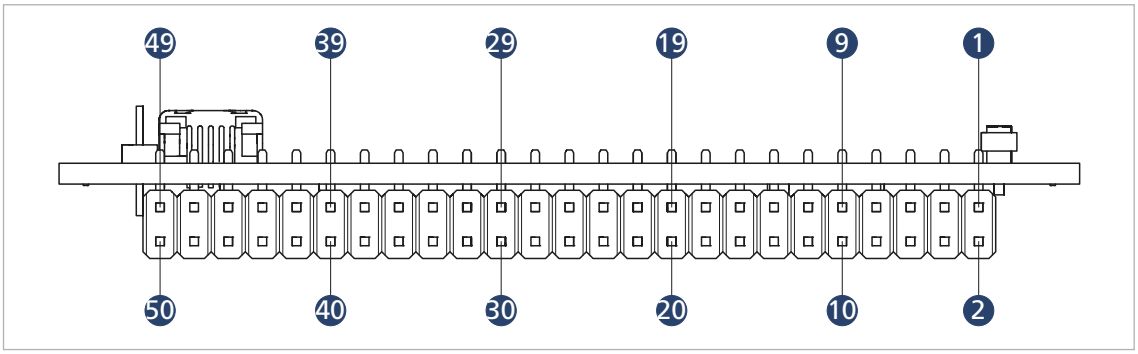


Fig. 14: Pin overview of the edge connector

For the technical data see the motherboard pin assignment.

Tab. 9: Pin assignment of the edge connector

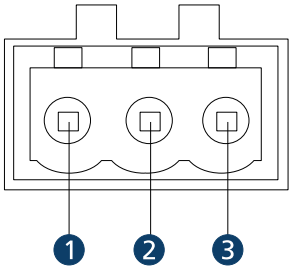
Pin	Designation	Meaning
1	Phase A	Motor phase A
2	Phase A	Motor phase A
3	Phase B	Motor phase B
4	Phase B	Motor phase B
5	Phase C	Motor phase C
6	Phase C	Motor phase C
7	U_{mot}	Supply voltage of the motor
8	U_{mot}	Supply voltage of the motor
9	GND	Ground
10	GND	Ground
11	U_p	Power supply of the electronics
12	n.c	–
13	n.c	–
14	Sens A	Hall sensor A
15	Sens B	Hall sensor B
16	Sens C	Hall sensor C
17	U_{DD}	Supply connection of the sensors
18	GND	Ground
19	Channel A	Encoder channel A
20	$\overline{\text{Channel A}}$	Encoder channel A (logically inverted signal)
21	Channel B	Encoder channel B
22	$\overline{\text{Channel B}}$	Encoder channel B (logically inverted signal)
23	Index	Index channel

Pin	Designation	Meaning
24	$\overline{\text{Index}}$	Index channel (logically inverted signal)
25	n.c	–
26	n.c.	–
27	DigOut 1	Digital output
28	DigOut 2	Digital output
29	DigOut 3	Digital output
30	U_{DD}	Supply voltage of the sensors
31	GND	Ground
32	DigIn 1	Digital input
33	DigIn 2	Digital input
34	DigIn 3	Digital input
35	DigIn 4	Digital input
36	DigIn 5	Digital input
37	DigIn 6	Digital input
38	DigIn 7	Digital input
39	DigIn 8	Digital input
40	AGND	Analogue ground
41	AnIn 1	Analogue input
42	AnIn 2	Analogue input
43	n.c.	–
44	n.c.	–
45	n.c.	–
46	CAN-H	CAN-High interface
47	CAN-L	CAN-Low interface
48	GND	Ground
49	TxD	RS232 interface transmit direction
50	RxD	RS232 interface receive direction

4.2.5.2 Motherboard pin assignment (motor side)

Motor connection (M1)

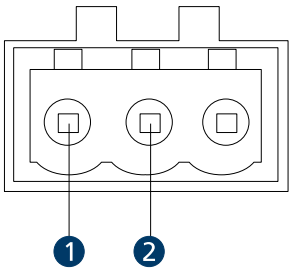
Tab. 10: Pin assignment at the BL motor connection (M1)

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

Designation	Value
Power supply for motor	0...U_{mot} max. 4/12 A 100 kHz

Tab. 12: Pin assignment at the DC motor connection (M1)

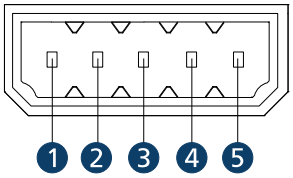
	Pin	Designation	Meaning
	1	Motor +	Connection to the motor plus pole
	2	Motor –	Connection to the motor minus pole

Tab. 13: Electrical data for the DC motor connection (M1)

Designation	Value
Power supply for motor	0...U_{mot} max. 4/12 A 100 kHz

Sensor connection (M2)

Tab. 14: Pin assignment at the sensor connection (M2)

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

Tab. 15: Electrical data for the sensor connection (M2)

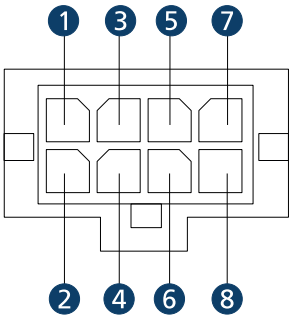
Designation	Value
Power supply for sensor	5 V <100 mA
Connection port for sensor	<5 V

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.

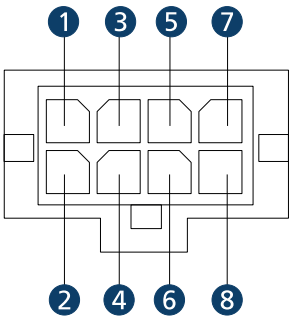
Tab. 16: Pin assignment for incremental encoder with line driver (M3)

	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. 17: 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 kΩ

Tab. 18: Pin assignment for incremental encoders without line driver (M3)

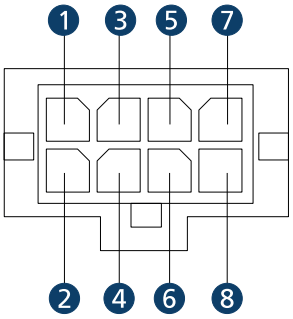


Pin	Designation	Meaning
1	U_{DD}	Power supply for the incremental encoder
2	GND	Ground
3	$\overline{\text{Channel A}}$	n.c.
4	Channel A	Encoder channel A
5	$\overline{\text{Channel B}}$	n.c.
6	Channel B	Encoder channel B
7	$\overline{\text{Index}}$	n.c.
8	Index	Encoder index

Tab. 19: 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 kΩ

Tab. 20: Pin assignment for absolute encoders with line driver (M3)

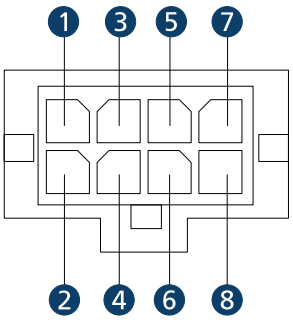


Pin	Designation	Meaning
1	U_{DD}	Power supply for absolute encoder
2	GND	Ground
3	$\overline{\text{CS}}$	Command Specifier for absolute encoder (logically inverted signal)
4	CS	Command Specifier for absolute encoder
5	$\overline{\text{Data}}$	Data for absolute encoder (logically inverted signal)
6	Data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

Tab. 21: 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 kΩ
Connection port for clock	5 V 1 MHz

Tab. 22: Pin assignment for absolute encoders without line driver (M3)



Pin	Designation	Meaning
1	U_{DD}	Power supply for absolute encoder
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

Tab. 23: Electrical data for absolute encoders without line driver (M3)

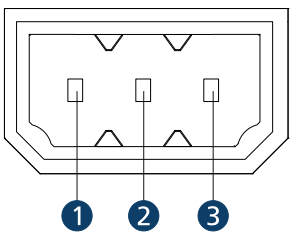
Designation	Value
Absolute encoder power supply	5 V <100 mA
Command Specifier connection port	5 V
Connection port for data	<5 V 5 kΩ
Connection port for clock	5 V 1 MHz

COM port (X2)

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

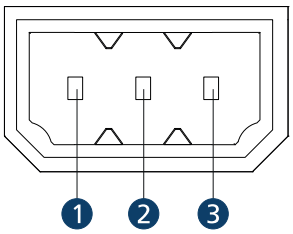
- RS232
- CANopen

Tab. 24: Pin assignment at the COM port (X2) for RS232



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

Tab. 25: Pin assignment CAN1/CAN2 (X2) for CANopen

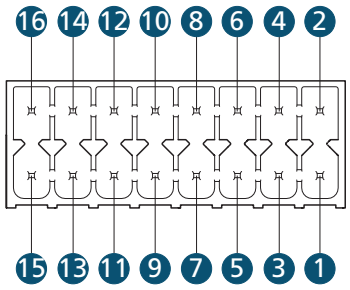


Pin	Designation	Meaning
1	CAN-H	CAN-High interface
2	CAN-L	CAN-Low interface
3	GND	Ground

4.2.5.3 Motherboard pin assignment (supply side)

I/O port (X3)

Tab. 26: Pin assignment at the I/O port (X3)



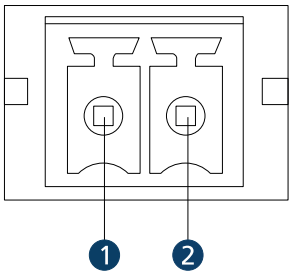
Pin	Designation	Meaning
1	U_{DD}	Supply voltage for external consumer load
2	GND	Ground
3	DigOut 1	Digital output (open collector)
4	DigOut 2	Digital output (open collector)
5	DigOut 3	Digital output (open collector)
6	DigIn 1	Digital input
7	DigIn 2	Digital input
8	DigIn 3	Digital input
9	DigIn 4	Digital input
10	DigIn 5	Digital input
11	DigIn 6	Digital input
12	DigIn 7	Digital input
13	DigIn 8	Digital input
14	AnIn 1	Analogue input
15	AnIn 2	Analogue input
16	AGND	Ground for analogue inputs

Tab. 27: 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 kΩ 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 kΩ <1 MHz
AnIn	±10 V AGND

Power supply of the controller (X4)

Tab. 28: Pin assignment for the power supply of the controller (X4)

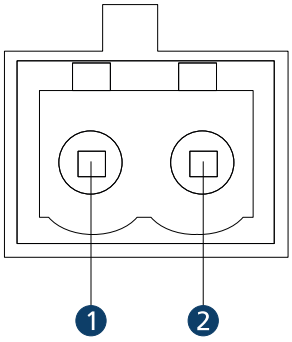
	Pin	Designation	Meaning
	1	GND	Ground
	2	U_P	Supply voltage of the controller

Tab. 29: 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. 30: Pin assignment for the power supply of the motor (X5)

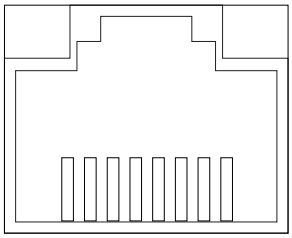
	Pin	Designation	Meaning
	1	GND	Ground
	2	U_{mot}	Supply voltage of the motor

Tab. 31: Electrical data for the power supply (X5)

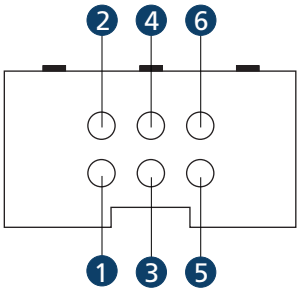
Designation	Value
Power supply for motor	≤50 V

EtherCAT port (IN/OUT)

Tab. 32: Pin assignment EtherCAT (IN/OUT), connector: RJ45

	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 –

Tab. 33: Pin assignment EtherCAT (IN/OUT), connector: DIN

	Designation	Meaning
	IN/OUT	EtherCAT communication Pin 1: TxD+ Transmit data + Pin 2: TxD– Transmit data – Pin 3: vGND Virtual ground Pin 4: vGND Virtual ground Pin 3: RxD+ Receive data + Pin 6: RxD– Receive data –

4.2.6 Motherboard: Connection at the motor side

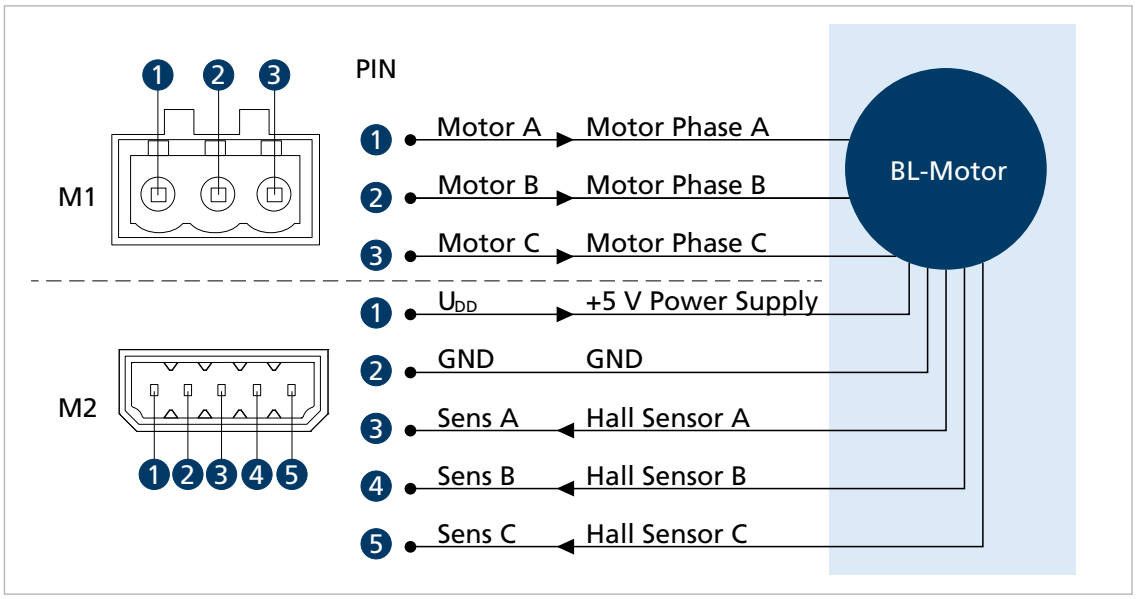


Fig. 15: BL/LM motor with Hall sensors

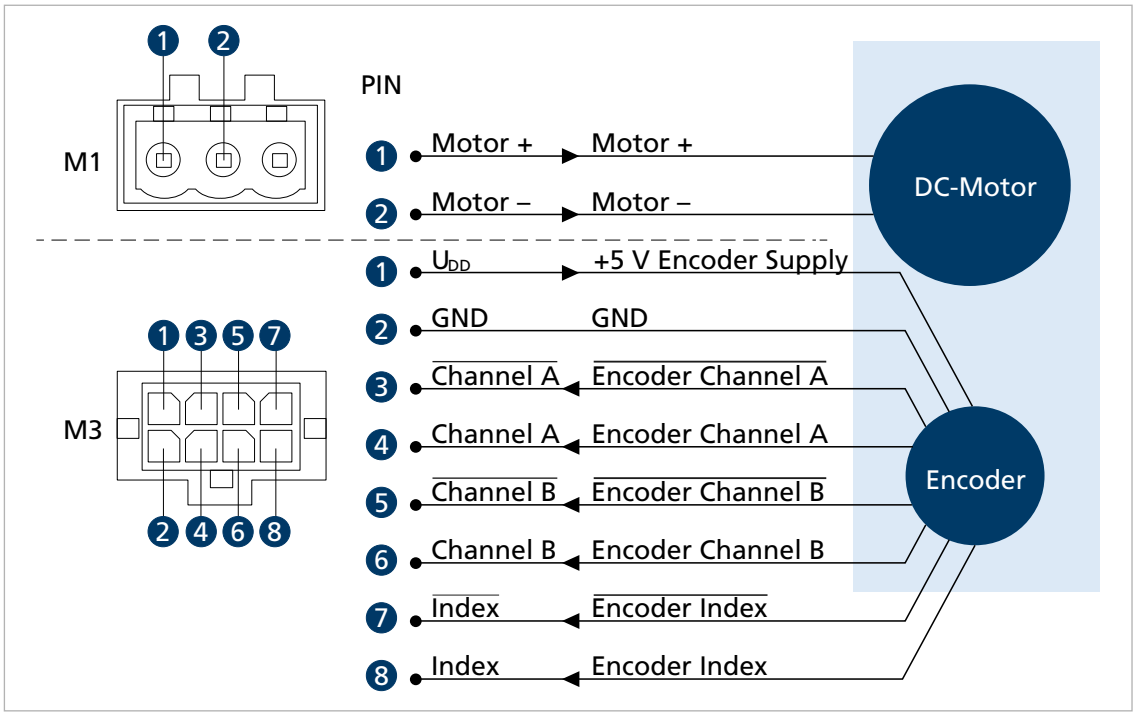


Fig. 16: DC motor with incremental encoder

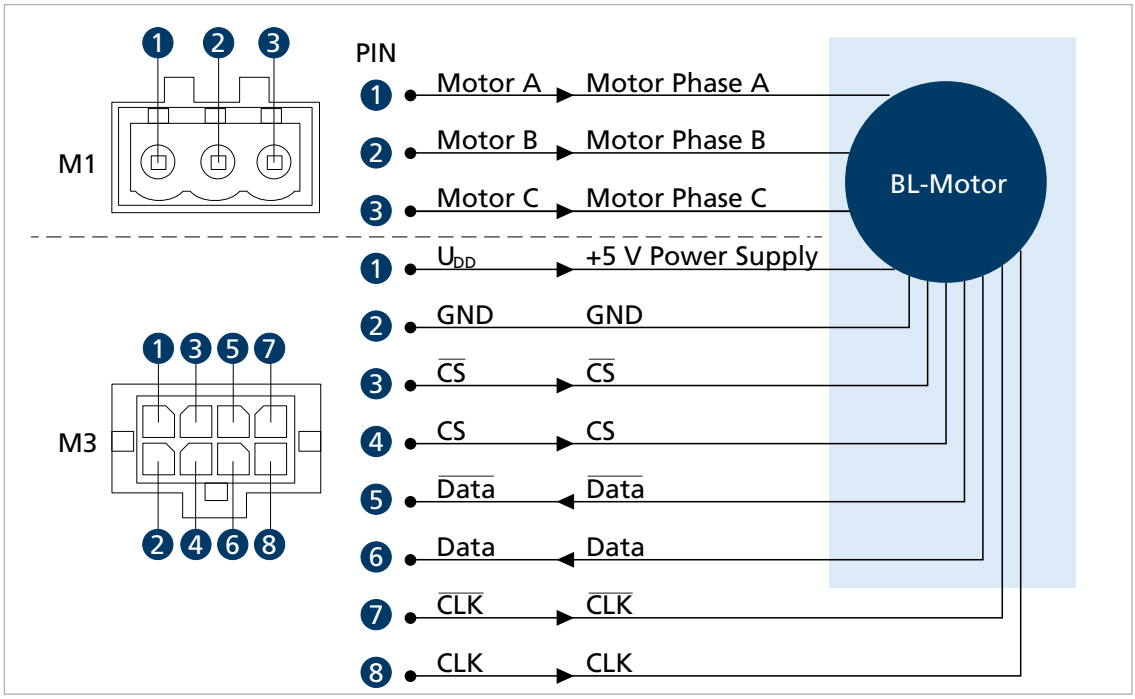


Fig. 17: BL motor with absolute encoder

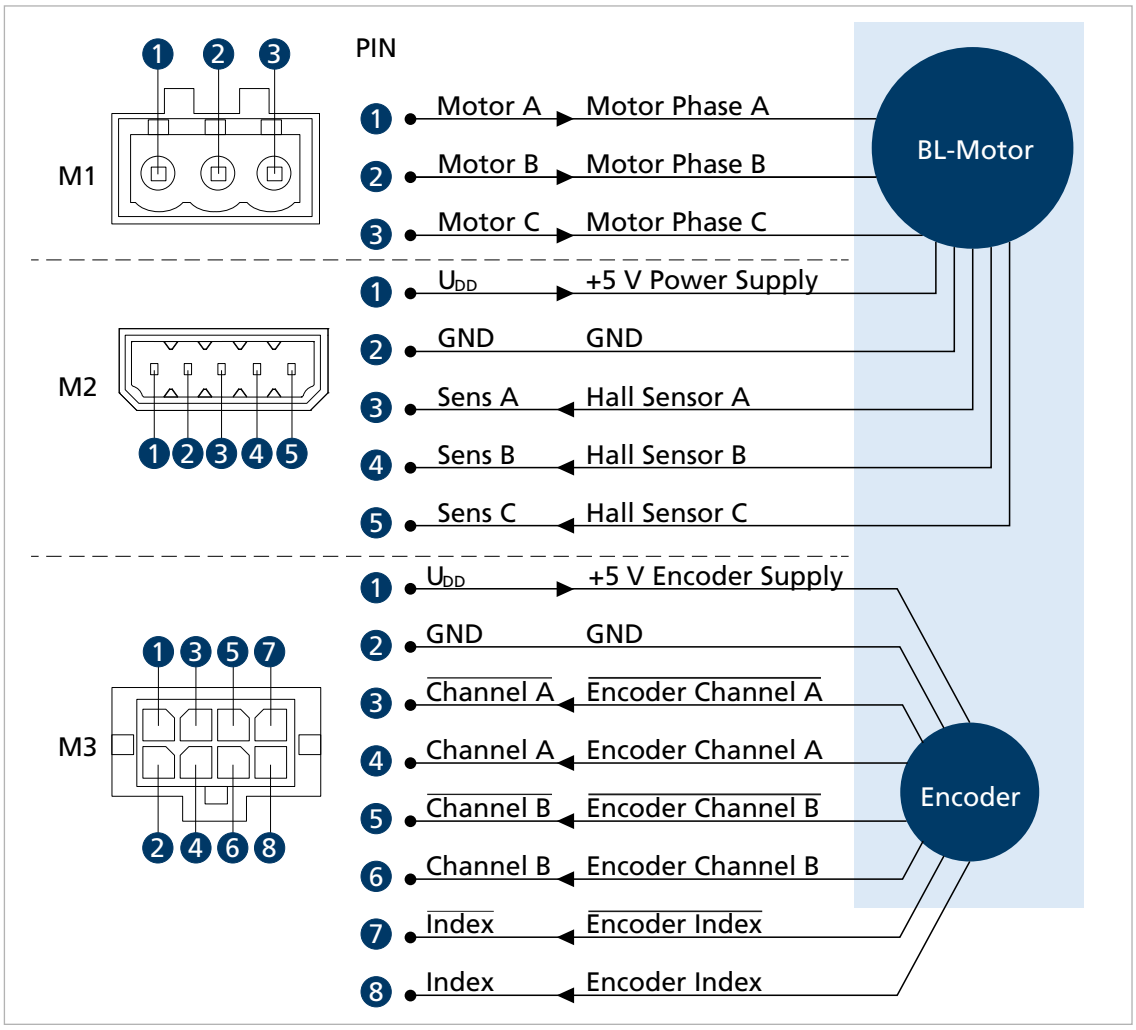


Fig. 18: BL motor with Hall sensors and incremental encoder

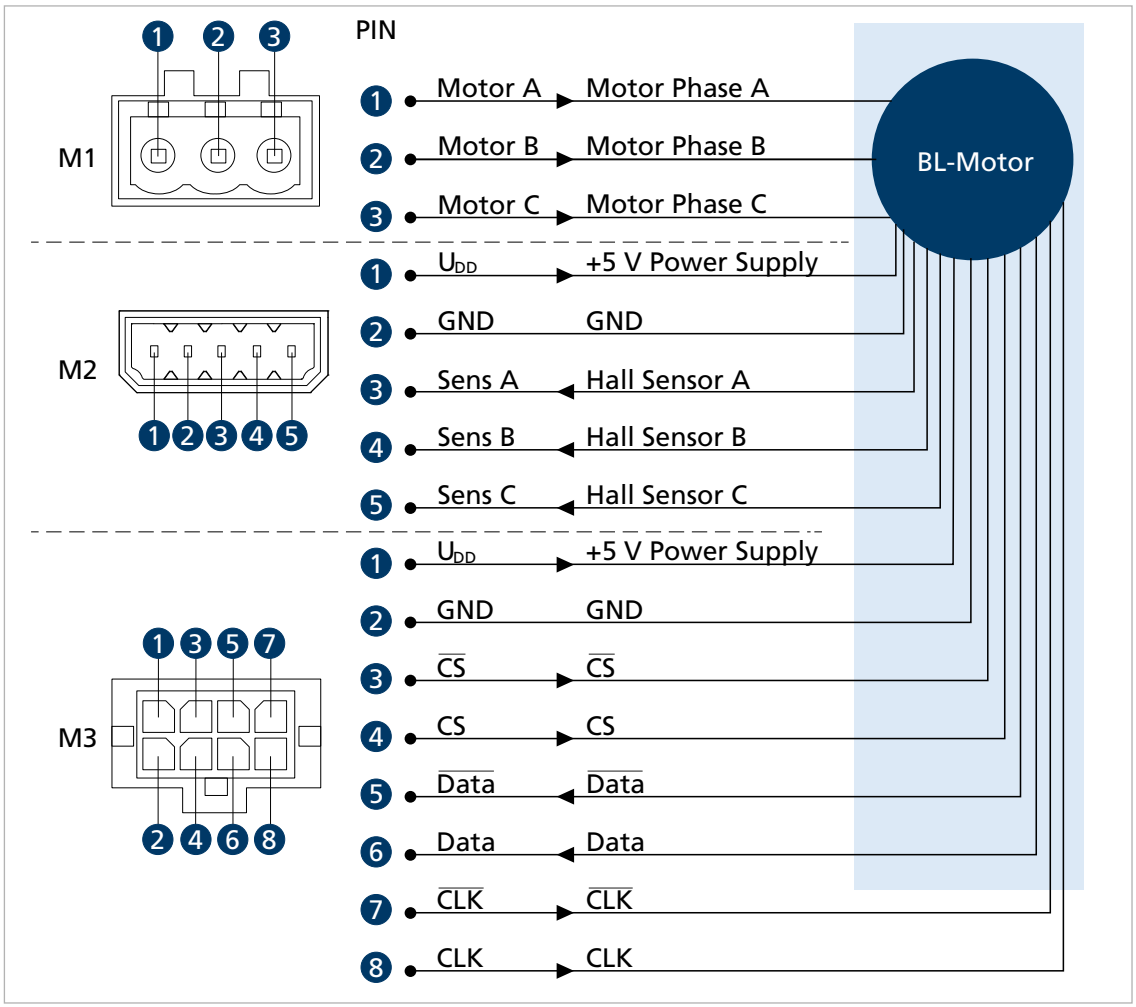


Fig. 19: BL motor with Hall sensors and absolute encoder

4.2.7 I/O circuit diagrams

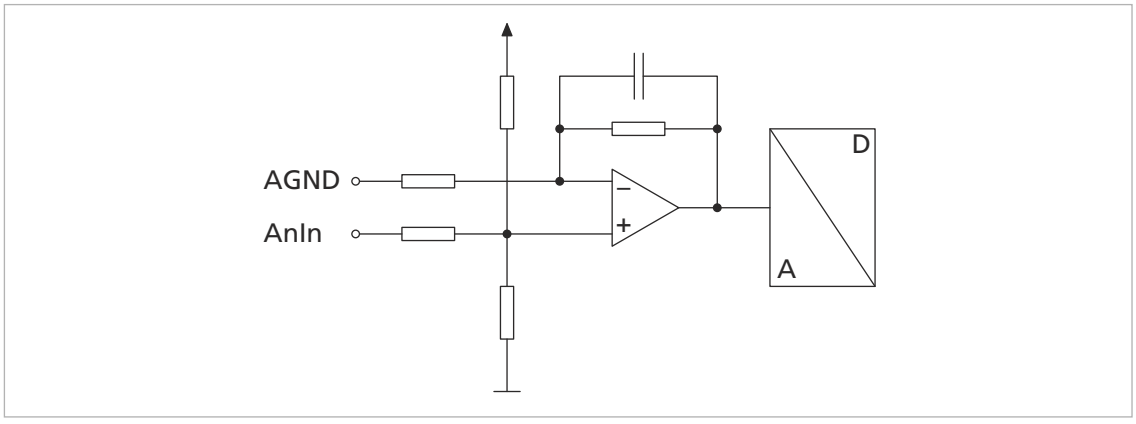


Fig. 20: Analogue input circuit diagram (internal)

So that the voltage drop on the supply side does not affect the speed specification 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:

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

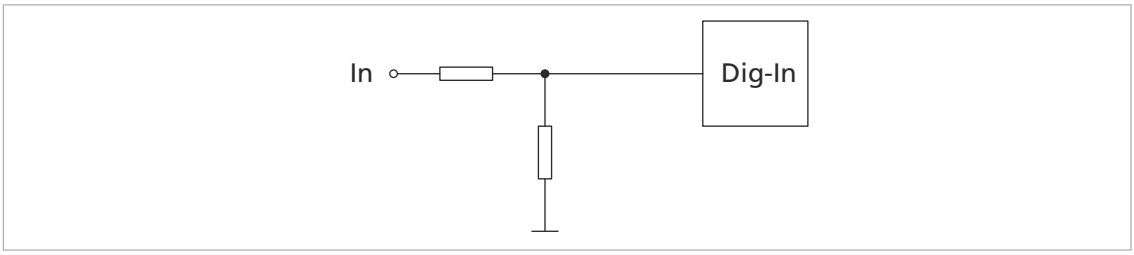


Fig. 21: Digital input circuit diagram (internal)

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

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

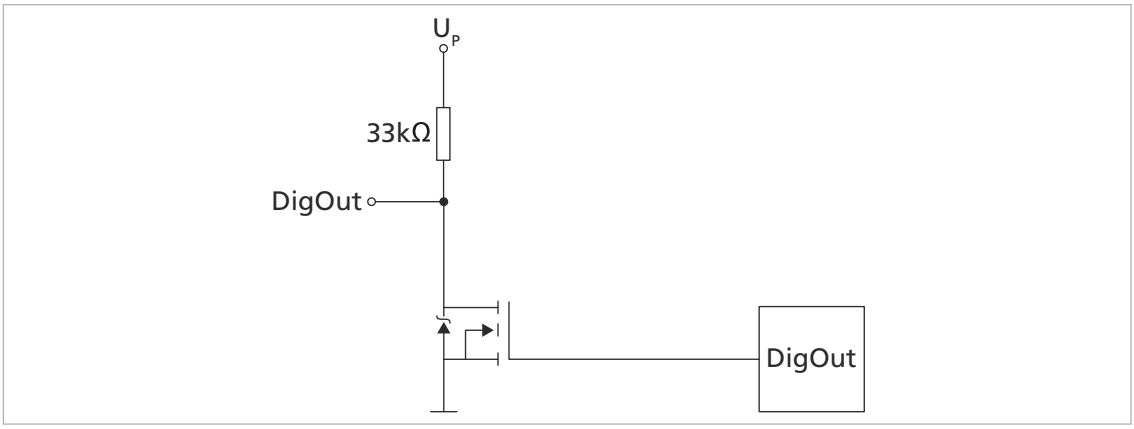


Fig. 22: Digital output circuit diagram (internal)

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 programmed freely.

4.2.8 External circuit diagrams

Bipolar analogue set value specification via potentiometer

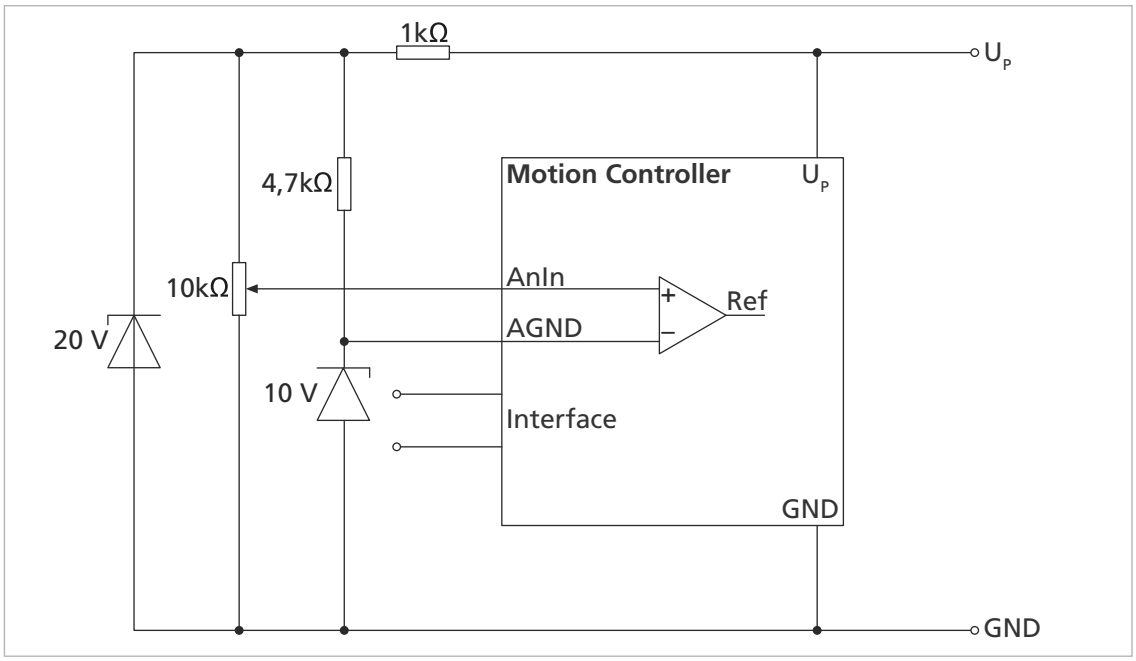


Fig. 23: Bipolar analogue set value specification via potentiometer

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

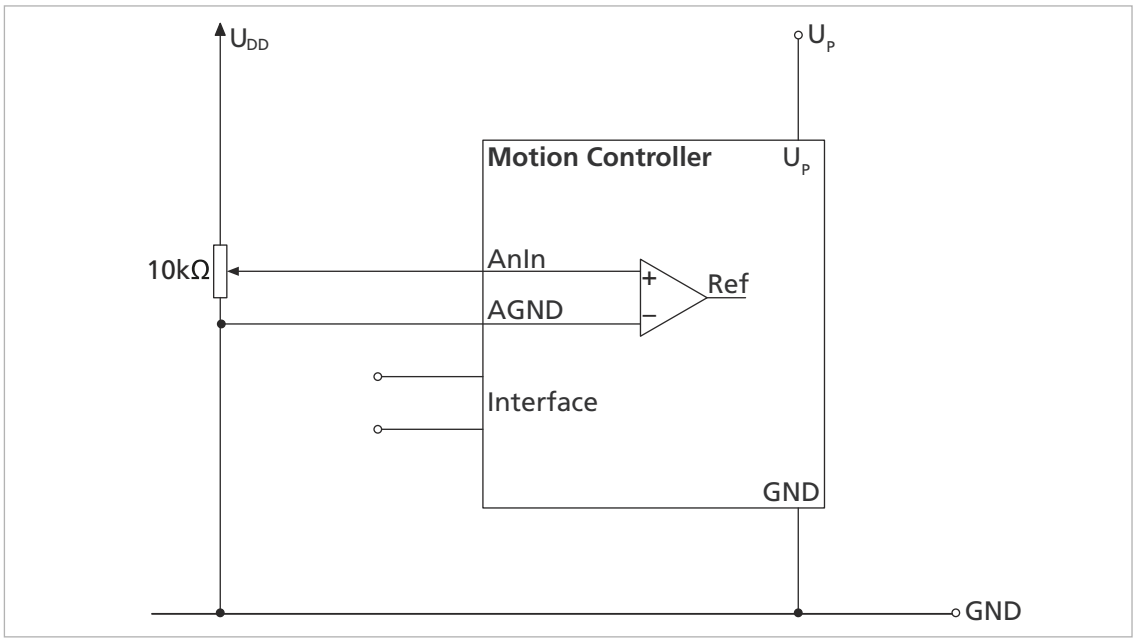


Fig. 24: Analogue set value specification via potentiometer with internally set offset and scaling

Connection of reference and limit switches

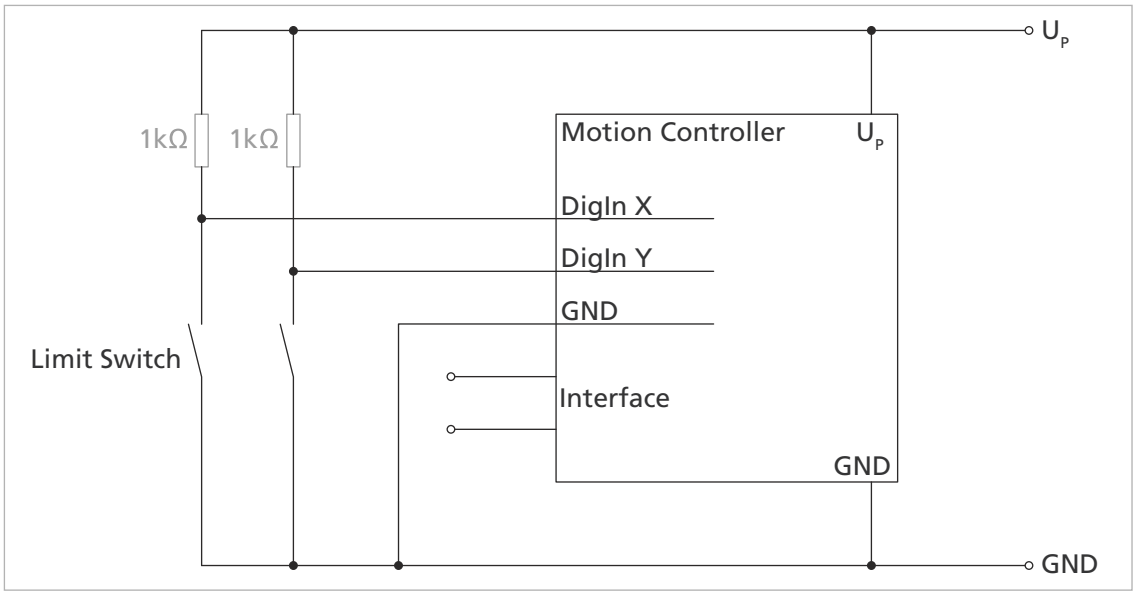


Fig. 25: Connection of reference and limit switches

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

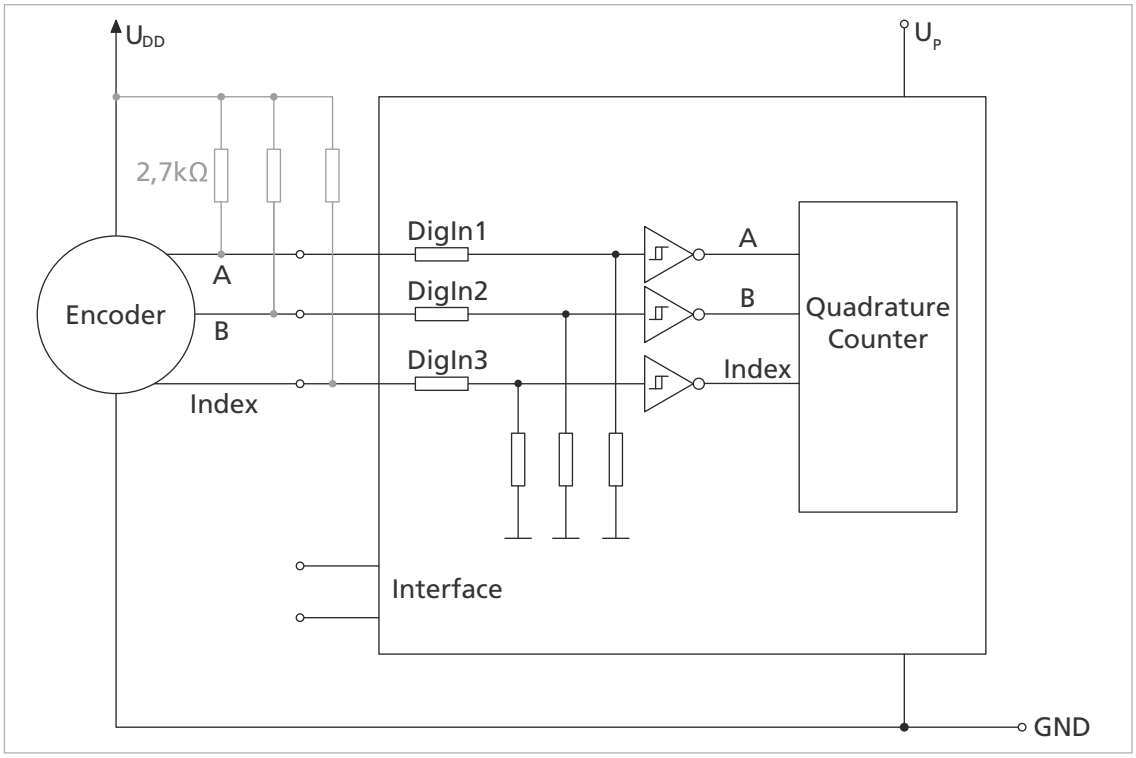


Fig. 26: Connection of an external incremental encoder

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 Controller.

Wiring between PC/controller and a drive

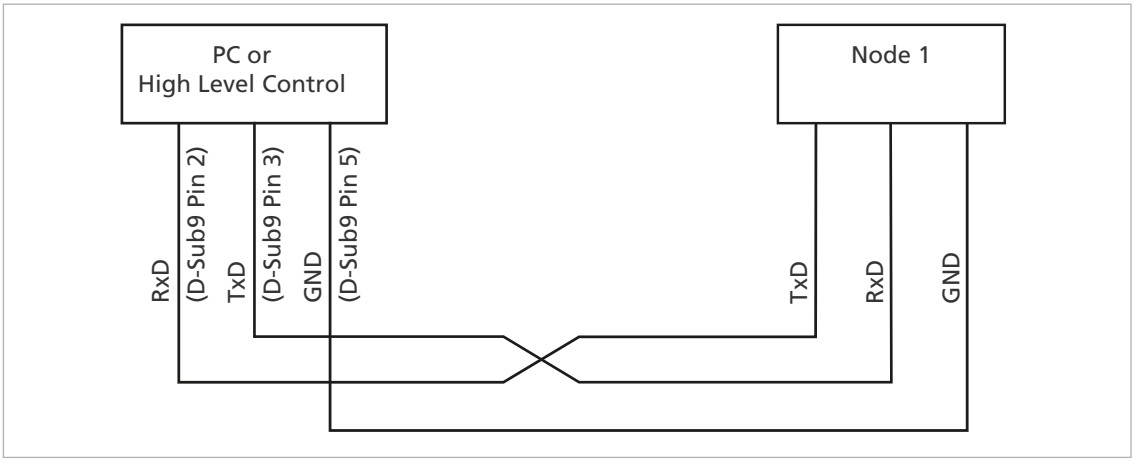


Fig. 27: Wiring between PC/controller and a drive

Wiring with several Motion Control Systems in RS232 network operation

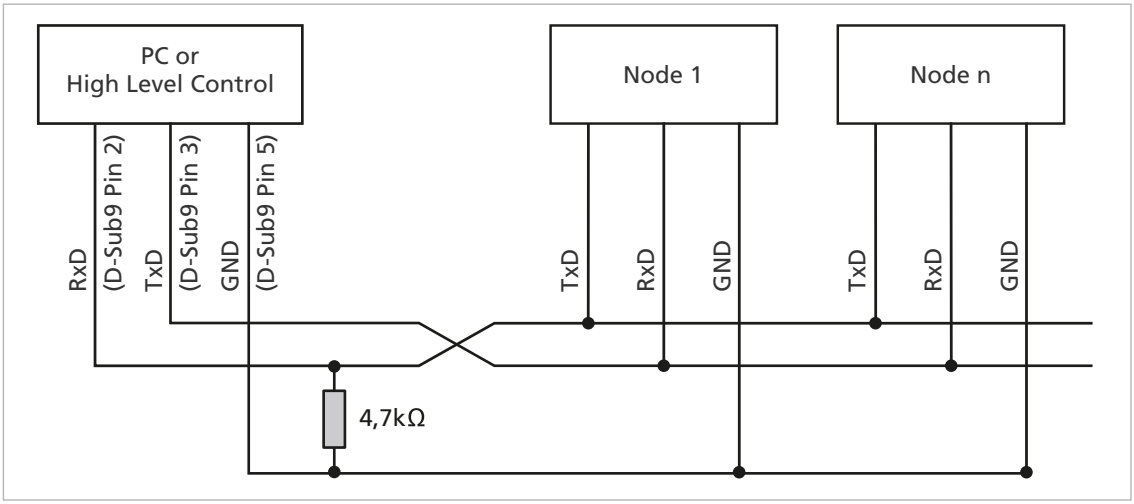


Fig. 28: Wiring with several Motion Control Systems in RS232 network operation

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

Connection to the CANopen network

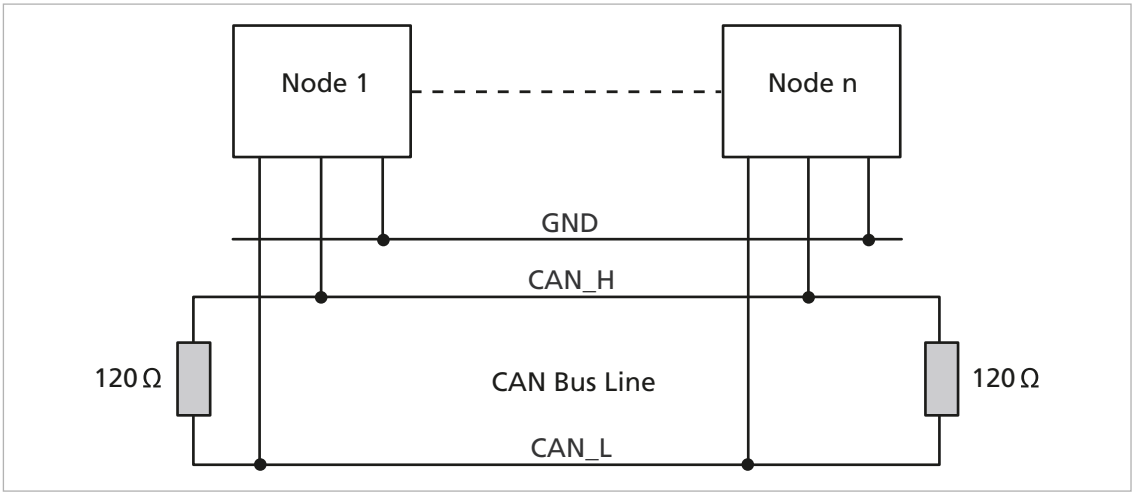


Fig. 29: Connection to the CANopen network

If the CAN wiring is not laid in a straight line it may be necessary to individually optimise 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.

5 Maintenance and diagnostics

5.1 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.

5.2 Diagnostics

Standard circuit board and circuit board with vertical plug connector

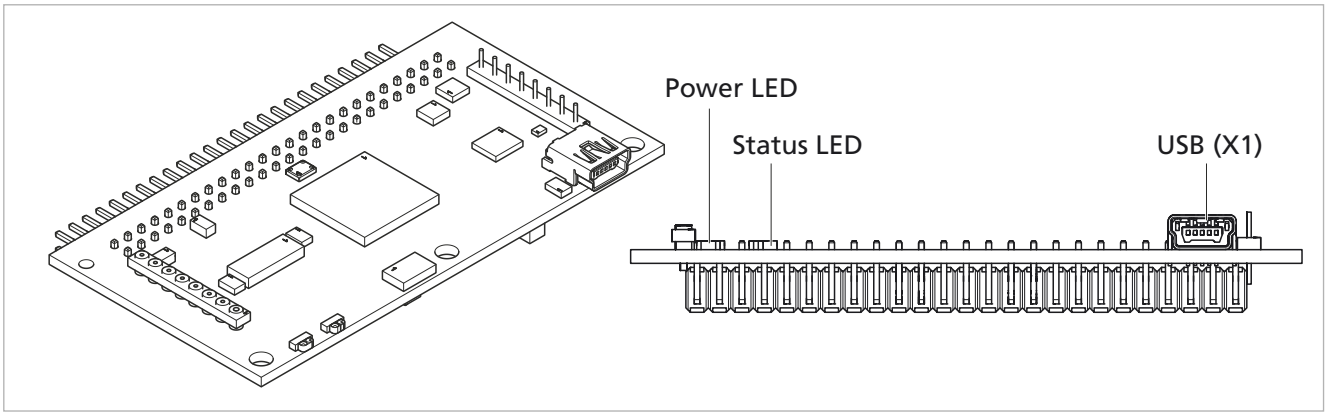


Fig. 30: ISO view (left) and front elevation (right) of the standard circuit board

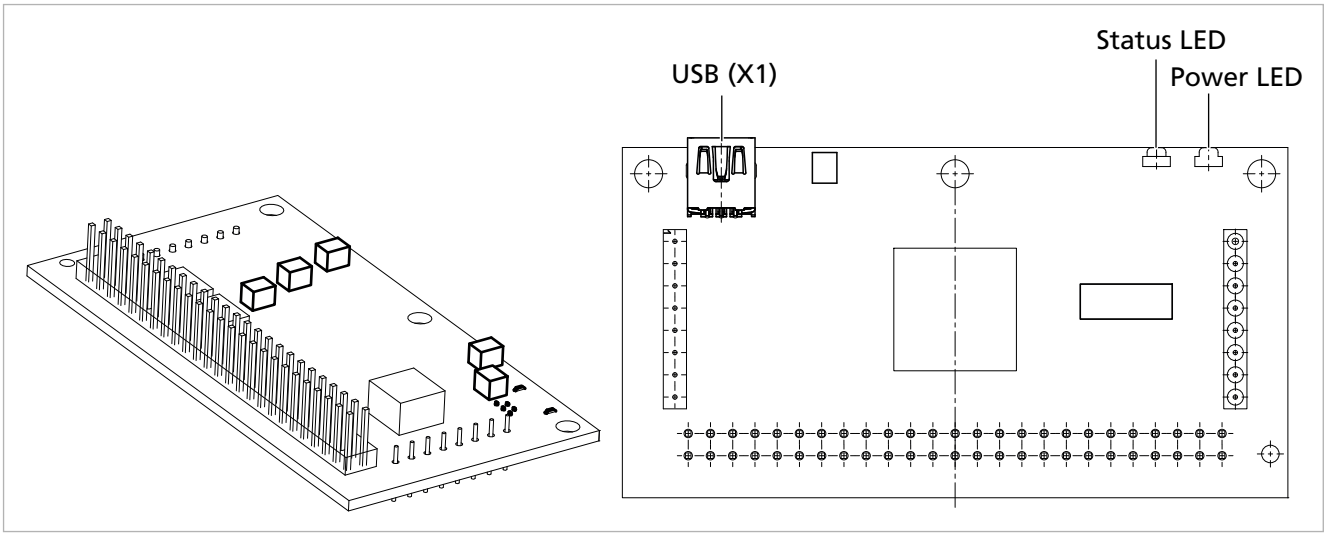


Fig. 31: ISO view (left) and plan view (right) of the circuit board with vertical plug connector

Tab. 34: LED overview

Designation	Function
Status LED	▪ Green (continuous): Device active. ▪ Green (flashing): Device active. However the state machine has not yet reached the *Operation Enabled* 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): Boot procedure failed. Please contact FAULHABER Support.
Power LED	▪ Green: Power supply within the permissible range. ▪ Off: Power supply not within the permissible range.

EtherCAT circuit board

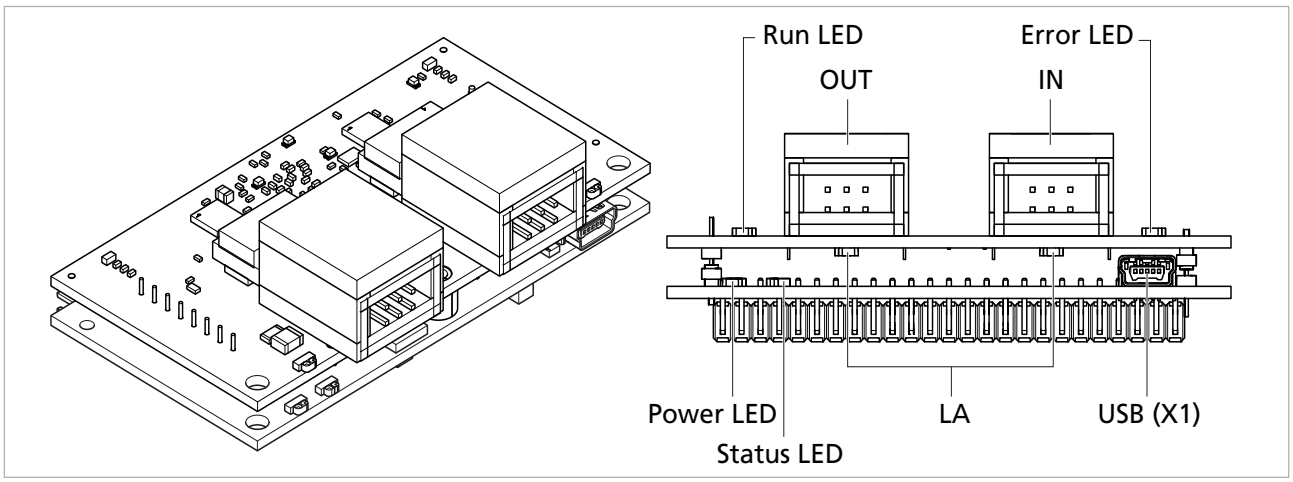


Fig. 32: ISO view (left) and front elevation (right) of the plugged-in EtherCAT circuit board

Tab. 35: LED overview

Designation	Interface	Function
Status LED	all	▪ Green (continuous): Device active. ▪ Green (flashing): Device active. However the state machine has not yet reached the *Operation Enabled* 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): Boot procedure failed. Please contact FAULHABER Support.
Power LED	all	▪ Green: Power supply within the permissible range. ▪ Off: Power supply not within the permissible range.
RUN LED	EtherCAT	▪ Green (continuous): Connection available. Device is ready for operation. ▪ Green (flashing): Device is in the *Pre-Operational* state. ▪ Green (single flash): Device is in the *Safe-Operational* state. ▪ Off: Device is in the *Initialisation* state.
ERR LED	EtherCAT	▪ Red (flashing): Defective configuration. ▪ Red (single flash): Local error. ▪ Red (double flash): Watchdog timeout. ▪ Off: No connection error
LA LED	EtherCAT	▪ Green (continuous): No data transfer. Connection to another participant has been established. ▪ Green (flashing): Data transfer active. ▪ Off: No data transfer. No connection to another participant.

5.3 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
- Connector sets
- Installation materials
- Additional equipment

7 Warranty

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