FAULHABER

Motion Controller

Series MCBL 3002/03/06 RS/CF/CO
Series MCDC 3002/03/06 RS/CF/CO
Series MCLM 3002/03/06 RS/CF/CO

Technical Manual

EN

FAULHABER

Imprint

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

Overview

This technical manual contains instructions on the installation and use of the series MCxx 3002, 3003 and 3006 external Motion Controllers.

Commissioning also requires use of the communication and function manual according to the interface option selected. Accordingly, reference is made here and elsewhere in this technical manual to the communication and function manual. Please note and follow the instructions given there.

Overview of the FAULHABER Motion Control Systems documents

Document	Contents
Technical Manual	Device installation, safety, specification
Communication and function manual (CANopen FAULHABER) Communication and function manual (CANopen CiA) Communication and function manual (RS232)	Initial start-up, function overview, protocol description, parameter description and notes on autonomous sequential programs (only RS232)
Motion Manager instruction manual	Operation of the "FAULHABER Motion Manager" PC software for configuration and commissioning
Product data sheets	Technical limit and operating data

NOTE

The documentation is available on request or on the FAULHABER internet site (www.faulhaber.com)

Table of Contents

1 Important Information

This technical manual describes the handling and technical features of the following FAULHABER equipment:

MCBL 3002 / 03 / 06

The MCBL is an external Motion Controller for brushless DC servomotors with analog Hall sensors, which can be operated without additional encoders.

MCDC 3002 / 03 / 06

The MCDC is an external Motion Controller that is designed for the entire range of FAULHABER DC micro motors.

MCLM 3002 / 03 / 06

The MCLM is an external Motion Controller for linear DC servomotors with analog Hall sensors, which can be operated without additional encoders.

- Before using the controller, please read the entire technical manual and at least the quick start chapter or the chapter on commissioning in the communication and function manual.
- Keep these manuals in a safe place for later use.

The information given in this technical manual refers to the standard versions of the respective equipment. Please refer to any additional information sheet provided in the event of differences in information due to a customer-specific modification.

1.1 Symbols used in this technical manual

WARNING!

Warning!

This pictogram with the wording "Warning!" indicates an imminent danger which can result in physical injuries.

▶ *This arrow points out the appropriate action to take to prevent the imminent danger.*

CAUTION!

Caution!

This pictogram with the wording "Caution!" indicates an imminent danger which can result in slight physical injuries or material damage.

▶ *This arrow points out the appropriate precautions.*

REGULATION!

Regulations, guidelines and directives

This pictogram with the wording "Regulation" indicates a statutory regulation, guideline or directive which must be observed in the respective context of the text.

NOTE

Note

This "Note" pictogram provides tips and recommendations for use and handling of the component.

1 Important Information

1.2 Safety instructions

Observance of the following safety instructions is prerequisite for trouble-free and safe operation of the drive. Therefore, please carefully read through all the notes and follow them when using the drives.

Intended use

The FAULHABER Motion Controllers described here are designed for the activation and control of DC micromotors (MCDC), linear DC servomotors (MCLM) and brushless DC motors (MCBL). They have numerous functions and operating modes which enable flexible adjustment to the respective drive function.

Thanks to the compact design, the units can be integrated into diverse applications with minimal wiring. The flexible connection options open up a broad field of application in all areas, for example in decentralized automation technology systems, as well as in handling devices and machine tools.

The Motion Controller's parametrisation can be individually adjusted to the respective application using a PC. The "FAULHABER Motion Manager" PC software for Microsoft Windows is available for commissioning and configuration of the Motion Controllers and can be downloaded free of charge from the FAULHABER homepage www.faulhaber.com.

- The Motion Controllers contain electronic components and are to be treated according to the ESD regulations.
- The Motion Controllers may not be used in environments where contact with water, chemicals and / or dust is possible or in potentially explosive atmospheres.
- Please ask the manufacturer for information about individual use under special ambient conditions.

1 Important Information

1.3 Ambient conditions

CAUTION! **Chemicals!**

The housings of the MC 3002 S and MC 3002 F Motion Controllers are only conditionally resistant to solvents such as methylated spirits and acetone.

▶ *In operation the housings must be protected against contact with solvents or substances containing substances.*

1.4 Servicing / maintenance

In principle, the drives are maintenance-free. The air filters of cabinet units must be regularly checked and cleaned if required, depending on the quantity of dust.

1.5 Troubleshooting

Due to their design, if the parameters given in this technical manual are complied with the drives are trouble-free. If malfunctions occur during proper intended use, please contact your responsible partner.

2 Description

2.1 Product information

```
MC   …   30   …   …   …   …
```

RS: RS 232, serial interface
CF: CAN interface FAULHABER
CO: CAN interface CiA

AES: Only for brushless DC motors with absolute encoders

S: Housing with screw-type terminal strip
F: Housing with LIF connector (motor)
P: Board version with male connectors

02:     Max. continuous output current 2 A
03:     Max. continuous output current 3 A
06:     Max. continuous output current 6 A

30:     Max. supply voltage 30 V

DC: DC micromotors
BL: Brushless DC motors
LM: Linear DC servomotors

MC: Motion Controller

2 Description

2.2 General product description

The FAULHABER Motion Controllers are based on a high performance digital signal processor (DSP), which enables a high control quality, precise positionability and very low speeds.
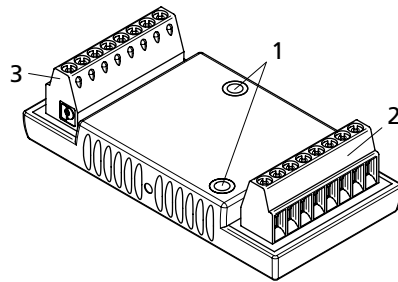
They are configured for different drive tasks; which can be configured via the respective communication interface.

The Motion Controller product family consists of the following products:

Motion Controllers for motors in the low power range

■ MCxx 3002 S RS/CF/CO

Motion Controller with hot-melt housing and screw terminals on the supply and motor end.

1 Fixing sockets

2 Screw-type terminal strip, motor end

3 Screw-type terminal strip, supply end

■ MCxx 3002 F RS/CF/CO

Motion Controller with hot-melt housing and screw terminals at the supply and flexboard connection on the motor end.

1 Fixing sockets

2 LIF connector, motor end, for FFC and FPC, 8-pole

3 Screw-type terminal strip, supply end

2 Description

2.2 General product description

■ MCxx 3002 P RS/CF/CO

Motion Controller without housing (board version) with pin headers on the supply and motor end.

1 Pin header, motor end
2 Pin header, supply end

■ MCxx 3003 P RS/CF/CO

Motion Controller without housing (board version) with pin headers on the supply and motor end.
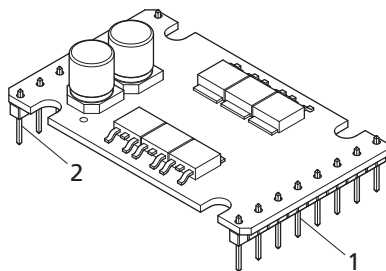
1 Pin header, motor end
2 Pin header, supply end

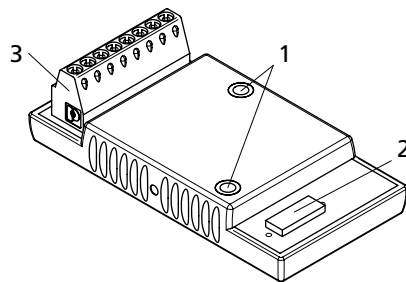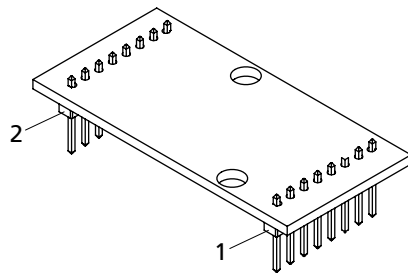### Motion Controllers for motors in the high power range

■ MCxx 3006 S RS/CF/CO

Motion Controller with metal housing and screw terminals on the supply and motor end.

1 Mounting hole
2 Screw-type terminal strip, motor end
3 D-Sub connector for serial connection (RS) or CAN connection (CF/CO)
4 Screw-type terminal strip, supply end

2 Description

2.2 General product description

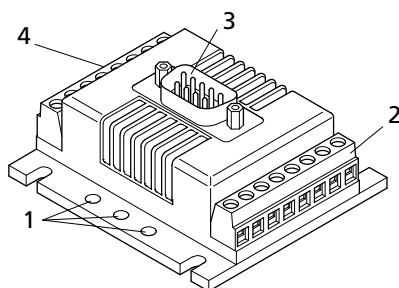The Motion Controllers are designed for different drive tasks, which can be configured via the respective communication interface.

Depending on the version, the following tasks can be performed:

- **Position control with analog or digital command source.**
- **Speed control with analog or digital command source**.
- **Acquisition of reference marks and limit switches**.
- **Enhanced operating modes such as step motor mode, electronic gear, voltage controller mode or current control with analog current preset**.
- Running of sequential programs saved in the Controller (only with RS version).

Various inputs and outputs are available for implementation of these functions:

- **Analog input**
  Usable as
  - **Command source via analog or PWM signal**
  - **Digital input for reference marks and limit switches**
  - **Pulse input**
  - **Incremental encoder connection**
- **Error output**
  Usable as
  - Digital output
  - Pulse output
  - Digital input for reference marks and limit switches
  - Rotational direction input
- 1 additional **digital input**
  Usable as
  - **Digital input for reference marks and limit switches**
- **Communication interface**
  Depending on the type, as a serial RS232 or CAN interface for linking to PC or control

The set configuration can be permanently saved.

NOTE *Communication interface*

Motion controllers with RS232 interface can also be operated independently of the communication interface, if a function or sequential program without digital command control was programmed beforehand.

NOTE *Options*

Separate power supply for the motor and control electronics is possible as an ex-factory option (important for safety-relevant applications). In this case the 3rd input is not required.

Special preconfiguration of modes and parameters is possible on request.

NOTE *The Motion Manager software can be downloaded free of charge from www.faulhaber.com/MotionManager.*

3 Installation

3.1 Assembly instructions

CAUTION!

Damage due to incorrect assembly!

Improper assembly or assembly with unsuitable fixing materials can cause damage to the Motion Controller.

▶ *Observe the following assembly instructions.*

Specialised staff

Only trained specialised staff and instructed persons with knowledge in the field of automation technology and standards and regulations such as the EMC Directive, Low Voltage Directive, Machinery Directive, VDE regulations (such as DIN VDE 0100, DIN VDE 0113/EN 0204, DIN VDE 0160/EN 50178), Accident Prevention Regulations may install and commission the units. This description must be carefully read and heeded prior to commissioning.

Please also note the additional instructions on installation in Chapter 5 "EC Product Safety Directives".

WARNING!

Risk of burns!

As the unit operates with surface cooling, temperatures of up to 85 °C can occur.

▶ *Attach a touch guard or warning notice in the immediate vicinity of the Controller.*

Off load

The Motion Controller must be disconnected from the power supply for all types of assembly and connection work.

ESD protection

The regulations for handling modules at risk from ESD must be observed.
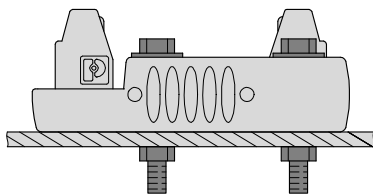
3 Installation

3.1 Assembly instructions

Surface

Motion Controllers may be screwed onto flat, hard surfaces only. The surface must be suitable for supporting the assembly sleeves against the screwing forces. Screwing onto a soft or uneven surface can cause the assembly sleeves to be pressed out.

Right	**Wrong**
The Motion Controller is mounted on a flat, hard surface.	The Motion Controller is screwed on over an edge. Risk of pushing out the assembly sleeves!
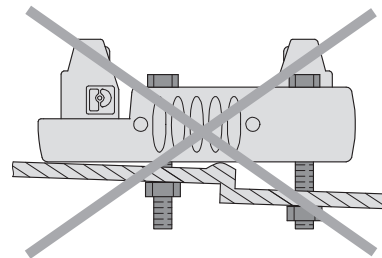
Screw-type terminal strips

The maximum tightening torque of the screw-type terminal strips must be noted and observed.

For series MCxx 3002 S: min. 0.12 Nm; max. 0.15 Nm

For series MCxx 3006 S: min. 0.5 Nm; max. 0.6 Nm

Flexboard connector

The motors' flexboards must be inserted into the connector flat. The connector pin assignment and connection symbols must be noted.

Never press the flexboard into the connector with force as this could damage it. If necessary, use a suitable tool (for example, tweezers or a flat-nose pliers). Ensure the flexboard is not squeezed or crushed.

3 Installation

3.2 EMC compatible installation

CAUTION!

⚠️

Length of the connection leads!

The maximum length of the connection leads is limited.

▶ _All supply end connection leads, with the exception of the power supply, may not exceed a length of 3 m. The maximum allowable length of the motor connection cable depends on the encoder type used._

Recommended values for the length of the motor connection cable

Encoder type	Length, unshielded	Length, shielded
Analog Hall	0.3 m	2.0 m
IE2/IE3	0.5 m	On request
IE3L	several metres; speed and resolution-dependent	On request
AES	0.3 m	On request

NOTE

ℹ️

The usability of a longer motor connection cable must be checked for each individual case.

Optimisation of performance with respect to emission and immunity requires the additional EMC measures:

■ Ensuring allowable emissions or necessary immunity in industrial environments may require the use of an EMC filter and / or a shield or an EMC suppressor circuit.

Suppressor circuit MCxx 3002
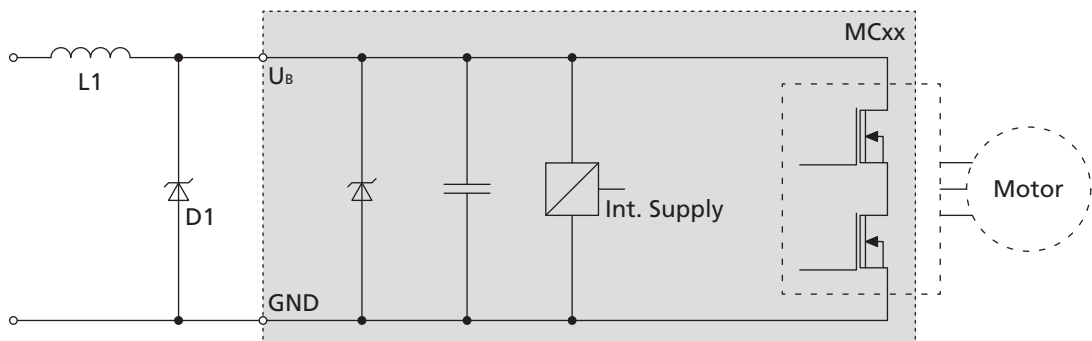
To protect against conducted emissions, it is advisable to plug in the supply line near the Controller with two windings via a ferrite sleeve L1 (e.g. WE 742 700 790).

The capacity of the internal suppressor diode is not sufficient to protect against overvoltage on the supply line (surge). An external diode D1, e.g. NTE 4934 (1500 W) is recommended for this.

3 Installation

3.2 EMC compatible installation

Protective measures MCxx 3003 / 3006

Motion Controller	Use environment	Interference type	Action
MCDC 3006 S	Industrial environment	Emission	EMC filter
MCBL 3006 S	Industrial environment	Emission	EMC filter
MCBL 3006 S	Industrial environment	Immunity	EMC suppressor circuit

This table shows which additional EMC measures can be implemented to optimise the behaviour of the equipment in the intended environment with regard to emission and immunity.

The devices are intended for use in the industrial sector only. If the devices are used in the home, in business or in commerce or in a small business, appropriate measures must be taken to ensure that the emitted interference is below the permitted limits!

The EMC filter (for MCDC 3006 S and MCBL 3006 S only)

The supply and motor supply cables must be laid directly on the unit, each with two windings through a suitable ferrite sleeve (e.g. Würth Elektronik No.: 74270090).

The EMC suppressor circuit (for MCBL 3006 S and MCLM 3006 S only)

The signal cables of the MCBL 3006 S and MCLM 3006 S must be laid directly on the unit with two windings through a star ring (e.g. Würth Elektronik No.: 7427153).

3 Installation

3.3 Connections

Depending on their type, Motion Controllers are equipped with either screw-type terminal strips, flexboard plug-in connectors or pin headers as connection options.

CAUTION!

⚠️

ESD protection/electronic damage!

Electrostatic discharges at the connections of the Motion Control systems can cause irreparable damage to the electronics.

▶ *Note and follow the ESD protective measures.*

Incorrect connection of the cores can cause damage to or destruction of the electronics.

▶ *Connect the connections in accordance with the connector pin assignment, see table.*

Please also note and follow the supplementary installation instructions in .

3.3.1 Supply end connection (MCxx 3002/3003/3006)

Pin	Designation	Meaning
1	TxD/CAN_H	RS232/CAN interface
2	RxD/CAN_L	RS232/CAN interface
3	AGND	Analog Ground
4	Fault	Error output
5	AnIn	Analog input
6	U_B	Controller supply voltage
7	GND	Controller ground connection
8	3. In	3. Input/opt. separated power supply

3.3.2 Motor end connection MCDC 3002

Pin	Designation	Meaning
9	4. In	4th input
10	Ch A	Encoder channel A
11	Ch B	Encoder channel B
12	U_{CC}	Supply voltage for external loads
13	SGND	Signal ground connection
14	Mot +	Supply voltage, motor +
15	Mot –	Supply voltage, motor -
16	5. In	5th input

3.3.3 Motor end connection MCBL/MCLM 3002

Pin	Designation	Meaning
9	Sensor A	Hall sensor A/DATA for absolute encoder
10	Sensor B	Hall sensor B/CS for absolute encoder
11	Sensor C	Hall sensor C/CLK for absolute encoder
12	U_{CC}	Supply voltage for external loads
13	SGND	Signal ground connection
14	Motor A	Motor Phase A
15	Motor B	Motor Phase B
16	Motor C	Motor Phase C

3 Installation

3.3 Connections

3.3.4 Motor end connection MCDC 3003 / 3006

Pin	Designation	Meaning
9	5. In	5th input
10	4. In	4th input
11	Ch A	Encoder channel A
12	Ch B	Encoder channel B
13	Ucc	Supply voltage for external loads
14	SGND	Signal ground connection
15	Mot +	Supply voltage, motor +
16	Mot –	Supply voltage, motor -

3.3.5 Motor end connection MCBL / MCLM 3003 / 3006

Pin	Designation	Meaning
9	Sensor A	Hall sensor A/DATA for absolute encoder
10	Sensor B	Hall sensor B/CS for absolute encoder
11	Sensor C	Hall sensor C/CLK for absolute encoder
12	Ucc	Supply voltage for external loads
13	SGND	Signal ground connection
14	Motor A	Motor Phase A
15	Motor B	Motor Phase B
16	Motor C	Motor Phase C

CAUTION!

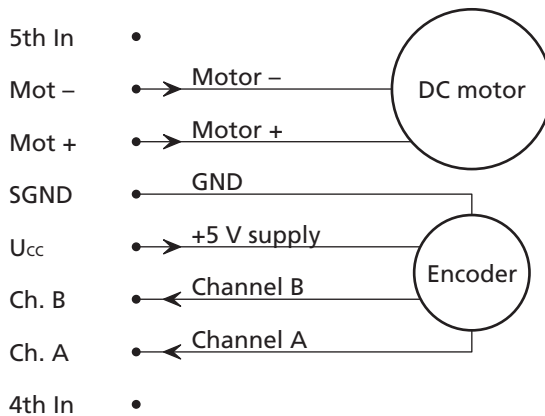⚠️

Note on MCBL and MCLM:

The terminal assignment on the motor side is not compatible with earlier controller versions.
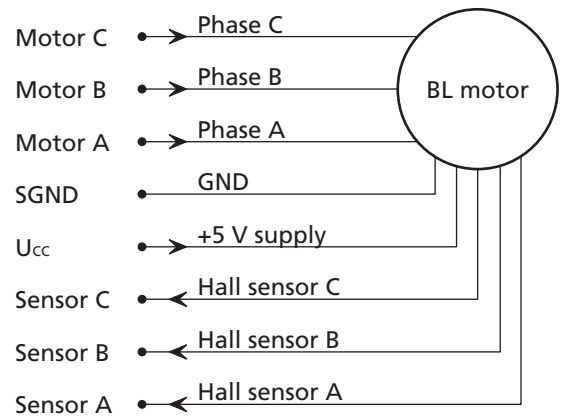
3 Installation

3.3 Connections

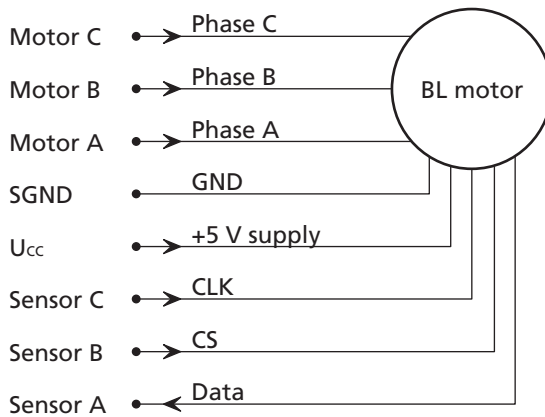### 3.3.6 Motor end connection examples

DC motor with encoder (at MCDC 3002*)

5th In

Mot –   Motor –

Mot +   Motor +

SGND   GND

U_{CC} +5 V supply

Ch. B   Channel B

Ch. A   Channel A

4th In

DC motor

Encoder

* Assignment differs from that of MCDC 3003/3006 (see Chapter 3.3.4)

BL/LM motor with Hall sensors

Motor C   Phase C

Motor B   Phase B

Motor A   Phase A

SGND   GND

U_{CC} +5 V supply

Sensor C   Hall sensor C

Sensor B   Hall sensor B

Sensor A   Hall sensor A

BL motor

BL motor with absolute encoder

Motor C   Phase C

Motor B   Phase B

Motor A   Phase A

SGND   GND

U_{CC} +5 V supply

Sensor C   CLK
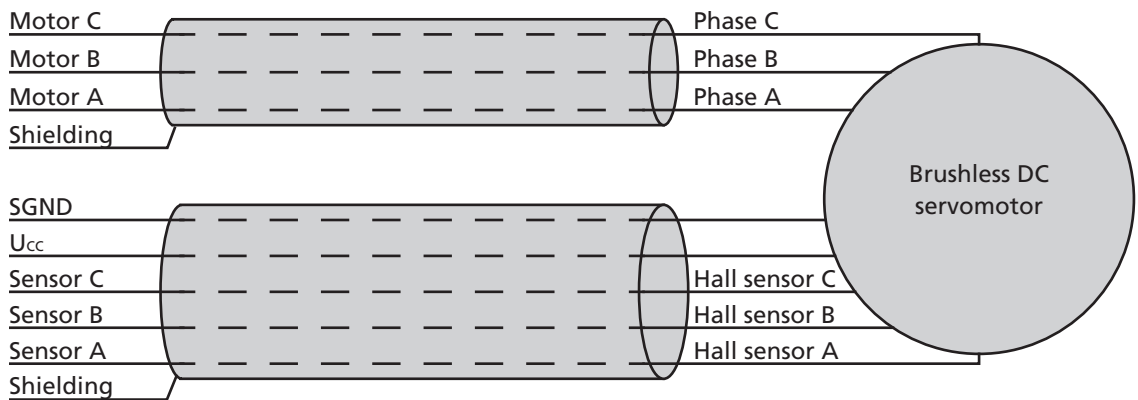
Sensor B   CS

Sensor A   Data

BL motor

3.3.7 Shielding the motor wiring

The encoder and signal lines are susceptible to interference, which makes it impossible to specify a maximum cable length.
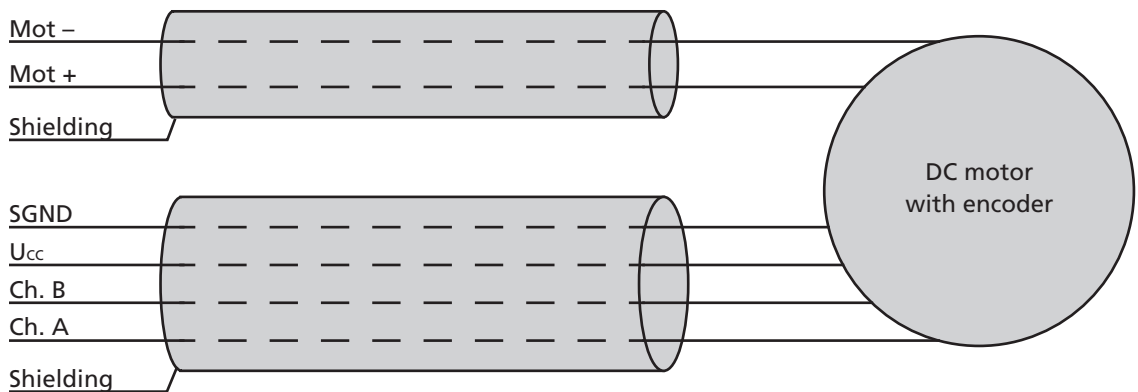
Shielded wires must always be used for cable lengths > 300 mm.

In general it is necessary to ensure that the cables between the Motion Controller and the motor are kept as short as possible, since drive system properties such as smooth and concentric running deteriorate as the length of the cables increases.
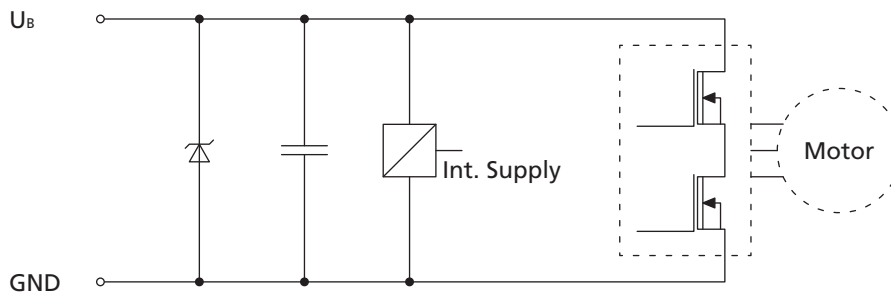
MCBL motor wiring

Motor C		Phase C	
Motor B		Phase B	
Motor A		Phase A	Brushless DC servomotor
Shielding			
SGND			
U_{CC}			
Sensor C		Hall sensor C	
Sensor B		Hall sensor B	
Sensor A		Hall sensor A	
Shielding			

MCDC motor wiring

Mot –		
Mot +		
Shielding		DC motor with encoder
SGND		
U_{CC}		
Ch. B		
Ch. A		
Shielding		

3 Installation

3.3 Connections

3.3.8 Power supply

**Supply connection**

CAUTION!

Power supply connections (U_B, GND)

Malfunctions can occur if an inadequately dimensioned power pack is used. If the supply leads are incorrectly connected (polarity reversal) the internal fuse trips. **This must be replaced in the factory (not possible with encapsulated versions)!**

▶ *The power pack must be adequately dimensioned for the connected motor.*

▶ *Ensure motor supply terminals are connected to the correct polarity.*

3.3.9 Separated electronic supply (Option 2993 or 3085)
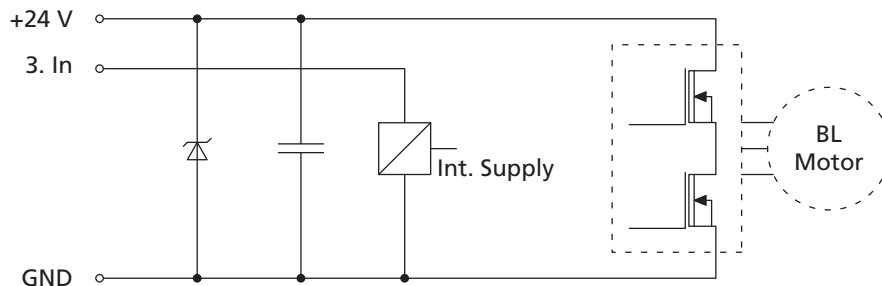
FAULHABER Motion Controllers can be delivered optionally with a separate electronic supply. This enables the motor supply to be switched off in case of a fault, e.g. by a safety relay, while the supply to the controller is maintained. After correcting the fault is not necessary to perform new reference (homing) run, as the supply to the motor's sensors is maintained. In this case the separate supply for the internal electronics is provided via contact 3rd In. The 3rd input is then omitted for this option.
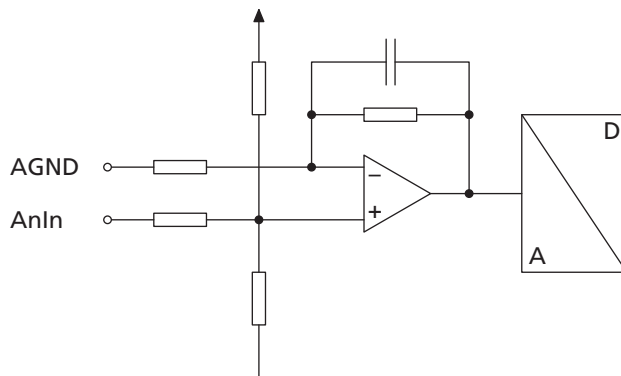
HINWEIS

Service life

Motion Controllers with separate electronics supply must at least be connected to the supply via 3rd In and GND for the startup, otherwise communication cannot be established!

3.3 Connections

3.3.10 Analog input

**Internal protective circuit, analog input**

The analog input is implemented as a differential input. The analog GND should be connected to the power supply GND. This prevents the voltage drop in the supply cable from affecting the target velocity value.

The analog input has various uses, depending on the option and configuration: (see communication manual)

- Presetting of target velocity value via analog voltage
- Presetting of target velocity value via PWM signal
- Current limitation value via analog voltage
- Presetting of target position via analog voltage
- Digital input for reference and limit switches
- Connection for an external encoder (analog input to GND: Channel A / Analog GND to GND: Channel B) in gearing or BL encoder mode.

3.3.11 Digital input

Internal protective circuit, 3rd input
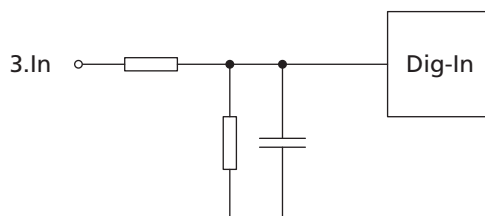
This connection can be used as reference or digital input. The drives can also be optionally provided with separate electronics supply at this connection ex-works, enabling the motor voltage to be switched off independently of the electronics supply.

3.3.12 Error output

CAUTION!

Electronic damage!

The fault output is configured as an output in the factory. Before connecting as an input, the fault pin must have been configured accordingly. The configuration must be saved (see communication and function manual / commissioning chapter).

The electronics can be damaged if a voltage is applied to the fault output while it is not configured as the input.

▶ *Check the fault output setting before applying a voltage.*

The voltage applied to the fault output must never exceed the voltage supply of the Motion Controller.

The supply voltages of the sensors must not exceed the supply voltage of the Motion Controller (e.g. in case of separate supply systems 24 V / 12 V).

▶ *Match the supply voltages of the sensors and the Motion Controller to each other.*

The supply voltage of the sensors must never be switched on while the supply voltage of the Motion Controller is switched off.

▶ *Ensure that the supply voltage of the sensors cannot be switched on independently of the supply voltage of the Motion Controller.*

Internal protection circuit Fault (Dig I / O)
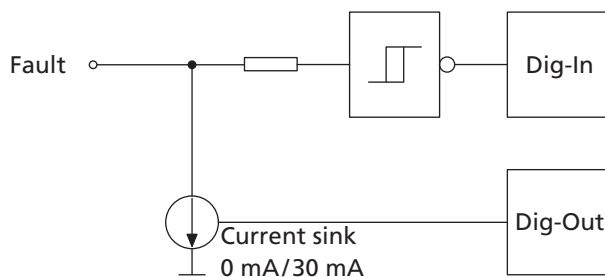
Pin	Designation	Meaning
4	Fault	Error output

The error output is characterised by the following characteristics:

- Circuit that switches to GND (Open Collector)
- Output resistance in open state (High Level): 100 kΩ
- The circuit is open in the event of error (High Level)
- Output current limited to approx. 30 mA, voltage in open state must not exceed the supply voltage (maximum U_B)
- Short-circuit proof

Depending on the option, the Fault error output connection can also be configured for other functions:

- Pulse output
- Digital output (freely programmable)
- Homing or digital input
- Rotational direction input

NOTE

Note

If the error output is used as an input, we recommended connecting an external resistor (1 kΩ / 0,25 Watt) in series.

3 Installation

3.3 Connections

3.3.13 Interfaces

RS232

The RS232 wiring is established via the connections RxD, TxD and the supply GND; alternatively, the installed D-sub connector can be used (not available for all variants). The installed RS232 interface allows direct connection with a higher level control.

Pin header / Terminal strip	D-Sub connector	Designation	Meaning
Pin 7	5	GND	GND
Pin 2	2	RxD	RS232 RxD
Pin 1	3	TxD	RS232 TxD

CAN

The CAN wiring is established via the connections CAN-H, CAN-L and the supply GND; alternatively, the installed D-sub connector can be used (not available for all variants).
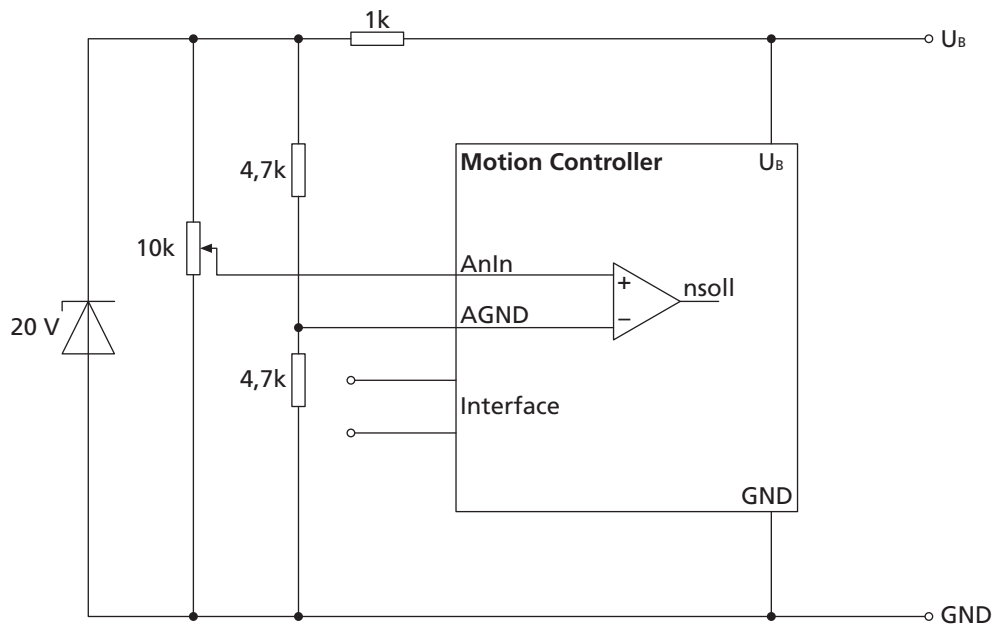
Pin header / Terminal strip	D-Sub connector	Designation	Meaning
Pin 7	3	GND	GND
Pin 2	2	CAN_L	CAN Low
Pin 1	7	CAN_H	CAN High

3 Installation
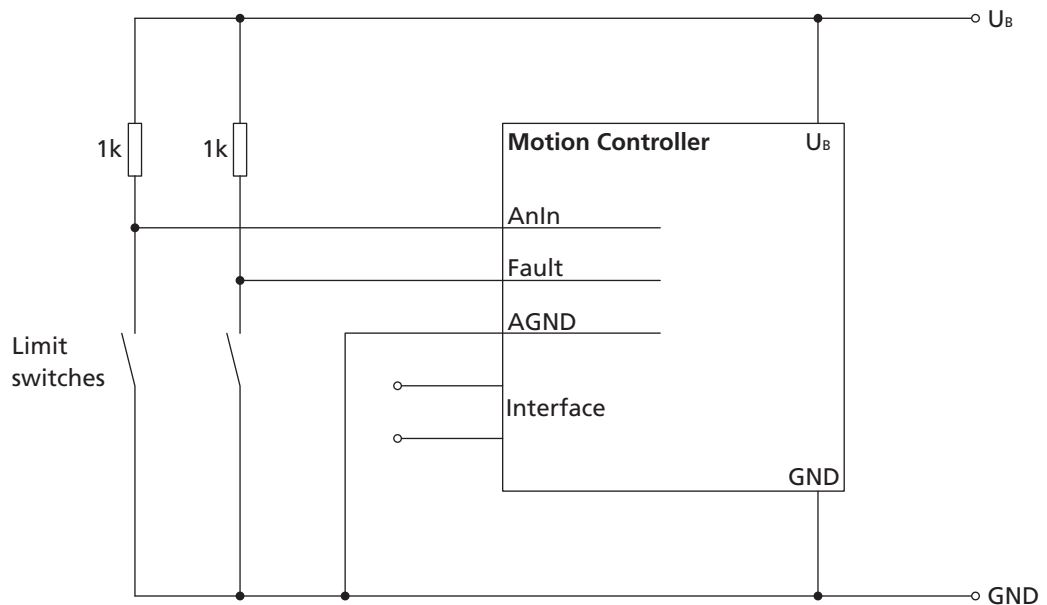
3.4 Connection examples

3.4.1 Command source via potentiometer

Bipolar analog command source via potentiometer

3.4.2 Homing and limit switches
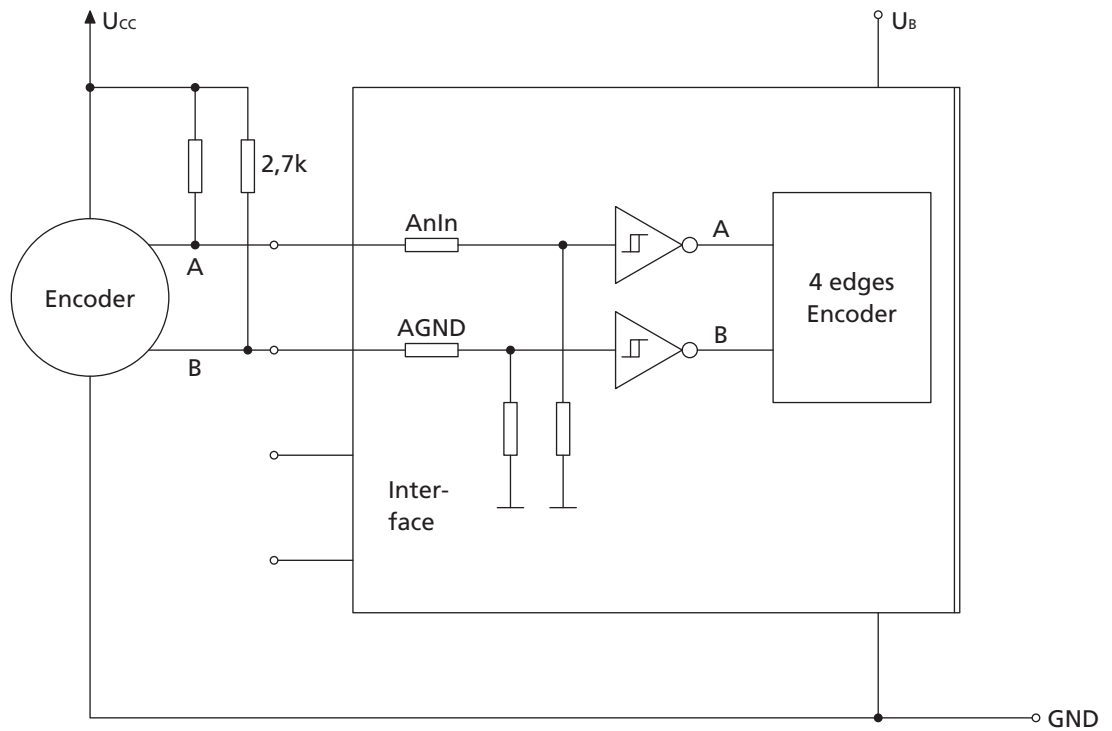
Connection of homing and limit switches

3 Installation

3.4 Connection examples

3.4.3 External incremental encoder

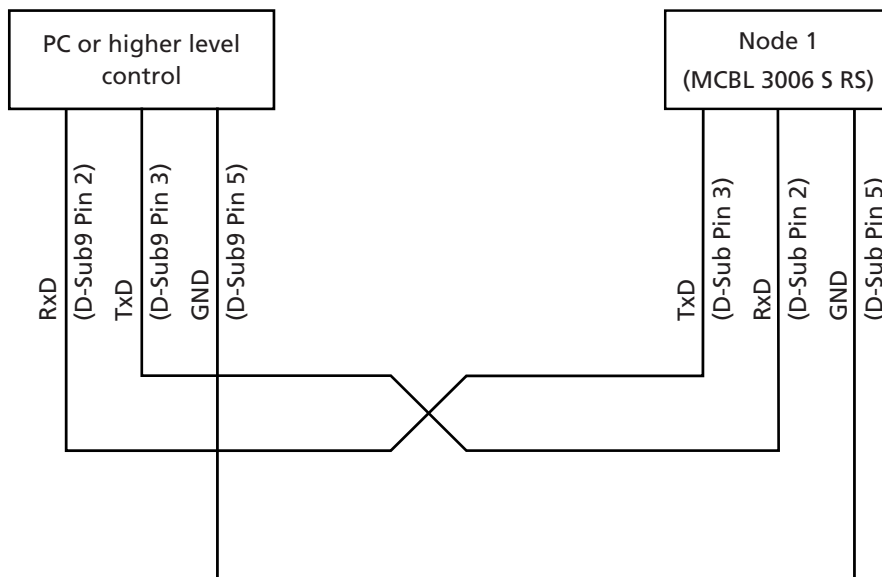**Connection of an external encoder**
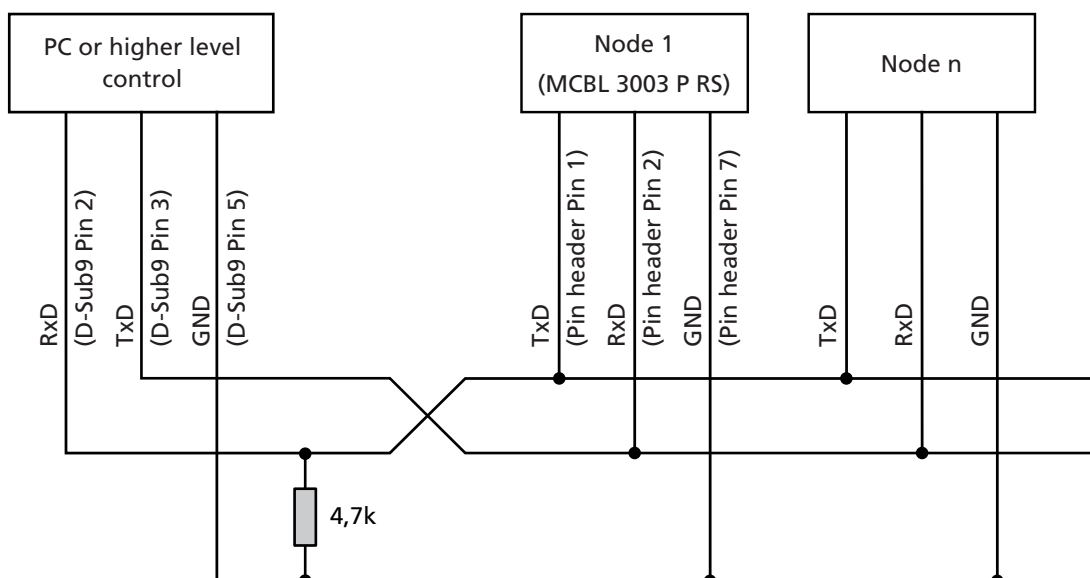
3 Installation

3.5 Communication port

3.5.1 RS232 port

The drives can be directly connected to a PC or a higher level control using transposed transmission and reception cables. This corresponds to implementation with a null modem cable.
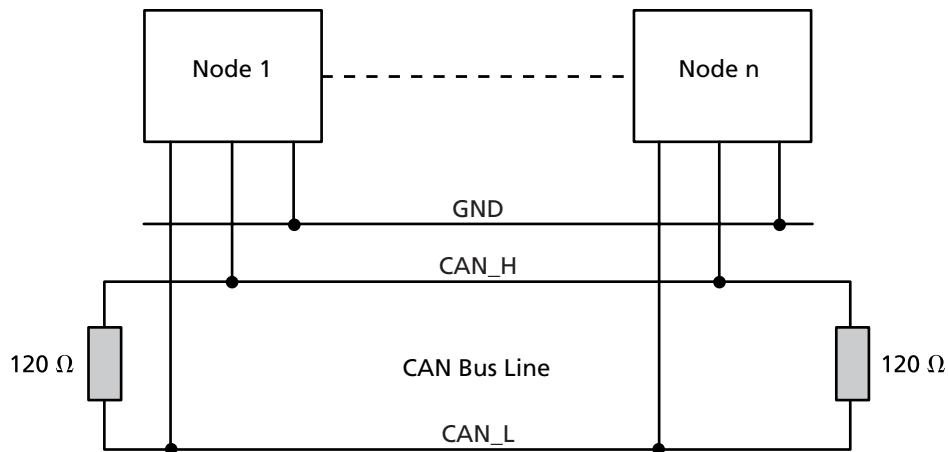
Wiring between PC / control and a drive

Wiring with several Motion Control systems in RS232 network mode

3 Installation

3.5 Communication port

3.5.2 CAN port

CAN is a bus system, to which all nodes are connected in parallel. A terminal resistance of 120 Ω must be connected to each end of the bus line.

In addition to the two signal lines CAN_H and CAN_L, the nodes must also be connected to each other by a common GND line.

The maximum line length is limited by the transfer rate and the signal propagation times:

Baud rate	Max. line length (incl. stub)
1 000 kBit/s	25 m
500 kBit/s	100 m
250 kBit/s	250 m
125 kBit/s	500 m
50 kBit/s	1,000 m
20 kBit/s	2,500 m
10 kBit/s	5,000 m

3.6 Baud rate and node number / node ID

NOTE

The baud rate and node number necessary for the communication link are set via the Motion Manager or as a direct command input. Please read the relevant function and communication manual and the Motion Manager's instruction manual.

4 Operation

4.1 Device start up

To start up a drive, please read in the communication and function manual.

Before starting up a drive the following points must be checked:

- The Motion Controller has been installed according to the specifications.
- The connection cables on the supply side are connected according to the requirements (risk of polarity reversal!) and are laid so that they cannot be damaged during operation. The maximum load values must be noted and observed.
- Terminals and connectors are protected against ESD.
- The power supply unit is designed according to the requirements.

CAUTION!   ***Power supply***

Due to the PWM of the power output stage the motor current is always larger or equal to the current that can be measured at the supply connection U_{mot}. The current information (continuous / peak current) in the data sheets and the adjustable parameters of the I²t current limiting refer to the motor current and not to the supply current of the drive system (Motion Controller)!

CAUTION!   ***Risk of injuries***

A risk of injuries can result from protruding rotating or moving parts of the driven mechanism.

▶ *Cover rotating and moving parts with appropriate devices.*

5 EC Product Safety Directives

REGULATION!

§

The following EC Product Safety Directives are important for users of the described products:

Machinery Directive (2006/42/EC):

Due to their small size, small standard electrical drives cannot cause any noteworthy risk of injuries to people.

Therefore, the Machinery Directive does not apply to our products.

The products described here are not "part machines" or "incomplete machines".

Therefore, Faulhaber does not provide a standard Declaration of Incorporation.

Low-Voltage Directive (2014/35/EU):

It applies to all electrical equipment with a nominal voltage from 75 to 1 500 V DC, or from 50 to 1 000 V AC. The products described in this instruction manual do not fall within the scope of this Directive as they are designed for smaller voltages.

EMC Directive (2014/30/EU):

The Electromagnetic Compatibility (EMC) Directive applies to all electronic and electrical equipment, plant and systems sold to end users (consumers). In addition, CE marking can be undertaken for built-in components according to the EMC Directive. Compliance is documented by the Declaration of Conformity.

6 Warranty

Note

Dr. Fritz Faulhaber GmbH & Co. KG products are produced to state of the art production methods and are subject to strict quality control.

All sales and deliveries made exclusively on the basis of our general Terms and Conditions of Business. These are available to view and download on the FAULHABER homepage at www.faulhaber.com/agb.

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