



Motion Control Systems

Series 2232...BX4 CSD/CCD/COD

Series 2250...BX4 CSD/CCD/COD

Technical Manual

DE

Imprint

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This technical manual has been prepared with care.
Dr. Fritz Faulhaber GmbH & Co. KG cannot accept any liability for any errors in this technical manual 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 technical manual 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

Overview

This instruction manual contains instructions on how to install and use the FAULHABER Motion Control Systems (drives), Series 22xx...BX4 CxD.

It is also necessary to use the communication and function manual for the commissioning, depending on the chosen interface option. 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	Content
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
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 page (www.faulhaber.com).

Inhaltsverzeichnis

1	Important Information	5
1.1	Symbols used in this technical manual	5
1.2	Safety instructions	6
1.3	Service/Maintenance	6
1.4	Troubleshooting	6
2	Description	7
2.1	General product description	7
3	Installation	9
3.1	Installation instructions	9
3.2	EMC compatible installation	12
3.3	Connections	13
3.3.1	Power supply	14
3.3.2	Separated electronic supply (Option 2993 or 3085)	14
3.3.3	Analog input	15
3.3.4	Digital input	15
3.3.5	Fault output	16
3.3.6	Internal protection circuit Fault (Dig I/O)	16
3.3.7	Interfaces	17
3.4	Connection examples	18
3.4.1	Command source via potentiometer	18
3.4.2	Homing and limit switches	18
3.4.3	External incremental encoder	19
3.5	Communication connection	20
3.5.1	RS232 interface	20
3.5.2	CAN connection	21
3.6	Baud rate and node number/node ID	22
4	Operation	23
4.1	Device start up	23
5	EC Product Safety Directives	24
6	Warranty	25

1 Important Information

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

Series 22xx...BX4 CxD

The 22xx...BX4 CxD series drives integrate a brushless DC servomotor of the 22xx...BX4 motor family with a high-resolution encoder and a motion controller in one complete drive unit.

- Please read through the complete installation manual and the communication and function manual before using the drive.
- Keep these instruction manuals in a safe place for later use.

The information given in this technical manual refers to the standard versions of the respective products. Please refer to any additional information sheet provided in the event of differences in information due to a requested product 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 Control systems described here have been designed for controller operation of the integrated brushless motor. 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 control parameters of the Motion Control systems can be individually adjusted to the respective application via a PC. The "FAULHABER Motion Manager" PC software for Microsoft Windows is available for commissioning and configuring the Motion Control systems and can be downloaded free of charge from the FAULHABER homepage www.faulhaber.com.

- The Motion Control systems contain electronic components and must be handled according to the ESD regulations.
- The Motion Control Systems 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 possible product modifications for use in special ambient conditions.

1.3 Service / Maintenance

When used according to specification the devices are maintenance free for the operational lifetime of the device.

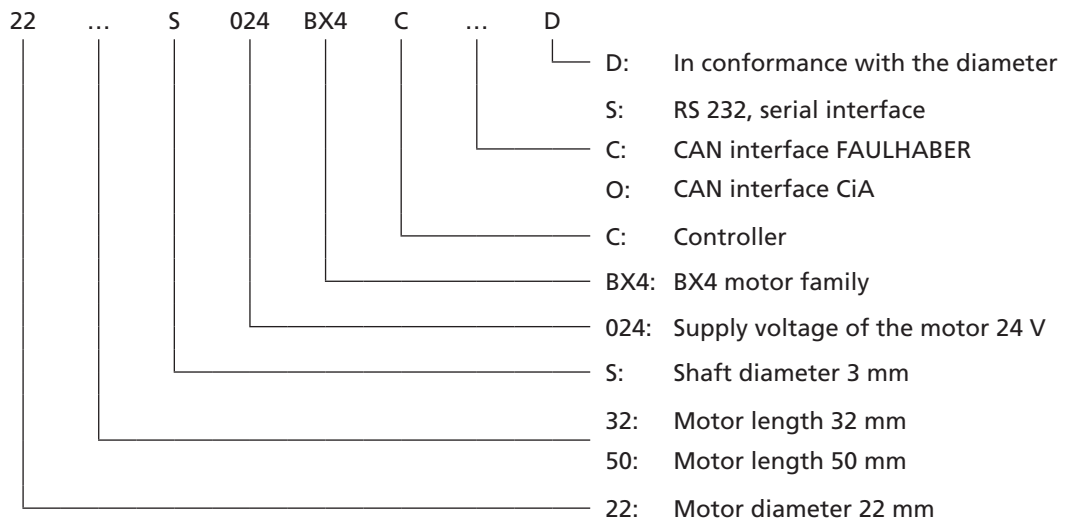
1.4 Troubleshooting

The device will not fail when used according to specification and the given instruction manuals. If malfunctions occur during proper intended use, please contact your responsible partner.

2 Description

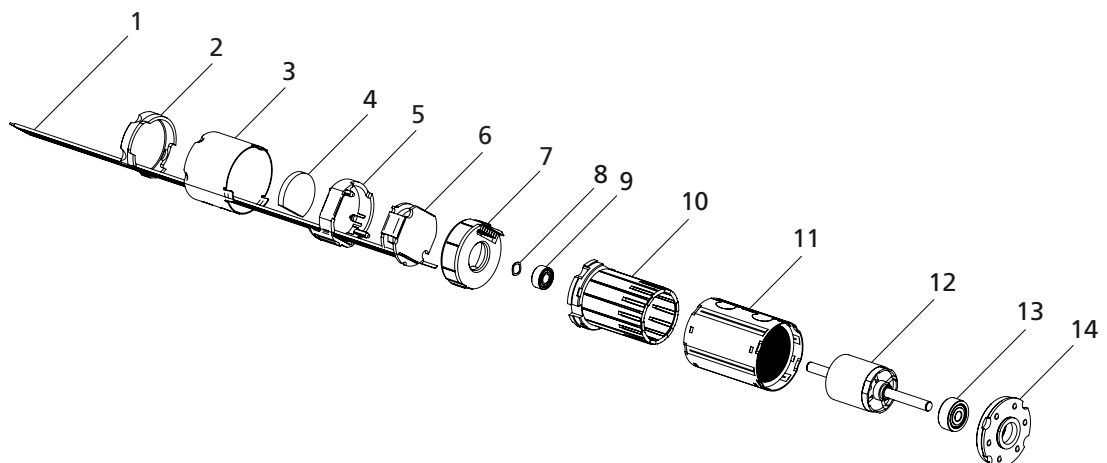
2.1 General product description

Product information



The drives integrate a brushless DC servomotor, a high-resolution encoder and a programmable position and speed controller, based on a high performance digital signal processor (DSP), within a complete drive unit.

Configuration example: 2232...BX4 CxD



- | | |
|-------------------------|------------------------|
| 1 Cable connection | 8 Press ring |
| 2 Cover | 9 Spring |
| 3 Built-on housing | 10 Rear motor bearing |
| 4 Heat transfer pad | 11 Winding |
| 5 Mounting flange 1 | 12 Housing |
| 6 Printed circuit board | 13 Rotor |
| 7 Mounting flange 2 | 14 Front motor bearing |

2 Description

2.1 General product description

The drive is 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.
- Velocity control with analog or digital command source.
- Acquisition of reference marks and limit switches.
- Enhanced operating modes such as stepper motor mode, electronic gearing, voltage regulator.
- Mode or current control with analog current control.
- Execution of sequential programs stored in the controller (in RS232 version only).

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

- **Analog input**

For use as:

- Command source via analog or PWM signal
- Digital input for reference marks and limit switches
- Pulse input
- Incremental encoder connection

- **Error output**

For use as:

- Digital output
- Pulse output
- Digital input for reference marks and limit switches
- Rotational direction input

- **1 additional digital input**

For use as:

- Digital input for reference marks and limit switches

- **Communication interface**

Depending on the version, designed as serial RS232 or CAN interface for linking to PC or control

The chosen configuration can be permanently saved.

NOTE



Communication interface

Drives 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

As an option, the power supply for the motor and electronics can be offered with separate connections (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 Installation instructions

CAUTION!



Damage due to incorrect assembly!

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

- ▶ *Observe the following assembly instructions.*

Trained Personnel

This device is for use by trained personnel with knowledge of the relevant 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 and follow the supplementary installation instructions in [section 5 "EC Product Safety Directives"](#).

Use environment

Depending on its use, the drives can get very hot. The unit should be installed in a clean, dry environment with access to ventilation. On installation, ensure that air can flow around the drive without obstruction. The rear attachment in particular may not be covered.

The units are intended for indoor operation. Large amounts of dust and high concentrations of chemical pollutants must be avoided.

Cooling of the unit must be guaranteed, especially when installing in secondary housings or boxes. Ensure unobstructed ventilation.

Perfect functioning is only guaranteed if the supply voltage lies within the defined tolerance ranges.

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 motor.*

Shaft load

Parts may only be pressed onto the motor shaft if the maximum allowable load values are taken into account according to the respective product data sheet.

3 Installation

3.1 Installation instructions

Mounting flange

The drive may only be fixed by means of the threaded holes provided in the front flange. The maximum length of the fixing screws must be noted and observed as otherwise the motor will be destroyed. The indicated screwing depth may not be exceeded.

The maximum tightening torques are usually limited by the strength of the screws.

CAUTION!



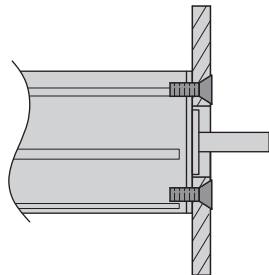
Risk of damage!

If the drives are installed on the mounting flange, the mounting flange can be damaged by high radial loads or stresses on the drives or by screws tightened with excessive torque.

- ▶ Do not load the drives at the rear end with a radial force greater than 30 N.
- ▶ Tighten the screws with maximum 50 Ncm. Note the strength of the screws and the maximum depth of engagement!

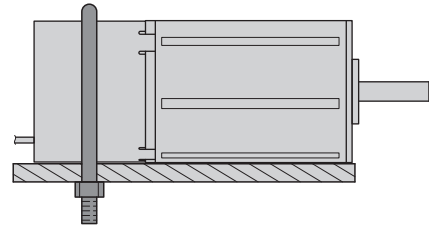
Correct

The motor is fixed by the screws on the mounting flange.



Incorrect

The motor is securely clamped to the attachment with a U-bolt.



Electrical connection

It is necessary to ensure that the connection cable is laid without risk of damage during installation and operation, e.g. through chafing, squeezing or insufficient bending radii.

CAUTION!



Risk of damage!

The ribbon cables may be damaged if the static or dynamic load is too high.

- ▶ The tension exerted on the cable must not exceed 30 N in each direction. If the cable is exposed to constant tensile loads the limit is 17 N.
- ▶ In case of frequent bending, the recommended minimum bending radius is 10 mm. The possible number of bending cycles increases with increasing bending radius.
- ▶ If the radii are small the cable may not be bent several times as otherwise the Litz wires will break. The bending radii if laid once must be larger than 1.2 mm.
- ▶ The cable may not be bent at temperatures < -10 °C.

3 Installation

3.1 Installation instructions

Power off during assembly

The drives must be disconnected from the power supply for all types of assembly and connection work, especially when making adjustments to the interface cables.

Shock loads

The noise emitted is increased and the life of the ball bearings and therefore of the motor becomes limited if they are exposed to impacts.

- The motor can still function if it is not exposed to higher shock loads than defined according to EN 60068-2-27.
- The motor may not be exposed to higher vibratory stresses than defined according to EN 60068-2-6.

NOTE



Service life

The full life is reached if the motor is not exposed to shock or vibration loads.

CAUTION!



Length of the connection leads!

The maximum length of the connection leads is limited.

- ▶ *None of the connection leads, with the exception of the power supply, may exceed a length of 3 m.*

CAUTION!



Risk of damage due to back-induced voltage!

The drive acts as a generator, if the motor shaft is driven by an external force.

The voltage generated can damage the drive's electronics, especially if this is not connected electrically to a supply and if the motor shaft is driven with a higher speed than the maximum or nominal speed.

A gearbox connected to the motor can also additionally affect the speed of the motor shaft.

- ▶ *During installation, connect the electronic supply of the drive to a power pack or connect its connections (+24 V DC and GND) with each other.*
- ▶ *Ensure that the drive, even when taking into account a possibly used gearbox, is not driven above the specified maximum or nominal speed.*
- ▶ *Use a protective circuit, as described in [section 3.2 "EMC compatible installation"](#).*

Calculation of the generated voltage with external driving of the motor shaft

The equivalent direct voltage (U_B) generated by external driving of the motor shaft equals the product of the speed (n) and generator voltage constant (k_n) as shown in the following formula:

$$U_B = k_n \times n$$

3 Installation

3.2 EMC compatible installation

CAUTION!



Length of the connection leads!

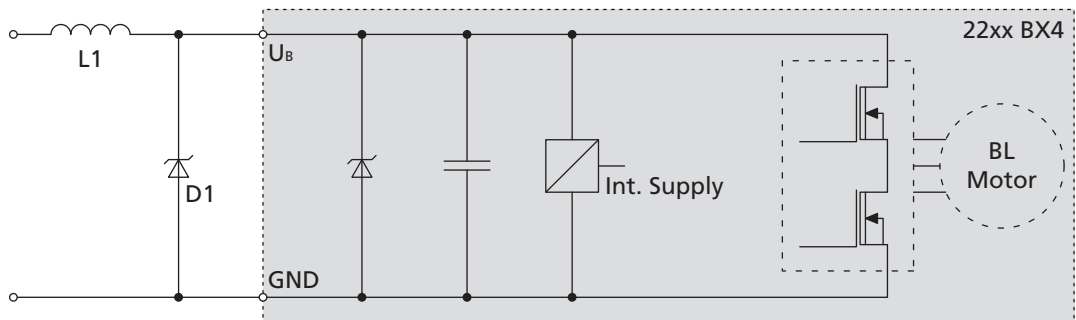
The maximum length of the connection leads is limited.

- ▶ None of the connection leads, with the exception of the power supply, may exceed a length of 3 m.

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

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

Suppressor circuit consisting of D1 and L1



To protect against conductive emissions, we recommend plugging in the supply cable near the drive with two windings via a ferrite sleeve L1 (e.g. WE 742 700 790).

The capacity of the internal suppressor diode is insufficient to protect against surges in the supply cable. Here an external diode D1 is recommended, e.g. NTE 4934 (1500 W).

3 Installation

3.3 Connections

The drives are equipped with an eight-core connection cable (AWG 26).

CAUTION!



Electronic damage/ESD protection

Electrostatic discharges at the Motion Control system's connections 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 [section 5 "EC Product Safety Directives"](#).

22xx... BX4 CSD

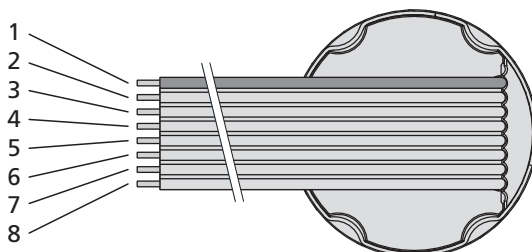
The connections are made using ribbon cables. Pin 1 is marked in colour:

Pin	Designation	Meaning
1	3.In	3rd input optional electronic supply U_B
2	U_B	Supply voltage
3	GND	GND
4	AnIn	Analog input
5	AGND	Analog GND
6	FAULT	Error output
7	RxD	RS232 RxD
8	TxD	RS232 TxD

22xx... BX4 CCD / COD

The connections are made using ribbon cables. Pin 1 is marked in colour:

Pin	Designation	Meaning
1	3.In	3rd input optional electronic supply U_B
2	U_B	Supply voltage
3	GND	GND
4	AnIn	Analog input
5	AGND	Analog GND
6	FAULT	Error output
7	CAN_L	CAN Low
8	CAN_H	CAN High

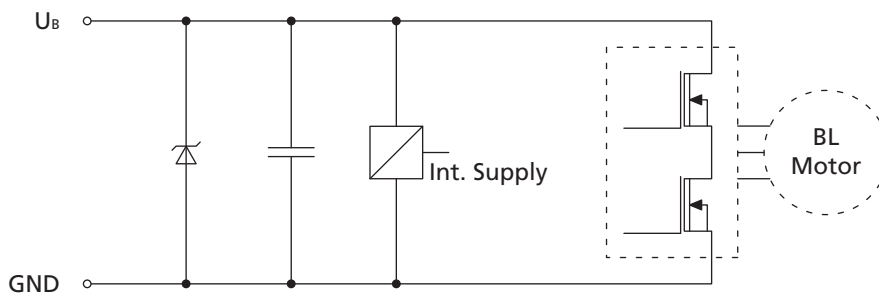


3 Installation

3.3 Connections

3.3.1 Power supply

Supply connection



Pin	Designation	Meaning
2	U_B	Supply voltage of the motor 24 V
3	GND	GND

CAUTION!

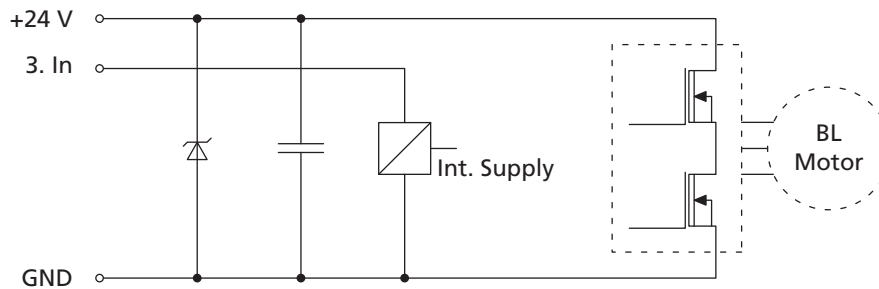


Power supply connections (U_B , GND)

Device malfunction can occur if the power supply is incorrectly dimensioned or connected.

If the supply leads are incorrectly connected (polarity reversal) the electronics are irreparably damaged.

3.3.2 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

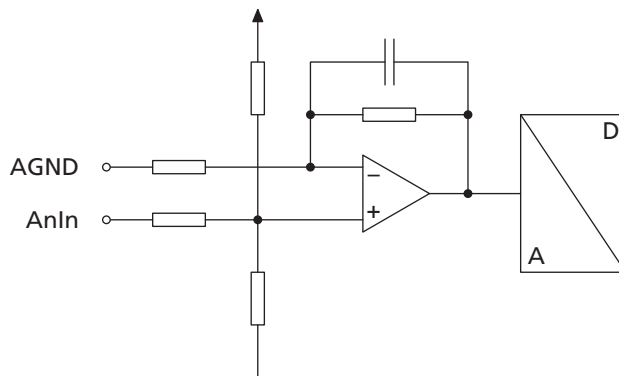
Motion Controllers with separate electronics supply must at least be connected to the supply via 2nd In and GND for the startup, otherwise communication cannot be established!

3 Installation

3.3 Connections

3.3.3 Analog input

Internal protective circuit, analog input



Pin	Designation	Meaning
4	AnIn	Analog input
5	AGND	Analog GND

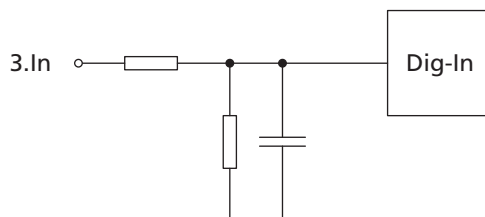
The analog input is executed as a differential input. The analog GND should be connected to the power supply GND. This prevents the voltage drop in the supply cable from affecting the target velocity value.

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.

3.3.4 Digital input

Internal protective circuit, 3rd input



Pin	Designation	Meaning
1	3.In	3rd input optional electronic supply U_s

This connection can be used as reference or digital input. As an option, this input can be modified by the manufacturer to serve as a separate connection for the supply voltage to the electronics allowing the motor to be disabled independently of the electronics.

3 Installation

3.3 Connections

3.3.5 Fault 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.

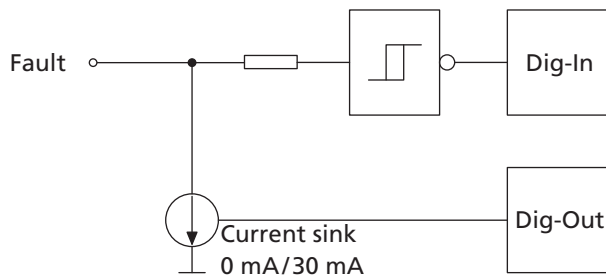
The voltage applied to the fault output must never exceed the voltage supply of the Motion Controller. The supply voltages of the sensors must not exceed the supply voltage of the Motion Controller (e.g. in case of separate supply systems 24 V/12 V).

- ▶ 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.

3.3.6 Internal protection circuit Fault (Dig I/O)



Pin	Designation	Meaning
6	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 k Ω
- 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 k Ω /0,25 watt) in series.

3 Installation

3.3 Connections

3.3.7 Interfaces

RS232

The RS232 wiring is established via the connections RxD, TxD and the supply GND. The installed RS232 interface allows direct connection with a higher level control.

Pin	Designation	Meaning
3	GND	GND
7	RxD	RS232 RxD
8	TxD	RS232 TxD

CAN

The CAN wiring is established using the CAN_H and CAN_L connections and the supply GND.

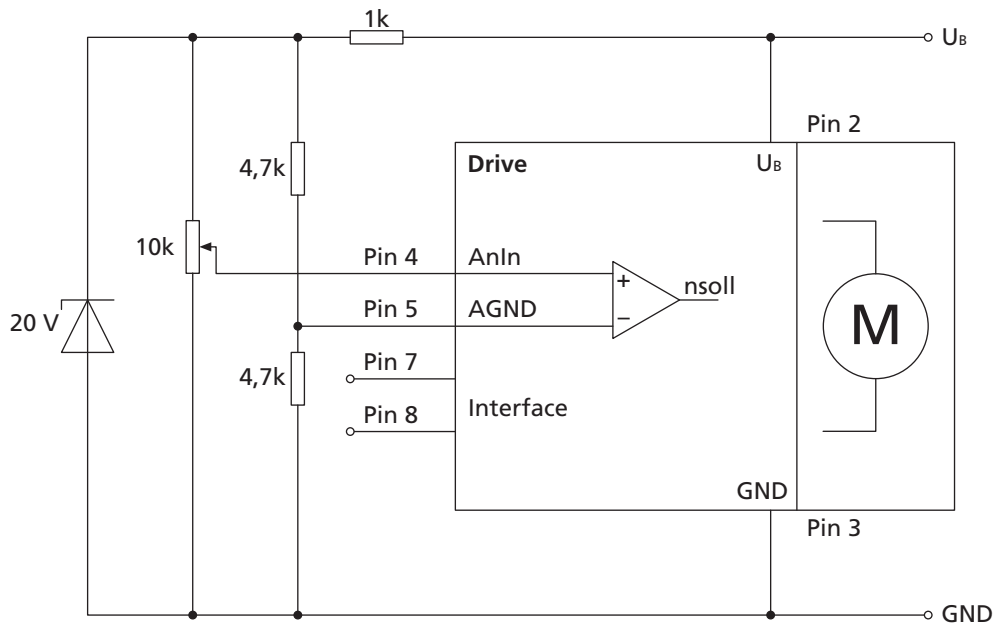
Pin	Designation	Meaning
3	GND	GND
7	CAN_L	CAN Low
8	CAN_H	CAN High

3 Installation

3.4 Connection examples

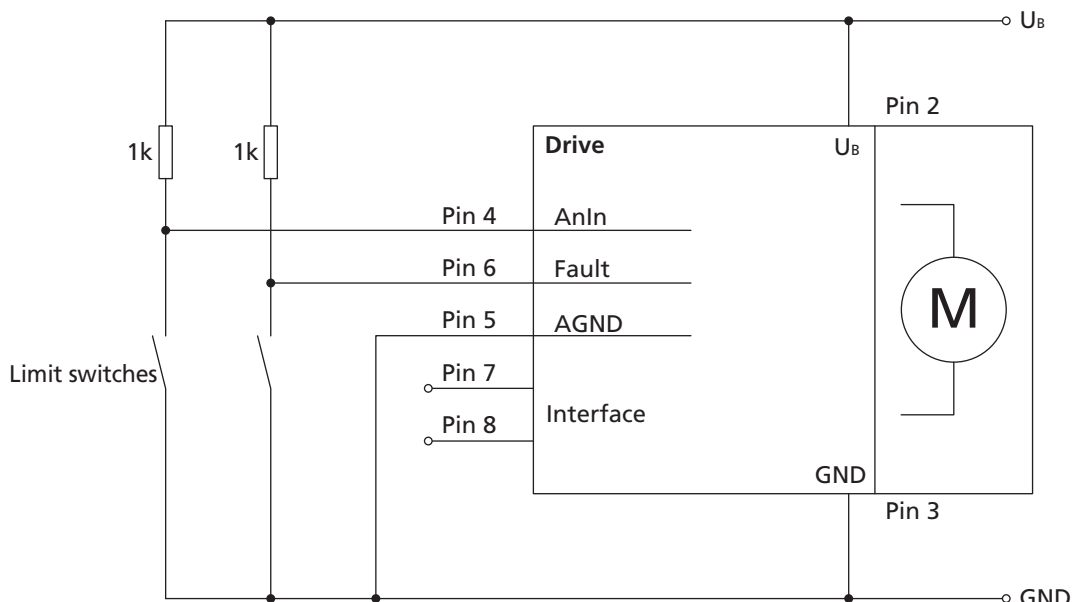
3.4.1 Command source via potentiometer

Bipolar analog command source via potentiometer



3.4.2 Homing and limit switches

Connection of homing and limit switches

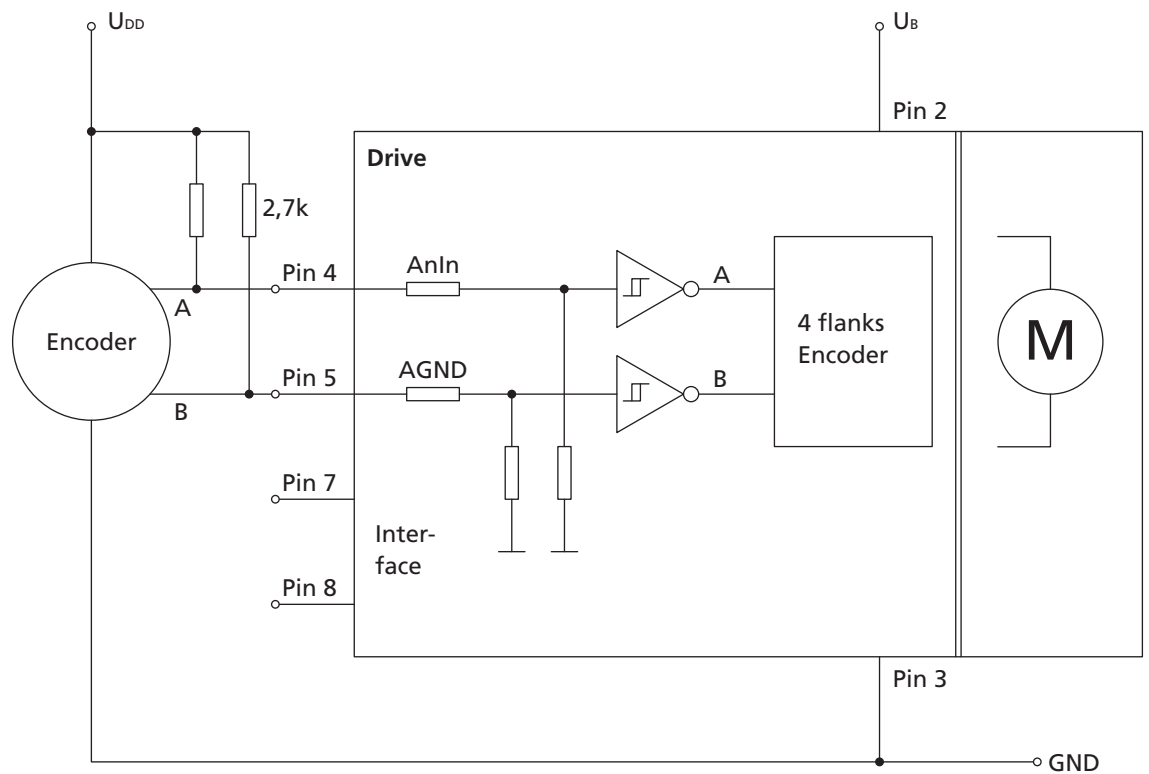


3 Installation

3.4 Connection examples

3.4.3 External incremental encoder

Connection of an external encoder



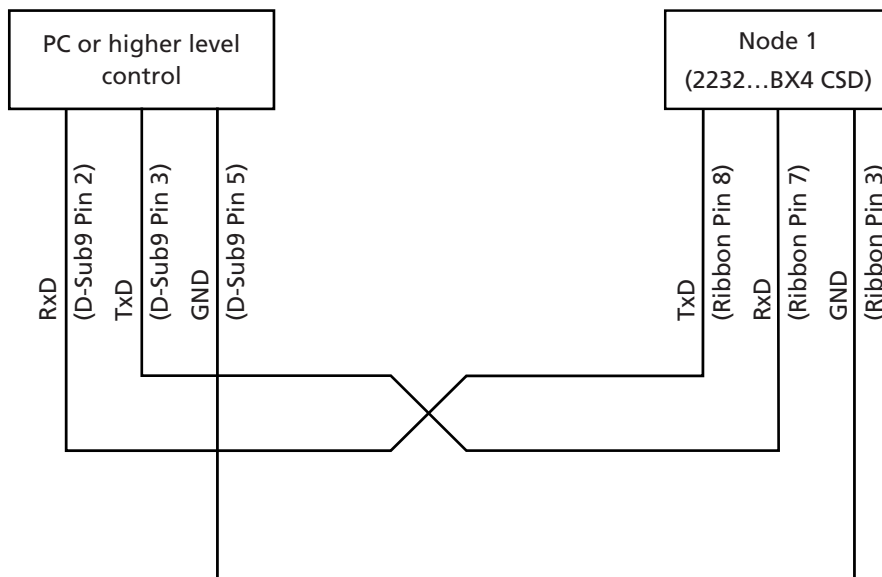
3 Installation

3.5 Communication connection

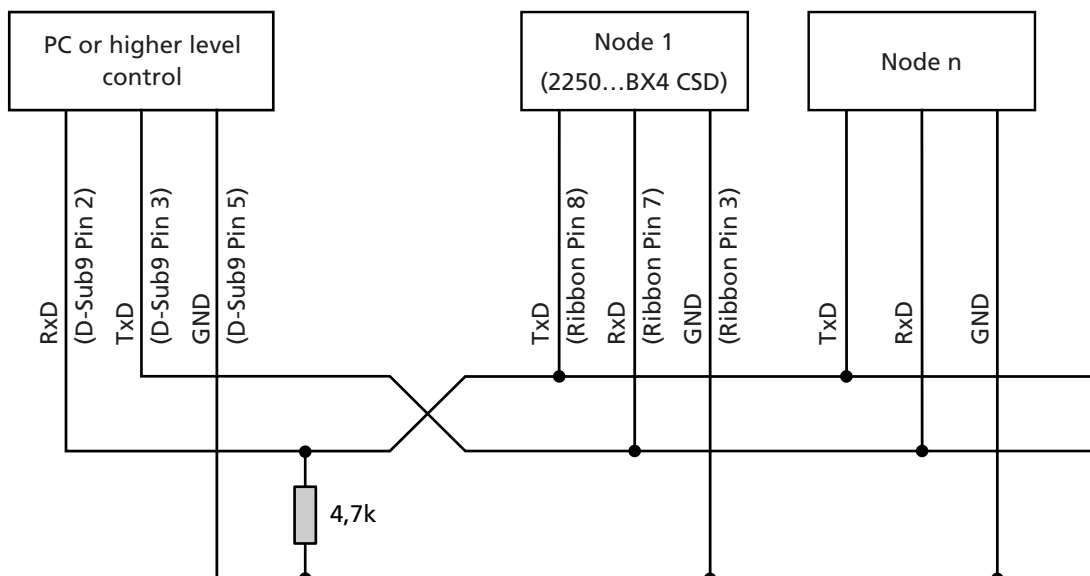
3.5.1 RS232 interface

The drive 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



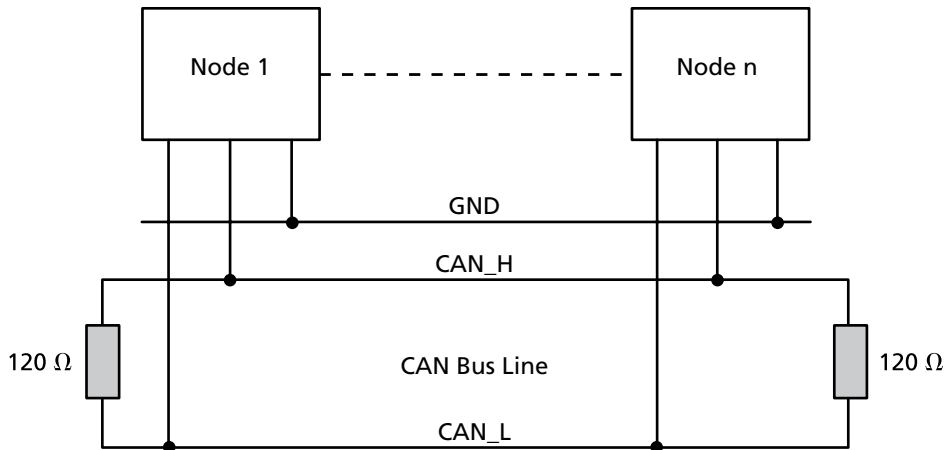
Wiring with several Motion Control systems in RS232 network mode



3 Installation

3.5 Communication connection

3.5.2 CAN connection



CAN is a bus system, to which all nodes are connected in parallel. A terminal resistance of 120 V 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 Installation

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 the communication and function manual.

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

- The drive 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. (See [section 3 "Installation"](#)).
- 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 I^2t current limiting refer to the motor current and not to the supply current of the 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.

CAUTION!



Risk of injuries

Depending on the load and ambient temperature, very high temperatures can occur on the surface of the unit.

- ▶ Contact protection (guards) must be provided if necessary.

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 (2006/95/EC):

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.

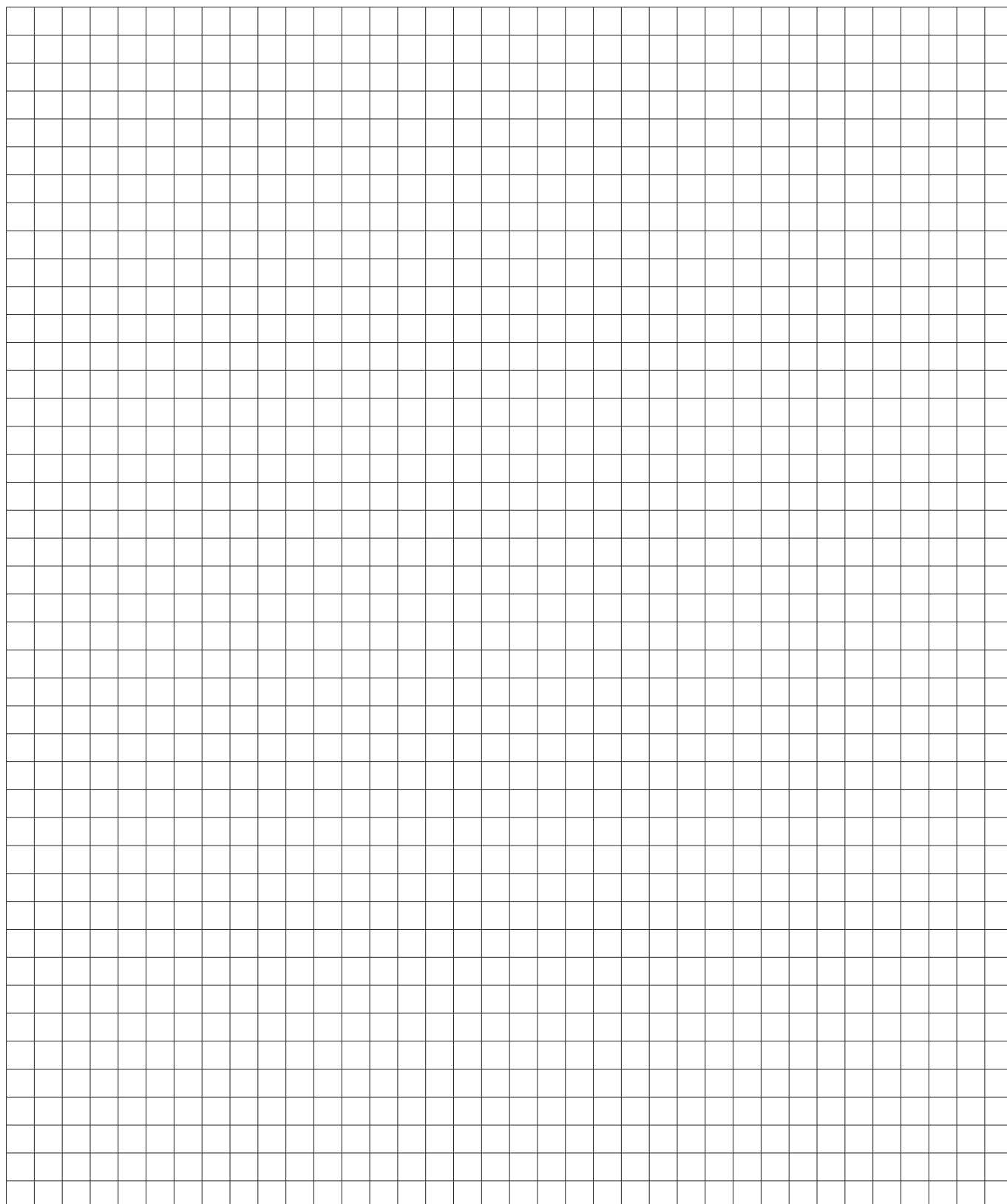
6 Warranty

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.

Notes



Notes

