FAULHABER

Motion Control Systems

Series 2232…BX4 CSD
Series 2232…BX4 CCD
Series 2250…BX4 CSD
Series 2250…BX4 CCD

Technical Manual

DE

WE CREATE MOTION

Imprint

Version:
2nd issue. 12.07.2010

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 technical manual contains instruction on installing and using the 22xx…BX4 CSD/CCD series drives, and the technical data for the drives.

However, it is absolutely necessary to use the communication and function manual for operation of the drives. 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 Drives documents

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

NOTE

The relevant communication and function manual is supplied, depending on the chosen option, on delivery of the drive.

Inhaltsverzeichnis

1 Important Information

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

Series 22xx…BX4 CSD / CCD

The 22xx…BX4 CSS/CCD 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.

2 Description

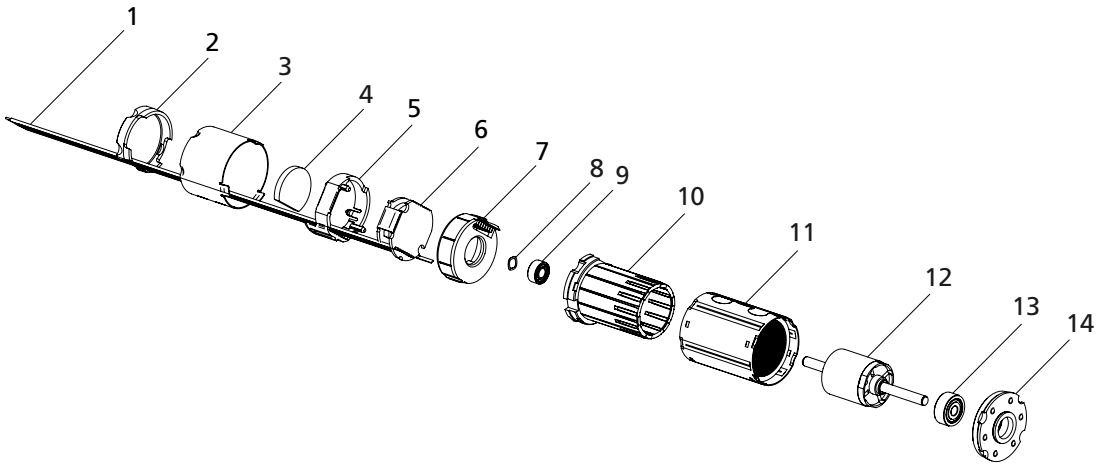
2.1 General product description

Product information

22 … S 024 BX4 C … D

- D: In conformance with the diameter
- S: RS 232, serial interface
- C: CAN interface
- C: Controller
- BX4: BX4 motor family
- 024: Supply voltage of the motor 24 V
- S: Shaft diameter 3 mm
- 32: Motor length 32 mm
- 50: Motor length 50 mm
- 22: Motor diameter 22 mm

The 22xx…BX4 CSD/CCD series drive integrates 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.



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

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

The drive 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/Motion-Manager .

3 Installation

3.1 Assembly

The 22xx…BX4 CSD/CCD series drive must be installed according to certain specifications to prevent malfunctions and damage.

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 7 “EC Directives”.

CAUTION!

Damage due to incorrect assembly!

Incorrect assembly or assembly using improper mounting materials or methods can cause damage to the 22xx…BX4 CSD/CCD series drive.

► *Observe the following assembly instructions.*

Use environment

Depending on its use, the 22xx…BX4 CSD/CCD series drive 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. See section 6 “Technical Data”.

3 Installation

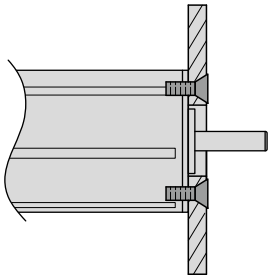
3.1 Assembly

Mounting flange

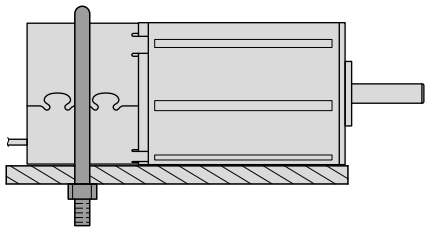
The drive may only be fixed by means of the threaded holes provided in the front flange. The maximum length of the fixing screws must be noted and observed as otherwise the motor will be destroyed. The indicated screwing depth may not be exceeded.

The maximum tightening torques are usually limited by the strength of the screws. However, they may not exceed the values given in section 6 “Technical Data”.

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. The maximum load of the cable must be noted and observed. See section 6.5 “Ambient conditions”.

Power off during assembly

The 22xx…BX4 CSD/CCD series drive must be disconnected from the power supply for all types of assembly and connection work, especially when making adjustments to the interface cables.

3 Installation

3.2 EMC compatible installation

CAUTION! ***Length of the connection leads!***

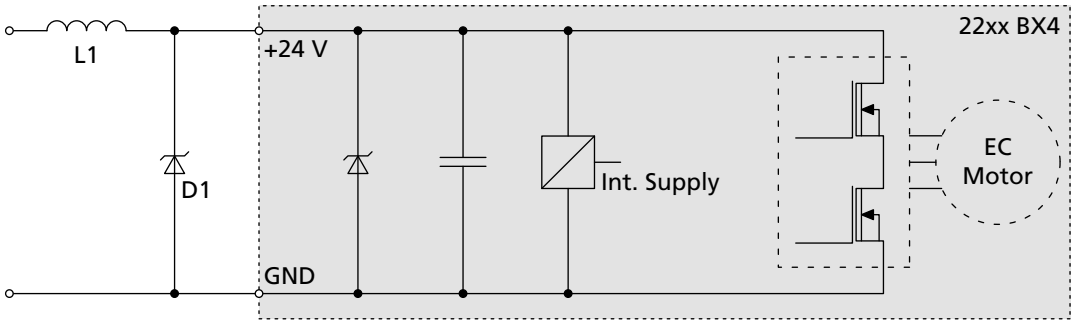
The maximum length of the connection leads is limited.

► *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

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 7 “EC Directives”.

22xx…BX4 CSD

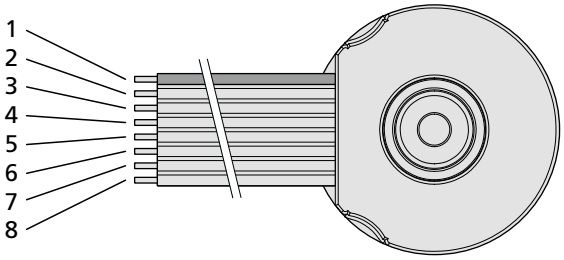
The connections are made using ribbon cables. Pin 1 is marked in colour:

Pin	Designation	Meaning
1	3.In	3rd input optional electronic supply
2	+24V	+24V
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

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

Pin	Designation	Meaning
1	3.In	3rd input optional electronic supply
2	+24V	+24V
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

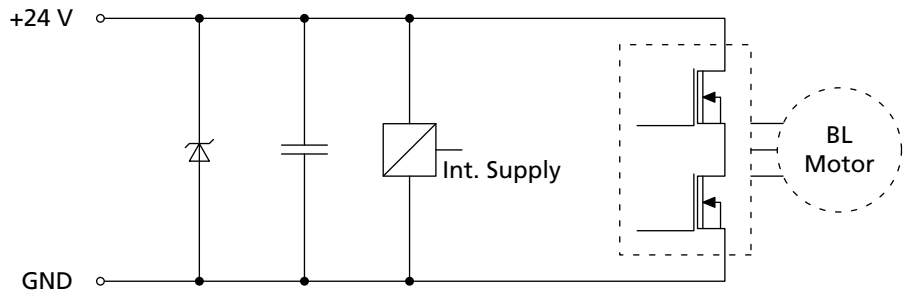


3 Installation

3.3 Connections

3.3.1 Power supply

Supply connection



Pin	Designation	Meaning
2	+24V	+24V
3	GND	GND

CAUTION! ***Power supply connections (+24 V, GND)***

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

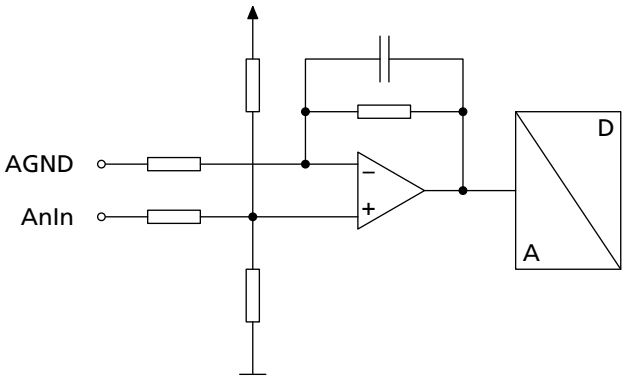
If the supply leads are incorrectly connected (polarity reversal) the electronics are irreparably damaged.

3 Installation

3.3 Connections

3.3.2 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)

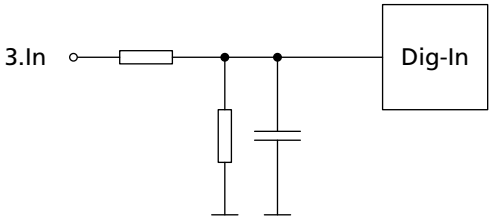
- Presetting of target velocity value via analog voltage
- Presetting of target velocity value via PWM signal
- Current limitation value via analog voltage
- Presetting of target position via analog voltage
- Digital input for reference and limit switches
- Connection for an external encoder (analog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

3 Installation

3.3 Connections

3.3.3 Digital input

Internal protective circuit, 3rd input

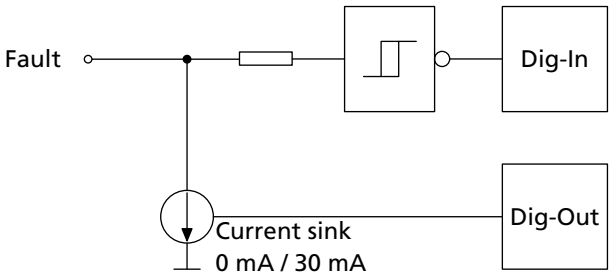


Pin	Designation	Meaning
1	3.In	3rd input optional electronic supply U_B

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.

3.3.4 Digital output

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 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

3 Installation

3.3 Connections

3.3.5 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
2	GND	GND
7	RxD	RS232 RxD
8	TxD	RS232 TxD

CAN

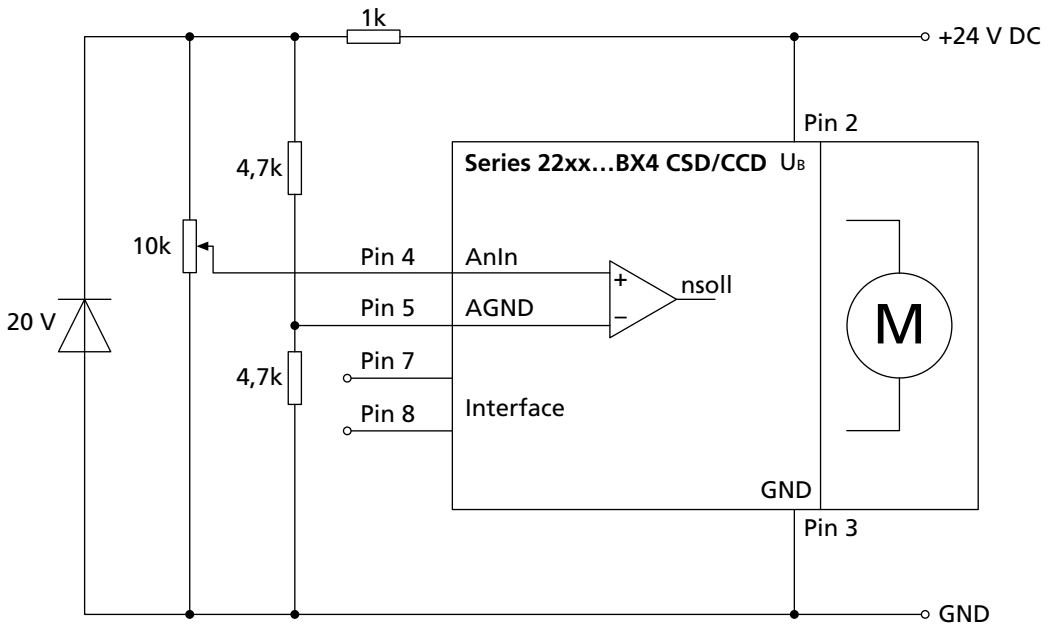
The CAN wiring is established using the CAN_H and CAN_L connections and the supply GND.

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

3.4 Connection examples

3.4.1 Command source via potentiometer

Bipolar analog command source via potentiometer

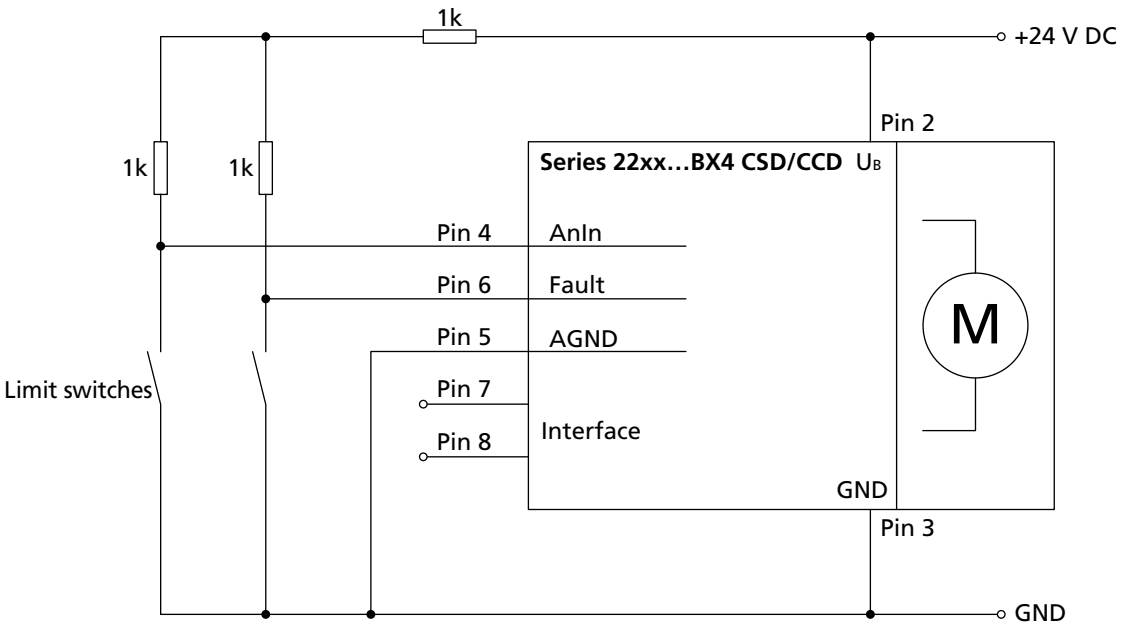


3 Installation

3.4 Connection examples

3.4.2 Homing and limit switches

Connection of homing and limit switches

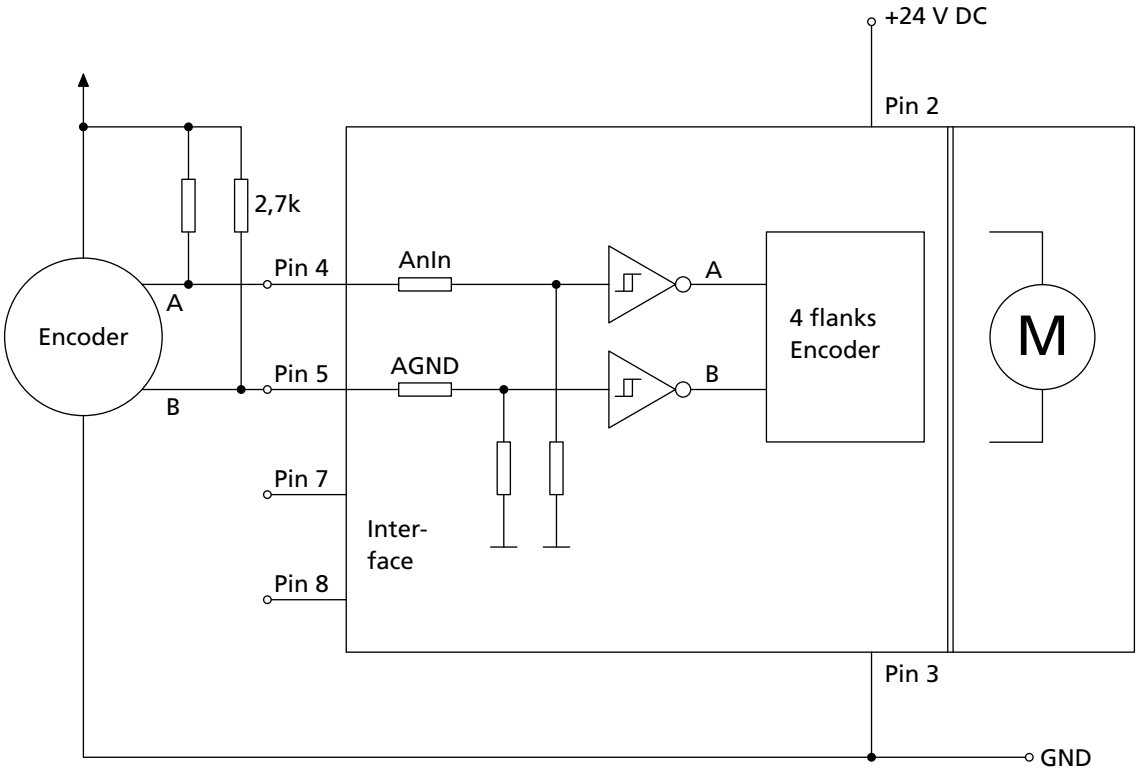


3 Installation

3.4 Connection examples

3.4.3 External incremental encoder

Connection of an external encoder



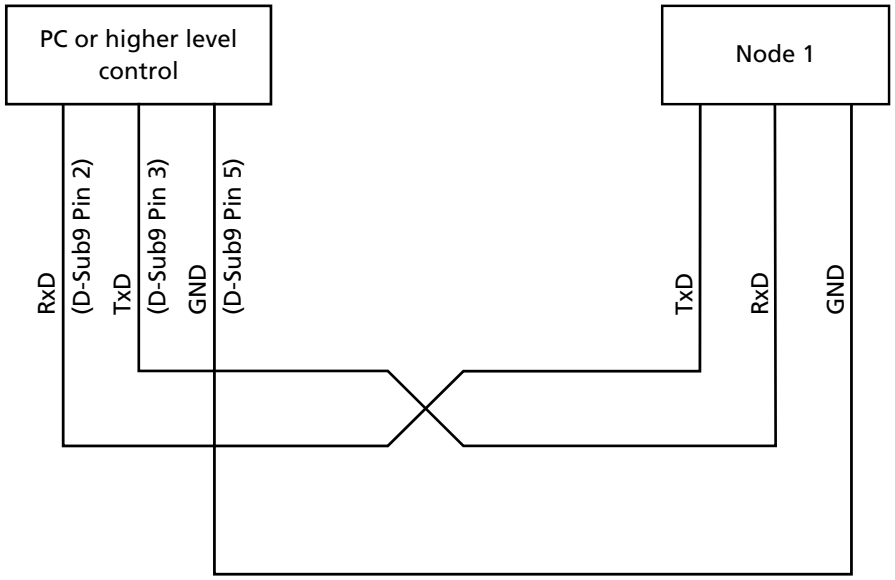
3 Installation

3.5 Wiring

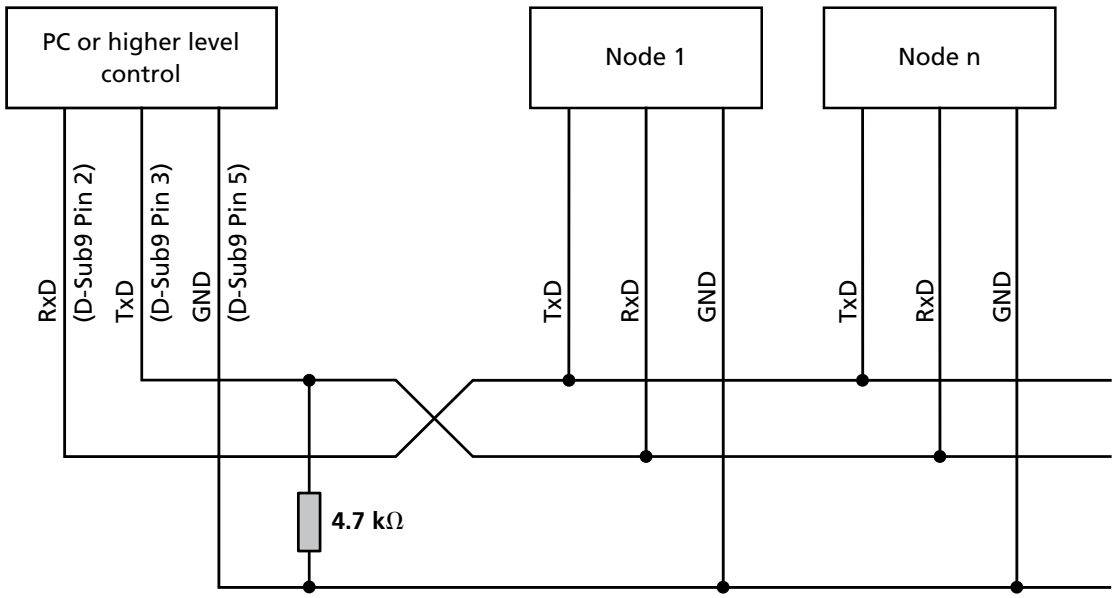
3.5.1 RS232 interface

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



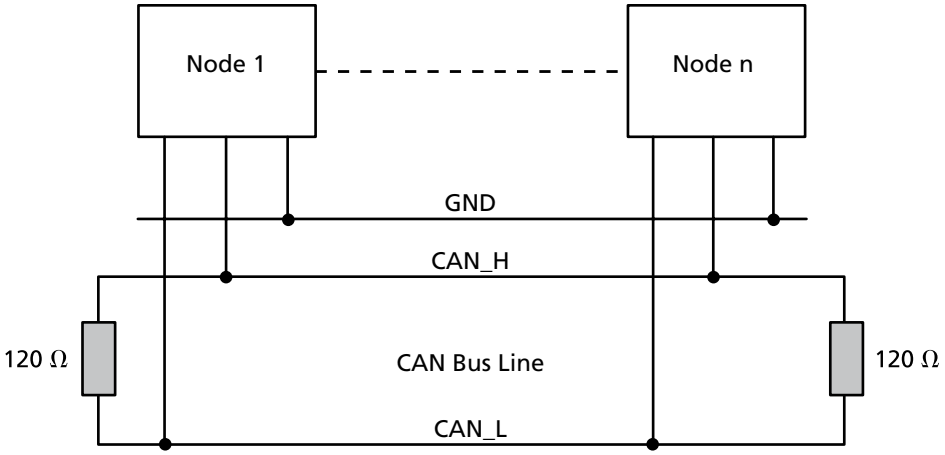
Wiring with several Motion Control systems in RS232 network mode



3 Installation

3.5 Wiring

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

Please read the communication and function manual for details of commissioning.

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 6 "Technical Data").
- 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 Maintenance

5.1 Service / Maintenance

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

5.2 Troubleshooting

The device will not fail when used according to specification and the given instruction manuals. Should a failure occur please contact the manufacturer.

Telephone: +49(0)7031/638-0

E-Mail: info@faulhaber.de

Internet: www.faulhaber.com

6 Technical Data

6.1 Series 2232…BX4 CSD

			2232 S		024 BX4 CSD	
1	Nominal voltage	U_N			24	Volt
2	Terminal resistance, phase-phase	R			12,4	Ω
3	Output power [1]	$P_{2\ max.}$			6,4	W
4	Efficiency	$\eta_{max.}$			67,7	%
5	No-load speed	n_o			6 800	rpm
6	No-load current	I_o			$6{,}1 \cdot 10^{-2}$	A
7	Stall torque at 1,8A	M_H			57	mNm
8	Friction torque, static	C_o			0,85	mNm
9	Friction torque, dynamic	C_v			$1{,}5 \cdot 10^{-4}$	mNm/rpm
10	Speed constant	k_n			304	rpm/V
11	Back-EMF constant	k_E			3,288	mV/rpm
12	Torque constant	k_M			31,40	mNm/A
13	Current constant	k_I			$3{,}18 \cdot 10^{-2}$	A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$			120	rpm/mNm
15	Terminal inductance, phase-phase	L			440	µH
16	Mechanical time constant	τ_m			6,5	ms
17	Rotor inertia	J			5,2	gcm²
18	Angular acceleration	$\alpha_{max.}$			109	$\cdot 10^3$rad/s²
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	2 / 17			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	4,1 / 360			s
21	Operating temperature range		– 25 ... + 85			°C
22	Shaft bearings		ball bearings, preloaded			
23	Shaft load max.:					
	– radial at 3 000 rpm (4 mm from mounting flange)		20			N
	– axial at 3 000 rpm		2			N
	– axial at standstill		20			N
24	Shaft play:					
	– radial	≤	0,015			mm
	– axial	=	0			mm
25	Housing material		stainless steel			
26	Weight		77			g
27	Direction of rotation		electronically reversible			
Recommended values - mathematically independent of each other						
28	Speed up to	$n_{e\ max.}$			5 - 8 000	rpm
29	Torque up to [1] [2]	$M_{e\ max.}$			11 / 18	mNm
30	Current up to [1] [2]	$I_{e\ max.}$			0,44 / 0,69	A

[1] at 4 000 rpm

[2] thermal resistance $R_{th\,2}$ not reduced / thermal resistance $R_{th\,2}$ by 55% reduced

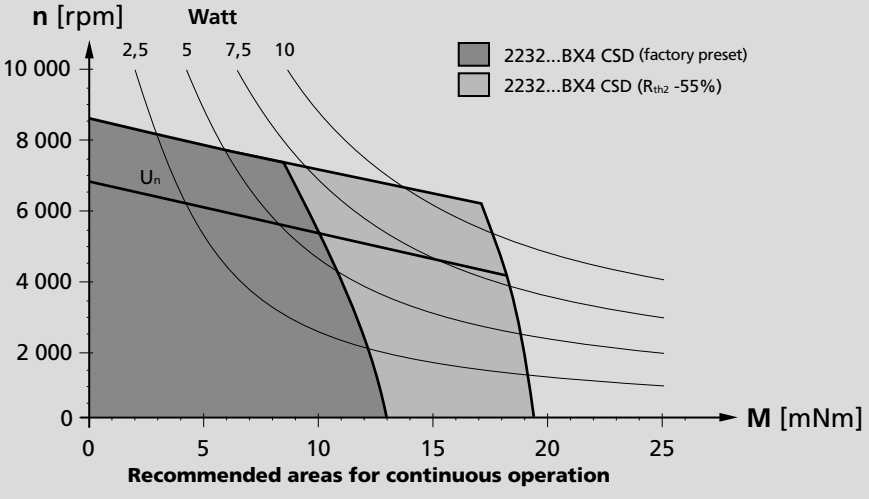
Note:

The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\,2}$ 55% reduced).

The motor is factory pre-configured to a continuous current for the thermally insulated condition. The controller must be reconfigured with the easy to use Motion Manager Software for use at higher continuous current.

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.

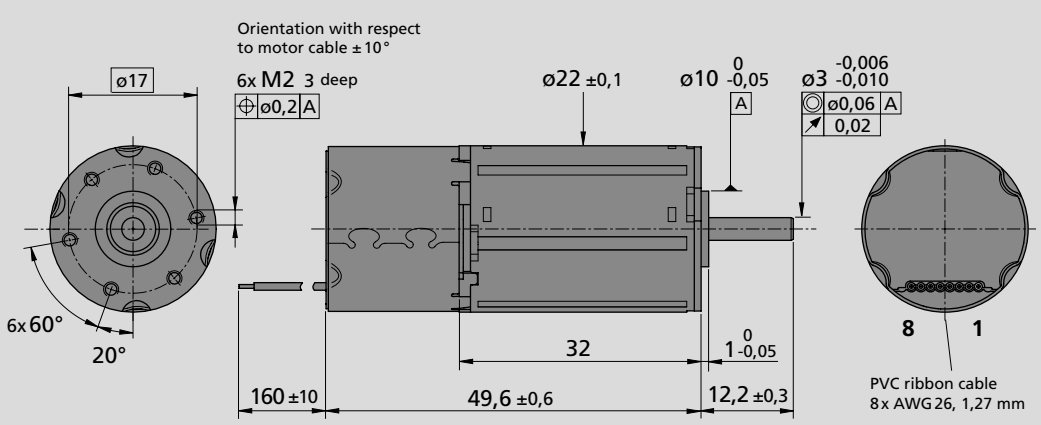


Recommended areas for continuous operation

6 Technical Data

6.1 Series 2232…BX4 CSD

2232 S 024 BX4 CSD



2232 S 024 BX4 CSD

Connection

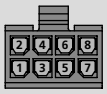
No.	Function
1	3.input
2	+24V
3	GND
4	Analog input
5	Analog GND
6	Fault output
7	RS232 RXD
8	RS232 TXD

Caution:
Incorrect lead connection will damage the motor electronics!

Options

Options

- Connector variant (Option no. 3830)
  AWG 26 / PVC ribbon cable
  with connector Micro-Fit



Full product description

- Example:
  2232S024 BX4 CSD

Motion Controller				
Supply voltage [1]	U_B		5 ... 30	V DC
Peak current [2]	$I_{max.}$		3	A
Input/output (see connection No. 1, 2 and 3)			3	
Connection No. 1				
– Speed command analog input		voltage range	±10	V
– Speed command PWM input		frequency range	100 ... 2 000	Hz
		pulse duty factor 50%	0	rpm
– Digital input		input resistance (at 24V)	5	kΩ
– External encoder	$f_{max.}$		400	kHz
– Step frequency input	$f_{max.}$		400	kHz
Connection No. 2				
– Fault output		no error	switched to GND	
– Digital output		open collector	max. U_B / 30 mA	
– Digital input		input resistance	100	kΩ
Connection No. 3				
– Digital input		input resistance	22	kΩ
– Electronic supply voltage [1]	U_B		5 ... 30	V DC
Encoder:				
– Scanning rate			200	µs
– Resolution internal encoder			3 000	Inc./turn

The signal level of the digital inputs can be set using the above commands:
Standard (PLC): Low 0...4,5V / High 12,5V...U_B, TTL: Low 0...0,5V / High 2,5V...U_B

[1] A separate supply for motor and drive electronic is optional available (important for safety-relevant applications), here escapes the digital input, connection 3.
[2] Preset value. Can be changed over the interface.

6 Technical Data

6.2 Series 2232…BX4 CCD

			2232 S		024 BX4 CCD	
1	Nominal voltage	U_N		24		Volt
2	Terminal resistance, phase-phase	R		12,4		Ω
3	Output power [1]	$P_{2\ max.}$		6,4		W
4	Efficiency	$\eta_{max.}$		67,7		%
5	No-load speed	n_o		6 800		rpm
6	No-load current	I_o		$6{,}1 \cdot 10^{-2}$		A
7	Stall torque at 1,8A	M_H		57		mNm
8	Friction torque, static	C_o		0,85		mNm
9	Friction torque, dynamic	C_v		$1{,}5 \cdot 10^{-4}$		mNm/rpm
10	Speed constant	k_n		304		rpm/V
11	Back-EMF constant	k_E		3,288		mV/rpm
12	Torque constant	k_M		31,40		mNm/A
13	Current constant	k_I		$3{,}18 \cdot 10^{-2}$		A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		120		rpm/mNm
15	Terminal inductance, phase-phase	L		440		µH
16	Mechanical time constant	τ_m		6,5		ms
17	Rotor inertia	J		5,2		gcm^2
18	Angular acceleration	$\alpha_{max.}$		109		$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	2 / 17			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	4,1 / 360			s
21	Operating temperature range		– 25 ... + 85			°C
22	Shaft bearings		ball bearings, preloaded			
23	Shaft load max.:					
	– radial at 3 000 rpm (4 mm from mounting flange)		20			N
	– axial at 3 000 rpm		2			N
	– axial at standstill		20			N
24	Shaft play:					
	– radial	≤	0,015			mm
	– axial	=	0			mm
25	Housing material		stainless steel			
26	Weight		77			g
27	Direction of rotation		electronically reversible			

Recommended values - mathematically independent of each other					
28	Speed up to	$n_{e\ max.}$		5 - 8 000	rpm
29	Torque up to [1] [2]	$M_{e\ max.}$		11 / 18	mNm
30	Current up to [1] [2]	$I_{e\ max.}$		0,44 / 0,69	A

[1] at 4 000 rpm

[2] thermal resistance $R_{th\,2}$ not reduced / thermal resistance $R_{th\,2}$ by 55% reduced

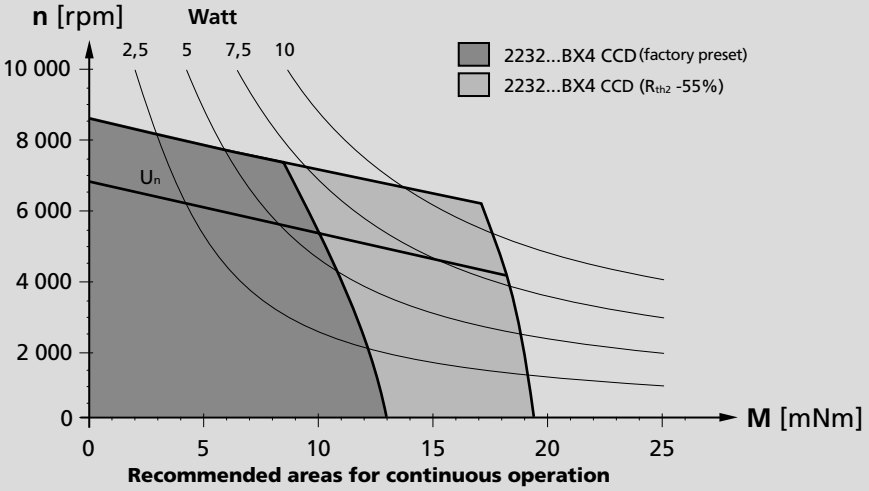
Note:

The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\,2}$ 55% reduced).

The motor is factory pre-configured to a continuous current for the thermally insulated condition. The controller must be reconfigured with the easy to use Motion Manager Software for use at higher continuous current.

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.

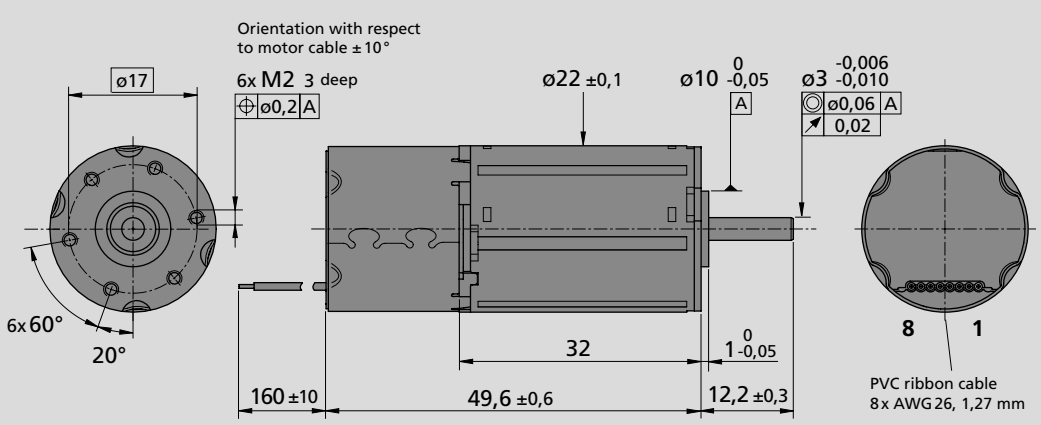


Recommended areas for continuous operation

6 Technical Data

6.2 Series 2232…BX4 CCD

2232 BX4 CCD



2232 BX4 CCD

Connection

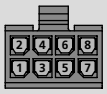
No.	Function
1	3.input
2	+24V
3	GND
4	Analog input
5	Analog GND
6	Fault output
7	CAN_L
8	CAN_H

Caution:
Incorrect lead connection will damage the motor electronics!

Options

Options

- Connector variant (Option no. 3830)
  AWG 26 / PVC ribbon cable
  with connector Micro-Fit



Full product description

- Example:
  2232S024 BX4 CCD

Motion Controller				
Supply voltage [1]	U_B		5 ... 30	V DC
Peak current [2]	$I_{max.}$		3	A
Input/output (see connection No. 1, 2 and 3)			3	
Connection No. 1				
– Speed command analog input		voltage range	±10	V
– Speed command PWM input		frequency range	100 ... 2 000	Hz
		pulse duty factor 50%	0	rpm
– Digital input		input resistance (at 24V)	5	kΩ
– External encoder	$f_{max.}$		400	kHz
– Step frequency input	$f_{max.}$		400	kHz
Connection No. 2				
– Fault output		no error	switched to GND	
– Digital output		open collector	max. U_B / 30 mA	
– Digital input		input resistance	100	kΩ
Connection No. 3				
– Digital input		input resistance	22	kΩ
– Electronic supply voltage [1]	U_B		5 ... 30	V DC
Encoder:				
– Scanning rate			200	µs
– Resolution internal encoder			3 000	Inc./turn

The signal level of the digital inputs can be set using the above commands:
Standard (PLC): Low 0...4,5V / High 12,5V...U_B, TTL: Low 0...0,5V / High 2,5V...U_B

[1] A separate supply for motor and drive electronic is optional available (important for safety-relevant applications), here escapes the digital input, connection 3 .
[2] Preset value. Can be changed over the interface.

6 Technical Data

6.3 Series 2250…BX4 CSD

			2250 S		024 BX4 CSD	
1	Nominal voltage	U_N		24		Volt
2	Terminal resistance, phase-phase	R		5,9		Ω
3	Output power [1]	$P_{2\ max.}$		12,2		W
4	Efficiency	$\eta_{max.}$		75,1		%
5	No-load speed	n_o		5 900		rpm
6	No-load current	I_o		$7{,}20 \cdot 10^{-2}$		A
7	Stall torque at 3A	M_H		110		mNm
8	Friction torque, static	C_o		1,20		mNm
9	Friction torque, dynamic	C_v		$2{,}4 \cdot 10^{-4}$		mNm/rpm
10	Speed constant	k_n		259		rpm/V
11	Back-EMF constant	k_E		3,864		mV/rpm
12	Torque constant	k_M		36,90		mNm/A
13	Current constant	k_I		$2{,}71 \cdot 10^{-2}$		A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		41,4		rpm/mNm
15	Terminal inductance, phase-phase	L		240		µH
16	Mechanical time constant	τ_m		4,3		ms
17	Rotor inertia	J		10		gcm^2
18	Angular acceleration	$\alpha_{max.}$		110		$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	1,2 / 14			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	4,2 / 566			s
21	Operating temperature range		– 25 ... + 85			°C
22	Shaft bearings		ball bearings, preloaded			
23	Shaft load max.:					
	– radial at 3 000 rpm (4 mm from mounting flange)		20			N
	– axial at 3 000 rpm		2			N
	– axial at standstill		20			N
24	Shaft play:					
	– radial	≤	0,015			mm
	– axial	=	0			mm
25	Housing material		stainless steel			
26	Weight		117			g
27	Direction of rotation		electronically reversible			

Recommended values - mathematically independent of each other					
28	Speed up to	$n_{e\ max.}$		5 - 7 000	rpm
29	Torque up to [1] [2]	$M_{e\ max.}$		22 / 35	mNm
30	Current up to [1] [2]	$I_{e\ max.}$		0,7 / 1,1	A

[1] at 4 000 rpm

[2] thermal resistance $R_{th\,2}$ not reduced / thermal resistance $R_{th\,2}$ by 55% reduced

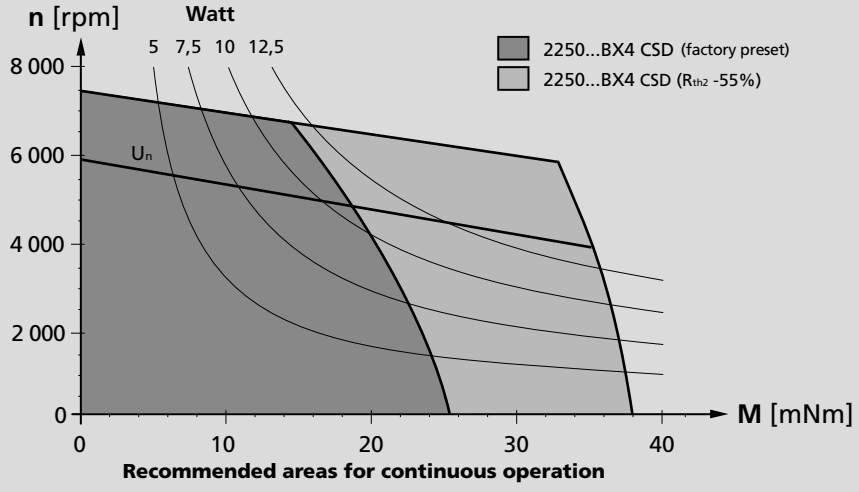
Note:

The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\,2}$ 55% reduced).

The motor is factory pre-configured to a continuous current for the thermally insulated condition. The controller must be reconfigured with the easy to use Motion Manager Software for use at higher continuous current.

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.

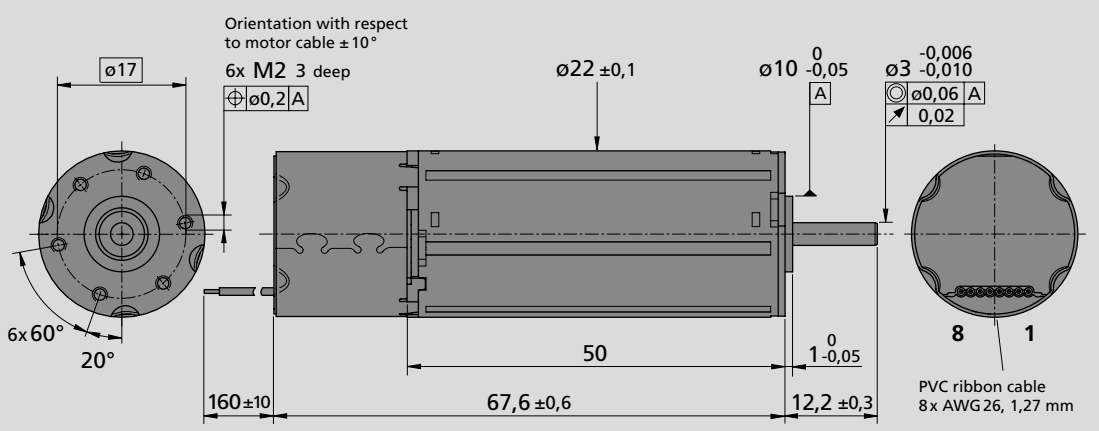


Recommended areas for continuous operation

6 Technical Data

6.3 Series 2250…BX4 CSD

2250 ... BX4 CSD



2250 ... BX4 CSD

Connection

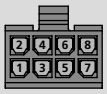
No.	Function
1	3.input
2	+24V
3	GND
4	Analog input
5	Analog GND
6	Fault output
7	RS232 RXD
8	RS232 TXD

Caution:
Incorrect lead connection will damage the motor electronics!

Options

Options

- Connector variant (Option no. 3830)
  AWG 26 / PVC ribbon cable
  with connector Micro-Fit



Full product description

- Example:
  2250S024 BX4 CSD

Motion Controller				
Supply voltage [1]	U_B		5 ... 30	V DC
Peak current [2]	$I_{max.}$		3	A
Input/output (see connection No. 1, 2 and 3)			3	
Connection No. 1				
– Speed command analog input		voltage range	±10	V
– Speed command PWM input		frequency range	100 ... 2 000	Hz
		pulse duty factor 50%	0	rpm
– Digital input		input resistance (at 24V)	5	kΩ
– External encoder	$f_{max.}$		400	kHz
– Step frequency input	$f_{max.}$		400	kHz
Connection No. 2				
– Fault output		no error	switched to GND	
– Digital output		open collector	max. U_B / 30 mA	
– Digital input		input resistance	100	kΩ
Connection No. 3				
– Digital input		input resistance	22	kΩ
– Electronic supply voltage [1]	U_B		5 ... 30	V DC
Encoder:				
– Scanning rate			200	µs
– Resolution internal encoder			3 000	Inc./turn

The signal level of the digital inputs can be set using the above commands:
Standard (PLC): Low 0...4,5V / High 12,5V...U_B, TTL: Low 0...0,5V / High 2,5V...U_B

[1] A separate supply for motor and drive electronic is optional available (important for safety-relevant applications), here escapes the digital input, connection 3.
[2] Preset value. Can be changed over the interface.

6 Technical Data

6.4 Series 2250…BX4 CCD

			2250 S		024 BX4 CCD	
1	Nominal voltage	U_N		24		Volt
2	Terminal resistance, phase-phase	R		5,9		Ω
3	Output power [1]	$P_{2\ max.}$		12,2		W
4	Efficiency	$\eta_{max.}$		75,1		%
5	No-load speed	n_o		5 900		rpm
6	No-load current	I_o		$7{,}20 \cdot 10^{-2}$		A
7	Stall torque at 3A	M_H		110		mNm
8	Friction torque, static	C_o		1,20		mNm
9	Friction torque, dynamic	C_v		$2{,}4 \cdot 10^{-4}$		mNm/rpm
10	Speed constant	k_n		259		rpm/V
11	Back-EMF constant	k_E		3,864		mV/rpm
12	Torque constant	k_M		36,90		mNm/A
13	Current constant	k_I		$2{,}71 \cdot 10^{-2}$		A/mNm
14	Slope of n-M curve	$\Delta n/\Delta M$		41,4		rpm/mNm
15	Terminal inductance, phase-phase	L		240		µH
16	Mechanical time constant	τ_m		4,3		ms
17	Rotor inertia	J		10		gcm^2
18	Angular acceleration	$\alpha_{max.}$		110		$\cdot 10^3 rad/s^2$
19	Thermal resistance	$R_{th\,1}$ / $R_{th\,2}$	1,2 / 14			K/W
20	Thermal time constant	τ_{w1} / τ_{w2}	4,2 / 566			s
21	Operating temperature range		– 25 ... + 85			°C
22	Shaft bearings		ball bearings, preloaded			
23	Shaft load max.:					
	– radial at 3 000 rpm (4 mm from mounting flange)		20			N
	– axial at 3 000 rpm		2			N
	– axial at standstill		20			N
24	Shaft play:					
	– radial	≤	0,015			mm
	– axial	=	0			mm
25	Housing material		stainless steel			
26	Weight		117			g
27	Direction of rotation		electronically reversible			

Recommended values - mathematically independent of each other

28	Speed up to	$n_{e\ max.}$	5 - 7 000		rpm
29	Torque up to [1] [2]	$M_{e\ max.}$	22 / 35		mNm
30	Current up to [1] [2]	$I_{e\ max.}$	0,7 / 1,1		A

[1] at 4 000 rpm

[2] thermal resistance $R_{th\,2}$ not reduced / thermal resistance $R_{th\,2}$ by 55% reduced

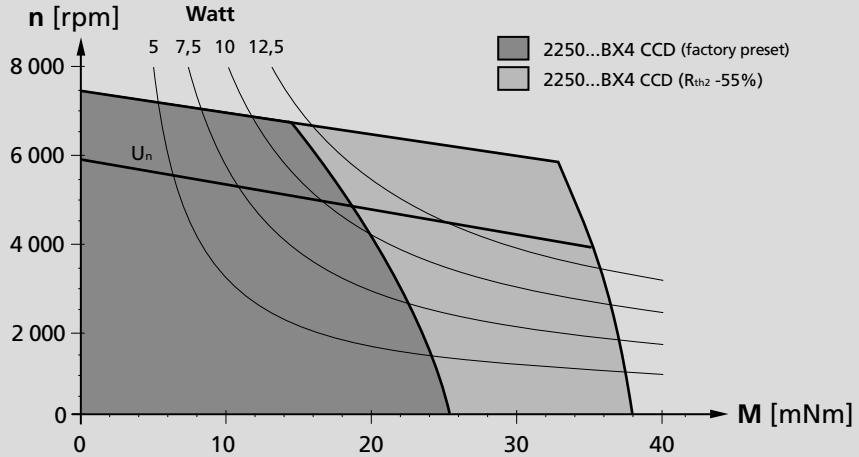
Note:

The diagram indicates the recommended speed in relation to the available torque at the output shaft for a given ambient temperature of 22°C.

The diagram shows the motor in a completely insulated as well as thermally coupled condition ($R_{th\,2}$ 55% reduced).

The motor is factory pre-configured to a continuous current for the thermally insulated condition. The controller must be reconfigured with the easy to use Motion Manager Software for use at higher continuous current.

The nominal voltage (U_N) curve shows the operating point at nominal voltage in the insulated and thermally coupled condition. Any points of operation above the curve at nominal voltage will require a higher operating voltage. Any points below the nominal voltage curve will require less voltage.

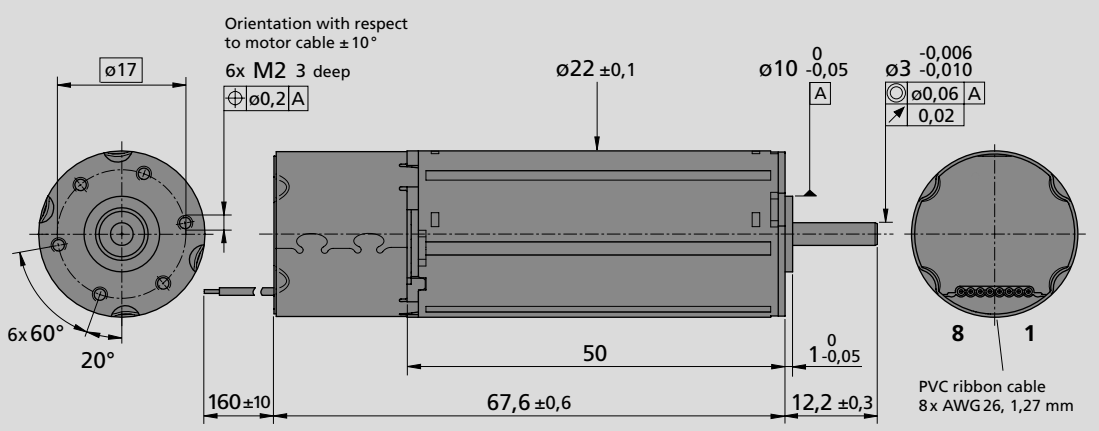


Recommended areas for continuous operation

6 Technical Data

6.4 Series 2250…BX4 CCD

2250 ... BX4 CCD



2250 ... BX4 CCD

Connection

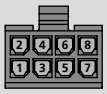
No.	Function
1	3.input
2	+24V
3	GND
4	Analog input
5	Analog GND
6	Fault output
7	CAN_L
8	CAN_H

Caution:
Incorrect lead connection will damage the motor electronics!

Options

Options

- Connector variant (Option no. 3830)
  AWG 26 / PVC ribbon cable
  with connector Micro-Fit



Full product description

- Example:
  2250S024 BX4 CCD

Motion Controller				
Supply voltage [1]	U_B		5 ... 30	V DC
Peak current [2]	$I_{max.}$		3	A
Input/output (see connection No. 1, 2 and 3)			3	
Connection No. 1				
– Speed command analog input		voltage range	±10	V
– Speed command PWM input		frequency range	100 ... 2 000	Hz
		pulse duty factor 50%	0	rpm
– Digital input		input resistance (at 24V)	5	kΩ
– External encoder	$f_{max.}$		400	kHz
– Step frequency input	$f_{max.}$		400	kHz
Connection No. 2				
– Fault output		no error	switched to GND	
– Digital output		open collector	max. U_B / 30 mA	
– Digital input		input resistance	100	kΩ
Connection No. 3				
– Digital input		input resistance	22	kΩ
– Electronic supply voltage [1]	U_B		5 ... 30	V DC
Encoder:				
– Scanning rate			200	µs
– Resolution internal encoder			3 000	Inc./turn

The signal level of the digital inputs can be set using the above commands:
Standard (PLC): Low 0...4,5V / High 12,5V...U_B, TTL: Low 0...0,5V / High 2,5V...U_B

[1] A separate supply for motor and drive electronic is optional available (important for safety-relevant applications), here escapes the digital input, connection 3.
[2] Preset value. Can be changed over the interface.

6 Technical Data

6.5 Ambient conditions

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.

CAUTION! ***Risk of damage***

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

- ▶ *Do not load the motor 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!*

NOTE ***Service life***

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

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.*

7 EC Directives

REGULATION! The following EC Directives are important for users of the described products:

§

Machinery Directive (98/37/EC):

It applies to independently functioning machines or a chain of machines forming whole plants or systems. For built in components, non-operational machines, a manufacturer's declaration is submitted according to Annex II B of the Machinery Directive 98/37/EC.

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 (2004/108/EC):

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.

8 Manufacturer's Declaration

Manufacturer's Declaration according to the Machinery Directive 98/37/EC, Annex II B

The manufacturer:

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

herewith declares that the products named in the following are built in components and therefore, in the definition of Article 4 (2) of the Directive of the European Parliament and the Council dated 22 June 1998 on the harmonisation of the legal regulations of Member States for Machinery 98/37/EC – in short: the Machinery Directive – are not themselves functioning machines, and for this reason do not yet comply with all parts of the relevant provisions of the Machinery Directive.

Product name:

Micro drives, DC micro motors, step motors, motion control systems, precision gears, servo components, controls, micro-precision systems, linear DC servomotors, piezometric motors

Brand names:

FAULHABER, PRECIstep, FTB, penny-motor, smoovy, FAULHABER BX4, FAULHABER motion control, Quickshaft, Smartshell, PiezoMotor

It is prohibited to start up the motor until it has been established that the machine in which these components are to be installed is fully functional and conforms to the safety requirements of the Machinery Directive.

Schoenaich, 2008-02-04
(Place, Date)

Dr. Thomas Bertolini,
Executive Management

Signature

9 Warranty

Extract from our warranty conditions

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

Should, contrary to all expectations, defects occur, we undertake to find a remedy within the warranty period.

- We shall make good or replace defective goods, at our own discretion, within a reasonable period set by you and at our own cost. Replaced goods become our property and are to be returned to us.
- If improvement or replacement delivery is not possible or does not occur or fails for other reasons for which we are responsible within a period determined by you, you can opt to withdraw from the contract for the defective delivery or reduce the purchase price.
- We are not liable for damage to the goods caused by natural wear and tear, wear, unsuitable, improper or non-contractual use, incorrect assembly, installation or putting into service, excessive loading or improper change, improvement or repair work by you or third parties or incorrect or negligent treatment, provided these are not through our fault.
- Further claims, in particular claims for compensation instead of the performance and for compensation of other direct or indirect losses – including accompanying or consequential loss, for whatever legal reason – are excluded. This does not apply if

  a)we are maliciously silent with regard to a legal or material defect or have issued a guarantee for the nature of the goods,

  b)the loss is due to deliberate intent or gross negligence by us, our legal representatives or vicarious agents or are based on negligent breach of fundamental contract obligations by these persons, or

  c)culpable violation of duty by us, our legal representatives or vicarious agents which have resulted in physical injuries or damage to health.

  In the case of simple negligence, however, our obligation to pay damages is limited to the amount of typical, foreseeable losses for the type of contract.
- All defect claims including the claims for compensation covered by our terms and conditions of supply expire one year after delivery of the goods to your. The limitation period for replacements and improvements is 1 year but it expires at least when the original limitation period for the delivered object expires. The period for defects liability for a supplied object will be extended by the duration of the operational interruption caused by the making good work. Provisions concerning a shorter life of the object supplied within the scope of its intended use remain unaffected by this limitation provision.

For further information, please refer to our terms and conditions of supply, which we will pleased to make available on request.

MA05028 deutsch, 2nd issue, 07.2010

DR. FRITZ FAULHABER GMBH & CO. KG
Antriebssysteme

Daimlerstraße 23/25
71101 Schönaich · Germany
Tel. +49(0)7031/638-0
Fax +49(0)7031/638-100
info@faulhaber.de
www.faulhaber.com