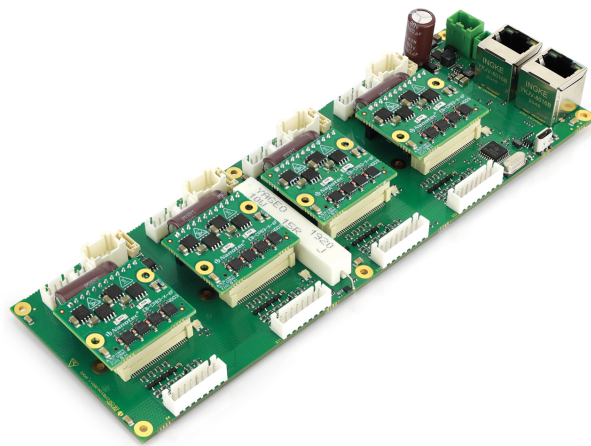


Technical Datasheet **CM-CPB3**

Fieldbus: EtherCAT

For use with the following variants:

CM-CPB3-x4-000x-1



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1 Introduction

CM-CPB3 is a multi-axis controller for up to four drive axes with BLDC or stepper motors. CM-CPB3 has four slots for controllers of the CPB3 series, which control the motors of the four axes, as well as connections for the components of the drive axes, and the interfaces to the CPB3.

You can find further information on commissioning and parameterization/programming as well as a detailed description of the functions of the CPB controller in the *technical manual for CPB* with EtherCAT fieldbus at www.nanotec.de.

This document describes the interfaces of the CM-CPB3 and the parameterization required for the CPB controllers so that the multi-axis controller is ready for operation.

NOTICE



You can use all operating modes of the CPB with the exception of *clock-direction mode*, for which CM-CPB3 does not provide the corresponding inputs.

1.1 Variants and article numbers

The following figure shows the article number key for the variants of the CM-CPB3 multi-axis controller with EtherCAT fieldbus:

CM - CPB3 - x 4 - xxxx - 1

1
2
3
4
5
6

1 Product name
Controller Multi-Axis

2 CPB variant
CPB3

3 Number CPB
0 or 4

4 Number of slots
4

5 Product variant
See following Table

6 Field bus
1= EtherCAT

Number	Product variant
0001	with/for CPB3-1-x (low current), 5 V PNP inputs
0002	with/for CPB3-1-x (low current), 5 V NPN inputs
	Note: Only available on request and in big quantities.
0003	with/for CPB3-1-x (low current), 24 V PNP inputs
	Note: Only available on request and in big quantities.
0005	with/for CPB3-2-x (high current), 5 V PNP inputs
0006	with/for CPB3-2-x (high current), 5 V NPN inputs
	Note: Only available on request and in big quantities.

Number	Product variant
0007	with/for CPB3-2-x (high current), 24 V PNP inputs
Note: Only available on request and in big quantities.	

NOTICE



The variants *CPB3-1-1M* and *CPB3-2-1M* are intended to be plugged in the first slot of the multi axis controller CM-CPB3 and should be ordered accordingly in case a replacement for the first slot is needed.

For the rest of the slots order the variant *CPB3-1-1S* resp. *CPB3-2-1S*.

1.2 Version information

Manual version	Date	Changes	Firmware version (CPB)	Hardware version
1.0.0	04/2021	First edition	FIR-v2115	W003a
1.0.1	06/2021	Correction: <i>Clock-direction mode</i> is not supported.	FIR-v2115	W003a
1.0.2	08/2021	<ul style="list-style-type: none"> ■ Corrections ■ Suitable Nanotec cables added. 	FIR-v2139	W003a
1.1.0	10/2021	Connection data for high current and 24 V variants added.	FIR-v2139	W004
1.1.1	11/2021	Added tip in chapter <u>Commissioning</u> on how to activate the special functions of the digital inputs.	FIR-v2139	W004
1.2.0	05/2022	<ul style="list-style-type: none"> ■ Added note on product delivery in <u>Variants and article numbers</u>. ■ Changes in chapter <u>Commissioning</u>: Object 3271_n now obsolete. 	FIR-v2213	W004
1.3.0	02/2023	Notice regarding the new CPB3 variants, intended for slot 1.	FIR-v2213	W004
1.3.1	05/2023	Correction: <i>Clock-direction mode</i> was still wrongly mentioned in the chapter <u>Electrical properties and technical data</u> .	FIR-v2213	W004
1.4.0	07/2024	Changes in chapter <u>Commissioning</u> : CPB3 is delivered pre-configured from FIR-v2213-B1062280 on.	FIR-v2213-B1062280	W004

1.3 Copyright, marking and contact

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1.4 Intended use

The *CM-CPB3* multi-axis controller controls drive axes with stepper and BLDC motors and is used as a component in drive systems in a wide range of industrial applications.

Use the product as intended within the limits defined in the technical data (in particular, see [Electrical properties and technical data](#)) and the approved [Environmental conditions](#).

Under no circumstances may this Nanotec product be integrated as a safety component in a product or system. All products containing a component manufactured by Nanotec must, upon delivery to end users, contain corresponding warning notices and instructions for safe use and safe operation. All warning notices provided by Nanotec must be passed on directly to the end user.

1.5 Target group and qualification

The product and this documentation are directed towards technically trained specialists staff such as:

- Development engineers
- Plant engineers
- Installers/service personnel
- Application engineers

Only specialists may install, program and commission the product. Specialist staff are persons who

- have appropriate training and experience in working with motors and their controller,
- are familiar with and understand the content of this technical manual,
- know the applicable regulations.

1.6 Warranty and disclaimer

Nanotec shall not be liable for damage and malfunctions attributable to installation errors, failure to observe this document or improper repair. The plant engineer, operating company and user shall be responsible for the selection, operation and use of our products. Nanotec shall not take responsibility for integration of the product in the end system. The general terms and conditions listed at www.nanotec.de shall apply. **Note:** Conversion/modification as well as opening of the product are prohibited.

1.7 EU directives for product safety

The following EU directives were observed:

- RoHS directive (2011/65/EU, 2015/863/EU)




1.8 Other applicable regulations

In addition to this technical manual, the following regulations are to be observed:

- Accident-prevention regulations
- Local regulations on occupational safety

1.9 Used icons

All notices are in the same format. The degree of the hazard is divided into the following classes.

CAUTION!	
	<p>The CAUTION notice indicates a possibly dangerous situation.</p> <p>Failure to observe the notice may result in moderately severe injuries.</p> <p>► Describes how you can avoid the dangerous situation.</p>
NOTICE	
	<p>Indicates a possible incorrect operation of the product.</p> <p>Failure to observe the notice may result in damage to this or other products.</p> <p>► Describes how you can avoid the incorrect operation.</p>
TIP	
	<p>Shows a tip for the application or task.</p>

1.10 Emphasis in the text

The following conventions are used in the document:

Underlined text indicates cross references and hyperlinks:

- The following bits in object 6041_h (statusword) have a special function:
- A list of available system calls can be found in chapter NanoJ functions in the NanoJ program.

Text set in *italics* marks named objects:

- Read the *installation manual*.
- Use the *Plug & Drive Studio* software to perform the auto setup.
- For software: You can find the corresponding information in the *Operation* tab.
- For hardware: Use the *ON/OFF* switch to switch the device on.

A text set in *Courier* marks a code section or programming command:

- The line with the `od_write(0x6040, 0x00, 5);` command has no effect.
- The NMT message is structured as follows: 000 | 81 2A

A text in "quotation marks" marks user input:

- Start the NanoJ program by writing object 2300_h, bit 0 = "1".
- If a holding torque is already needed in this state, the value "1" must be written in 3212_h:01_h.

1.11 Numerical values

Numerical values are generally specified in decimal notation. The use of hexadecimal notation is indicated by a subscript *h* at the end of the number.

The objects in the object dictionary are written with index and subindex as follows: <Index>:<Subindex>

Both the index as well as the subindex are specified in hexadecimal notation. If no subindex is listed, the subindex is 00_h.

Example: Subindex 5 of object 1003_h is addressed with 1003_h:05_h, subindex 00 of object 6040_h with 6040_h.

1.12 Bits

The numbering of individual bits in an object always begins with the LSB (bit number 0). See the following figure, which uses data type *UNSIGNED8* as an example.

	MSB				LSB				
Bit Nummer	7	6	5	4	3	2	1	0	
Bits	0	1	0	1	0	1	0	1	$\triangleq 55_{\text{hex}} \triangleq 85_{\text{dec}}$

2 Safety and warning notices

NOTICE



In addition, observe all notices regarding installation and commissioning in the *CPB technical manual*.

NOTICE



Damage to the controller!

Changing the wiring during operation may damage the controller.

- Only change the wiring in a de-energized state. After switching off, wait until the capacitors have discharged.

NOTICE



Damage to the controller due to excitation voltage of the motor!

Voltage peaks during operation may damage the controller.

- Install suitable circuits (e.g., charging capacitor) that reduce voltage peaks.

NOTICE



Damage to the electronics through improper handling of ESD-sensitive components!

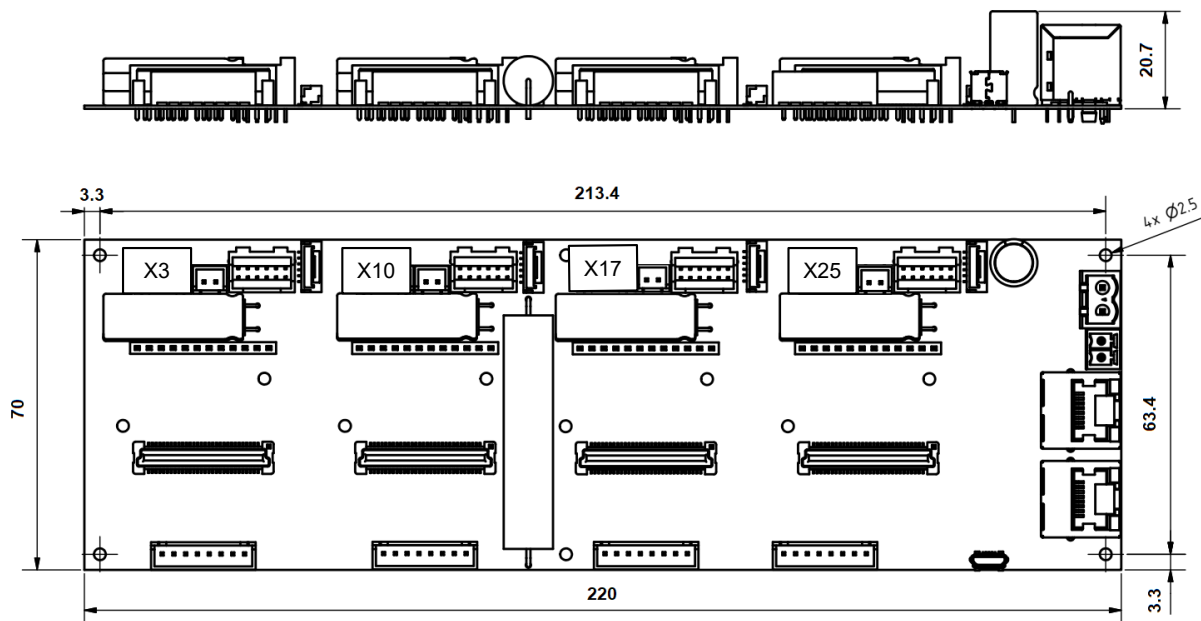
The device contains components that are sensitive to electrostatic discharge. Improper handling can damage the device.

- Observe the basic principles of ESD protection when handling the device.

3 Technical details and pin assignment

3.1 Dimensioned drawings

The drawing below shows the multi-axis controller without plugged-in *CPB* controllers. All dimensions are in millimeters.



3.2 Environmental conditions

Environmental condition	Value
Protection class	No IP protection
Ambient temperature (operation)	-10 ... +40°C
Ambient temperature (storage and transport)	-25 ... +85°C
Relative humidity (operation), non-condensing	0 ... 95 %
Relative humidity (storage and transport), non-condensing	0 ... 90 %
Absolute humidity (storage and transport), non-condensing	30 g/m ³
Max. altitude of site above <i>sea level</i> (without drop in performance in operation)	2000 m (drop in performance above 1000 m: -1%/100 m)
Max. altitude of site above <i>sea level</i> (storage and transport)	3000 m

3.3 Electrical properties and technical data

Property	Description / value
Operating voltage	12 ... 57.6 V DC
Rated current (per axis)	3 A _{rms}
Peak current (per axis)	<ul style="list-style-type: none"> ■ <u>Product variants</u> 0001, 0002 and 0003 (<i>low current</i>): 3 A_{rms} ■ <u>Product variants</u> 0005, 0006 and 0007 (<i>high current</i>): 6 A_{rms}, for max. 5 seconds
Commutation	Stepper motor <i>open loop</i> , stepper motor <i>closed loop</i> with encoder, BLDC sine commutated via Hall sensor, BLDC sine commutated via encoder
Operating modes	<i>Profile Position Mode, Profile Velocity Mode, Profile Torque Mode, Velocity Mode, Homing Mode, Interpolated Position Mode, Cyclic Sync Position Mode, Cyclic Sync Velocity Mode, Cyclic Synchronous Torque Mode</i>
Set value setting / programming	<i>Analog, NanoJ program</i>
Interfaces	USB, EtherCAT
Encoder/Hall	1x incremental encoder, 1x SSI encoder, 1x Hall sensor
I/O	4x digital inputs, 2x digital outputs (<i>open drain</i>), 1x analog input, 1x output for external brake
Overtemperature protection	Above a temperature of approx. 75°C, the power part of the CPB controller switches off and the error bit is set (see the <i>CPB technical manual</i> for details). After cooling down and error acknowledgment, the controller functions normally again.
Charging capacitor	For each ampere of rated current on the motor, Nanotec recommends a capacitance of approx. 1000 µF.
Protection circuit	<p>A line protection device (fuse) is required in the supply line. The values of the fuse are dependent on the application and must be dimensioned</p> <ul style="list-style-type: none"> ■ greater than the maximum current consumption of the controller(s), ■ less than the maximum current of the voltage supply. <p>If the fuse value is very close to the maximum current consumption of the controller, a medium / slow tripping characteristics should be used.</p>

3.4 LED signaling

CM-CPB is equipped with two LEDs on each EtherCAT connection (IN/OUT) which indicate the status of the controller on the EtherCAT bus. The green LED is on if the EtherCAT cable is connected and flashes during data transfer. The red LED lights up if there is a communication error.

Every CPB has its own power LED. You can find details in the *CPB technical manual*.

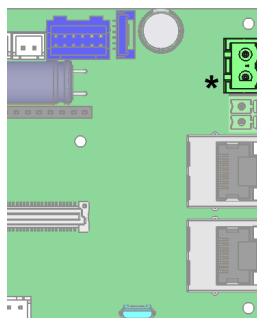
3.5 Pin assignment

3.5.1 X30 – voltage supply

Connection for the supply voltage

- Type: Würth Elektronik 691311700102
- Mating connector (included in scope of delivery): Würth Elektronik 691352710002 (or equivalent), Nanotec part number: ZCWE-RM5-2

In the following figure, pin 1 is marked with "*".



Pin	Function	Note
1	+UB	Supply voltage 12...57.6 V DC
2	GND	

NOTICE



EMC: For a DC power supply line longer than 30 m or when using the motor on a DC bus, additional interference-suppression and protection measures are necessary.

- ▶ An EMI filter is to be inserted in the DC supply line as close as possible to the controller/motor.
- ▶ Long data or supply lines are to be routed through ferrites.

3.5.1.1 Permissible operating voltage

The maximum operating voltage is 57.6 V DC. If the input voltage of the controller exceeds the threshold value set in object 2034_h, the respective motor is switched off and an error triggered. Above the response threshold set in 4021_h:02_h, the integrated ballast circuit is activated (wirewound resistor with 10 W continuous output).

The minimum operating voltage is 12 V DC. If the input voltage of the controller falls below 10 V, the motor is switched off and an error triggered.

These limits can be set individually for each CPB. The ballast is controlled only by the CPB at slot C1. See also Commissioning.

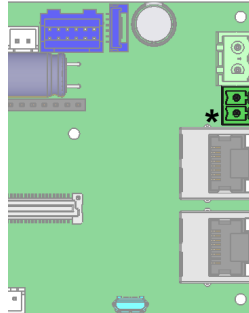
A charging capacitor of at least 4700 µF / 50 V (approx. 1000 µF per ampere rated current) must be connected to the supply voltage to avoid exceeding the permissible operating voltage (e. g., during braking).

3.5.2 X31 – Logic supply

Connection for the optional external logic supply

- Type: Phoenix Contact MC 1.5/ 2-G-3.5
- Mating connector (included in scope of delivery): FMC 1,5/ 2-ST-3,5 (or equivalent), Nanotec part number: ZCPHOF-MC1,5-2

In the following figure, pin 1 is marked with "*".



Pin	Function	Note
1	+UB_Logic	Optional external logic supply, 12...30 V DC
2	GND	

NOTICE

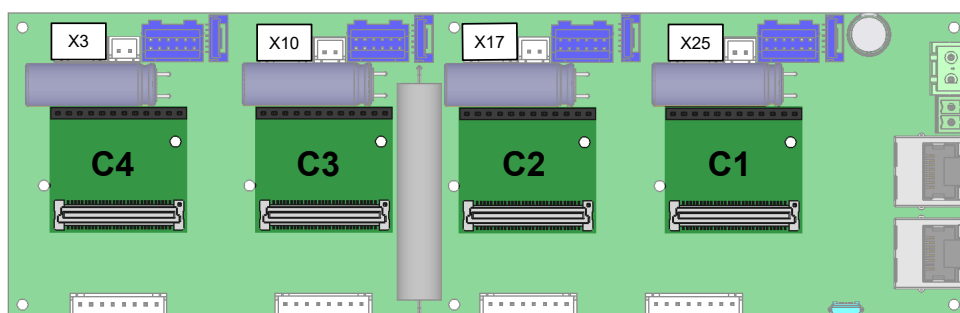


Should the main supply fail, the logic supply keeps the electronics, the encoder and the communication interface in operation.

The windings of the motor are not supplied by the logic supply.

3.5.3 C1...C4 – Slots for CPB3

Slots for the CPB3 controller for axes 1...4



Depending on the variant, 0...4 slots are already assigned a CPB3 ex factory.

NOTICE



When replacing a *CPB*, please refer to the chapter *Commissioning*. In case a replacement is needed for the controller at the first slot, please note the deviating order number *CPB3-1-1M* resp. *CPB3-2-1M*.

For the rest of the slots order the variant *CPB3-1-1S* resp. *CPB3-2-1S*.

3.5.4 X3, X10, X17, X25 – Motor connection

Connections for the motors of axes 1...4

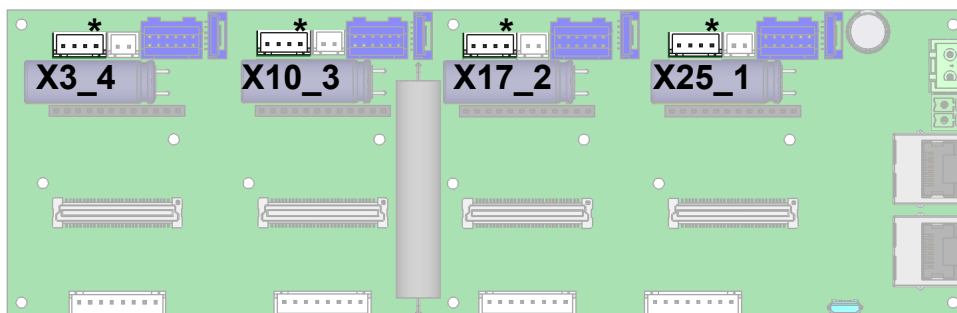
In the following figures, pin 1 is marked with "*".

- Product variants 0001, 0002 and 0003 (*low current*): JST B4B-XH-A(LF)(SN)

Mating connector (not included in scope of delivery):

- Housing: JST-XHP-4 (or equivalent)
- Socket contacts: SXH-001T-P0.6 (or equivalent)

Suitable Nanotec cable (not included in the scope of delivery): ZK-XHP4-300

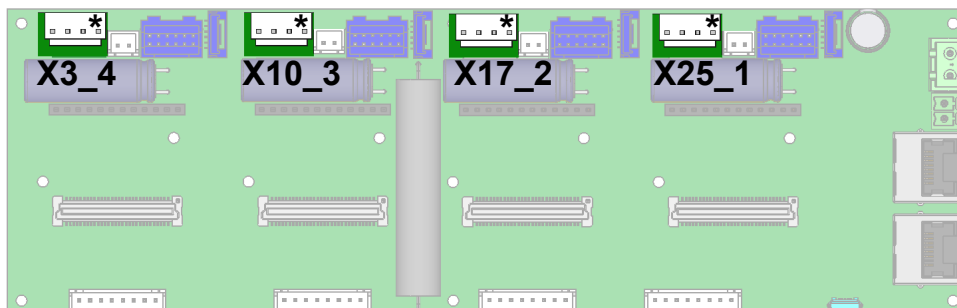


- Product variants 0005, 0006 and 0007 (*high current*): JST B4P-VH(LF)(SN)

Mating connector (not included in scope of delivery):

- Housing: JST-VHR-4N (or equivalent)
- Socket contacts: SVH-41T-P1.1 (or equivalent)

Suitable Nanotec cable (not included in the scope of delivery): ZK-VHR4-500



Pin	Function	Note
1	A_OUT	A (stepper motor) or U (BLDC)
2	AN_OUT	A\ (stepper motor) or V (BLDC)

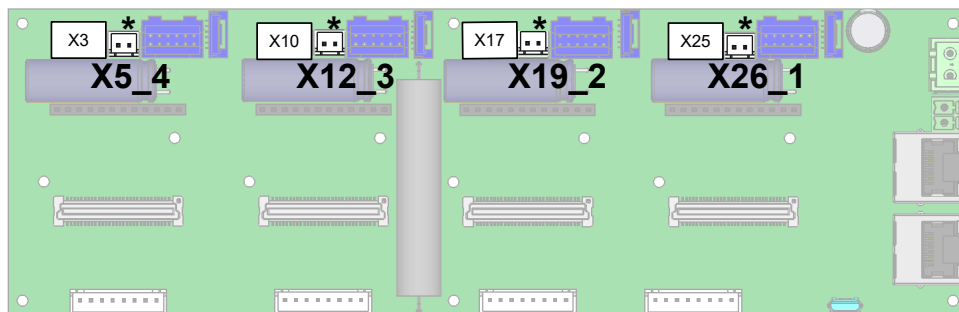
Pin	Function	Note
3	B_OUT	B (stepper motor) or W (BLDC)
4	BN_OUT	B\ (stepper motor)

3.5.5 X5, X12, X19, X26 – Brake connection

Connection for the brake of axes 1...4

- Type: JST B2B-XH-A(LF)(SN)
- Mating connector (not included in scope of delivery):
 - Housing: JST-XHP-2 (or equivalent)
 - Socket contacts: SXH-001T-P0.6 (or equivalent)
- Suitable Nanotec cable (not included in the scope of delivery): ZK-XHP2-500-S

In the following figure, pin 1 is marked with "*".



Pin	Function	Note
1	Brake +	internally connected to +UB
2	Brake -	PWM-controlled open drain output, max 1 A, see chapter <i>Automatic brake control</i> in <i>CPB technical manual</i>



NOTICE

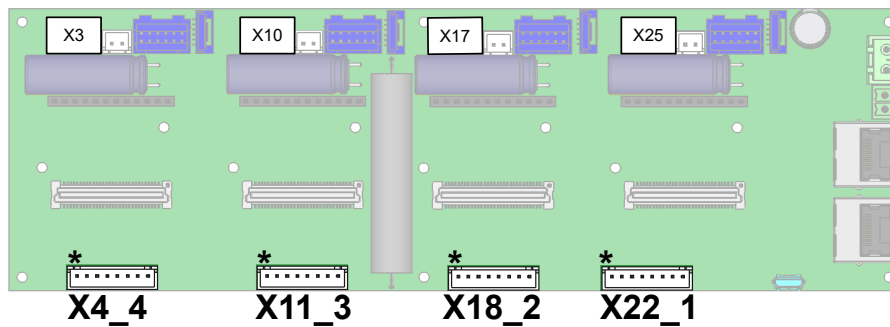
When replacing a *CPB*, please refer to the chapter [Commissioning](#).

3.5.6 X4, X11, X18, X22 – Inputs and outputs

Connections for the inputs/outputs of axes 1...4

- Type: JST B8B-XH-A(LF)(SN)
- Mating connector (not included in scope of delivery):
 - Housing: JST-XHP-8 (or equivalent)
 - Socket contacts: SXH-001T-P0.6 (or equivalent)
- Suitable Nanotec cable (not included in the scope of delivery): ZK-XHP8-500-S

In the following figure, pin 1 is marked with "*".



Pin	Function	Note
1	Digital input 1	
2	Digital input 2	
3	Digital input 3	
4	Digital input 4	
5	Analog input 1	10 bit, 0-10 V
6	Digital output 1	Open drain, maximum 60 V / 1 A
7	Digital output 2	Open drain, maximum 60 V / 1 A
8	GND	

The following switching thresholds apply for the inputs:

Product variants	Switching thresholds	
	On	Off
5 V	> 2.3 V	< 1 V
24 V	> 13.5 V	< 5.7 V

The table below shows the correspondence of the inputs/outputs of the multi-axis controller to the pins of the CPB:

Function of multi-axis controller	Pin CPB, connection X2
Digital input 1	45
Digital input 2	43
Digital input 3	41
Digital input 4	39
Analog input 1	4
Digital output 1	42
Digital output 2	44



NOTICE

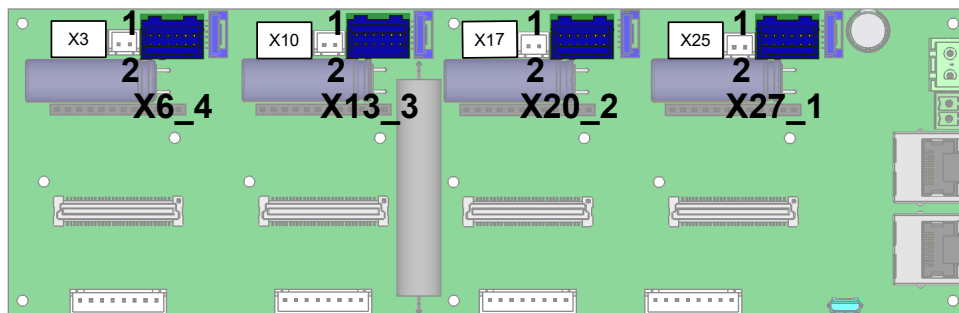
When replacing a CPB, please refer to the chapter [Commissioning](#).

3.5.7 X6, X13, X20, X27 – Encoder and Hall sensors

Connections for the encoder and the Hall sensors of axes 1...4

- Type: JST B12B-PADSS-1F(LF)(SN)
- Mating connector (not included in scope of delivery):
 - Housing: JST PADP-12V-1-S (or equivalent)
 - Contacts: JST SPH-001T-P0.5L (or equivalent)
- Suitable Nanotec cables (not included in the scope of delivery):
 - ZK-PADP-12-500-S: with free cable ends
 - ZK-M12-8-2M-2-PADP: for motors AS41... and AS59...
 - ZK-M12-12-2M-2-PADP: for motors ASB42... and ASB87...
 - ZK-NT03-10-500-PADP / ZK-NT03-10-1000-PADP: for encoder NTO3
 - ZK-NOE-10-500-S-PADP: for encoder NOE
 - ZK-WEDL-500-S-PADP: for encoder WEDL

Pin 1 and pin 2 are marked in the figure.



Pin	Function	Note
1	GND	
2	Vcc	5 V DC, output and supply voltage for encoder / Hall sensor; max. 600 mA
3	A	5 V signal, max. 1 MHz
4	B	5 V signal, max. 1 MHz
5	A\	5 V signal, max. 1 MHz
6	B\	5 V signal, max. 1 MHz
7	I	5 V signal, max. 1 MHz
8	I\	5 V signal, max. 1 MHz
9	Hall 1	5 V signal
10	Hall 2	5 V signal
11	Hall 3	5 V signal
12	GND	

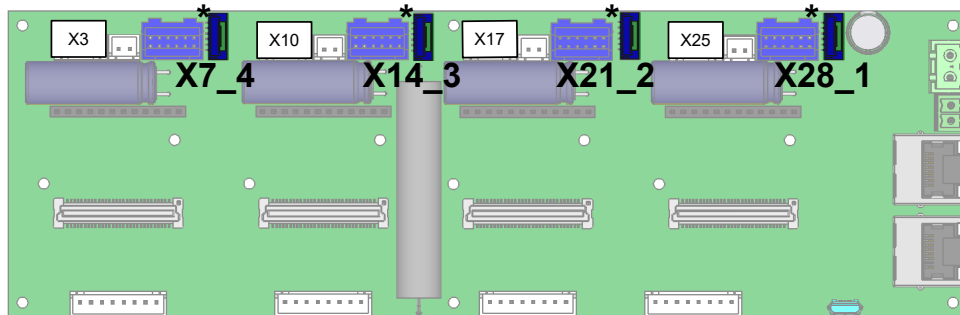
3.5.8 X7, X14, X21, X28 – SSI encoder

Connections for the SSI encoder of axes 1...4

- Type: JST BM06B-GHS-TBT(LF)(SN)(N)
- Mating connector (not included in scope of delivery):

- Housing: GHR-06V-S (or equivalent)
- Socket contacts: SSLH-002T-P0.2 (or equivalent)
- Suitable Nanotec cable (not included in the scope of delivery): ZK-GHR6-500-S

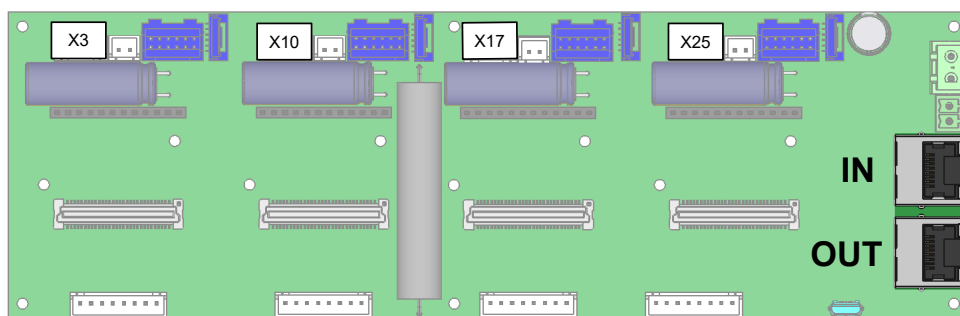
In the following figure, pin 1 is marked with "*".



Pin	Function	Note
1	GND	
2	DATA A	
3	DATA B	
4	CLCK A	
5	CLCK B	
6	Vcc	+10 V DC, output and supply voltage for SSI encoder

3.5.9 EtherCAT IN/OUT

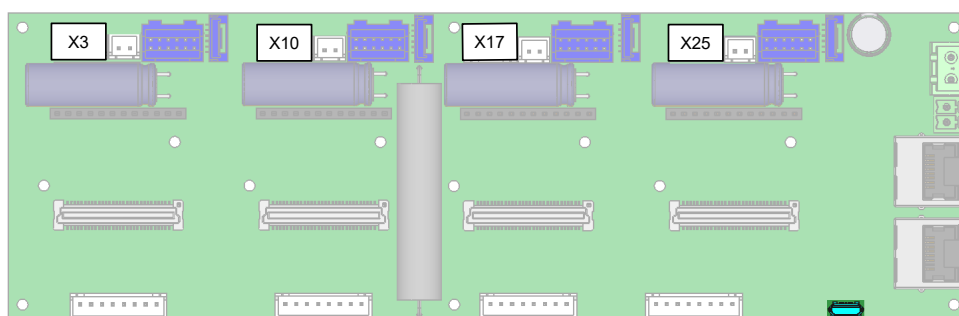
Type: RJ45 socket



3.5.10 USB

USB hub for configuration of the CPB via USB

- Type: Micro-USB 2.0 female



4 Commissioning

This chapter describes how you correctly configure the individual *CPB* controllers of the multi-axis controller before plugging them into one of the slots provided. This applies in particular when replacing a *CPB*. The *CPB* supplied with your multi-axis controller are preconfigured at the factory.

In case a replacement is needed for the controller at the first slot, please note the deviating order number *CPB3-1-1M* resp. *CPB3-2-1M*. For the rest of the slots order the variant *CPB3-1-1S* resp. *CPB3-2-1S*.

NOTICE



From firmware version FIR-v2213-B1062280 on, the *CPB3-...S* resp. *CPB3-...M* are delivered preconfigured. You can read out the firmware version using Plug&Drive Studio or in the object 1009h.

They can be configured via EtherCAT or USB (using the configuration file) or using the NanoJ program. You can find further information on commissioning and parameterization/programming as well as a detailed description of the functions of the *CPB* controller in the *CPB technical manual* at www.nanotec.de.

NOTICE



In addition, observe all safety and warning notices in the *CPB technical manual*.

Configure inputs and outputs

The table below shows the correspondence of the inputs/outputs of the multi-axis controller to the pins of the *CPB* when the multi-axis controller is delivered:

Function of multi-axis controller	Pin <i>CPB</i>	Object to read out / control
Digital input 1	45 (DIO7)	60FD _h :00 _h , bit 16
Digital input 2	43 (DIO5)	60FD _h :00 _h , bit 17
Digital input 3	41 (DIO3)	60FD _h :00 _h , bit 18
Digital input 4	39 (DIO1)	60FD _h :00 _h , bit 19
Analog input 1	4 (ANA1)	3320 _h
Digital output 1	42 (DIO2)	60FE _h :01 _h , bit 16
Digital output 2	44 (DIO4)	60FE _h :01 _h , bit 17
Brake – (PWM)	48 (DIO8 / BRAKE)	60FE _h :01 _h , bit 0

To restore this configuration after replacing a *CPB* or after resetting to the factory settings, set the following objects to the corresponding values:

```
3272h:10h=128 // Pin 42 is output 1
3272h:12h=128 // Pin 44 is output 2
```

```
3242h:13h=11h // DIO7 to Bit 16 of object 60FDh
3242h:11h=12h // DIO5 to Bit 17 of object 60FDh
3242h:0Fh=13h // DIO3 to Bit 18 of object 60FDh
3242h:0Eh=14h // DIO1 to Bit 19 of object 60FDh
3242h:nnh=0 // set all further subindices to "0"
```

```
3252h:10h=90h // DIO2 to Bit 16 of 60FEh:01h, inverted
3252h:12h=91h // DIO6 to Bit 17 of 60FEh:01h, inverted
```

```
3252h:16h=1080h // DIO8 to Bit 0 of 60FEh:01h, inverted
3252h:nnh=FFFFh // set all further subindices to "FFFFh"
```

TIP



To use the special functions of the inputs (limit/reference switch, interlock), configure the source for bits 0 to 3 of 60FD_h in 3242_h:01_h bis :04_h, depending on your cabling.

Should for example the negative limit switch be connected to the first input of the multi-axis controller, set object 3252_h:01_h to the value "90"_h.

You can find further details in chapter *Digital inputs and outputs* in the *CPB technical manual*.

Configure ballast

The multi-axis controller has a ballast resistor to protect against overvoltages that occur particularly during braking. The ballast is controlled only by the *CPB* at slot C1.

You enter the response threshold in millivolts and the hysteresis at switch on/off in 4021_h:02_h and 4021_h:03_h, depending on the characteristics of your application. If, in spite of the activation, the ballast is not able to limit the increase in the DC-link voltage, an error is generated and the respective driver output stage switched off when the overvoltage threshold (object 2034_h) is exceeded.

Nanotec recommends the following parameterization for ballast control and monitoring (preconfigured for the multi-axis controller):

```
4021h:01h=1 // Activate ballast
4021h:02h=60000 // Response threshold
4021h:03h=500 // Hysteresis for response threshold
4021h:04h=15000 // Rated value of ballast resistor
4021h:05h=120400 // Long-term overload capacity
4021h:06h=1000 // Reference time for long-term overload capacity
4021h:07h=48990 // Short-term load capacity
4021h:08h=1000 // Amount of heat that can be dissipated through convection
```

You can find further details in chapter *External ballast circuit* in the *CPB technical manual*.

Saving configuration

To save the configuration, set the object 1010_h:01_h to the value "1702257011". You can find further details in chapter *Saving objects* in the *CPB technical manual*.