Technical Datasheet CM-CPB3
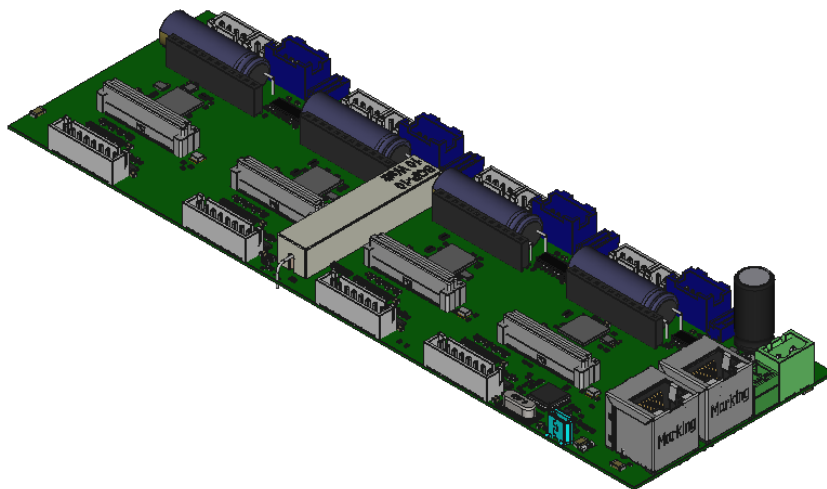
Fieldbus: EtherCAT

For use with the following variants:

CM-CPB3-x4-000x-1

Contents

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
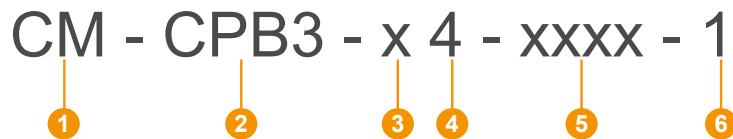
1 Product name
Controller Multi-Axis

2 CPB variant
CPB**3**

3 Number CPB
0 to 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
0003	with/for CPB3-1-x (low current), 24 V PNP inputs
0005	with/for CPB3-2-x (high current), 5 V PNP inputs
0006	with/for CPB3-2-x (high current), 5 V NPN inputs
0007	with/for CPB3-2-x (high current), 24 V PNP inputs

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: *Clock-direction mode* is not supported.	FIR-v2115	W003a
1.0.2	08/2021	■ 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 Commissioning on how to activate the special functions of the digital inputs.	FIR-v2139	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 the end user, be provided with 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 control,
- are familiar with and understand the content of this technical manual,
- know the applicable regulations.

1.6 Warranty and disclaimer

Nanotec assumes no liability for damages and malfunctions resulting from installation errors, failure to observe this manual or improper repairs. The selection and use of Nanotec products is the responsibility of the plant engineer or end user. Nanotec accepts no responsibility for the integration of the product in the end system.

Our general terms and conditions at www.nanotec.com apply.

NOTICE
Changes or modifications to the product are not permitted.

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
The CAUTION notice indicates a possibly dangerous situation.
Failure to observe the notice **may** result in moderately severe injuries.
► Describes how you can avoid the dangerous situation.

NOTICE
Indicates a possible incorrect operation of the product.
Failure to observe the notice may result in damage to this or other products.
► Describes how you can avoid the incorrect operation.

TIP
Shows a tip for the application or task.

Nanotec
PLUG & DRIVE

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	≙ 55$_{hex}$ ≙ 85$_{dec}$	

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.
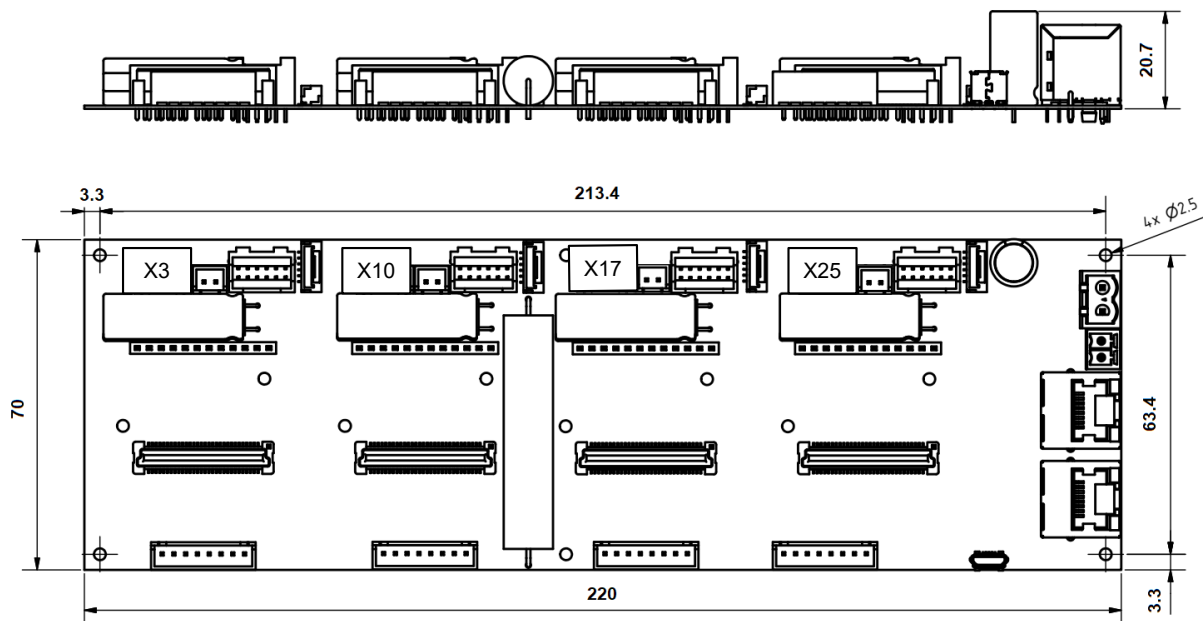
3.2 Environmental conditions

Environmental condition	Value
Protection class	No IP protection
Ambient temperature (operation)	-10 … +40°C
Air humidity (non-condensing)	0 … 95 %
Max. Altitude of site above *sea level* (without drop in performance)	2000 m (drop in performance above 1000 m: -1%/100 m)
Ambient temperature (storage)	-25 … +85°C

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)	■ Product variants 0001, 0002 and 0003 (*low current*): 3 A$_{rms}$ ■ Product variants 0005, 0006 and 0007 (*high current*): 6 A$_{rms}$, for max. 5 seconds
Commutation	Stepper motor *open loop*, stepper motor *closed loop* with encoder, BLDC sine commutated via Hall sensor, BLDC sine commutated via encoder
Operating modes	*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*, *Clock-Direction Mode*
Set value setting / programming	*Analog*, *NanoJ program*
Interfaces	USB, EtherCAT
Encoder/Hall	1x incremental encoder. 1x SSI encoder, 1x Hall sensor
I/O	4x digital inputs, 2x digital outputs (*open drain*), 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 *CPB technical manual* 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	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 ■ greater than the maximum current consumption of the controller(s), ■ less than the maximum current of the voltage supply. If the fuse value is very close to the maximum current consumption of the controller, a medium / slow tripping characteristics should be used.

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*.
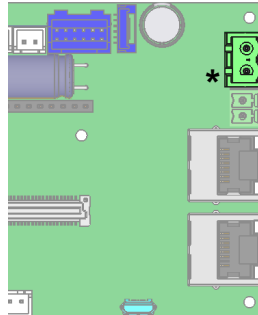
3.5 Pin assignment

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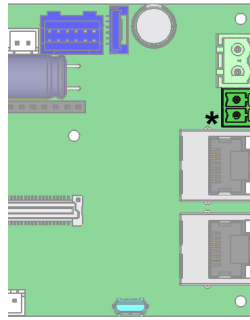
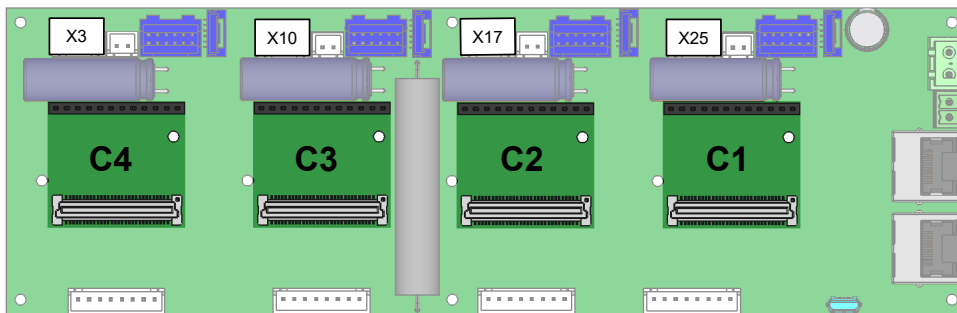| Pin	Function	Note
1	+UB_Logic	Optional external logic supply, 12…30 V DC
2	GND	

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. |

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
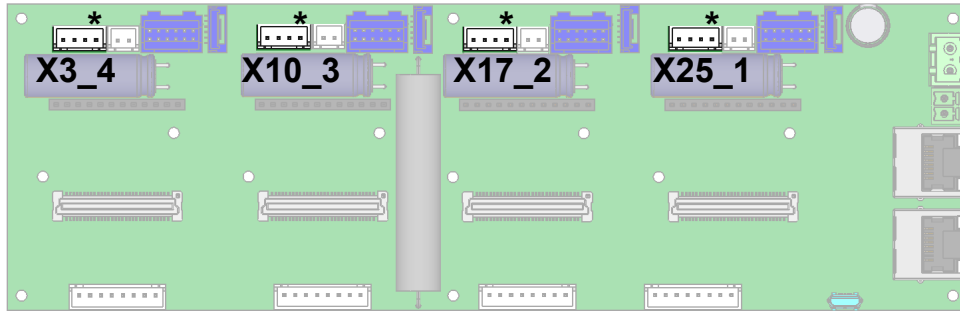
■ Product variants 0005, 0006 and 0007 (*high current*): JST B4P-VH(LF)(SN)
Mating connector (not included in scope of delivery):

□ 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
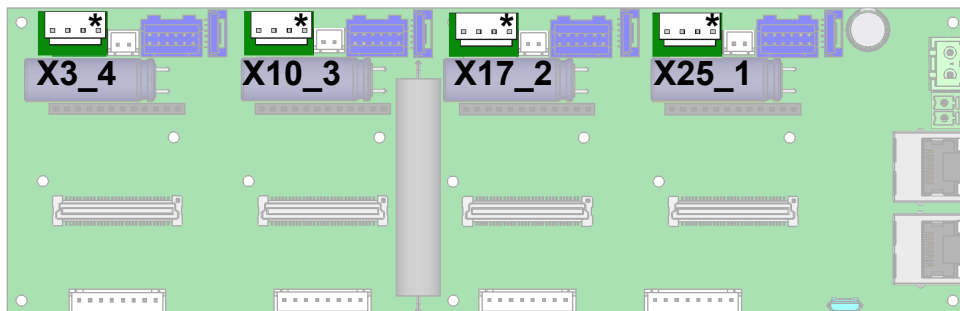
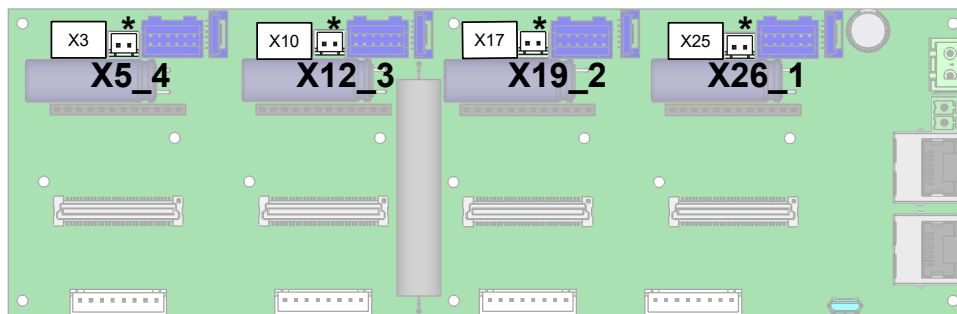| Pin	Function	Note
1	A_OUT	A (stepper motor) or U (BLDC)
2	AN_OUT	A\ (stepper motor) or V (BLDC)
3	B_OUT	B (stepper motor) or W (BLDC)
4	BN_OUT	B\ (stepper motor)

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 "*".

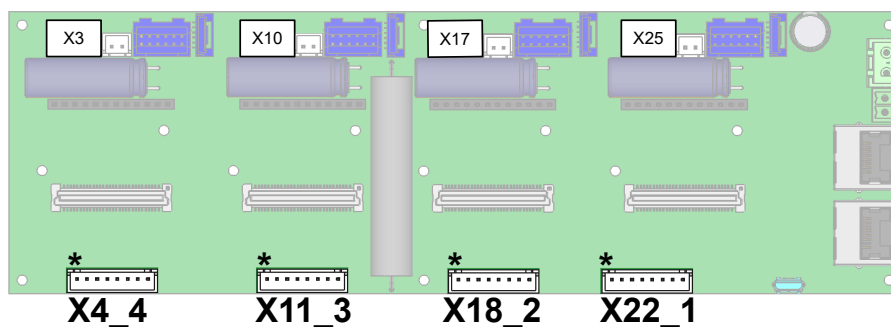| Pin	Function	Note
1	Brake +	internally connected to +UB
2	Brake -	PWM-controlled open drain output, max 1 A, see chapter *Automatic brake control* in *CPB technical manual*

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-NTO3-10-500-PADP / ZK-NTO3-10-1000-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.
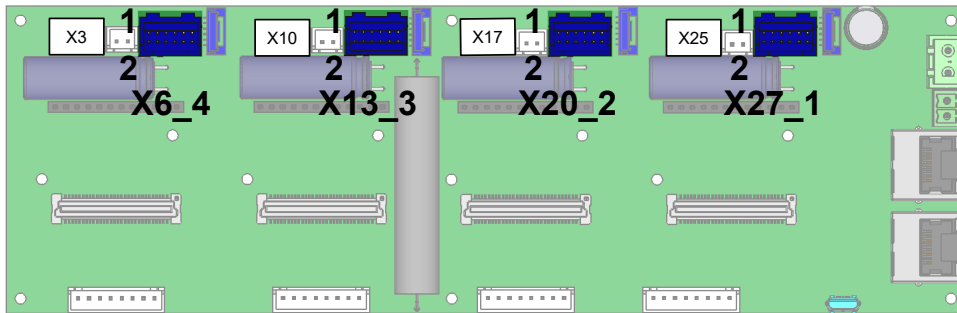
Pin	Function	Note
1	GND	
2	Vcc	5 V DC, output and supply voltage for encoder / Hall sensor; max. 600 mA
3	A	5 V signal, max. 1 MHz
4	B	5 V signal, max. 1 MHz
5	A\	5 V signal, max. 1 MHz
6	B\	5 V signal, max. 1 MHz
7	I	5 V signal, max. 1 MHz
8	I\	5 V signal, max. 1 MHz
9	Hall 1	5 V signal
10	Hall 2	5 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: SSHL-002T-P0.2 (or equivalent)
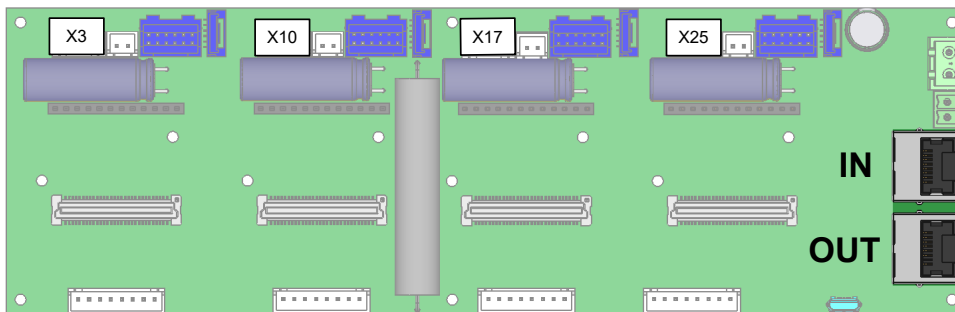■ Suitable Nanotec cable (not included in the scope of delivery): ZK-GHR6-500-S

In the following figure, pin 1 is marked with "*".
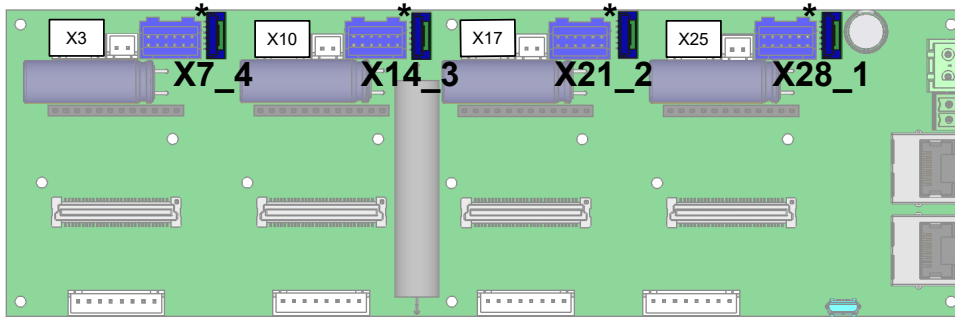
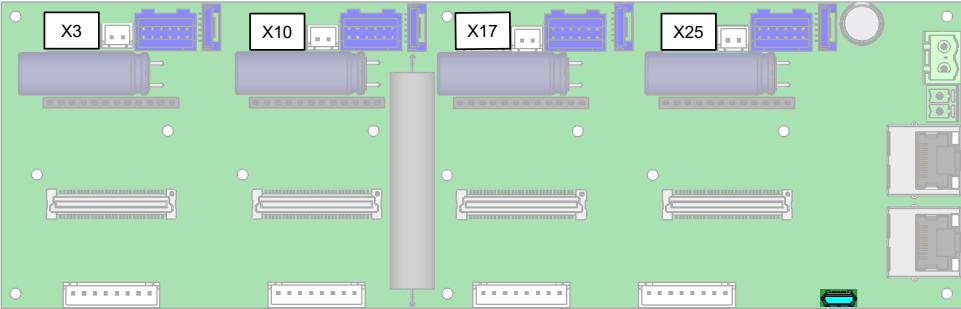| Pin	Function	Note
1	GND	
2	DATA A	
3	DATA B	
4	CLCK A	
5	CLCK B	
6	Vcc	+10 V DC, output and supply voltage for SSI encoder

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.

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 *CPB*	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 17
Digital output 2	44 (DIO4)	$60FE_h:01_h$, bit 19
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:

```
3271h:10h=1 // Pin 42 is output 1
3272h:10h=128 // Pin 42 is a digital output
3271h:12h=1 // Pin 44 is output 2
3272h:12h=128 // Pin 44 is a digital output
```

```
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 object 60FEh:01h
3252h:12h=91h // DIO6 to Bit 17 of object 60FEh:01h
3252h:16h=1080h // DIO8 to Bit 0 of object 60FEh:01h
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 4021h:02h and 4021h:03h, 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 2034h) 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*.