Hardware Technical Manual

CPBA-E

Fieldbus: EtherCAT, USB

For use with the following variants:

CPBAE-ET03LA, CPBAE-ET03HA

Valid with firmware version FIR-v2213
and since hardware version W002

Technical Manual Version: 1.6.0

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1 Introduction

The *CPBAE-ET03* is a controller for the *open loop* or *closed loop* operation of stepper motors and the *closed loop* operation of BLDC motors.

This manual describes the functions of the controller and the available operating modes. It also shows how you can address and program the controller via the communication interface.

You can find further information on the product on www.yanlanmc.com.

1.1 Version information

Manual version	Date	Changes	Firmware version	Hardware version
1.0.0	06/2018	First edition	FIR-v1748	W002
1.1.0	11/2018	Changes in Limitation of the range of motion and Setting the motor data	FIR-v1825	W002
1.2.0	08/2019	■ New chapter Configuring the sensors ■ Changes and additions in chapter Closed-Loop ■ New sections in chapter *Control modes:* Controller structure, Feed forward, Assignment of the feedbacks to the control loops and Slow Speed ■ Addition to the connection data for the connectors ■ Minor additions and error corrections in the object dictionary	FIR-v1926	W002
1.3.0	10/2019	Error corrections	FIR-v1939	W002
1.4.0	11/2020	■ New chapter Analog inputs ■ New objects $606F_h$ and 6070_h for monitoring the actual speed in *Profile Velocity* mode ■ New object 3250_h:09_h for switching the LEDs on/ off ■ New object $320E_h$:$0D_h$ for setting a voltage feed forward (see Feed forward) ■ New objects $320E_h$:$0F_h$ and $320F_h$:05_h for setting the maximum PWM voltage ■ New object 4021_h for configuring the ballast circuit	FIR-v2039	W002
1.5.0	09/2021	Additions and error corrections	FIR-v2139	W002
1.6.0	07/2022	Changes in chapter Controller structure: New objects $321A_h$, $321B_h$, $321C_h$, $321D_h$ and $321E_h$ for the control parameters replace $320E_h$. The current controller in *open-loop* is now only parameterized in 3210_h, object $320F_h$ has been removed. New object 230Eh Timer	FIR-v2213	W002

1.2 Copyright, marking and contact

CE

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1.3 Intended use

The *CPBAE-ET03* serves to control stepper motors 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 Permissible operating voltage) and the approved Environmental conditions.

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

1.4 Warranty and disclaimer

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

Our general terms and conditions at www.yanlan.net apply.

NOTICE

Changes or modifications to the product are not permitted.

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 EU directives for product safety

The following EU directives were observed:

- RoHS directive (2011/65/EU, 2015/863/EU)
- EMC directive (2014/30/EU)

1.7 Other applicable regulations

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

- Accident-prevention regulations
- Local regulations on occupational safety

1.8 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.

1.9 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.

1.10 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.

1.11 Bits

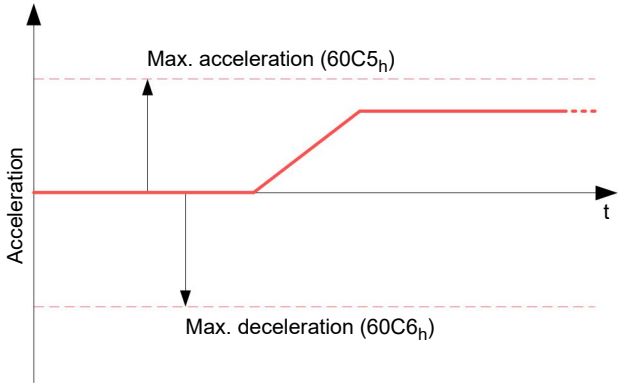
The numbering of individual bits in an object always begins with the LSB (bit number 0). See the following figure, which uses data type *UNSIGNED8* as an example.

	MSB							LSB
Bit Nummer	7	6	5	4	3	2	1	0
Bits	0	1	0	1	0	1	0	1

$\triangleq 55_{hex} \triangleq 85_{dec}$

1.12 Counting direction (arrows)

In figures, the counting direction is always in the direction of an arrow. Objects $60C5_h$ and $60C6_h$ depicted as examples in the following figure are both specified as positive.



2 Safety and warning notices

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.

NOTICE

Damage to the electronics if the supply voltage is connected with reversed polarity!

Polarity reversal results in a short-circuit between supply voltage and GND (earth) via the power diode.

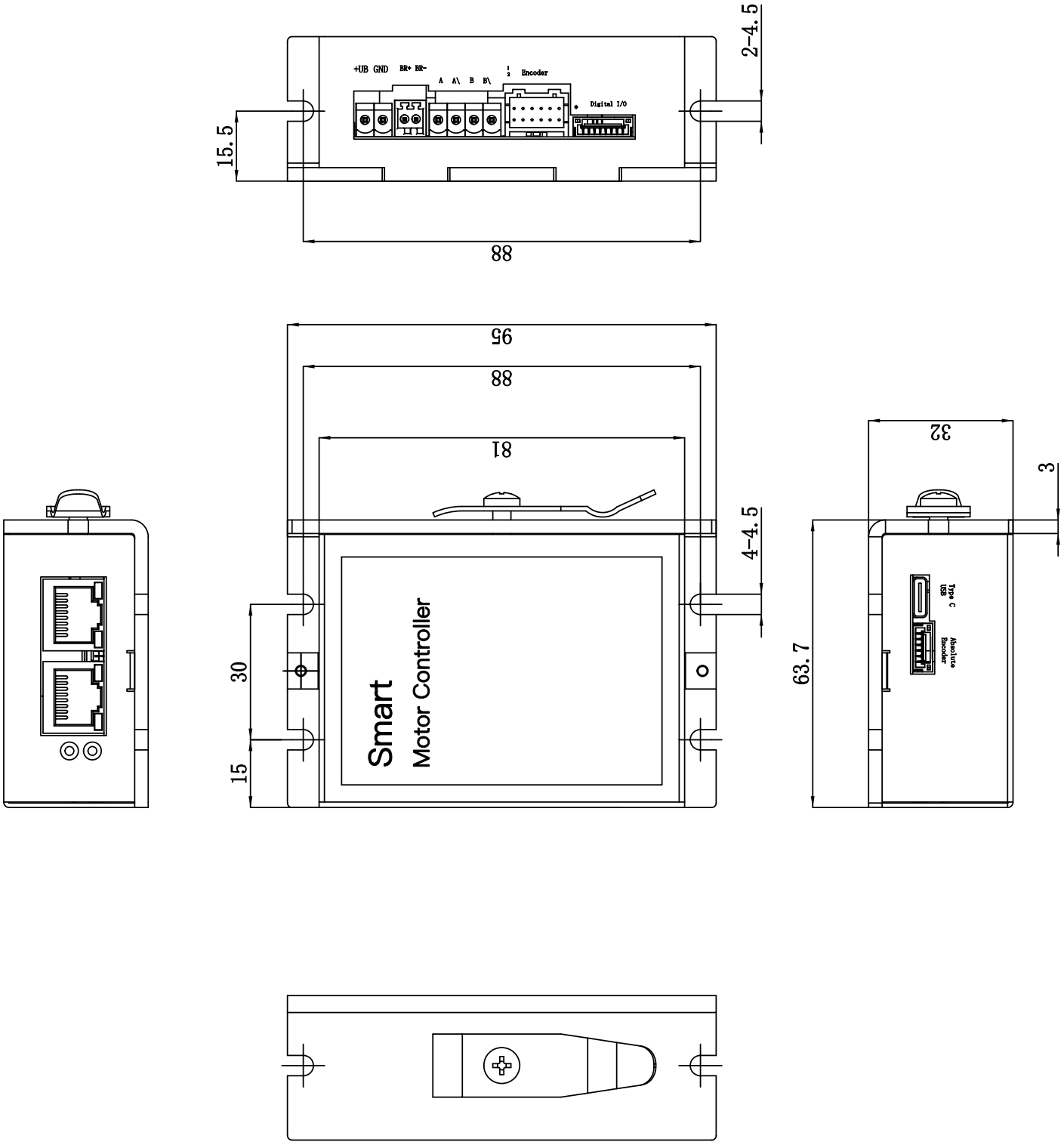
► Install a line protection device (fuse) in the supply line.

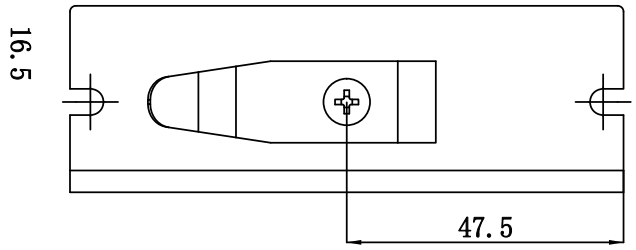
3 Technical details and pin assignment

3.1 Environmental conditions

Environmental condition	Value
Protection class	IP20
Ambient temperature (operation)	-10 … +40°C
Air humidity (non-condensing)	0 … 95 %
Max. Altitude of site above *sea level* (without drop in performance)	1500 m
Ambient temperature (storage)	-25 … +85°C

3.2 Dimensioned drawings and installation options





You can secure the controller by its side tabs to a flat mounting surface using screws or mount it on a TH35 DIN rail in your switch cabinet using the supplied DIN rail clip.

3.3 Electrical properties and technical data

Property	Description / value
Operating voltage	12 … 57.6 V DC
Rated current	CPBAE-ET03LA (*low current*): 3 A_{rms} CPBAE-ET03HA (*high current*): 3 A_{rms}
Peak current	CPBAE-ET03LA (*low current*): 3 A_{rms} CPBAE-ET03LA (*high current*): 9 A_{rms} for 5 seconds
Commutation	Stepper motor – open loop, stepper motor – closed loop with encoder, BLDC motor – closed loop with Hall sensor, and BLDC motor – closed loop with 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	*Clock-direction*, *analog*, *NanoJ program*
Interfaces	USB, EtherCAT
Inputs	■ 4 inputs, 24 V (inputs 1 to 4) individually switchable between 5 and 24 V, factory setting: 24 V ■ 1 analog input, 10 bit, 0-10 V
Outputs	2 outputs, (max. 24 V and 100 mA)
Protection circuit	Overvoltage and undervoltage protection Overtemperature protection (> 80° Celsius on the power board) Polarity reversal protection: In the event of a polarity reversal, a short-circuit will occur between supply voltage and GND over a power diode; a line protection device (fuse) is therefore necessary 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, ■ 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 Overtemperature protection

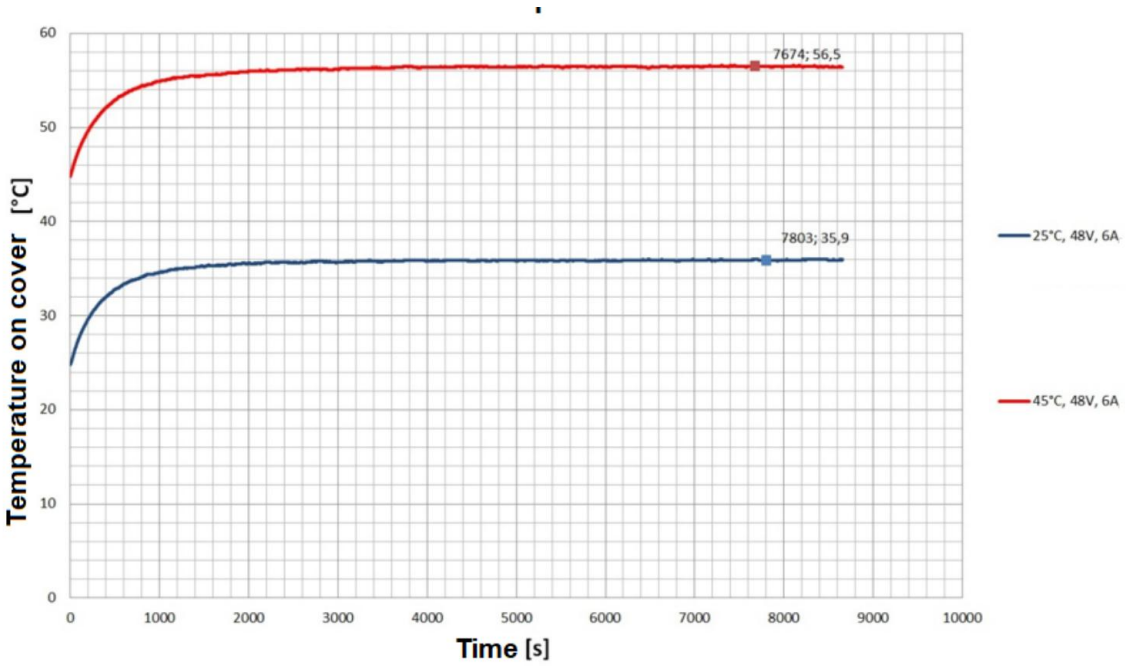
Above a temperature of approx. 80°C on the power board (corresponds to 65–72°C outside on the back cover), the power part of the controller switches off and the error bit is set (see objects 1001_h and 1003_h). After cooling down and confirming the error (see table for the controlword, "Fault reset"), the controller again functions normally.

The following temperature test results provide information on the temperature behavior of this controller.

Temperature tests are performed under the following conditions:

- Operating voltage: 48 V DC
- Motor current: 3 A (CPBAE-ET03LA *low current*)
- Operation mode: Velocity Mode, full step, 30 rpm
- Ambient temperature: 25 °C / 45 °C
- Altitude of site: 500 m above sea level
- No external cooling in the climatic chamber, e. g., via fan

The following graphic shows the results of the temperature tests:



Summary:

At 25°C (+48 V, 3/3 A rms, Velocity Mode 30 rpm), the controller was in operation for longer than 3 hours without having been switched off. The temperature on the cover was stable at approx. 37°C.

At 45°C (+48 V, 3/9 A rms, Velocity Mode 30 rpm), the controller was in operation for longer than 3 hours without having been switched off. The temperature on the cover was stable at approx. 57°C.

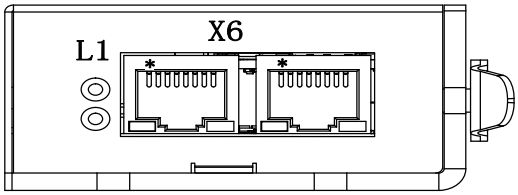
NOTICE

Aside from the motor, the exact temperature behavior is also dependent on the flange connection and the heat transfer there as well as on the convection in the application. For this reason, we recommend always performing an endurance test in the actual environment for applications in which current level and ambient temperature pose a problem.

3.5 LED signaling

3.5.1 Power LED

The power LED indicates the current status.



3.5.1.1 Normal operation

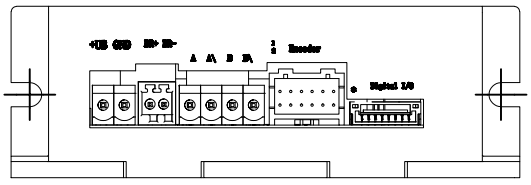
In normal operation, the green power LED L1 Light.

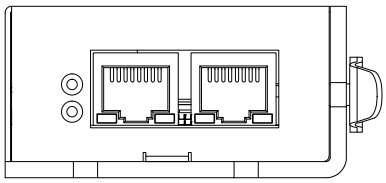
3.5.1.2 Case of an error

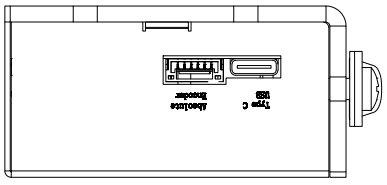
If network error has occurred, the LED L2 turns red

3.6 Pin assignment

3.6.1 Overview







Connection	Function
X1	Voltage supply
X2	Brake connection
X3	Motor connection
X4	Encoder and Hall sensor connection
X5	Digital/analog inputs and outputs
X6	EtherCAT IN and OUT
X7	TypeC USB connection
X8	Multi turn absolute encoder interface
L1	Power LED

NOTICE

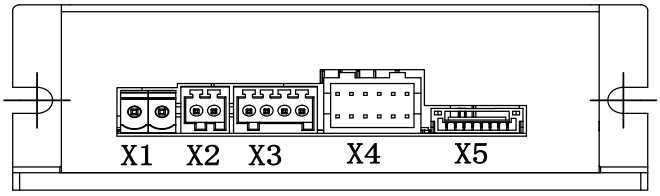
All pins with designation *GND* are internally connected.

3.6.2 X1 – voltage supply

- Type: HT396R-3.96-2P-15
- Mating connector (included in scope of delivery): HT396K-3.96 (or equivalent)
- Yanlanmc article number: HT396K-3.96

3.6.2.1 Voltage source

The operating or supply voltage supplies a battery, a transformer with rectification and filtering, or a switching power supply.

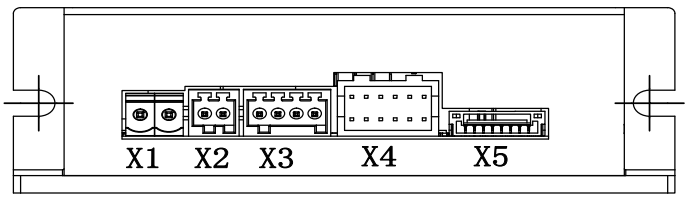


Pin	Function	Note
1	+UB	12 V - 58 V DC, ±5%
2	GND	

3.6.3 X2 – brake connection

- Type: KF2EDGR-2.54-2P-14
- Mating connector (included in scope of delivery): KF2EDGKD-2.54 (or equivalent)
- Yanlanmc article number: KF2EDGKD-2.54

Pin 1 is marked with an asterisk "*".

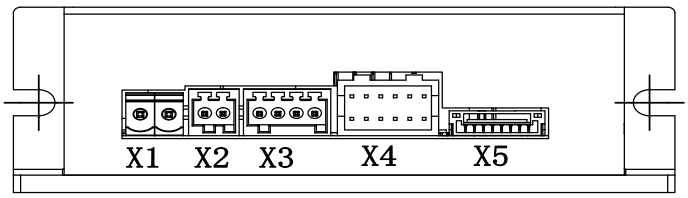


Pin	Function	Note
1	Brake +	Internally connected to +UB
2	Brake -	PWM-controlled max. 1A

3.6.4 X3 – motor connection

- Type: KF2EDGR-2.54-4P
- Mating connector (included in scope of delivery): KF2EDGKD-2.54 (or equivalent)
- Yanlanmc article number: KF2EDGKD-2.54

Pin 1 is marked with an asterisk "*".

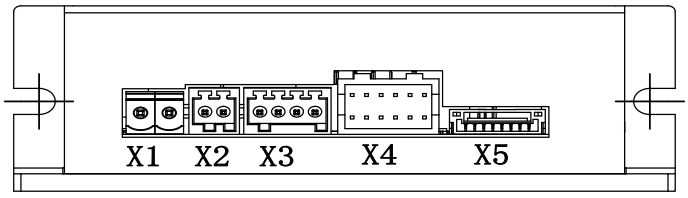


Pin	Function (Stepper)	Function (BLDC)
1	A	U
2	A\	V
3	B	W
4	B\	Not used

3.6.5 X4 – encoder/Hall sensor

- Type: JST S12B-PADSS-1
- 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 YanLan cables (not included in the scope of delivery):
  - ZK-PADP-12-500-S
  - ZK-M12-8-2M-2-PADP
  - ZK-M12-12-2M-2-PADP
  - ZK-NTO3-10-500-PADP / ZK-NTO3-10-1000-PADP
  - ZK-NOE-10-500-S-PADP
  - ZK-WEDL-500-S-PADP

Pin 1 and pin 2 are marked in the figure.

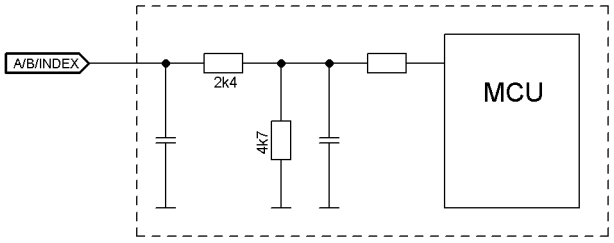


Pin	Function	Note
1	GND	
2	Vcc	5 V DC, output and supply voltage for encoder / Hall sensor; max. 200 mA
3	A	5 V signal, max. 1 MHz
4	B	5 V signal, max. 1 MHz
5	A\	5 V signal, max. 1 MHz
6	B\	5 V signal, max. 1 MHz
7	I	5 V signal, max. 1 MHz
8	I\	5 V signal, max. 1 MHz
9	Hall 1	5 V signal
10	Hall 2	5 V signal
11	Hall 3	5 V signal
12	Shielding	Shielding

The following switching thresholds apply for the encoder inputs:

Type	Switching thresholds	
	On	Off
Single	> 3.8 V	< 0.26 V
Difference	> 3.8 V	< 0.26 V

The internal wiring of the encoder inputs is shown in the following.



3.6.6 X5 – inputs and outputs

- Type: SM08B-GHS-TB
- Mating connector (included in scope of delivery): JST-GHR-08V-S (or equivalent)
- Yanlanmc article number: SSHL-002T-P0.2

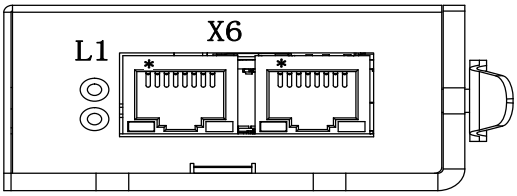
Pin 1 is marked with an asterisk "*".

Pin	Function	Note
1	Digital input 1	24 V signal
2	Digital input 2	24 V signal
3	Digital input 3	24 V signal
4	Digital input 4	24 V signal
5	Analog input	10 bit, 0-10 V
6	Digital output 1	Open drain, maximum 24 V / 100 mA
7	Digital output 2	Open drain, maximum 24 V / 100 mA
8	GND	GND

3.6.2 X1 – EtherCAT IN and OUT

Type: RJ45 socket

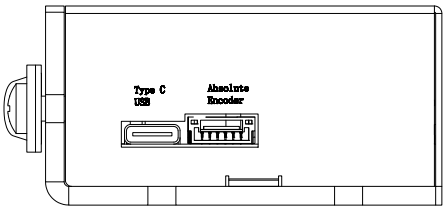
Pin 1 is marked with an asterisk "*". Both connectors are configured identically according to the following table.



Pin	Function	Note
1	TD+	
2	TD-	
3	RD+	
4	n.c.	
5	n.c.	
6	RD-	
7	n.c.	
8	n.c.	

3.6.8 X7 – TypeC USB

A cable of type "TypeC" is needed for this USB connection.



3.6.9 X8 – SSI encoder

- Type: JST BM06B-GHS-TBT(LF)(SN)(N)
- Mating connector (included in scope of delivery): JST-GHR-06V-S (or equivalent)
- Yanlanmc article number: SSHL-002T-P0.2

Pin 1 is marked with an asterisk "*".

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