xMate CR12
Hardware Installation Manual

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Contents in this manual are subject to change without notice. We assume no responsibility for any errors that may appear in this manual.

Please understand that in no event shall we be liable for incidental or consequential damages arising from the use of this manual and the products described herein.

We cannot foresee all possible dangers and consequences.

Therefore, this manual cannot warn the user of all possible hazards.

Unauthorized copying or reprinting of some or all contents of this manual is prohibited.

If you find the contents of this manual wrong or in need of improvement or supplement, please do not hesitate to point them out so that they can be corrected.

This manual is originally written in Simplified Chinese. Other language versions are translated.

Contents

1 Manual Overview

1.1 About this manual

Thank you for choosing ROKAE robot system.

This manual contains the following instructions for correct installation and use of the robot:

- Mechanical and electrical installation of the robot
- Maintenance and calibration of the robot

Please read this manual and other related manuals carefully before installing and using the robot system.

After reading, keep it properly for future reference.

1.2 Target group

This manual is intended for:

- Installation personnel
- Maintenance personnel

Please ensure that the above personnel have the necessary knowledge of mechanical and electrical installation and maintenance, and have received our training.

1.3 How to read the product manual

This manual includes a separate safety section that must be read through before proceeding with any installation or maintenance procedures.

1.4 Illustrations in this manual

Due to product upgrades or other reasons, some figures in the product manual may differ from the actual product. However, the operating procedures are correct.

Also, figures of other models may be used to describe some general information.

1.5 Related product documents

This document is the product manual for the xMate CR12 robot and is intended to be used with the following documents:

- xCore Control System User Manual

1.6 Contact

For information about the maintenance and repair of the robot, please contact our after-sales department or the local reseller.

Get the following information ready before contacting us:

- Robot model/serial number
- Software name/version
- Problems with the system

2 Safety

2.1 Introduction

This section describes the principles and procedures that must be followed to ensure the safe use of the xMate CR12 robots. Robot integrators must read and understand the information listed here before powering on the robot for the first time.

The contents related to the design and installation of the external safety protection devices of the robot are not covered in this section. Please contact your system integrator to obtain such information.

2.1.1 Safety responsibilities

ROKAE is dedicated to but not liable for providing reliable safety information. Even if all safety instructions are followed, there is no guarantee that xMate CR12 will not cause any personal injury or property damage.

In addition to the safety section, this document contains further safety instructions.

2.1.2 Intended use

The xMate CR12 robots should be used in accordance with local laws and regulations, and must not be used for any purpose that violates such laws and regulations.

Using the robots in compliance with instructions also means observing the instructions in the product manual of each component, including the operation, installation, and maintenance instructions.

The following uses that go against the instructions are prohibited:

- Use in human and animal transportation
- Use in potentially explosive environments
- Use in flammable environments
- Use outside the permissible limits
- Downhole use

xMate CR12 robots are industrial robots intended to handle tools/end effectors and fixtures, or to process or transfer components or products. xMate CR12 robots are equipped with special safety-related features, which are purposely designed to enable collaborative operation, where the robot system operates without fences and/or together with a human.

Collaborative operation is only intended for non-hazardous applications, where the complete application, including the tools/end effectors, workpieces, obstacles, and other machines, is without any significant hazards according to the risk assessment of the specific application.

Any use or application deviating from the intended use is deemed to be impermissible misuse.

This includes, but is not limited to:

- Use in potentially explosive environments
- Use in medical and life-critical applications

- Use before performing a risk assessment
- Use outside of stated specifications
- Use as a climbing aid
- Operation outside the permissible operating parameters

2.2 Safety notice

2.2.1 Instructions

- A risk assessment must be conducted before operating or controlling the robot, and the robot must be used according to the safety instructions described in this document.
- When the robot is controlled by an external controller using RCI, the safety protection during the control process must be implemented by the external controller. Any personal or device safety issues caused by the lack of safety features in the external controller are not covered by robot safety management.
- If you are unsure about the risks during the use of the robot, please contact ROKAE Technical Support. Problems arising from non-intended use are not covered by our support.

2.3 Safety protection devices

2.3.1 Emergency stop

2.3.1.1 Definition of emergency stop

Emergency stop possesses the highest priority in the robot system. Pressing the emergency stop button will trigger the emergency stop and all the functions will be frozen immediately. The robot will stop running and the power of each joint will be cut off. The control system will be switched into the emergency stop state, which will be maintained before releasing the emergency stop manually.

To resume the operation, release the emergency stop button first for the motor of each joint to execute the power-on command.

> ℹ️ Notes
>
> Emergency stop should not be used for normal stops, otherwise it may cause extra and unnecessary wear to the brake and transmission system, which will eventually reduce the robot's lifespan.
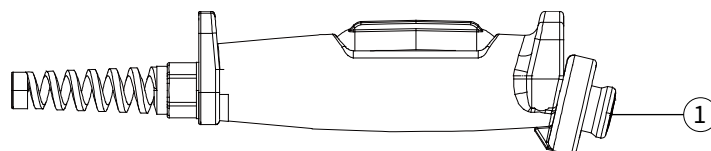
Figure 1. Emergency stop button on the handheld emergency stop and enabling device

No.	Name
1	Emergency stop button

2.3.2 Enabling switch

2.3.2.1 Enabling device

The enabling device is a special switch with two contacts and three positions, and is also called a three-position enabling switch (hereinafter referred to as "enabling switch"). It is used to power on/off the joints in Manual mode to enable robot motions.

The robot will be powered on and able to move only after the enabling switch is pressed and held in the middle position. Releasing or pressing the switch all the way down will cut the power off.
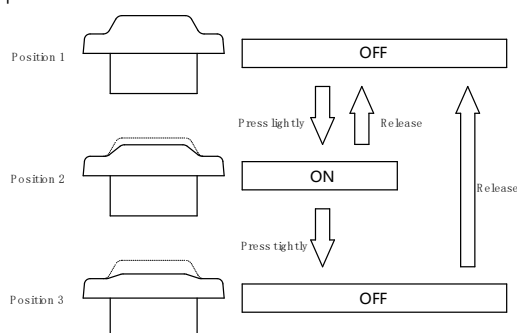
Position 1 ᵣₑ 2. Positions of the enabling switch

> **Notes**
>
> When the enabling switch is pressed and held in the middle position in Manual mode, the robot will be powered on, the system will enter the Motor On state, and you can jog the robot or execute a program. The robot will be powered off and the system will return to the Motor Off state when the switch is released or pressed all the way down.
>
> To ensure safe use of the robot, the following requirements must be observed:
>
> - Make sure the enabling switch functions properly in any circumstances.
> - Release the enabling switch immediately when no robot motion is required during programming or debugging.
> - Any person who enters the robot's working space must carry a handheld enabling device to prevent others from starting the robot without the knowledge of the involved personnel.

> ⚠ **Warning**
>
> It is strictly prohibited to use external devices to hold the enabling switch in the middle position.

2.4 Emergency stop types

2.4.1 Emergency stop

There are two types of stops for robots according to ISO 13850 and IEC 60204 safety standards:

- STOP0: The motor power is switched off and brakes are engaged.
- STOP1: The robot comes to a controlled stop. Then the motor power is switched off and brakes are engaged.

For the xMate CR12 robots, STOP0 is used for handheld emergency stop signal processing.

2.5 Safety precautions

2.5.1 Operating safety

2.5.1.1 General principles

A few simple principles should be followed in order to operate the robot safely:

- Always operate the robot in Manual mode if personnel are inside the safeguarded space.
- Always bring the handheld emergency stop device along when you enter the safeguarded space so that robot control is in your hands.
- Watch out for rotating or moving tools installed on the robot. Make sure those tools are stopped before you approach the robot.
- Watch out for grippers and objects gripped. If the gripper is opened, the workpiece could fall and cause personal injury or equipment damage. The gripper can be very powerful and can also cause injuries if not operated in a safe manner.

2.5.2 Recovering from emergency stops

2.5.2.1 Instructions

In the case of an emergency stop, a reset is required to return to normal operation. The reset is a simple but important procedure. It ensures that the robot system is not returned to production in a hazardous condition.

2.5.2.2 Emergency stop button and reset

The emergency stop button is located on the handle of the handheld emergency stop and enabling device. It has a latching feature that must be released in order to remove the emergency stop condition of the device. This can be done by rotating the button as marked.

2.5.3 Safety precautions in Manual mode

2.5.3.1 About the Manual mode

In Manual mode, the robot's movement is under manual control. You can only jog the robot or execute a program when the enabling switch is held in the middle position.

The Manual mode is used during programming, debugging, and commissioning of the workstation.

2.5.3.2 Speed limit in Manual mode

In Manual mode, the speed of the robot's end effector is limited to 250 mm/s. This means that the maximum speed of the robot will not exceed 250 mm/s whether you jog the robot or execute a program, regardless of the speed set in the program.

2.5.3.3 Bypassing external safety signals

In Manual mode, signals of external safety devices such as the safety gate and safety grating will be bypassed. This means that the emergency stop will not be triggered in Manual mode even if the safety gate is open, which facilitates the debugging.

2.5.4 Safety precautions in Automatic mode

2.5.4.1 About the Automatic mode

The Automatic mode is used for running the robot program in production.

In Automatic mode, the enabling switch will be bypassed so that the robot can run automatically without manual intervention.

> ⚠️ DANGER
>
> In Automatic mode, the robot moves at the speed set in the program, which is up to 2 m/s for the end effector. In this mode, personnel must not enter the working space of the robot to avoid personal injury.

2.5.4.2 Enabling external safety signals

External safety devices such as the safety gate and safety grating will be enabled in Automatic mode. Opening the safety gate will trigger an emergency stop.

2.5.4.3 Safe troubleshooting in production

In most cases, the robot is part of the production line. Therefore, the impact of a robot fault may go beyond the workstation itself. Likewise, problems with other parts of the production line may also impact the workstation. For this reason, a troubleshooting plan should be designed by personnel who are familiar with the entire production line to improve safety.

For example, a robot on the production line grabs workpieces from the conveyor belt. When the robot encounters a fault, the robot maintenance personnel should consider additional safety measures for working beside the moving conveyor belt to ensure uninterrupted production while the robot is under repair.

For another example, when removing a welding robot from the production line for routine maintenance, the robot supplying materials to it must also be stopped to avoid personal injury.

2.6 Pre-use assessment

The following tests must be conducted before using the robot for the first time or after making any modifications. Verify that all safety inputs and outputs are correct and properly connected. Test that all connected safety inputs and outputs are functioning. To do this, you must:

- Test that the emergency stop button on the handheld emergency stop and enabling device can stop the robot and engage brakes.
- Test that the robot can switch between Manual and Automatic mode.
- Test that the 3-position handheld emergency stop and enabling device must be pressed to enable motion in Manual mode and that the robot is under reduced speed control.

3 Product Overview

3.1 Introduction

xMate CR12 is a new generation of flexible collaborative robot that boosts industrial productivity with highly sensitive force sensing and highly dynamic force control.

3.2 Robot

3.2.1 Overview

The basic configuration of xMate CR12:

Product name	Maximum payload	Maximum reach	Weight
xMate CR12	12 kg	1300 mm	About 43 kg

3.2.2 Robot system

The new-generation flexible collaborative robot xMate CR12 comprises a robot system (robot and built-in controller), a handheld safety protection device, a power adapter and cables, and other interfaces and accessories. For details, see Figure 3:
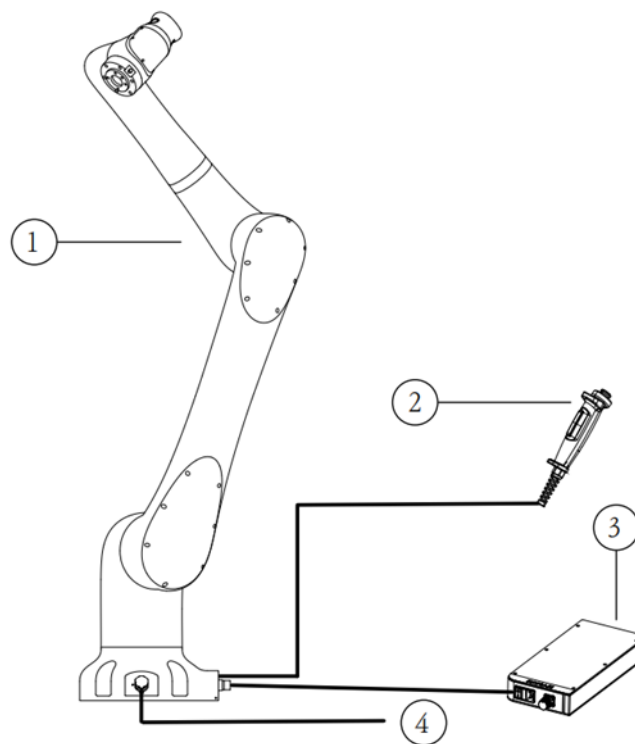

Figure 3. Robot system

No.	Name
1	xMate CR12 robot system
2	Handheld safety

	protection device
3	Power adapter and cables
4	Other interfaces and accessories

3.2.3 Definitions of rotation directions and coordinate systems

The flexible collaborative robot features 6 degrees of freedom, or 6 joints or axes (see Figure 4 for details). The definitions of axis rotation directions and coordinate systems are described below.

Base coordinate system: The -X axis points in the outgoing cable direction of the base, and the +Z axis in a direction perpendicular to the mounting surface. The Y axis is determined by the right-hand rule.

Flange coordinate system: When the robot is in the zero pose, the +Z axis points in the outward direction vertical to the flange surface, and the exit of the base is + X in the opposite direction. The Y axis is determined by the right-hand rule.

Rotation axis directions: When the axes are in the zero position, the A1, A4 and A6 perform forward rotation in the +Z direction of the base coordinate system, and the A2 in the +Y direction, the A3, and A5 in the -Y direction.

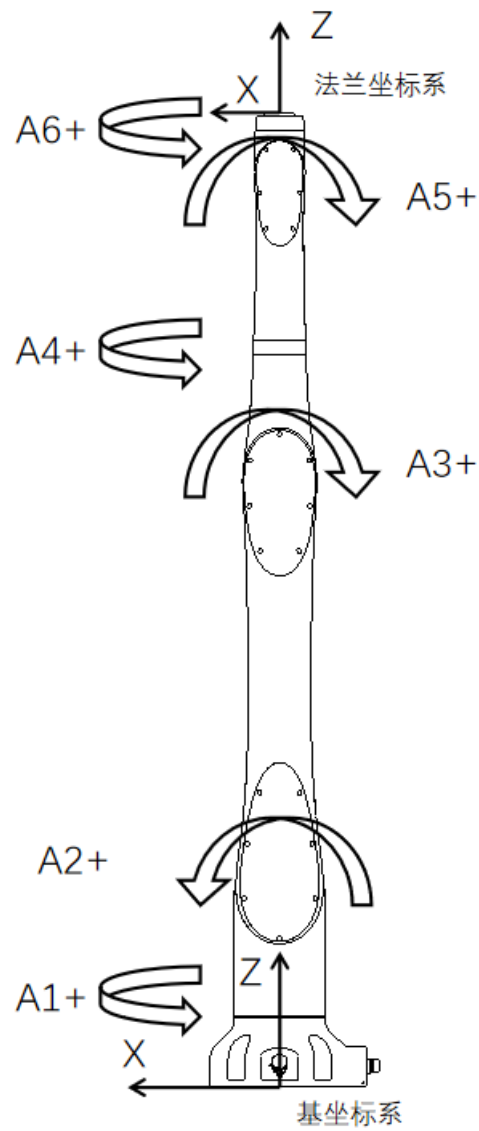Figure 4. Definitions of robot rotation directions and coordinate systems

3.3 Symbols and labels
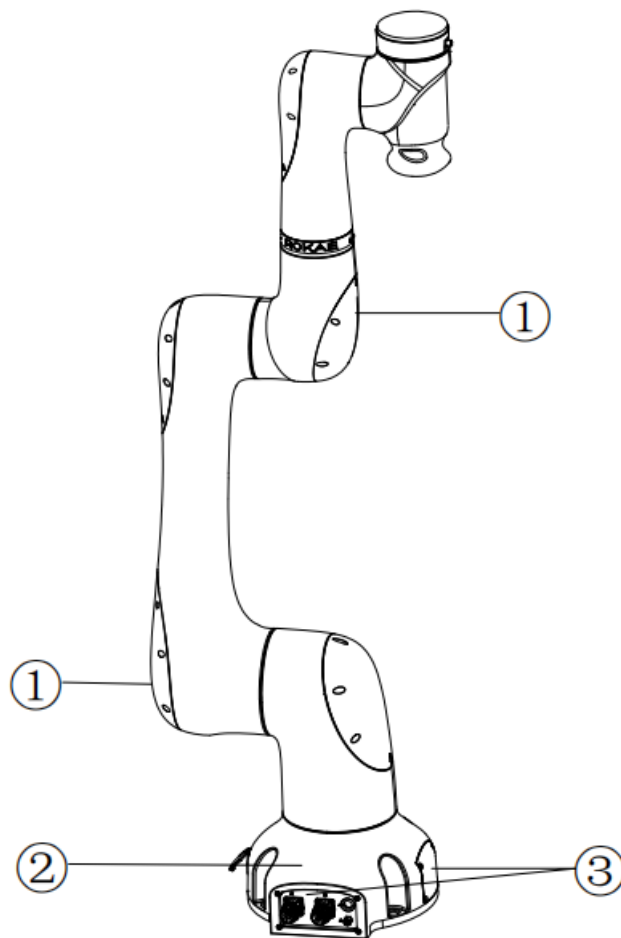
Figure 5. Symbols and labels

Position	Label type	Remarks
1	Arm body logo	
2	Product nameplate	Indicates product model and other product information.
3	Electrical hazard symbol	Do not touch the electrical components inside a live robot to avoid the risk of electric shock.

4 Technical Specifications

4.1 Introduction

This section describes the performance parameters of the xMate CR12 flexible collaborative robot.

4.2 Model and nameplate

4.2.1 Model

Figure 6. Model description

4.2.2 Nameplate
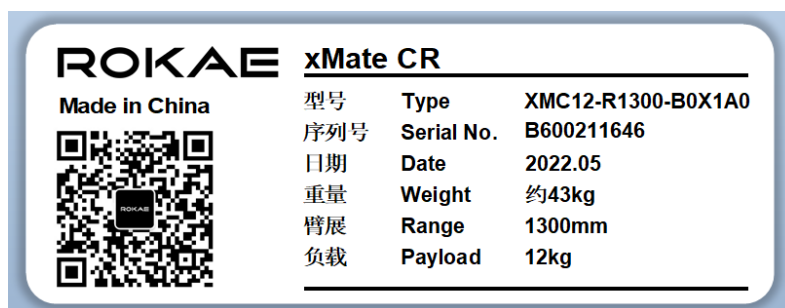
Figure 7. Nameplate

4.3 Specifications

4.3.1 Data sheet

Product name	xMate CR12

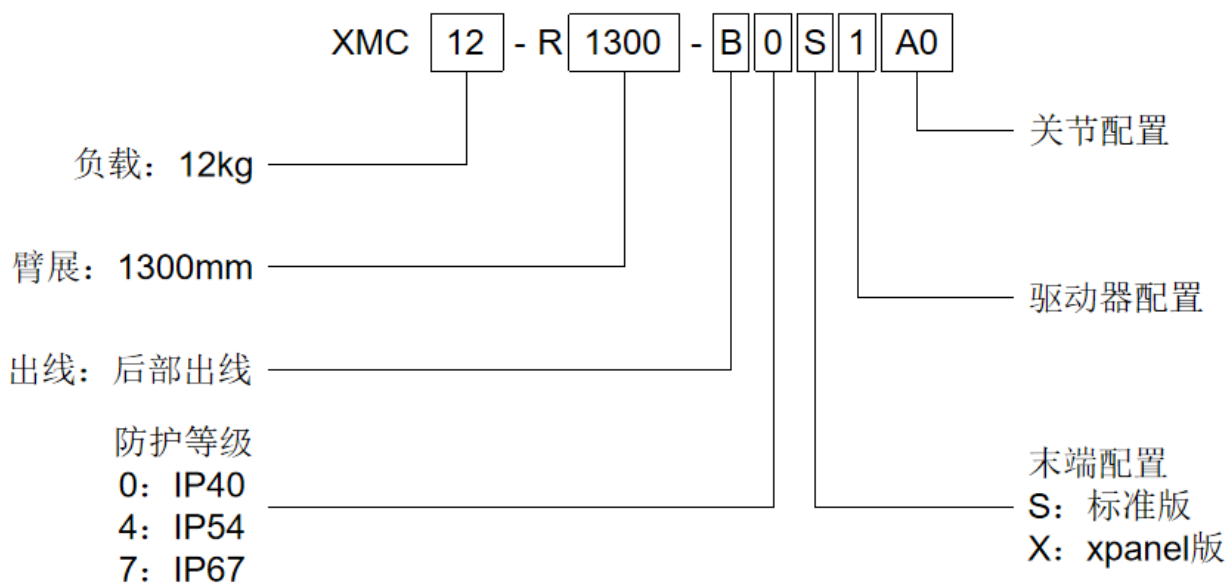| Number of axes		6
Maximum reach		1300 mm
Repeatability		±0.02 mm
Maximum payload		12 kg
Range of motion	Axis 1	±175°
	Axis 2	±170°
	Axis 3	±175°
	Axis 4	±175°
	Axis 5	±175°
	Axis 6	±175°
Maximum speed	Axis 1	120°/s
	Axis 2	120°/s
	Axis 3	180°/s
	Axis 4	234°/s
	Axis 5	240°/s
	Axis 6	240°/s
Operating temperature		0°C to +45°C
Storage temperature		-10°C to +55°C
Protection level		IP54
Mounting method		Floor mounted, suspension mounted, side mounted
Weight		about 43 kg
Noise level		≤70 dB(A)

4.4 Working space

The working space of xMate CR12 is shown in the figure below.

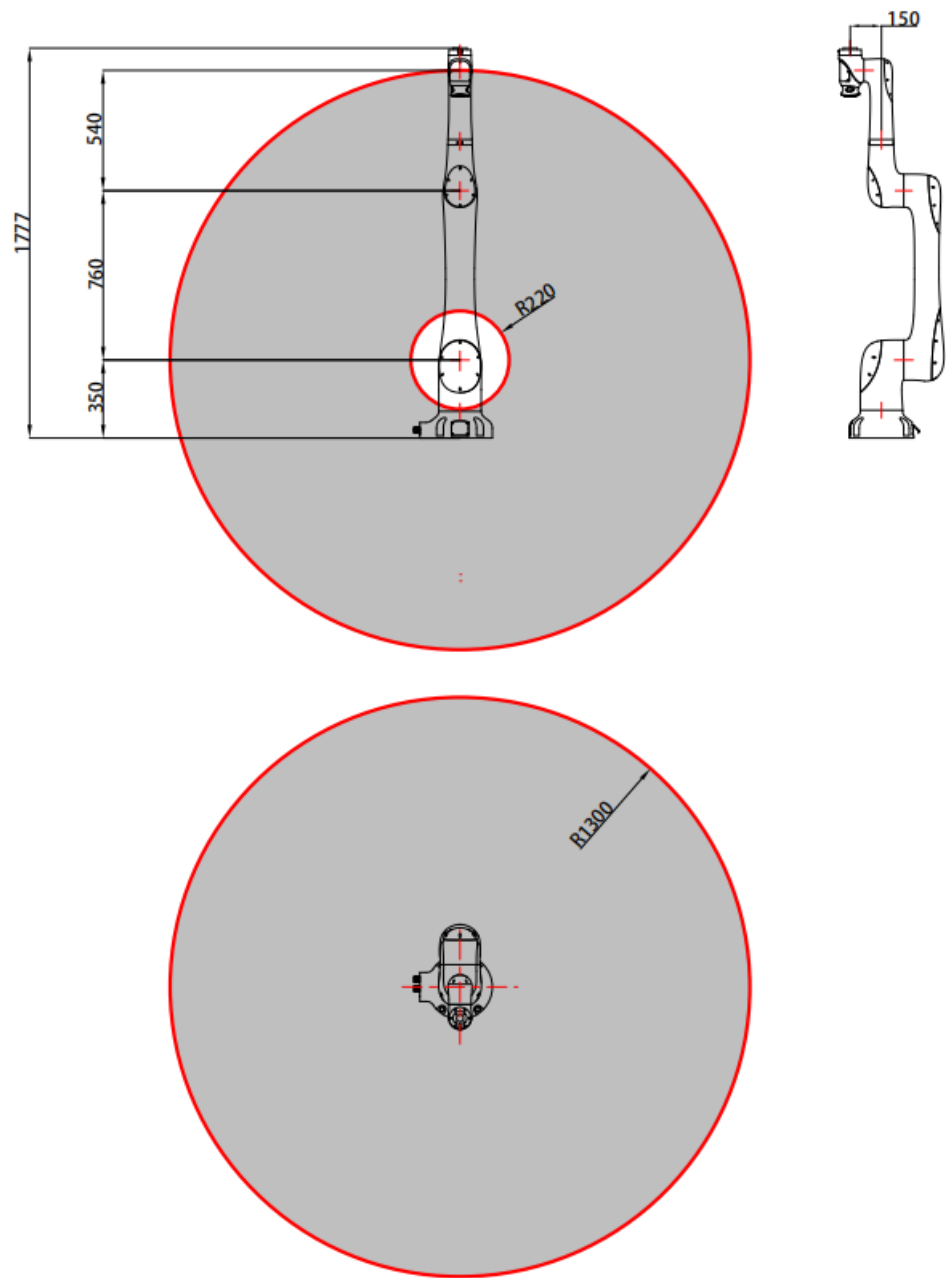Figure 8. The working space of xMate CR12

5 Unpacking and Installation

5.1 Introduction

This section contains instructions for unpacking and installing the xMate CR12 flexible collaborative robot.

5.2 Installation flow chart

The installation flow chart is used to check the robot installation progress. Put a check mark in the "Completed" column when a step is finished.

Step	Operation	Completed
1. Preparation before the installation		
①	Installation personnel	
②	Installation environment	
③	Installation foundation	
④	Support pillar	
2. Installation dimensions		
3. Unpacking and handling		
①	Unpack	
②	Check the packing list	
③	Transport	
4. Installing the robot body		
①	Install the robot in place	
5. Cable connection		
①	Connect the power supply and signal cables between the robot body and the control cabinet	
6. User wiring/routing		
①	Connect the I/O signal cable and air pipe	

5.3 Environmental conditions

The robot is suitable for general industrial environments, which should meet the following conditions:

Item	Condition
Temperature	0°C to +45°C
Relative humidity	20% to 80%, non-condensing
Electrical fast transient (EFT)	Below ±2 kV
Electrostatic discharge (ESD)	Below ±8 kV
Environment	Indoor installation.

	Avoid exposure to sunlight.
	Keep away from salt, etc.
	Keep away from flammable and corrosive liquids and gases.
	Protect from shock and vibration.
	Keep away from sources of electrical interference.

⚠ Warning
Never place or use the robot in any explosive environment!
ℹ Notes
At low ambient temperature (< 10°C), the grease (or lubricating oil) inside the reducer (or gearbox) has a high viscosity and may cause the robot to stop or operate inefficiently. In this case, it is recommended to warm up the robot and other auxiliary equipment.

The storage environment of the robot should meet the following conditions:

Item	Condition
Temperature	-10°C to +55°C
Relative humidity	20% to 80%, non-condensing

5.4 Unpacking and hardware installation

5.4.1 Unpack

Preparation for unpacking

Prepare necessary tools for unpacking according to the table below.

No.	Tool	Quantity
1	Utility knife/scissors	1
2	M10 hex wrench	1
3	Protective gloves	1

Unpacking procedures:

① Step 1: Open the packaging box

Wear protective gloves and cut open the sealed package with scissors or a utility knife.

You will find the following items in the box:
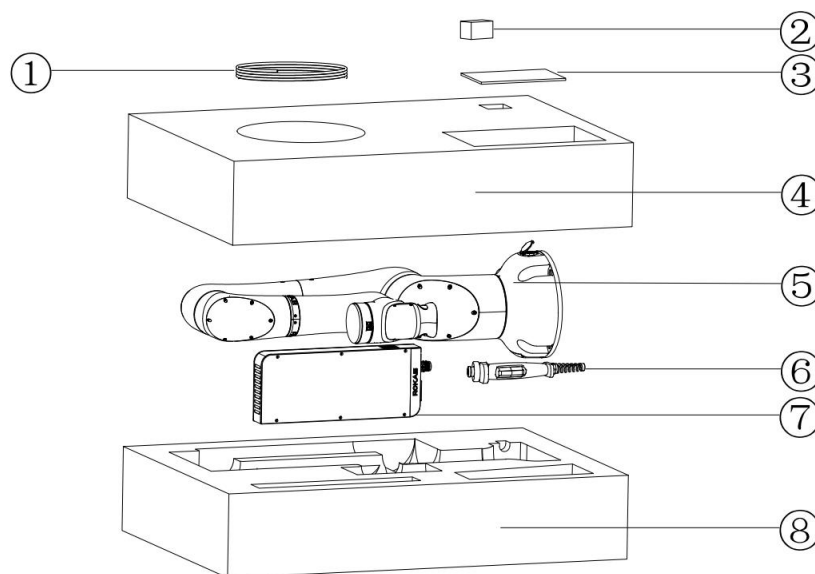
Figure 9. Unpacking

No.	Item	Model	Quantity	Remarks
1	Power cord	AC 220V 2M	1	
	Power cord	DC 48V 5M	1	
	Servo debug cable		1	
2	USB drive	Rokae 32G	1	
	Mechanical zero calibration block	xMate CR12 calibration block	1	
	Interface adapter		1	With wrist flange interface
3	xMate CR12 Hardware		1	Electronic

	Installation Manual			documents are
	xCore Control System User Manual		1	stored on a flash drive
4	Top liners		1	
5	Power adapter		1	
6	xMate CR12		1	
7	Handheld emergency stop & enabling device		1	With cables
8	Bottom liners		1	

② Step 2: Take out the parts from the box in order

Keep the above parts and accessories properly and handle items such as power adapters and cables with care.

> ⚠️ Warning
>
> Always transport the robot together with the top and bottom liners after it is unpacked and before it is installed in place. During transportation, keep the robot balanced to prevent it from tipping over. Remove the liners only before the installation of the robot body.

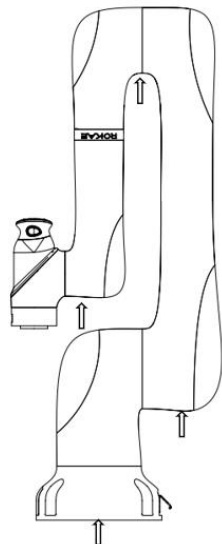## 5.4.2 Robot angle and force application points during transportation

Figure 10. Robot pose and suggested points of force application during packing and transportation

A1	A2	A3	A4	A5	A6
0°	0°	175°	0°	0°	0°

> ⚠️ Warning
>
> The arrows in the figure indicate the suggested locations and directions of force application on the robot during packaging and transportation. It is strongly NOT recommended to apply force to other parts of the robot during transportation. Improper operations and force application points may damage the robot.

5.4.3 Check before installation

Personnel who install and operate the robot must have the necessary knowledge for installation, maintenance, and repair of mechanical and electronic equipment, and must comply with all the relevant national and local regulations.

Check the prerequisites for installation:

No.	Operation
1	Visually inspect the robot to make sure that it is not damaged.
2	Make sure that the expected operating environment of the robot conforms to the descriptions in this section.
3	Make sure that the installation site complies with the requirements.
4	Make sure that the storage environment complies with the requirements if the robot is not installed directly.
5	When these prerequisites are met, install the robot as described in the next section.

5.5 On-site installation

5.5.1 Transportation

5.5.1.1 Risk of tipping

When the robot is not fastened to the foundation and standing still, make sure that the robot is enclosed in the bottom liners. In this case, the robot is unstable and moving the arms may displace or tilt the center of gravity, and even cause the robot to tip over.

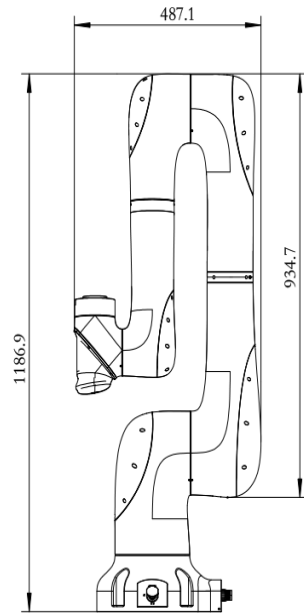#### 5.5.1.2 Transportation dimensions

Figure 11. Reference transportation dimensions of the robot

5.5.2 Robot installation

5.5.2.1 Parts required for fixing

Part name	Description	Bracket installation
Socket head cap screw	4-M12x35 (Grade 12.9)	✓
Mounting seat	Mounting plate thickness: At least 25 mm	✓

Notes:

1. No insulating layer is allowed between the fixing plate/mounting seat and the manipulator/concrete.

2. "✓" indicates that the item is required for the installation.

3. The fixing strength of the mounting bracket should not be lower than that of the robot fixing plate and the foundation in the foundation installation.

5.5.2.2 Bracket installation

Here is the specific fixing method: Use pins in the reserved cylindrical pin holes for accurate positioning. Then use four M12x35 socket head cap bolts (strength grade 12.9) to fix the robot's base to the bracket.

> ⚠️ Warning
>
> Please note that the bolts of the base must be tightened with a torque of 150 Nm to ensure that the robot is properly secured in place. Any unstable installation may result in accidents.
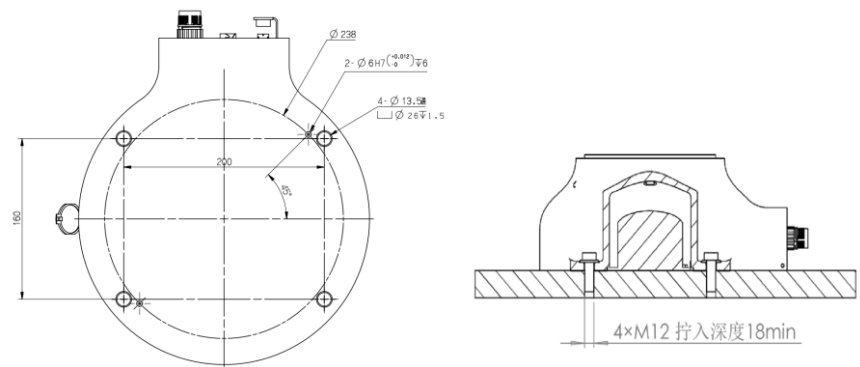
Figure 12. Reference bracket fixing method

5.5.3 Flange

To ensure the accurate positioning of the tool, the reserved Φ6 pin holes should be used. There are six M6 threaded holes on the wrist flange of the robot to attach the tool to the flange. The M6 bolts must be tightened with a torque of 15 Nm. See the figure below for the detailed dimensions.
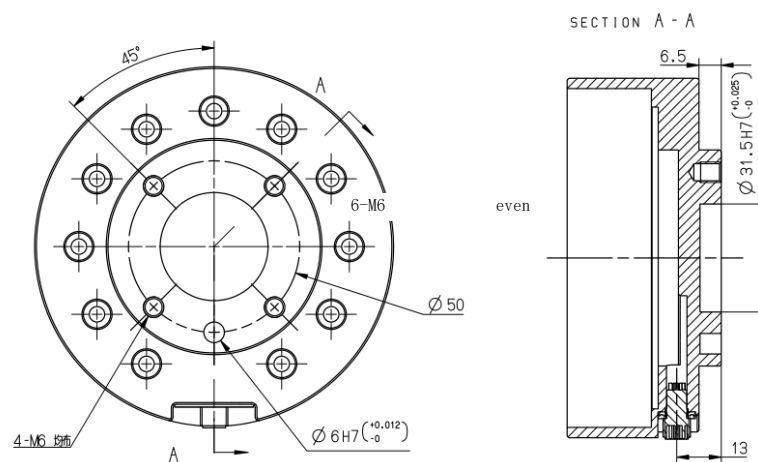
Figure 13. Tool flange installation

⚠ Warning
● Make sure the tools are properly secured in place. Check if the tool's range of motion overlaps with the robot's working space.
● Make sure that the length of the M6 screws on the installed tool does not exceed the length of thread indicated in the figure to avoid any irreparable damage.
● Make sure that the tool operates safely without any detached parts to cause dangers.

5.5.4 Power adapter

The power adapter has no additional mechanical interface for installation. It can be put in a designated location as needed at the site. The location must meet the following conditions:

1. With good ventilation and heat dissipation conditions;
2. Outside the range of motions of xMate CR12;
3. The power switch is easy to access for operators.

6 Electrical Connections

6.1 Electrical layout

This section describes the usage of all the electrical and operation interfaces of the xMate CR12 robot and its related devices. The xMate CR12 robot comes with a handheld emergency stop and enabling device that integrates an optional power adapter to supply power to the robot. The network interfaces are used to connect the robot to an external network or to a pad or PC that has the xMate CR12 software installed for control and debugging of the robot.
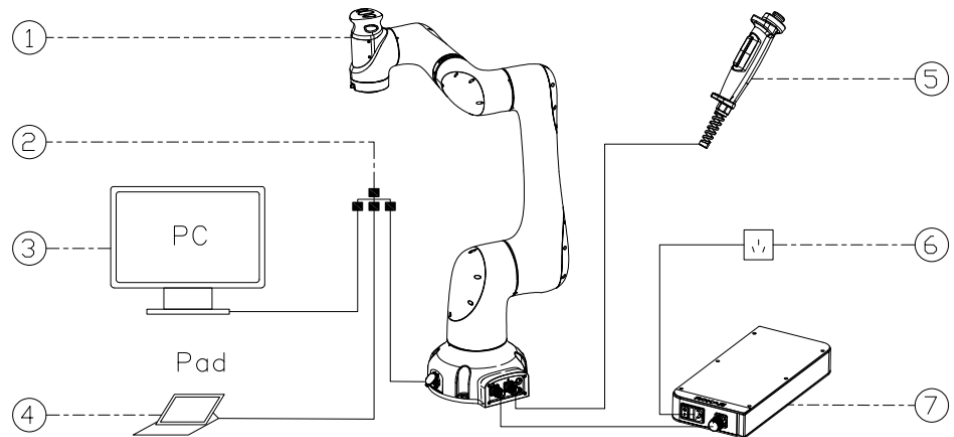
Figure 14. Electrical layout

No.	Name
1	xMate CR12 robot
2	External network
3	PC
4	Pad
5	Handheld emergency stop and enabling device
6	External power supply
7	Power adapter

> **ℹ Notes**
>
> For information on how to control and use the xMate CR12 robot, see the user manual of the robot software.

6.2 Robot base

This section describes all the inbound and outbound interfaces on the robot base.
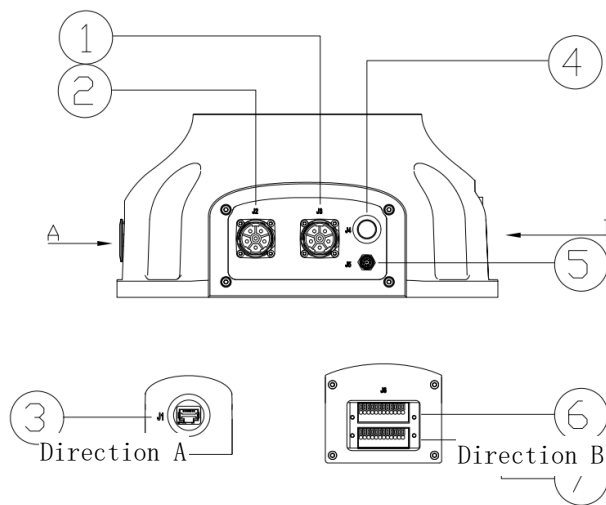
Figure 15. Base interface layout

Mark	Definition	No.
J1	Extended EtherNet interface (custom IP address)	3
J2	Robot power supply interface	2
J3	Handheld emergency stop and enabling device interface	1
J4	Power-on button and indication interface	4
J5	EtherCAT servo drive debug interface	5
J6	Safety DIO	6
J7	General-purpose DIO	7

6.2.1 Robot power supply

The robot's power supply interface is an M23 special-purpose socket (pin-type). It works with the xMate CR12 power cord that has a special-purpose plug (hole-type) to supply power to the robot. The electrical specifications of the power supply of the robot are shown below.

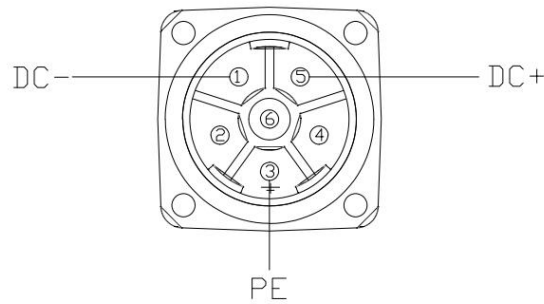| Parameter	Min	Typical	Max	Unit
Input voltage range	43.2	48	52.8	VDC
Power range	200	——	2000	W

Figure 16. Power supply interface

6.2.2 Powering on the robot

The Power On/Off button is the main power switch for the 24V DC power supply to the robot. As a flat self-locking push button with an indicator, it controls the power supply to the robot while indicating the supply status.

Button status (self-locking)	Indicator status	Robot status
Not pressed	Out	Not powered on
Pressed	The green light is always on	Powered on

6.2.3 Handheld emergency stop and enabling device interface

The M9 round connector marked with J3 on the robot base is the interface for the handheld emergency stop and enabling device. It works with the dedicated handheld emergency stop and enabling module to bring the robot to an emergency stop or enable the robot to move.
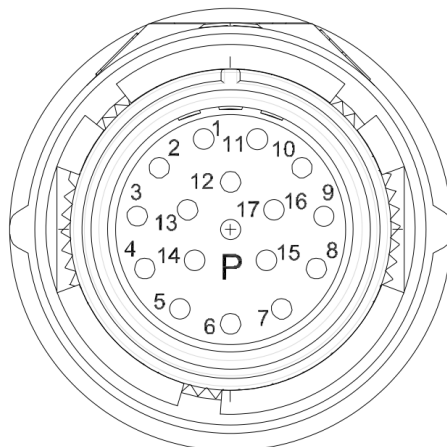

Figure 17. Handheld emergency stops and enabling device interface

6.2.4 General-purpose DIDO

xMate CR12 provides 4 digital input and 4 digital output channels on terminal connector J7. Users must connect to the corresponding channel using a cable with the E0308 pin-type cold-pressed terminal in order to use the DIO function.
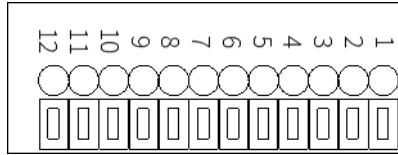
Figure 18. General-purpose DIO interface J8

Point position	Definition
1	24V+
2	GND
3	DI_COM
4	DO_COM
5	DI_00
6	DO_00
7	DI_01
8	DO_01
9	DI_02
10	DO_02
11	DI_03
12	DO_03

6.2.4.1 General-purpose DI

Digital inputs can be configured as PNP or NPN inputs. The user-input electrical specifications supported in the two modes are listed below.

	Min	Typical	Max	Unit
Input voltage range	21	24	27	V

The electrical principles in the two modes are shown below.

● PNP input

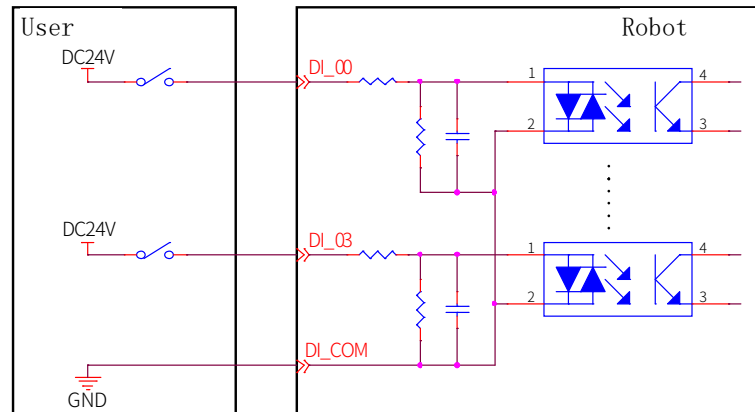See Figure 20 for details on a PNP configuration.

Figure 19. PNP input wiring diagram

- NPN input

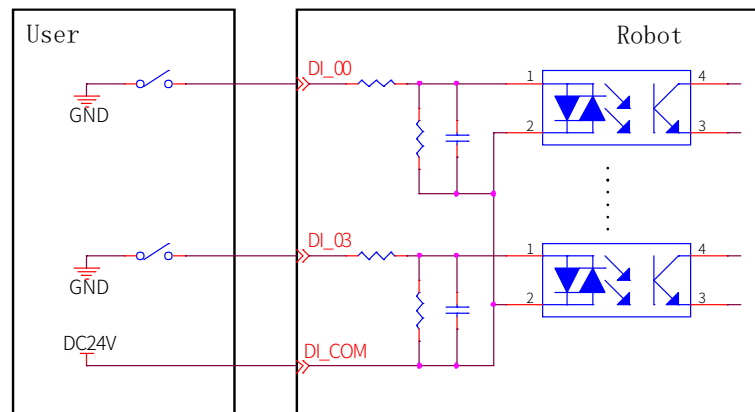 See Figure 21 for details on an NPN configuration.

Figure 20. NPN input wiring diagram

6.2.4.2 General-purpose DO

Digital outputs can be configured as PNP or NPN outputs. The user-output electrical parameter specifications supported in the two modes are listed below.

	Min	Typical	Max	Unit
Load voltage range	12	24	30	V
Continuous load current	0	——	300	mA

If the continuous load current exceeds the limit, an additional relay will be required to drive the system.

The electrical principles in the two modes are shown below.

- NPN output

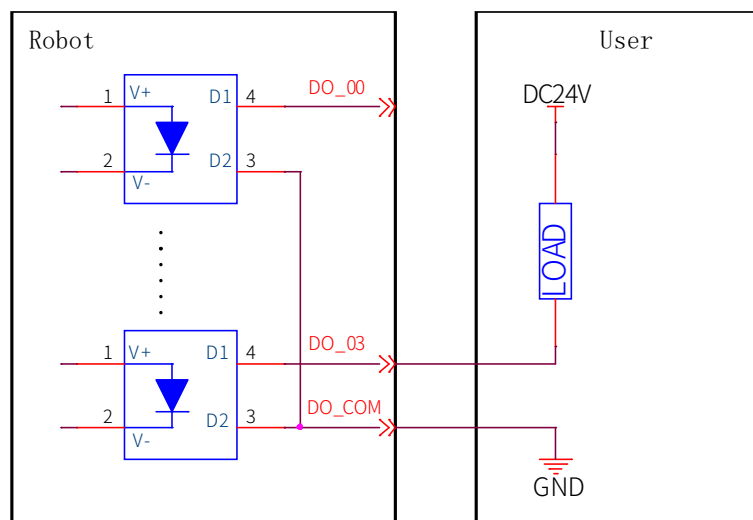 Connect the DO_COM end to the negative terminal of the power supply, as shown in Figure 22.

Figure 21. PNP output wiring diagram

● PNP output

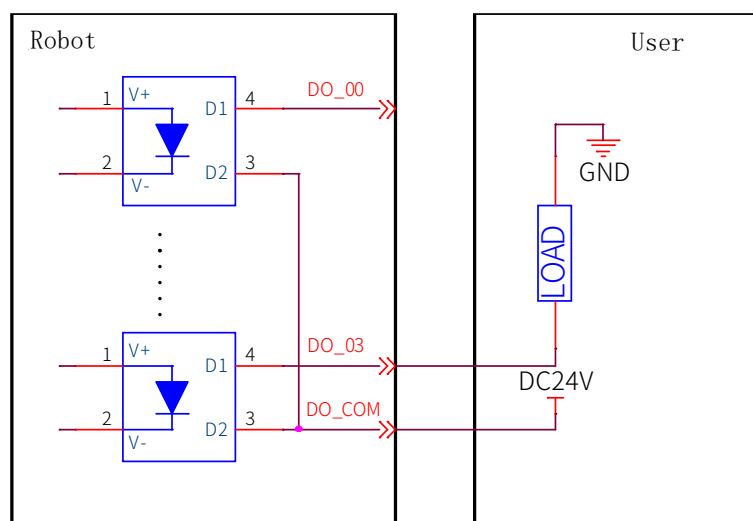Connect the DO_COM end to the positive terminal of the power supply, as shown in Figure 23.

Figure 22. NPN output wiring diagram

6.2.5 Safety DIO

xMate CR12 supports dedicated safety inputs such as external emergency stop and safeguard stop (for example, the safety gate), and dedicated safety outputs such as safety status feedback. The channels are located on terminal connector J6. Users must connect to the corresponding channel using a cable with the E0308 pin-type cold-pressed terminal in order to use this safety DIO function.

All safety DIOs are redundant in pairs and must be kept as two independent branches so that

a fault on one branch will not cause the failure of the safety function.
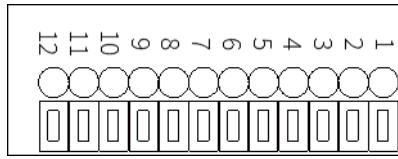
Point position	Definition
1	VCC24
2	SGATE1
3	VCC24
4	SGATE2
5	VCC24
6	EXSTOP1
7	VCC24
8	EXSTOP2
9	STOP_STATE_00_A
10	STOP_STATE_00_B
11	STOP_STATE_01_A
12	STOP_STATE_01_B

6.2.5.1 Safety DI

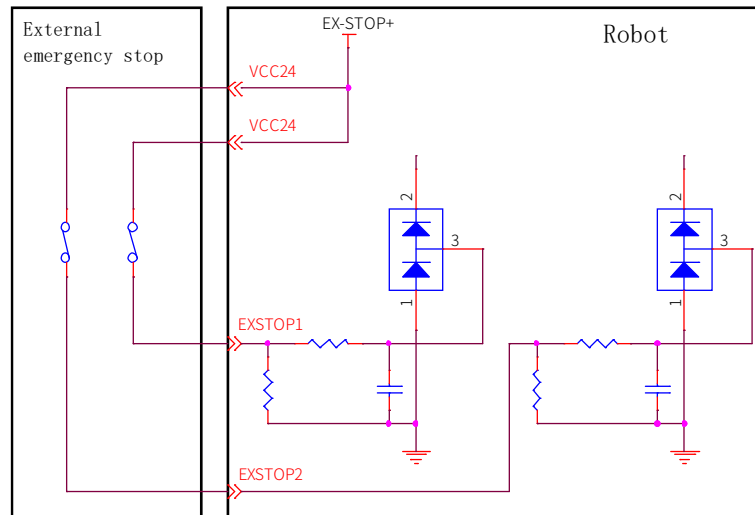The electrical principles and specifications of the safety DI interface are shown below.

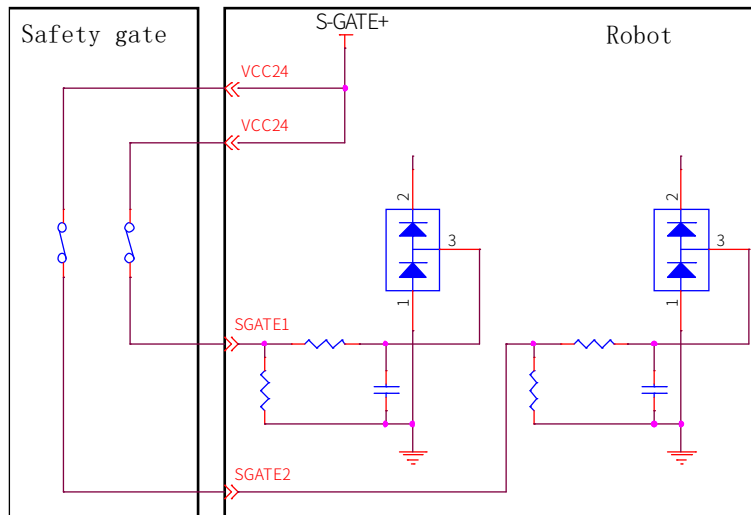Figure 23. External emergency stop interface

Figure 24. Safety gate interface

	External emergency stop	Safeguard stop (safety gate)
Application	For emergency stop equipment only	For other safety protection equipment
Robot status	Stopped	Stopped
Program execution	Paused	Paused
Drive power	Off[1]	Off[1]
Frequency of use	Infrequent	Infrequent

⚠ Warning

- All safety-related I/Os are constructed redundantly (two independent channels). Keep the two channels separate so that a fault on one channel will not cause the failure of the safety function.
- Be sure to check the safety functions before putting the robot into operation. The safety functions must be checked regularly.
- The robot must be installed in compliance with these specifications. Failure to do so could result in serious injury or death as the safety function could be overridden.

⚠ Attention

[1] This is not supported by the XM3p-R760-B0S0 model.

Default safety configuration:

All safety function input and status output signals are controlled via two channels. The external emergency stop and safeguard stop functions are short connected when leaving the factory and enable operation without any additional safety equipment.
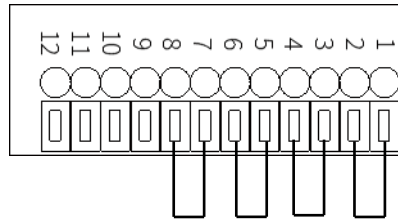

Figure 25. Short connection wiring diagram

The robot is delivered with a default configuration. Integrators can connect the safety protection devices to the safety DIO as needed at the site.

6.2.5.2 Safety DO

Every safety DO has two channels to provide feedback on the safety input status of external emergency stop devices. When an external emergency stop or handheld emergency stop occurs, the feedback loop between A and B of both two channels is disconnected. When no external emergency stop occurs, the loop is short connected.

6.2.6 Extended EtherNet interface

J1 is standard RJ45 interfaces that can be connected by a standard network cable. They support EtherNet and Modbus TCP/IP communication protocols, with a maximum communication speed of 100 Mbps. You can connect the xMate CR12 robot to a network device that has the xMate CR12 software installed.

6.2.7 EtherCAT servo drive debug interface

M8 is a round connector that can be connected by a dedicated extension cable. It allows for servo parameter setting and status monitoring, which are only available to internal debugging professionals.
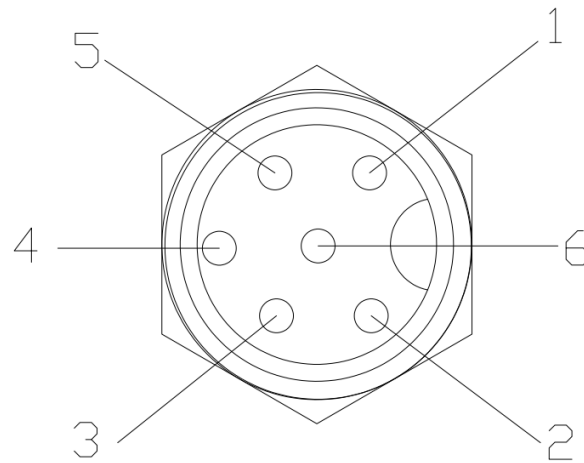
Figure 26. The EtherCAT debug interface

6.2.8 Function buttons on the wrist

The robot is equipped with function buttons on the wrist for continuous path recording, direct teaching control, etc. under safe conditions, as shown in the figure below.
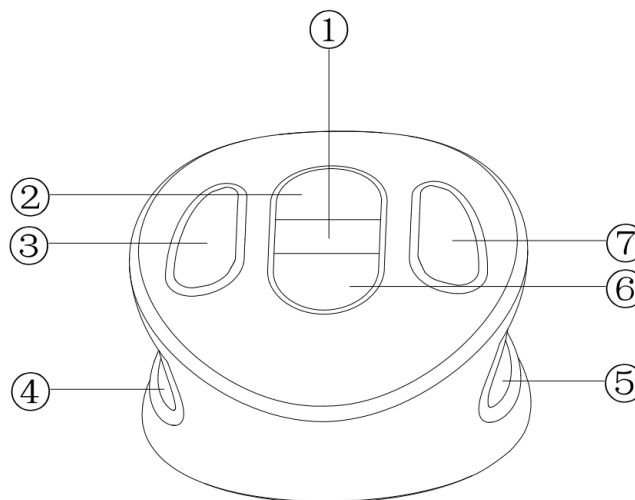
Figure 27. The wrist buttons

No.	Definition
1	Update the teaching point with the current position and start / stop continuous track recording
2	Moves forward
3	Delete the point / track in the list and cancel the pop-up prompt
4	In Manual mode, press the two enabling buttons at the same
5	time to activate the direct teaching control
6	Moves backward
7	Add the midpoint / track in the list and confirm the pop-up

	prompt

6.2.9 Tool interface

Adjacent to the tool flange on the robot wrist, there is a round connector that provides the extended electrical interface for the robot end effector. A special-purpose gripper of the xMate CR12 robot can be used as the end effector in this interface.
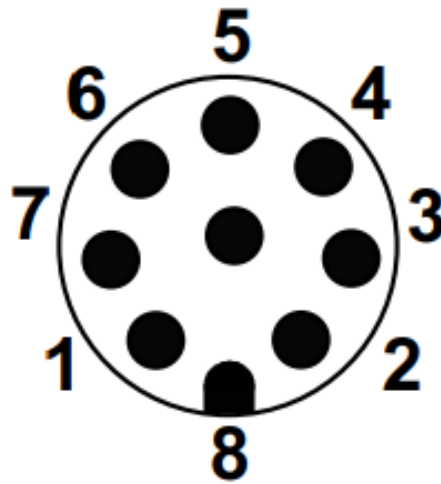

Figure 28. The wrist round connector interface

No.	Definition
1	0V/+12V/+24V(电源)
2	GND
3	DI_0
4	DI_1
5	DO_0
6	DO_1
7	AI_0/RS485A
8	AI_1/RS485B

6.2.9.1 Special-purpose tool IO

The xMate CR12 robot supports the use of a special-purpose gripper as the end effector. The electrical and special-purpose communication interfaces of the gripper are integrated into this connector.

6.2.9.2 General-purpose tool IO

This connector provides power and control signals for grippers and sensors used on a specific robot tool.

The electrical specifications of the tool's power supply are listed below.

	Min	Typical	Max	Unit

Supply voltage	12	24	24.8	V
Supply current	——	1	2	A

> ⚠️ **Attention**
>
> 1. The maximum supply current of the tool is 2A, which lasts up to 1 second.

Tool digital outputs:

The robot provides two channels of tool digital outputs. The digital outputs, once activated, provide 24V power to the user side using the internal 24V power supply. The electrical principles and specifications of the tool digital output load to the user side are shown below.

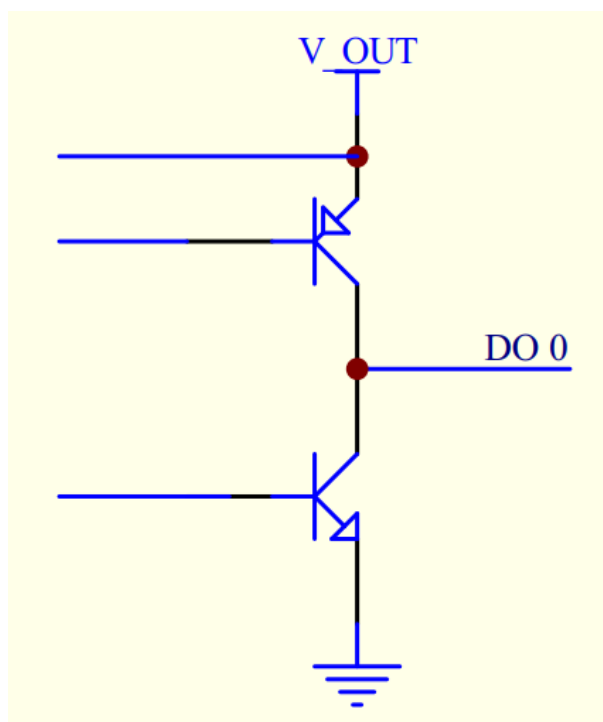|	Default	Activated	Max	Unit
Output level	Low	High	——	——
Continuous load current	0	——	100	mA

Figure 29. Wrist output interface

> ⚠️ **Attention**
>
> The digital outputs in the tool are not current-limited. Overriding the specifications can cause permanent damage.

Tool digital inputs:

The robot provides two channels of tool digital inputs. With 24V pull-up resistors, the floating digital inputs always read as high. The electrical principles of the user side connected to 2 simple buttons are shown below.
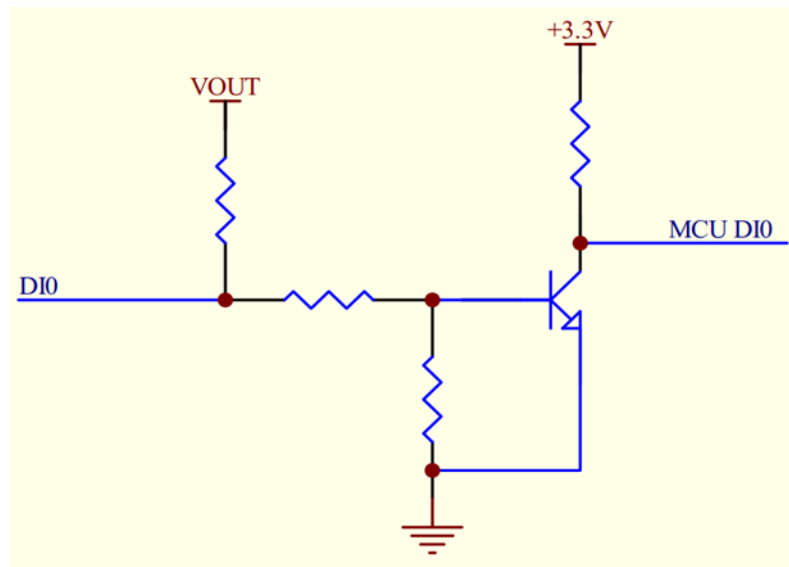
Figure 30. Wrist input interface

6.3 Power adapter

The power adapter is an optional part of the xMate CR12 robot. It converts the mains power to the DC power usable by the robot and provides a power supply indicator.
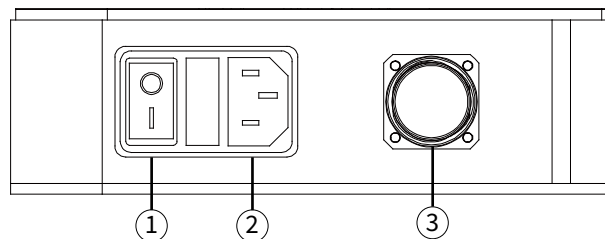
Figure 31. Power adapter interface

No.	Meaning
1	Power-on button and indicator
2	Power input
3	Power output

6.3.1 Power-on button of the power adapter

The power-on button of the power adapter is a ship-shaped self-locking rotary switch with an indicator. It serves as the main power switch and indicates the power supply status of the adapter.

Rotary switch (self-	Indicator status	Adapter status

locking)		
OFF	O press	Not powered on
ON	I press	Powered on

6.3.2 Power input

The input power interface of the power adapter is an IEC C14 socket (pin-type), which adapts to IEC C13 plugs (hole-type). The rated current of the external mains fuse is 10 A. The input power indications are as follows.

Rotary switch (self-locking)	Indicator status	Adapter status
OFF	Off	Not powered on
ON	Steady red	Powered on

The electrical specifications of the input power are listed below.

| ROKAE power adapter		
Output	DC voltage	48 V
	Rated current	42 A
	Ripple and noise	150 mVp-p
Input	Voltage range	90 to 264 VAC
	Frequency range	47 to 63Hz
	Efficiency	90%
Environment	Operating temperature	-20 to +60°C
	Operating humidity	20 to 90% RH, non-condensing
	Storage temperature and humidity	-40 to +85°C, 10 to 95% RH
	Vibration resistance	10 to 500 Hz, 2G 10 min/cycle, 60 min for each of the X, Y, and Z axes
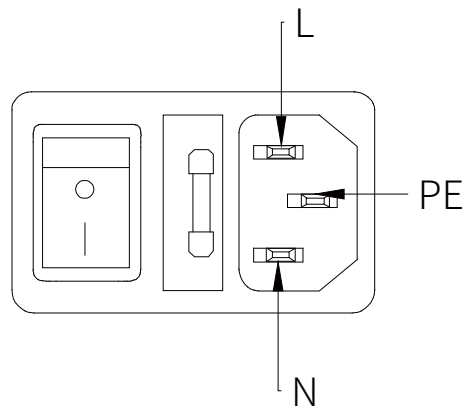
Figure 32. Power input interface

6.3.3 Power output

The power output interface of the adapter is an M23 special-purpose socket (hole-type) that outputs the 48V DC voltage usable by the xMate CR12 robot. It works with the xMate CR12 power cord that has a special-purpose plug (pin-type) to supply power to the robot.
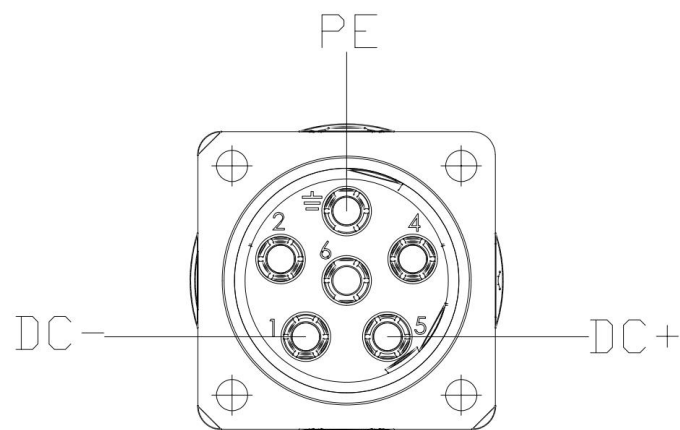

Figure 33. Power output interface

7 Maintenance

7.1 Introduction

Please read the "Maintenance Safety" section, this manual, and other related documents carefully before maintenance. Perform the maintenance after you have gained a full understanding of the safe maintenance methods.

7.2 Maintenance safety

⚠ Warning
● Strictly follow the maintenance procedures. Do not disassemble any part of the robot.
● The maintenance should only be performed by designated professionals.
● If you have not been trained, stay away from the robot when it is powered on. Also, do not enter the robot's range of motion. Even if a powered-on robot seems to stop, it may move accidentally and cause serious safety problems.
● Be sure to confirm the action of the robot after replacing the parts outside the safety fence. Otherwise, the robot may perform unexpected actions and cause serious safety problems.
● Before entering normal operation, make sure that the emergency stop switch and the safety fence switch are operating normally. If the robot works in a state where the switches are not operating normally, the safety functions cannot be guaranteed in the event of an emergency, and serious injury or damage may occur, which is extremely dangerous.

7.3 Maintenance schedule

The robot must be maintained regularly to ensure high performance over a long period of time. The maintenance personnel must prepare maintenance plans and implement such plans strictly.

7.4 Check

No.	Item	Position	Interval				
			Daily	1 month	3 months	6 months	12 months
1	Check the appearance for any damage.	Robot appearance					
		External cables					
2	Check the power adapter	Robot base					

and the robot base connectors for any loose connection.	Power adapter						

7.5 Cleaning

> ⚠️ **Warning**
>
> Improper use of liquid detergents or incorrect disconnection of the power supply may cause electric shock and result in serious injury or death.

> ⚠️ **Warning**
>
> Perform cleaning only after the robot is completely powered off.
>
> Do not clean the robot with liquid detergents.
>
> Do not power on the robot when it is wet.

Observe the following instructions when cleaning the robot:

Cleaning should only be performed by trained users.

Do not clean the robot with any chemical solvents. Use a damp cloth that has been wrung out to clean all devices.

Do not apply excessive force to the manipulator during cleaning. Always hold the part that is manually cleaned by hands to avoid overloading the manipulator and causing any damage.

Power on the robot only after all the surfaces are completely dry.

> ⚠️ **Warning**
>
> Improper cleaning may damage the robot.

8 Zero Calibration

8.1 Introduction

8.1.1 Overview

This section describes the zero calibration. Use the calibration tools described in this section during calibration.

8.1.2 What is a mechanical zero?

The robot is pre-defined with an initial pose during its design, in which the angle of each joint is zero. From a mechanical viewpoint, the zero pose is the pose where a certain angle is formed between adjacent links. From a software viewpoint, since the robot uses the encoder to record the joint angle, the zero pose refers to the robot's pose when the servo motor rotates to a certain encoder value. Therefore, the mechanical zero can be explained in two ways:

- From the perspective of the observer, the mechanical zero is the robot's pose when each joint of the robot moves to a certain position.
- From the perspective of the control system, the mechanical zero is a combination of encoder values.

8.1.3 What is zero calibration?

The zero point is a point of reference for the robot coordinate system. It is required for the robot to determine its own position. To maximize the absolute positioning accuracy and allow the link system to properly respond to the position and speed instructions from the control system, a zero calibration must be performed on the robot to bring the mechanical zero as close to the algorithm zero as possible.

Put simply, zero calibration is the process of using the pre-designed positioning devices on the mechanical arm body to rotate the joints of the robot to a certain angle, and notifying the control system to record the value of each joint motor encoder.

8.1.4 When is zero calibration required?

8.1.4.1 When the mechanical transmission system fails to operate properly

A zero calibration must be performed using dedicated calibration tools in the following circumstances:

- After replacing mechanical system parts such as motors and reducers;
- After a violent collision;
- When moving the robot joints manually after the control system is switched off.

8.1.4.2 When the multi-turn counter data of the encoder is lost

A zero calibration can be performed using dedicated calibration tools in the following circumstances:

- After reinstalling the entire hard disk system;

- After replacing the encoder battery.

8.2 Calibration method

8.2.1 Mechanical calibration

The keyway calibration method is adopted from the first axis to the sixth axis of the xMate CR12 robot. Only one axis can be calibrated at a time, and the specific operation process is as follows.

Step 1: calibrate the first axis

When the calibration pin is aligned with the calibration slot, the special calibration tool is used to try to insert the keyway into the keyway according to the graphic direction. if the keyway of the upper and lower connecting rod is not inserted at the same time, the axis will continue to rotate slowly until it is inserted at the same time. It is considered that the zero point of the axis is mechanically calibrated.
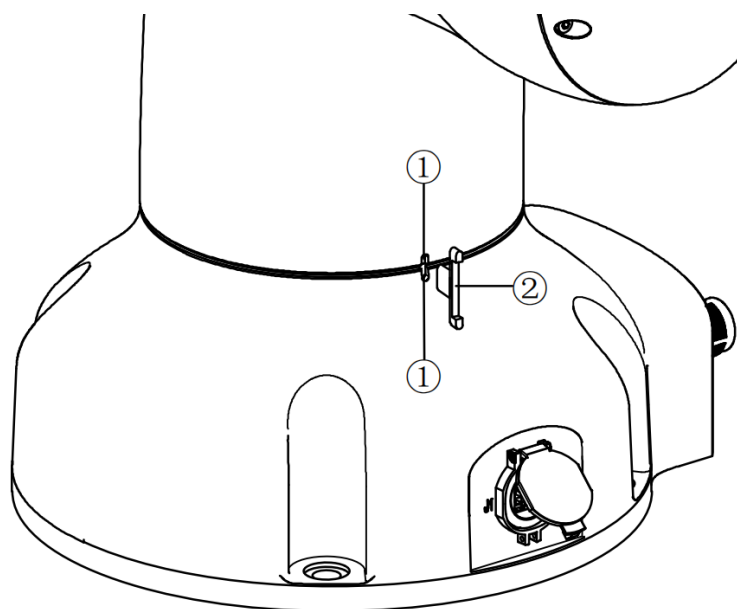

Figure 34. step 1

Step 2: calibrate the second, third, fifth and sixth axis
Calibrate according to step 1.

Step 3: calibrate the fourth axis
Refer to step 1 to calibrate the fourth axis, and note that the direction of the special calibration tool is opposite to that of step 1.
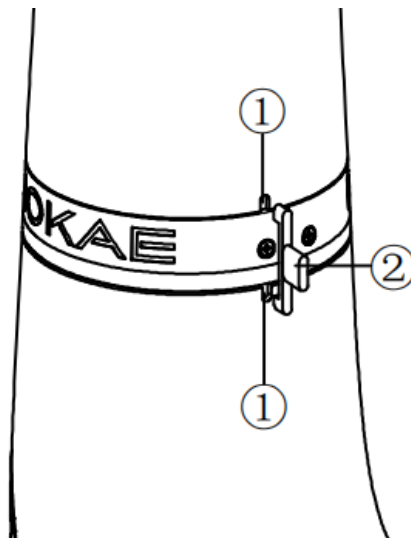
Figure 38.step 3

No.	Definition
1	Calibration slot
2	Special calibration tool

⚠️ Warning

Note that after the mechanical zero calibration is finished, the special calibration tool must be removed from the corresponding calibration keyway. After the mechanical calibration process is over, be sure to check the robot body status to prevent accidents.

9 Decommissioning

9.1 Robot decommissioning

The decommissioning, storage and disposal of the robot must be performed in compliance with relevant national laws, regulations, and standards.

9.2 Recycling

Contact us for the recycling of batteries.