

ROKAE



xMate CR12

Hardware Installation Manual

A Partner You can Rely on in Production

xMate CR12

Hardware Installation Manual

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

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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. xMate CR12 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 flexible cobots 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.
- 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.

 **Notes**

Emergency stops 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.

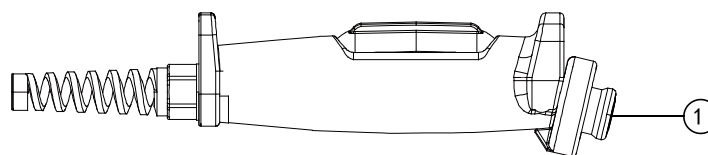


Figure 2-1. Emergency stop button on the handheld emergency stop and enabling device

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 motor power is switched on only when the enabling switch is pressed and kept in the middle so that the robot is in a state that is permitted for motion. Releasing or pressing the switch all the way down will cut the power off.

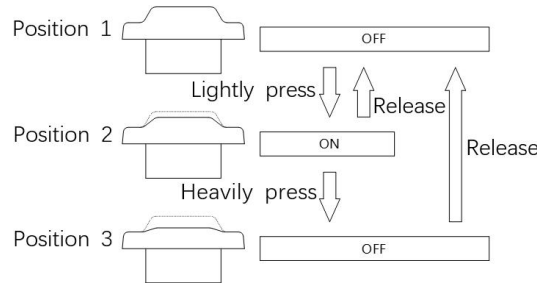



Figure 2-2. Positions of the enabling switch


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

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

2.5 Safety precautions

2.5.1 Operator 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 Safety precautions for operating the Teach Pendant

2.5.2.1 Safe storage of the Teach Pendant

The Teach Pendant no longer used should be properly stored in a place that is far away from the robot workstation, so as to prevent the operator from mistakenly believing that this Teach Pendant is still connected to the robot and attempting to use it to stop the robot in case of danger.

2.5.2.2 Teach Pendant cable

The Teach Pendant and controller are connected through a Teach Pendant cable. Please comply with the following requirements when using the Teach Pendant in order to avoid personal injury or equipment damage:

- Make sure that the working personnel does not stumble over the Teach Pendant cable so as to avoid dropping the Teach Pendant or making personnel fall.
- Don't squeeze the cable of the Teach Pendant, otherwise, its internal cores may be damaged.
- Don't put the Teach Pendant cable on the edge of the sharp objects, otherwise, the cable sheath may be damaged.
- Make sure that the bending radius of the Teach Pendant cable is greater than 100mm, otherwise, the cable may be damaged.

2.5.2.3 Permission of using the Teach Pendant

Generally, only those who have completed safety training and basic operation training can have permission to use the Teach Pendant. The user permissions for operating the Teach Pendant interface should also be distinguished to ensure that the debugging personnel and maintenance personnel can use the Teach Pendant correctly and reasonably according to their work.

The control system is built-in with three user levels, namely Operator, Admin, and God,

with the operation permissions ranking from low to high. Switching from a low-privileged user to a high-privileged user requires a password. Otherwise, it is not required. A user of a higher permission level can modify the password of a same- or lower-level user. The password of an Operator-level user cannot be modified.

2.5.2.4 No Teach Pendant mode

When the No Teach Pendant mode is selected for the control system, special attention must be paid to safety during debugging and programming. An emergency stop button device must be installed or placed within the reach of the operator and the signal of the emergency stop button must be routed into the safe DIO interface of the robot system so that the person can protect the safety of himself/herself and the equipment by pressing the emergency stop button promptly in case of emergencies.

2.5.3 Recovering from emergency stops

2.5.3.1 Instructions

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

2.5.3.2 Emergency stop button and reset

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

2.5.4 Safety precautions in Manual mode

2.5.4.1 About the Manual mode

In Manual mode, the robot's movement is under manual control. You can jog the robot or execute a program only when the enabling switch is held in the middle position. The enabling switch is on the handle of the handheld emergency stop and enabling device as well as on the handle of the Teach Pendant.

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

2.5.4.2 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.

2.5.4.3 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.

2.5.5 Safety precautions in Automatic mode

2.5.5.1 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 3 m/s for the end effector. In this mode, personnel must not enter the working space of the robot to avoid personal injury.

2.5.5.2 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.

2.5.5.3 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.

- Pay attention to other running devices around the robot

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.

- Pay attention to other devices that interact with the robot

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.

2.5.6 Safe handling of fire accidents

2.5.6.1 Treatment of mild fire disaster

Do not panic and keep calm when a fire hazard is imminent or has not yet begun to spread; you can use on-site fire-extinguishing devices to put out the flame. It is strictly prohibited to use water to put out a fire caused by short circuits.

**Warning**

The fire-extinguishing device on the working field of the robot shall be supplied by the user, the user shall choose the appropriate fire-extinguishing device according to the actual situations of the field. For fire with the controller, use a carbon dioxide (CO₂) fire extinguisher.

2.5.6.2 Treatment of severe fire disaster

If the fire has spread and is beyond control, the workers on site shall notify other workers immediately to give up their personal belongings and evacuate immediately through emergency exits rather than try to put out the fire. DO NOT use an elevator, and be sure to inform the fire department during evacuation.

If a person's clothing catches fire, ask them not to run but to lie flat on the ground immediately. Put out the fire using clothes or other suitable items and methods.

2.5.7 Safe handling of electric shock accidents

2.5.7.1 Treatment of an electric shock

When someone gets an electric shock, do not panic and cut off the power supply immediately. Appropriate methods and measures should be adopted without hesitation according to the site conditions:

- If the power switch or button is very near to the location of the electric shock, it shall be switched off at once, and the power supply shall be cut off.
- If the power switch or button is far away from the location of the electric shock, it is suggested to use insulated pliers or ax, knife, and shovel with dry wooden handles to cut off live wires on the mains' side (power supply), the separated wire must not contact with the human body.
- If the conducting wire is over or under the body of the victim, it is suggested to use a dry stick, board, bamboo pole, or other tools with insulated handles (by gripping the insulated handle) to remove the wire. No metal bar or wet object shall be used to avoid the rescuer from also getting an electric shock.



Warning

The rescuer should not be in direct contact with the electrically shocked person. Otherwise, they may also get an electric shock!

2.5.7.2 Treatment of the wounded after being separated from the power source

- If the wounded is conscious, they shall be made to lie on the back and watched out. They are not suggested to stand or walk for the time being.
- If the wounded is unconscious, make them lie on the back to keep the airway open. Call the wounded or pat them on the shoulder at an interval of 5 seconds to judge if they lose consciousness. Do not call the wounded by shaking their head. Meanwhile, contact the hospital as soon as possible.
- If the wounded loses consciousness, their respiratory conditions and heartbeat shall be confirmed within 10 seconds. If neither breath nor arterial pulse is sensed, the wounded may have a cardiac arrest and shall be given immediate first aid treatment by cardiopulmonary resuscitation.

2.6 Personnel and work content requirements

2.6.1 Definition of personnel

There are three types of personnel:

- Operator

The operating personnel can switch on/off the robot power supply and start robot programs through the Teach Pendant or other interfaces.

- Debugging personnel

The debugging personnel can conduct robot operations, enter into the safeguarded space, and perform operations such as setting, teaching, and programming on the robot.

- Maintenance personnel

The maintenance personnel can conduct robot operations, enter the safeguarded space, perform operations such as setting and teaching on the robot, as well as adjust and repair the robot.



Warning

The debugging and maintenance personnel who can enter the safeguarded space must accept and pass professional robot training in advance.



Warning

When performing robot operations, programming, and maintenance, personnel must pay attention to safety and wear necessary equipment, including work clothes, safety shoes, and safety helmets suitable for the work contents according to the actual conditions.

2.6.2 Personnel requirements

2.6.2.1 Operator requirements

The operator should meet the following conditions:

- The age of the operator should fall within the age range of local employment laws.
- The operator should be in good physical condition. A good physical condition means good vision (glasses and contact lenses are allowed), good hearing, and good coordination ability. The operator may not intake substances that may reduce their mental level (such as medicines, alcohol, and drugs) during work.
- The operator should understand applicable local safety regulations, such as the work safety and health regulations and the industrial accident prevention regulations.

2.6.2.2 Debugging personnel requirements

The debugging personnel should meet the criteria of operating personnel. In addition, the debugging personnel should also meet the following conditions:

- The debugging personnel should have basic technical knowledge, understand the technical documents and drawings related to the robot, and be able to complete their tasks according to manual documents.
- The debugging personnel must be very familiar with the use of the robot system and be able to reasonably achieve the purpose by operating the robot according to actual needs.

2.6.2.3 Maintenance personnel requirements

The maintenance personnel should meet the criteria of operating personnel. In addition, the maintenance personnel should also have a certain level of other expertise (such as electrical, mechanical, and pneumatic) and can complete their tasks according to manual documents.

2.6.3 Work content requirements

2.6.3.1 Safety requirements for installation and operation

- Handling and installation of the robot equipment must be carried out according to the methods described in our manual. Otherwise, the robot may fall due to misoperation, thus leading to personal injury and death or equipment damage.
- When the robot equipment is put into use for the first time after installation, make sure to run it at low velocity first and then gradually increase the velocity rather than running at high velocity from the start.
- By default, program and system variable information is stored in the controller storage device. In order to prevent data loss caused by accidents, it is recommended that the user makes data backups regularly.

2.6.3.2 Safety requirements for debugging

Debugging should be carried out outside the safety zone as much as possible. When debugging must be carried out inside the safeguarded space, special attention should be given to the following issues:

- Carefully check the situation inside the safeguarded space and enter into it only after confirming no danger exists.
- Confirm the positions of all debugging personnel inside the safeguarded space.
- Confirm the status of the entire system before proceeding with the work.
- Make sure that the emergency stop button can be pressed whenever necessary.
- Run the robot at low velocity.

When debugging is finished, the debugging personnel must stay outside the safeguarded space.

2.6.3.3 Safety requirements for maintenance

- Carefully check the situation inside the safeguarded space and enter into it only after confirming no danger exists.
- Confirm the positions of all maintenance personnel inside the safeguarded space.
- When the power supply is switched on, some maintenance operations may pose the danger of electric shock. Switch off the power supply of the robot equipment and system before carrying out the maintenance.
- During the maintenance, prevent other personnel from switching on the power supply accidentally.
- To avoid unnecessary personal injury or adverse impact on the equipment, do not place any part of your body on any part of the robot equipment during the operation.
- Appropriate lighting should be provided during the maintenance.

- In case of part replacement, make sure to use a part specified by ROKAE. Otherwise, the robot equipment may be damaged.
- Parts removed during the replacement (such as screws) should be correctly installed back to their original positions. If you find the parts not enough or redundant, confirm again and make sure to install them correctly.

2.7 Safety training

2.7.1 Overview

The on-site operator, debugging personnel, and maintenance personnel must accept formal robot safety and operation training and pass the exams before they can perform operation, debugging, and maintenance on the robot. Operating, debugging, or maintaining robots by non-professional personnel or personnel who failed during the training is prohibited in order to avoid severe personal injury and damage to the robot equipment.

All the personnel of the equipment should:

- Judge the current condition of the equipment and ensure that no failure is present before performing operation and debugging on the robot equipment.
- Minimize life and property losses by choosing the safest method to handle emergency incidents as they occur.
- Fully understand our product manual documents and work on the equipment according to the requirements of documents.

2.7.2 Personnel safety

Consider the following general precautions to ensure personnel safety:

- When the equipment is running, even if the robot seems to have stopped, it may be waiting for the start signal to run. In this state, the equipment should also be deemed as in the operational state.
- All peripheral equipment should be well grounded.
- Peripheral equipment should be installed outside the working range of the robot as much as possible.
- The motion range of the robot equipment should be marked, e.g., by drawing lines on the floor.

2.7.2.1 Safety of operator

The operator may not enter the safeguarded space:

- Operate the robot outside the safeguarded space.
- A protective fence or safety door should be set up in order to prevent irrelevant

- personnel from entering the safeguarded space.
- Switch off the power supply or press the emergency stop button when not operating the robot.
- The emergency stop button should be set up within reach of the operator.

2.7.2.2 Safety of debugging personnel

During the debugging, you need to enter into the working range of the robot under some circumstances. Special attention must be paid to safety:

- Make sure that the equipment is safe before debugging.
- Check the position and status of the safety devices (such as the emergency stop button) in advance.
- Take caution not to allow other personnel to enter the working range of the robot.
- Before starting the robot, make sure that there is no personnel in the working range of the robot.

When the debugging is finished, execute a test run according to the following procedures:

- At low velocity, execute the program one step after another for at least one cycle to confirm that everything is normal.
- At low velocity, execute the program continuously for at least one cycle to confirm that everything is normal.
- At the running velocity of the actual application, execute the program continuously for at least one cycle to confirm that everything is normal.

2.7.2.3 Safety of maintenance personnel

The following precautions should be fully noted in order to ensure the safety of the maintenance personnel:

- Make sure that the peripheral equipment is safe before maintenance.
- Switch off the equipment power supply as much as possible before maintenance. Lock the main circuit breaker using a lock as necessary in order to prevent other personnel from switching on the power supply accidentally.
- When you have to enter into the working range of the robot while the power is on, press the emergency stop button before entering. The maintenance personnel should put up an "under repair" sign in order to prevent other personnel from operating the equipment accidentally.
- Never enter into the working range of the robot while it is moving.
- Never execute the automatic running of the program when there is other personnel within the working range of the robot.
- During maintenance, a person who is familiar with the robot system and is able

to sense dangers should be present near the equipment so that they can press the emergency stop button in case of an emergency.

- During component replacement or reassembly, be careful to avoid the adhesion or inclusion of foreign objects.
- When servicing the interior of the robot, if it is necessary to touch the power supply unit or printed circuit board, make sure to switch off the power supply of the robot in advance to prevent electric shock.

2.8 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/Teach Pendant can stop the robot and engage the brakes.
- Test that the robot can switch between Manual and Automatic modes.
- 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	1434 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:

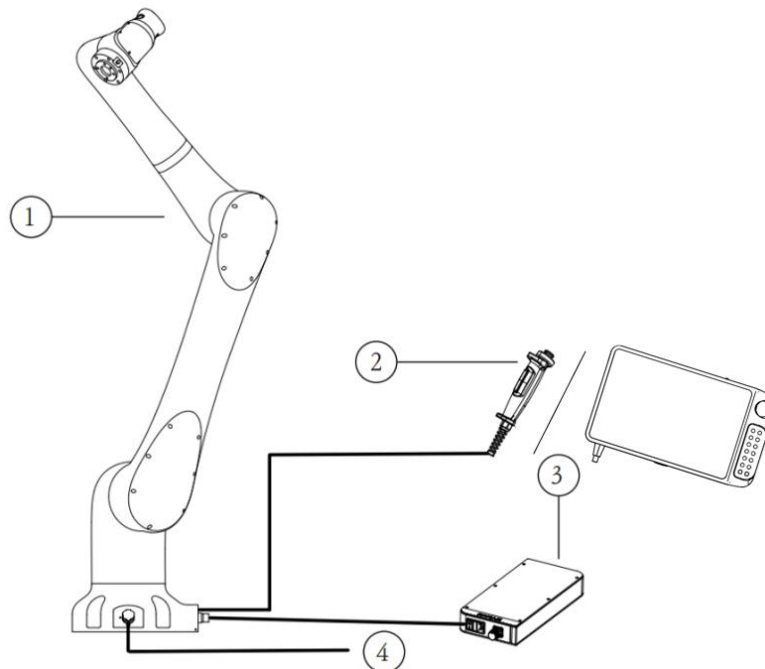


Figure 3-1. Robot system

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.

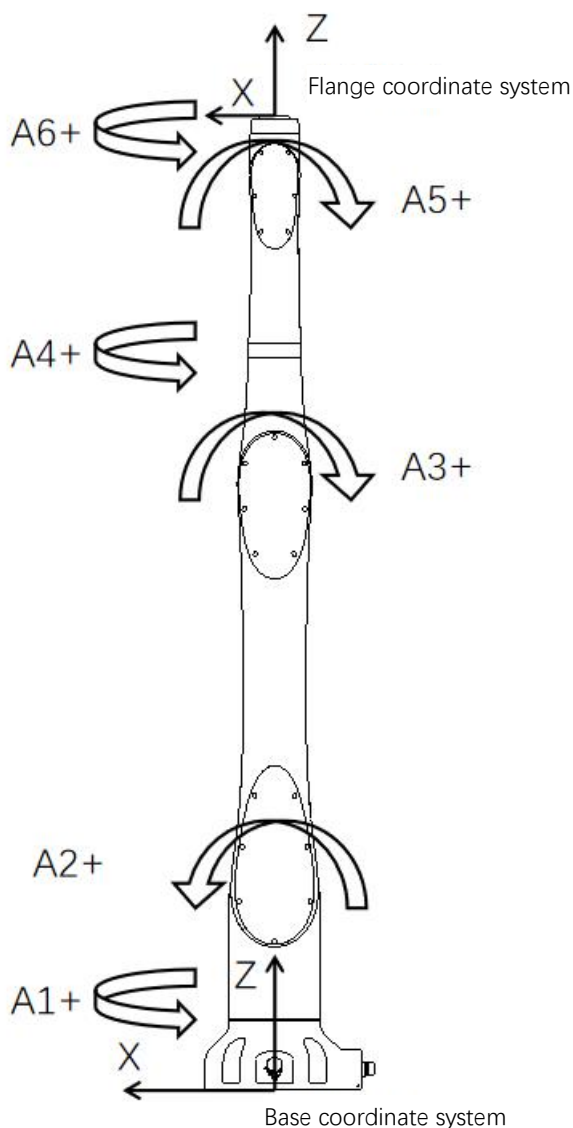


Figure 3-2. Definitions of robot rotation directions and coordinate

systems

3.3 Robot Teach Pendant overview

3.3.1 Teach Pendant overview

The Teach Pendant is an embedded handheld device integrated with complete hardware and software. It can be used to perform all robot-related functions, including programming and debugging, viewing system status, and setting system parameters.

The robot system is equipped with a Teach Pendant called xPad2, which is well-designed, reliable, and easy to use. Skilled use of xPad2 will greatly improve the efficiency of the robot.

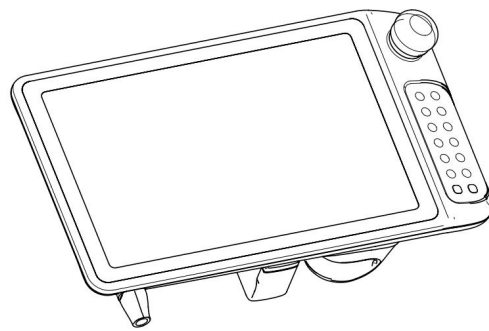


Figure 3-3 Teach Pendant

3.3.2 Teach Pendant components

The xPad2 Teach Pendant consists of the following components:

- Touch LCD
- Keys
- Buttons
- USB interface, etc.

3.4 Symbols and labels

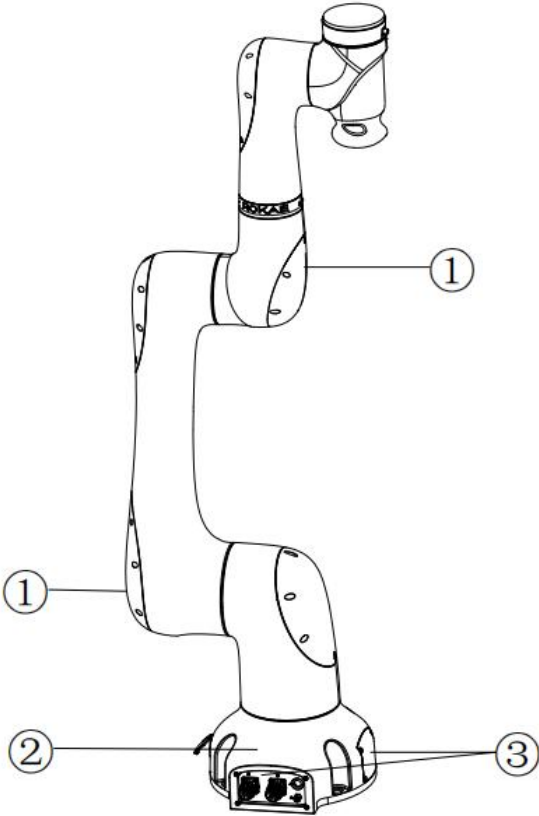


Figure 3-4. Symbols and labels

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 description

The meaning of the model code is shown in the figure 4-1.

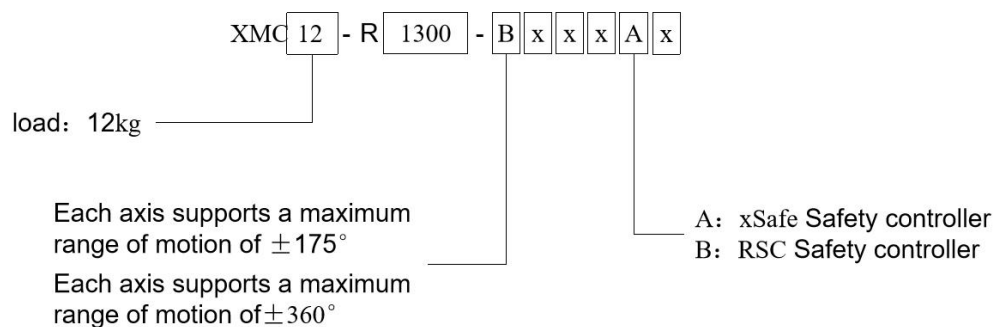


Figure 4-1. The model description of xMate CR12

4.3 Specifications

4.3.1 Data sheet

The following table applies to: XMC12-R1300-BxxxAx

Product name		xMate CR12
Number of axes		6
Maximum reach		1434mm
Repeatability		$\pm 0.03\text{mm}$
Maximum payload		12kg
Range of motion	Axis 1	$\pm 175^\circ$
	Axis 2	$\pm 170^\circ$
	Axis 3	$\pm 175^\circ$
	Axis 4	$\pm 175^\circ$
	Axis 5	$\pm 175^\circ$
	Axis 6	$\pm 175^\circ$
Maximum speed	Axis 1	$120^\circ/\text{s}$
	Axis 2	$120^\circ/\text{s}$
	Axis 3	$180^\circ/\text{s}$
	Axis 4	$234^\circ/\text{s}$
	Axis 5	$240^\circ/\text{s}$
	Axis 6	$240^\circ/\text{s}$
Operating temperature		$0^\circ\text{C} \sim +50^\circ\text{C}$
Storage temperature		$-10^\circ\text{C} \sim +55^\circ\text{C}$
Maximum humidity		0%~93%, non-condensing, non-frost
Protection level		IP54

Mounting method	Floor mounted, suspension mounted, side mounted
Weight	约 43kg
Noise level	≤70dB(A)

The following table applies to: XMC7-R850-WxxxBx

Product name		xMate CR12
Number of axes		6
Maximum reach		1434mm
Repeatability		±0.03mm
Maximum payload		12kg
Range of motion	Axis 1	±360°
	Axis 2	±170°
	Axis 3	±360°
	Axis 4	±360°
	Axis 5	±360°
	Axis 6	±360°
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~+50°C
Storage temperature		-10°C~+55°C
Maximum humidity		0%~93%, non-condensing, non-frost
Protection level		IP54
Mounting method		Floor mounted, suspension mounted, side mounted
Weight		约 43kg
Noise level		≤70dB(A)

4.3.2 Teach Pendant specifications

Product name		xPad2
Screen size		10.1 inches
Resolution		1920*1200
Dimensions		290×170×80 mm ³
Weight		840 g (excluding cable)
Minimum cable bending radius		77 mm
Protection level		IP54
External interface		USB 3.0
Environment	Operating temperature	0°C to +45°C
	Storage temperature	-25°C to +55°C
	Maximum humidity for operation/storage	≤ 90%, non-condensing, non-frost

4.4 Working space

The working space of xMate CR12 which mean the space skimmed by the wrist reference point (the intersection of the 4-axis and the 5-axis axis) is shown in the figure below:

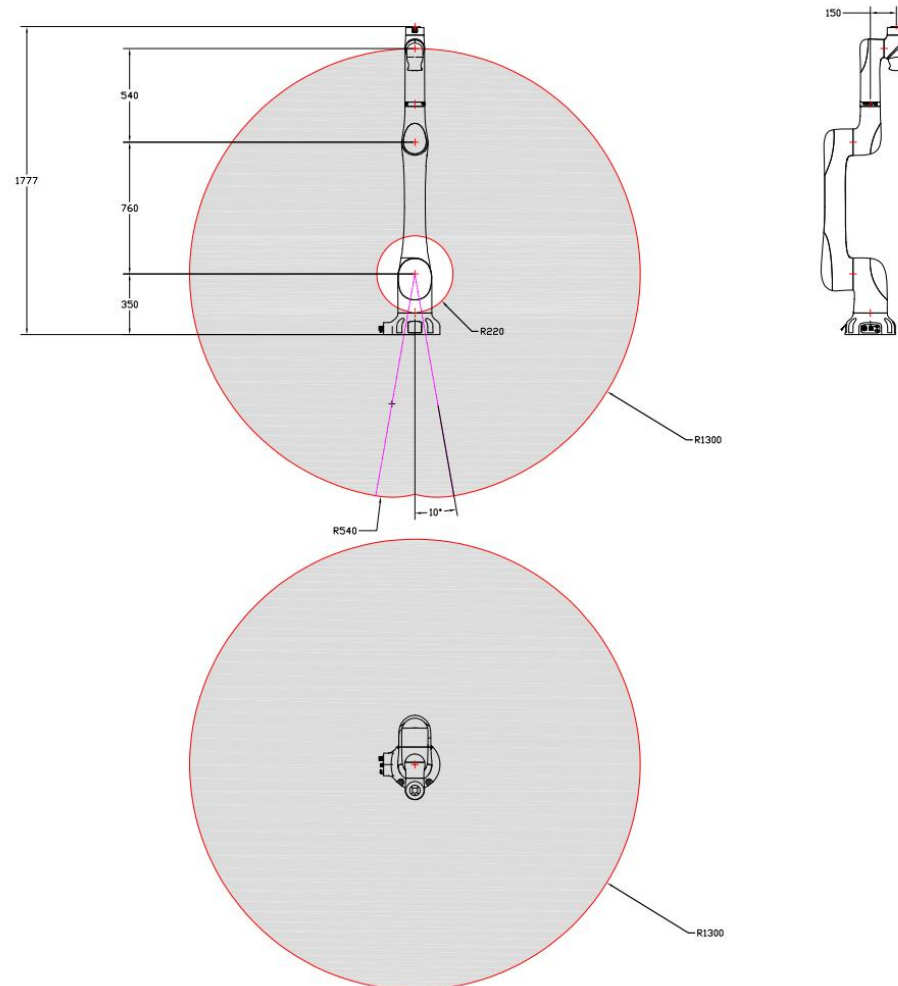


Figure 4-2. The working space of xMate CR12

4.5 Allowable load



Warning

It is very important to always define the correct actual load data and calibrate the payload of the robot. Incorrectly defined load data may result in robot overload. If incorrect load data and/or loads other than those specified in the load diagram are used, the following components may be damaged due to overload:

- Motor
- Reducer
- Mechanical structure



Warning

All loads installed on the robot, including the total weight of the end tooling


fixture and workpiece, should be less than the maximum payload of the robot. Robots operating with incorrect load data and/or loads other than those specified in the load diagram shall not be covered by the robot warranty.

4.5.1 Allowable wrist torque and inertia

To fully leverage the robots' performance and protect the robots from any failure or damage caused by overload, the payload installed on the robots must not exceed the allowable torque and inertia.

The allowable torque and inertia of CR12 are listed in the table below:

Axis	Allowable Torque (Unit: Nm)	Allowable Inertia (Unit: kg·m ²)
Axis 4	44.3	2.82
Axis 5	28.6	1.62
Axis 6	30.0	1.63

 **Warning**
 The payload must not exceed the allowable torque and inertia!
 Make sure to match the load according to the robot's carrying capacity. The load exceeding the carrying capacity of the robot will trigger the alarm or even cause damage to robot components, thereby reducing the robot's service life.

4.5.2 Maximum payload diagram

The position of the center of gravity of the load is determined by the distance between the load center and the flange surface, where L_{xy} represents the distance between the load center and the axis A6 and L_z represents the distance between the load center and the flange mounting surface. The distance corresponding to loads of different weights is shown in the following diagram.

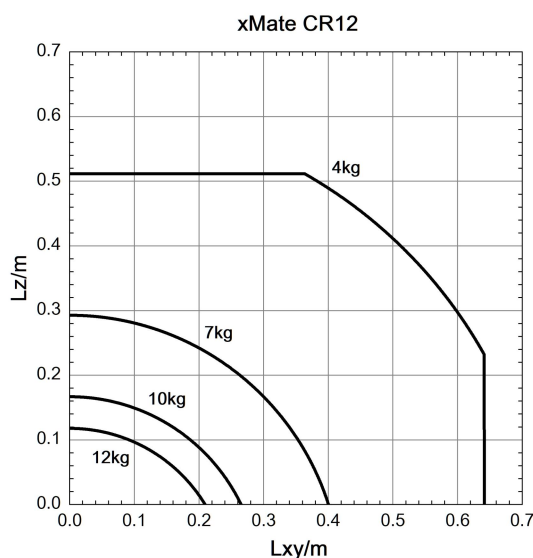



Figure 4-3. Maximum wrist payload and center-of-gravity shift

 **Warning**

Always include the weight of the end effector and make sure it is in accordance with the robot specifications when calculating the load weight. Make sure the system never exceeds the maximum payload.

4.5.3 Calculation of load inertia

In order to achieve optimal robot performance, you must clearly confirm that the load (the weight of the end effector and workpiece) and the load inertia are within the maximum allowable value of the robot. When installing the effector at the robot end, take the moment of inertia of the effector into consideration. See 4.5.1 for the maximum allowable inertia of the xMate CR12 robots. Calculate the rotational inertia of the load before use and ensure that it is within the allowable range.



Notes

Generally, with an accurate three-dimensional model, the mass, center of mass, and inertia of the load can be obtained quickly from the three-dimensional CAD software.

4.5.4 Joint torque limit

In collaborative applications, joint torque must be taken into account in risk analysis. The following table shows the joint torque limits that need to be observed during use. Otherwise, the robot may be damaged due to overload.

Axis	Joint Torque Limit (Nm)
1	400
2	400
3	194
4	102
5	60
6	60

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 +50°C
Relative humidity	0% to 93%, 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!
 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	0% to 93%, 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:

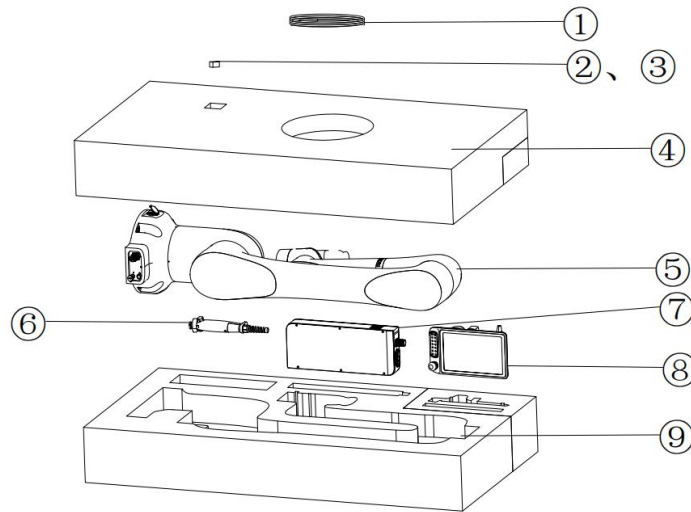


Figure 5-1. Unpacking

No.	Item	Model	Quantity	Remarks
1	AC 220V power cord	6051.2032	1	2 m
	DC 48V power cord	LS18E2-A02-200	1	5 m
	servo external debug cable	LS28E2-A-319	1	3 m
	External connecting cable for tool DIO interface	M8-FS-8CON-PVC-2.0	1	2 m
	Extension cable for Teach Pendant interface on the base (Optional accessories)	LS28E2-A-316	1	
2	USB flash drive	Rokae 32G/PD095	1	
	Mechanical zero calibration block	LS28-A0-101	1	xMate CR7/xMate CR12/xMate CR18

3	xMate CR12 Hardware Installation Manual		1	Electronic documents are stored on a USB flash drive
	xCore Control System User Manual		1	
4	Top liners		1	
5	xMate CR12		1	
6	CR series handheld emergency stop and enabling device (Optional accessories)	LS28E2-400	1	
7	Power adapter		1	
8	xPad2 teach pendant	xPad2	1	
9	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

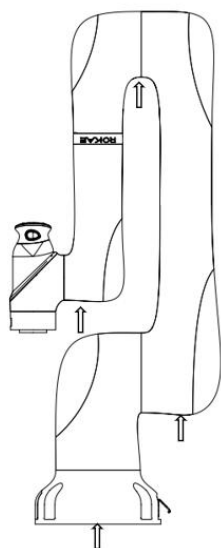


Figure 5-2. Robot pose and suggested points of force application during

packing and transportation

A1	A2	A3	A4	A5	A6
90°	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

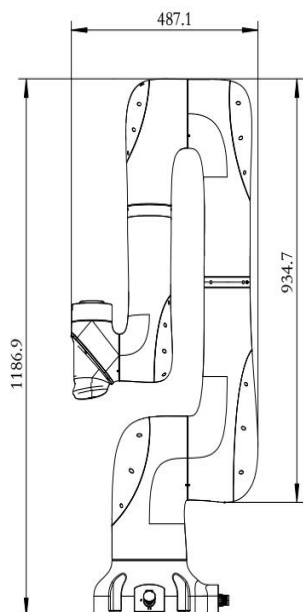


Figure 5-3. Reference transportation dimensions of the robot

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 30 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.

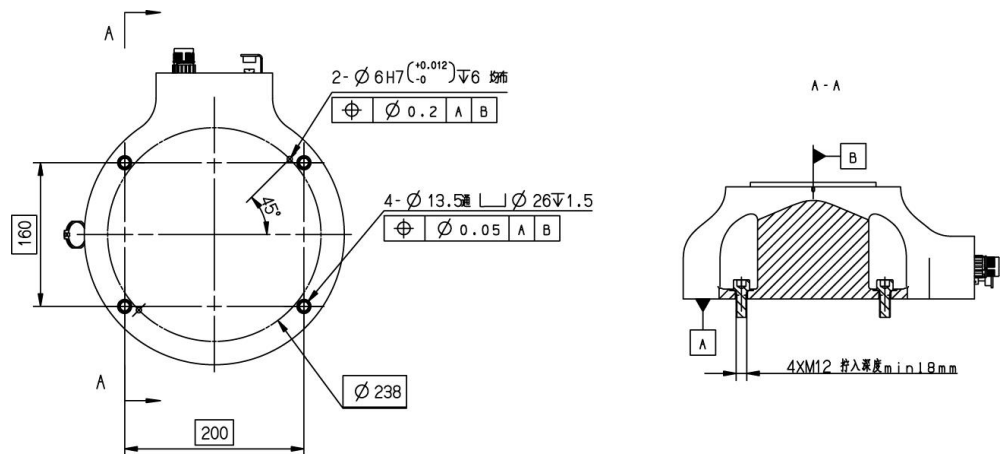


Figure 5-4. Reference bracket fixing method

5.5.2.3 Robot supporting reaction force

After the robot is installed, its mounting base will generate a large supporting reaction force due to the static force and dynamic force of the robot, as shown in the figure below. Therefore, the robot base must be able to bear this supporting reaction force.

Name	Description
F_{xy}/N	Force along any direction in the XY-plane
F_z/N	Force in the Z-plane
M_{xy}/Nm	Bending torque along any direction in the XY-plane
M_z/Nm	Bending torque in the Z-plane

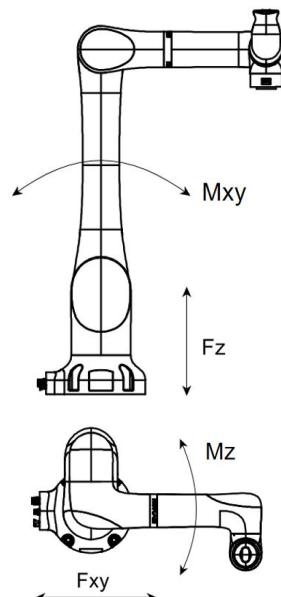


Figure 5-5. Supporting reaction force of the robot

Force	Max. Value for CR12
F_{xy}/N	1600

Fz/N	2139
Mxy/Nm	1307
Mz/Nm	1206



Notes

The above force and torque data are the limit values that may appear during the motion of the robot. The limit values seldom occur and cannot be reached at the same time.

5.5.3 Flange

To ensure the accurate positioning of the tool, the reserved $\Phi 6$ 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.

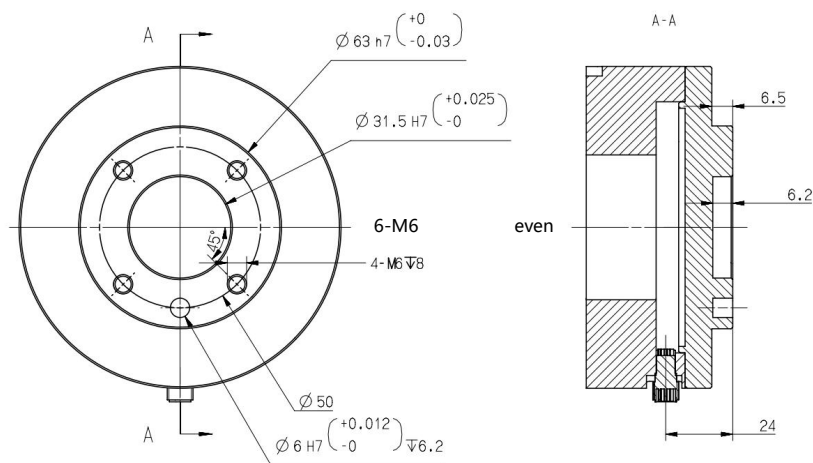


Figure 5-6. Tool flange installation



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.

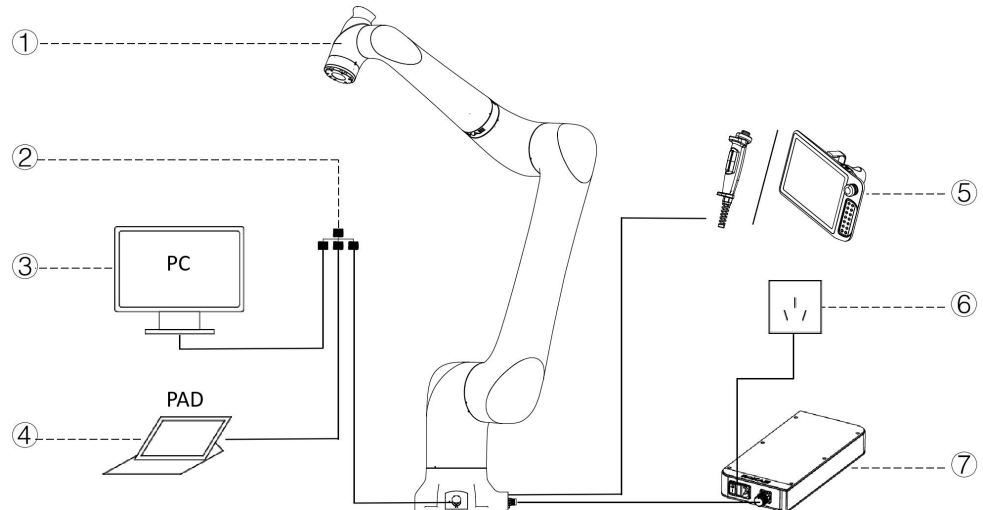


Figure 6-1. Electrical layout

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



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.

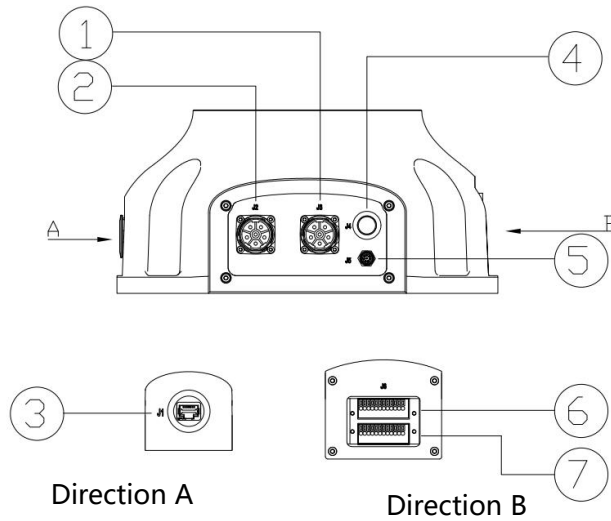


Figure 6-2. Base interface layout

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	250	—	2000	W

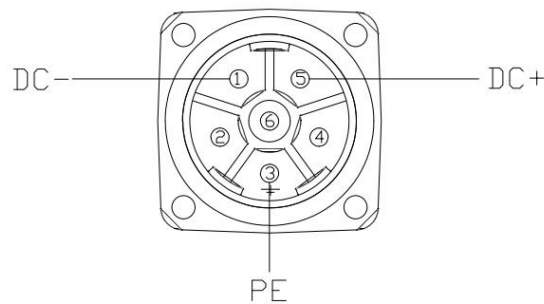


Figure 6-3. Power supply interface

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.

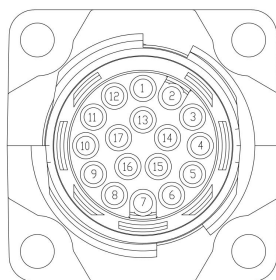


Figure 6-4. Handheld emergency stops and enabling device interface

6.2.4 General-purpose DIO (normal)

The following table applies to: XMC12-R1300-xxxxAx

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.

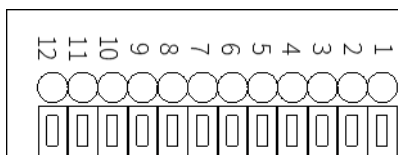


Figure 6-5 General-purpose DI0 interface J8

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 6-6 for details on a PNP configuration.

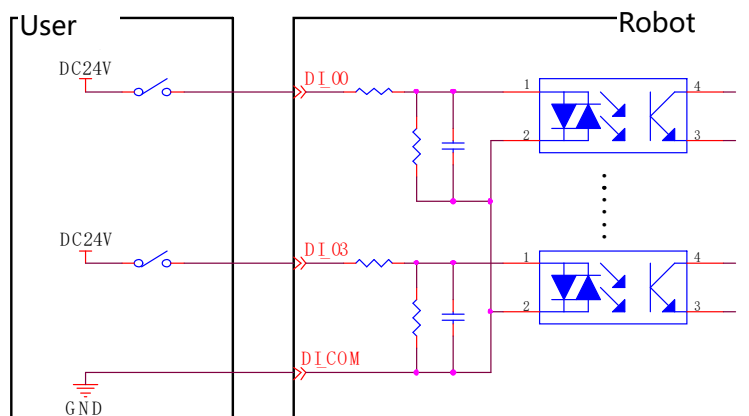


Figure 6-6 PNP input wiring diagram

- NPN input

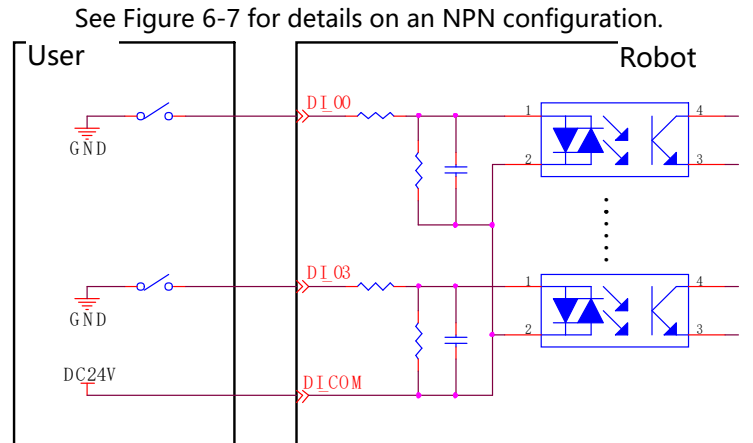


Figure 6-7 NPN input wiring diagram

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 6-8

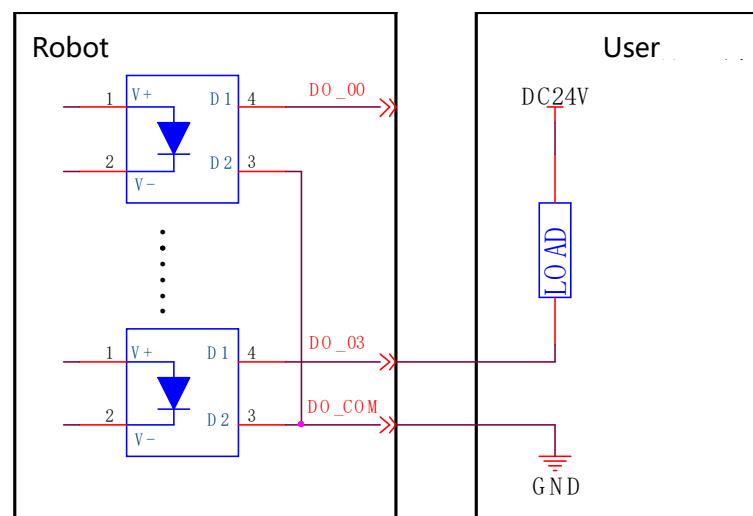


Figure 6-8 PNP output wiring diagram

- PNP output

Connect the DO_COM end to the positive terminal of the power supply, as shown in Figure 6-9

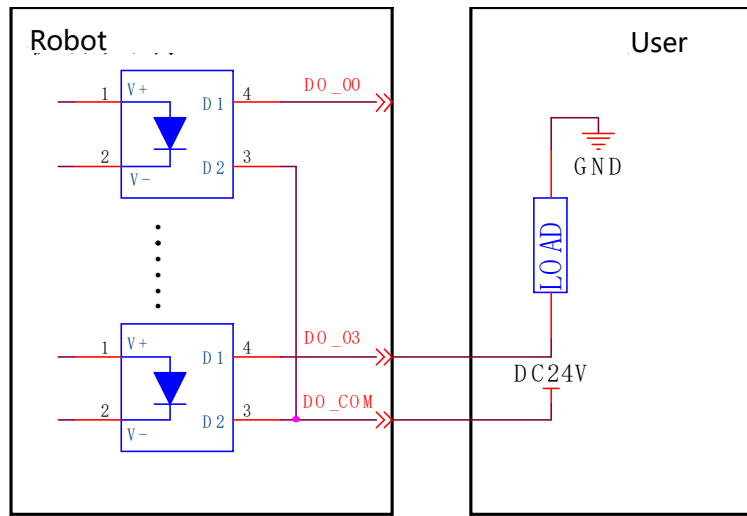


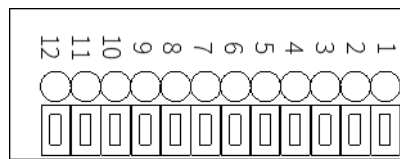
Figure 6-9 NPN output wiring diagram

6.2.5 Safety DIO(normal)

The following table applies to: XMC12-R1300-xxxxAx

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.

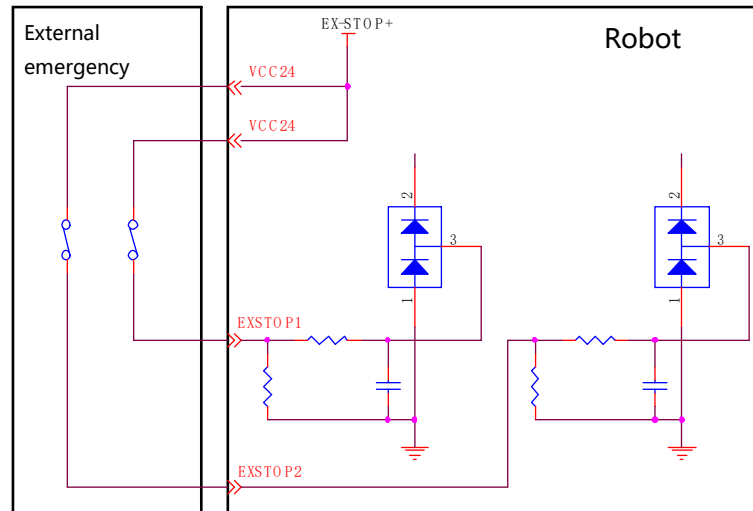


Figure 6-10 External emergency stop interface

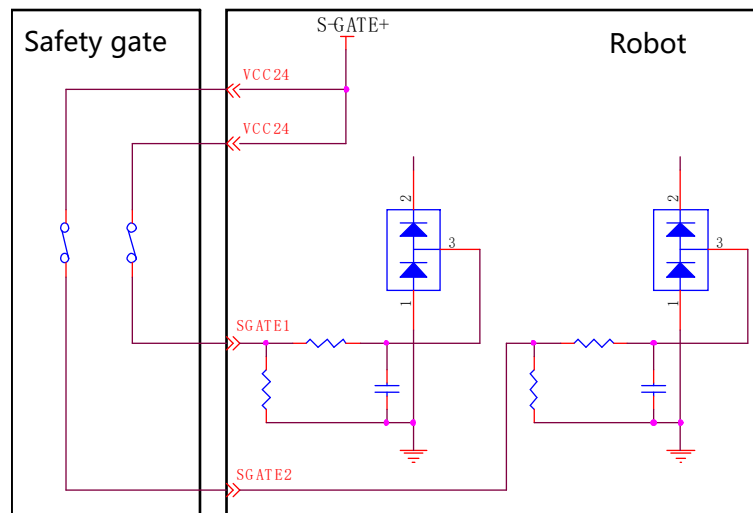


Figure 6-11 Safety gate interface

	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.

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.

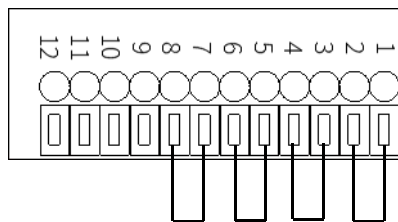


Figure 6-12 Short connection wiring diagram

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 General-purpose DIO(RSC)

The following table applies to: XMC12-R1300-xxxxBx

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.

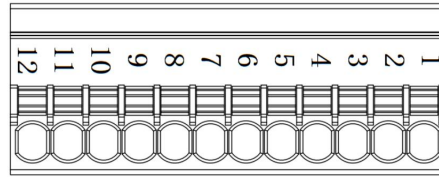


Figure 6-13 General-purpose DIO interface J8

Port	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

- Description of general-purpose DI ports

The 4 digital inputs include drain and source type. When the input is active high (sink), the PNP level signals are available, and when the input is active low (source), the NPN type level signals are available:

Item	Parameter
Input voltage range	0 VDC to 28 VDC
Turn-on voltage	Common port 0 VDC: high input, 15 VDC to 28 VDC Common port 24 VDC: low input, 0 VDC to 10 VDC
Turn-off voltage	Common port 0 VDC: high input, 0 VDC to 5 VDC Common port 24 VDC: low input, 19 VDC to 24 VDC
Input impedance	7.5 kΩ

The electrical principles in the two modes are shown below.

When the common port is 0 VDC, the PNP input signals are available, as shown below:

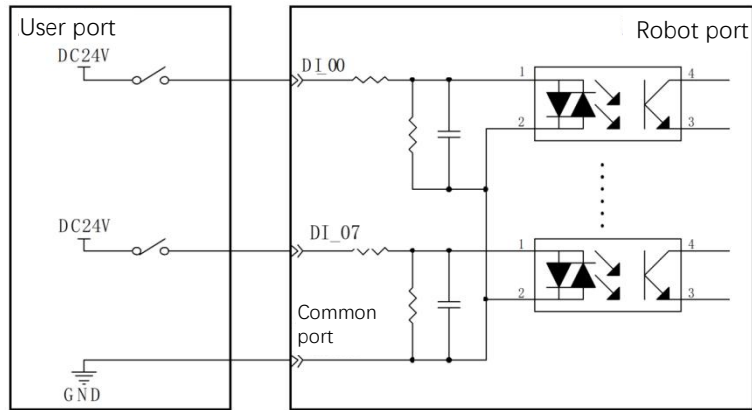


Figure 6-14. The electrical principle

When the common port is 24 VDC, the NPN input signals are available, as shown below:

- Description of general-purpose DO ports

The 16 digital outputs include drain and source type, which can be configured to active high and active low, and the output parameters are as follows:

Item	Parameter
Load voltage range	≤28 VDC
Rated load current	Max. 300 mA (continuous load current cannot exceed the maximum)
Output impedance	≤2.5 Ω
Drain current	Max. 5 uA

The electrical principles in the two modes are shown below.

When the output is active low, the DO_COM (common port) is connected to 0 VDC, as shown below:

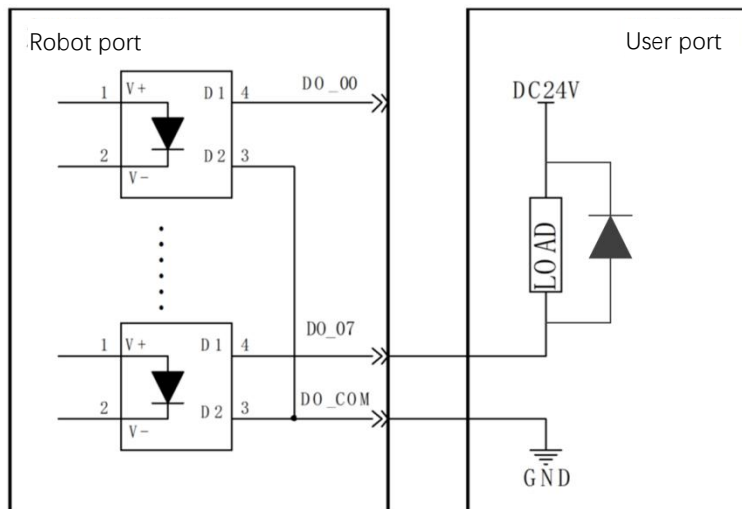


Figure 6-15. The electrical principle

When the output is active high, the DO_COM (common port) is connected to 24 VDC, as shown below.

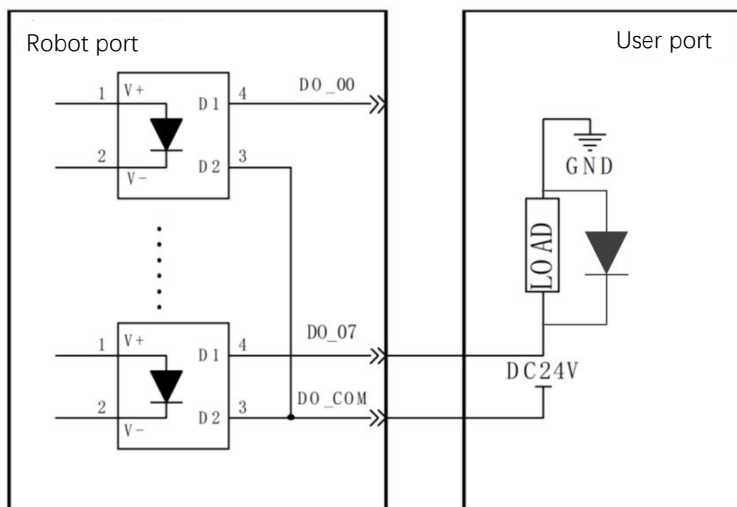


Figure 6-16. The electrical principle



Notes

We highly recommend connecting a freewheeling diode in parallel at both ends of inductive loads.

6.2.7 Safety DIO(RSC)

The following table applies to: XMC12-R1300-xxxxBx

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.

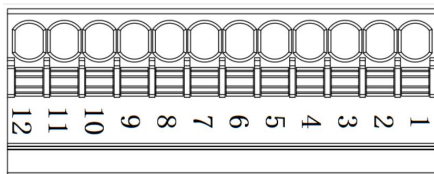


Figure 6-17. Safety IO

Port	Definition
1	Safety gate AP
2	Safety gate AN
3	Safety gate BP
4	Safety gate BN
5	External emergency stop AP

6	External emergency stop AN
7	External emergency stop BP
8	External emergency stop BN
9	Safety output AP
10	Safety output AN
11	Safety output BP
12	Safety output BN

6.2.7.1 Safety DI

● Description of safety input loop ports

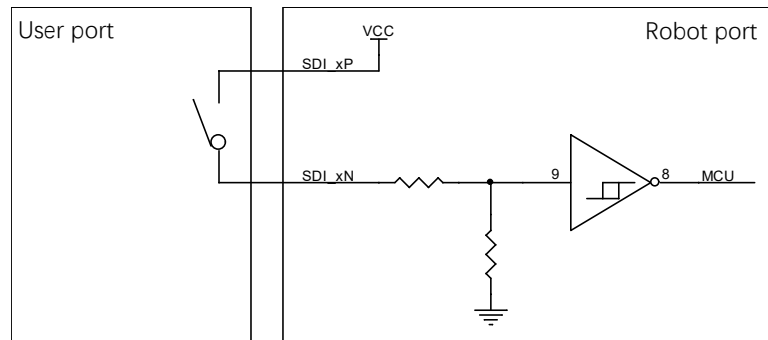


Figure 6-18. The electrical principle

The principle of both loops is the same, and 24 VDC signals are supported. When wiring, if the safety signals 1AP and 1AN, 1BP and 1BN are short-circuited at the same time, the safety input is valid, and if they are open-circuited at the same time, the safety input is invalid, and the others are abnormal state.

Item	Parameter
Input current	≤50 mA per loop
Wire resistance	≤15 Ω per loop
Quantity	2

	External emergency stop	Safety guard (Safety gate)
Function	Only for emergency stop devices	Used for other safety protection devices
Robot states	Stop moving	Stop moving
Program	Suspend	Suspend
Drive power	off ⁽¹⁾	off ⁽¹⁾
Frequency of use	Not commonly used	Not commonly used



Warning

- Safe I/O has redundancy (two independent channels). Maintaining two independent channels ensures that safety functions are not lost in the event of a single channel failure
- Before putting the robot into use, it is essential to verify its safety functions. Regular testing of safety features is necessary
- The installation of robots needs to follow these

specifications. If these specifications are not followed, there is a possibility of serious personal injury as safety functions may fail!

Default security configuration:

Each safety function input or status output signal is controlled by dual channels. External emergency stop and protection stop are short circuited at the factory and can be operated without any additional safety equipment.

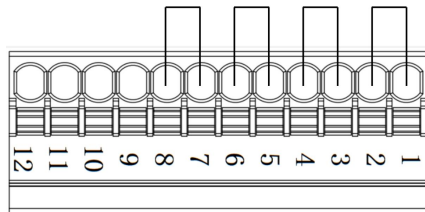


Figure6-19. Short circuit diagram

The default safety configuration for robots leaves the factory, and integrators can integrate safety equipment into safety I/O based on the on-site safety equipment configuration.

6.2.7.2 Safety D0

● Description of safety output loop ports

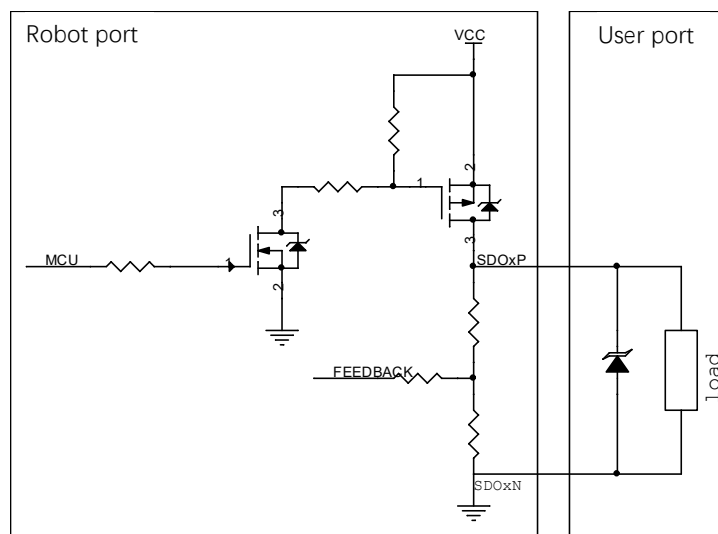


Figure 6-20. The electrical principle

Notes
 We highly recommend connecting a freewheeling diode in parallel at both ends of inductive loads.

The safety output loop uses MOSFET output and re-collects the voltage of the MOSFET. The principle of two loops is the same, and 24 VDC signals are supported. When the output signal is valid, a voltage of 24 VDC is generated between the SDOxP and SDOxN.

Item	Parameter
Type	Semiconductor output
Voltage range	High level: 20 VDC to 30 VDC; low level: -5 VDC to +5 VDC
Drive current	100 mA per circuit
Quantity	1

6.2.8 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.

6.2.9 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.

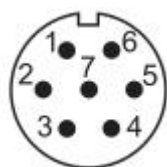


Figure 6-21. The EtherCAT debug interface

6.2.10 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.

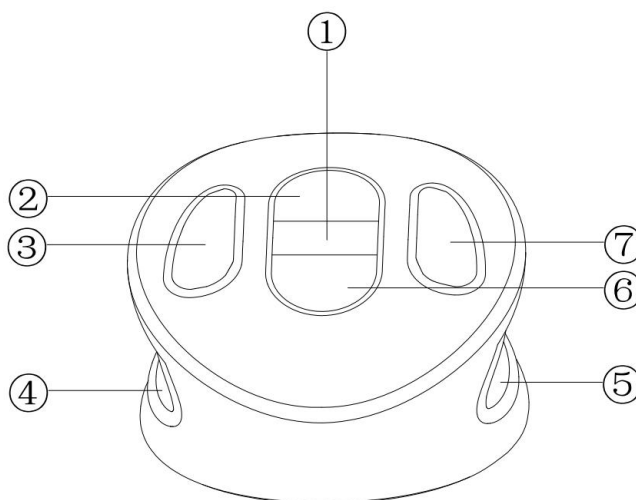


Figure 6-22. The wrist buttons

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

6.2.11 Tool interface

Adjacent to the tool flange on the robot wrist, there is a round connector that provides an 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. It can be used with the M8-FS-8CON-PVC-2.0 industrial cable.

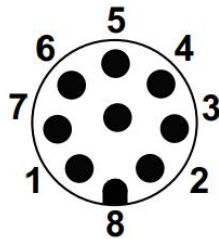


Figure 6-23 End effector round connector interfaces

No.	Color	Definition
1	White	AI_0/RS485+
2	Brown	AI_1/RS485-
3	Green	DI_1
4	Yellow	DI_0
5	Gray	0V/12V/24V
6	Black	DO_1
7	Blue	DO_0
8	Red	GND

Note: The analog input and RS485 need to be configured before use, and only one function can be selected at one time.

6.2.11.1 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.

6.2.11.2 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**
 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 inputs and outputs. The output can be configured to NPN or PNP using HMI. Input only supports NPN. 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

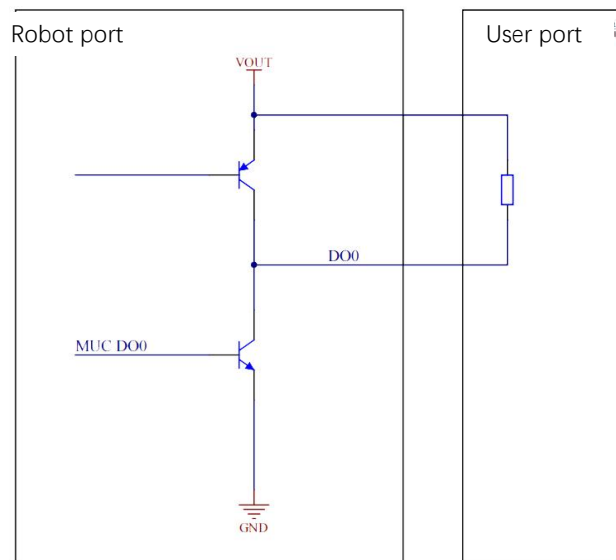


Figure 6-24 NPN end-effector output interface

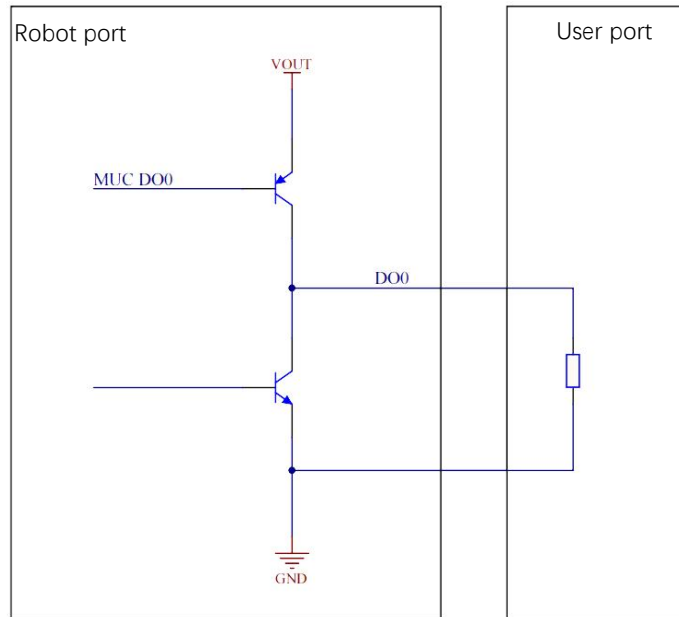



Figure 6-25 PNP end-effector output interface



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

Tool digital input:

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 a simple button are shown below.

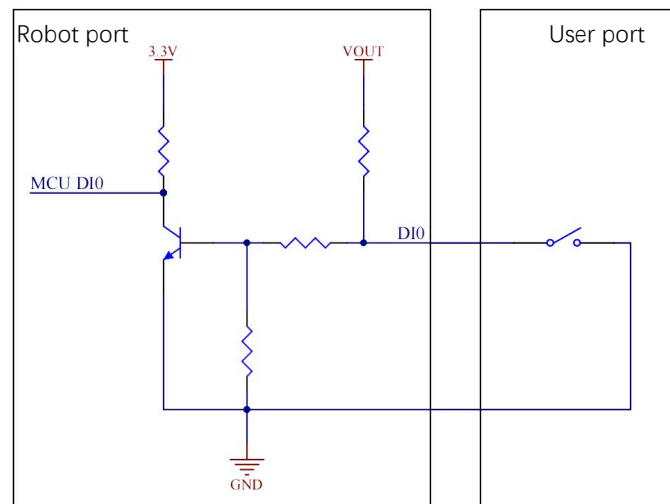


Figure 6-26 End-effector input interface

6.3 Power adapter

The power adapter converts the mains power to the DC power usable by the robot and provides a power supply indicator.

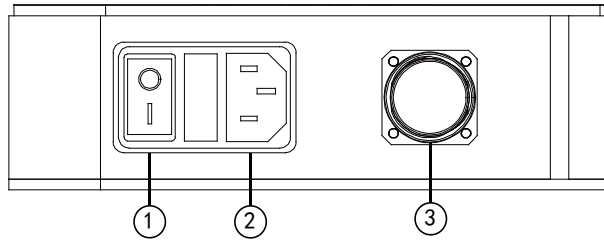


Figure 6-27. Power adapter interface

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-locking)	Indicator status	Adapter status
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

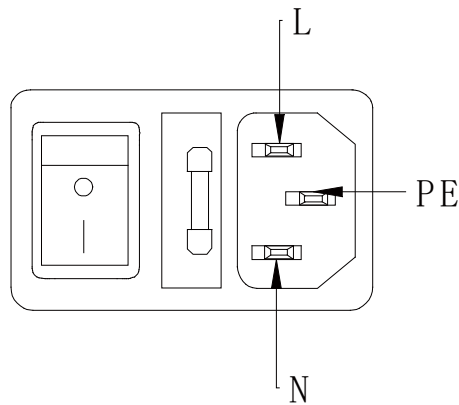


Figure 6-28. Power input interface

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.

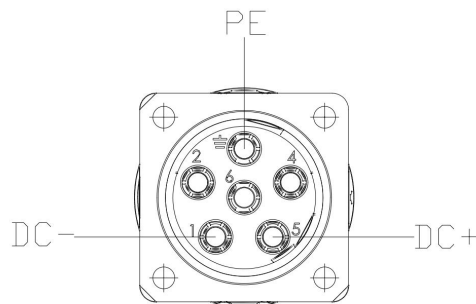


Figure 6-29. Power output interface

6.4 Teach Pendant

6.4.1 Teach Pendant buttons

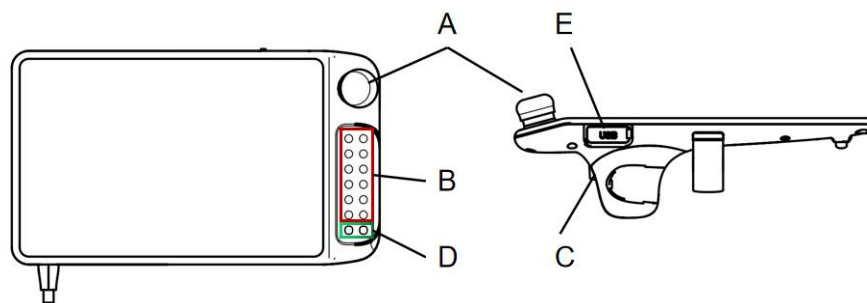


Fig 6-22. Teach Pendant buttons

	Description
A	Emergency stop button: used to trigger an emergency stop in case of danger
B	Jog buttons: 12 buttons in 6 groups corresponding to the robot's 6 joints or 6 DOF in Cartesian space
C	Three-position enabling switch: used to enable robot motion in the manual mode
D	Function buttons: used to scroll between functions displayed on the touch screen
E	USB interface: used for connecting the USB drive and protected with a rubber cover

6.4.2 How to hold the Teach Pendant

The Teach Pendant is usually used for handheld operation. Right-hand users need to hold the Teach Pendant with left hand and operate the buttons and touch screen with right hand. It is recommended to hold the Teach Pendant in the way shown in the figure below:

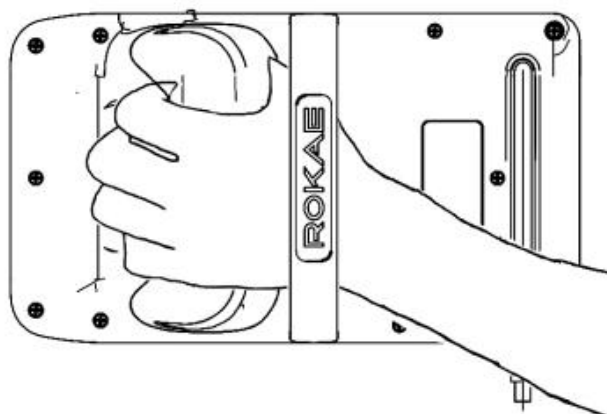


Fig 6-30. How to hold the Teach Pendant

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 and the robot base connectors	Robot base			√		
		Power adapter			√		


	for any loose connection.						
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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;

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.

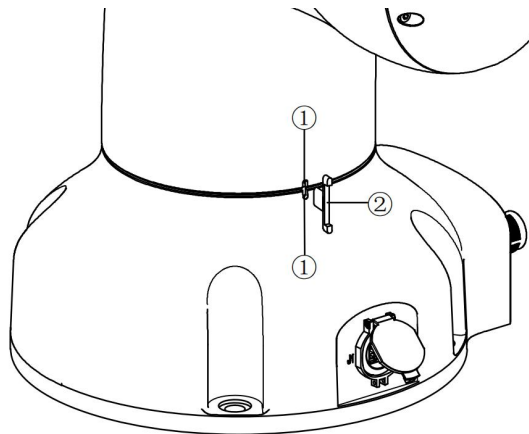


Figure 8-1. step 1

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.

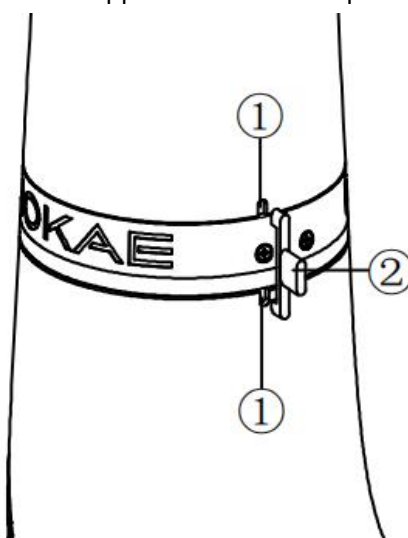


Figure 8-2. step 3

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.

10 Revision History

Version	Date	Revision
A	2024/1/30	Initial version

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