

xMate SR5-C

Hardware installation manual



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xMate SR5-C

Hardware installation manual

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We cannot foresee all possible dangers and consequences. Therefore, this manual cannot warn the user of all possible hazards.

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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 SR5-C 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:

- Controller model/serial number
- 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 SR5-C 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 SR5-C 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 SR5-C 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 SR5-C robots are industrial robots intended to be used as handling tools/end effectors and fixtures, or to process or transfer components or products. xMate SR5-C 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.



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.

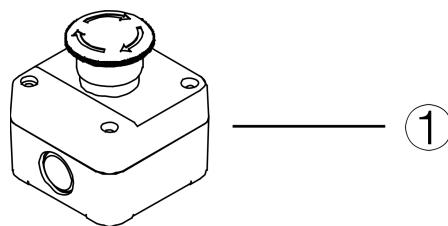


Figure 2-1 Emergency stop button

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.

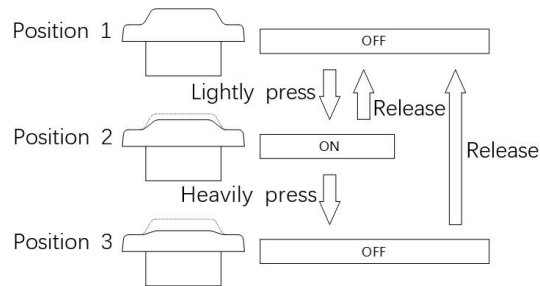


Figure 2-2. Positions of the enabling switch



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 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 SR5-C robots, STOP0 is used for collision detection in the case of external control with RCI and 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 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 personnel do not stumble over the Teach Pendant cable so as to avoid falling of the Teach Pendant or personnel.
- 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 the 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.

Three user levels are built into the control system, namely operator, admin and god. The operation permissions rank from low to high. A password must be entered when a user with lower permission level wants to switch to a higher one; but not vice versa. A user of higher level can modify the password of a same- or lower-level user. You cannot modify the password of an operator.

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 IO 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 is a simple but important procedure. 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 only jog the robot or execute a program 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 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

When the fire has spread and become out of control, the personnel on site should immediately notify other personnel to give up their personal belongings and evacuate from the emergency exit as soon as possible rather than trying to put out the fire. Do not use the elevator during evacuation and call the fire brigade during evacuation.

If the clothes catch fire, do not run but quickly lie flat on the ground, and put out the fire using clothes or other appropriate items or 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 but cut off the power supply as soon as possible. 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 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 electric shock, it is suggested to use insulated pliers or ax, knife, and shovel with dry wooden handle to cut off live wire on mains side (or power source side), the separated wire must not contact with a 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 insulated handle tools (by gripping insulated handle) to remove the wire. No metal bar or wet object shall be used lest the rescuer gets an electric shock.

Warning

The rescuer should not be in direct contact with the electric shocked person, otherwise he or she 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, he/she shall be made lie on the back and watched out. He/she is not suggested standing or walking for the time being.
- If the wounded is unconscious, make him/her lie on the back to keep the airways open. Call the wounded or pat him/her on the shoulder at an interval of 5 seconds to

judge if he/she loses consciousness. Do not call the wounded by shaking his/her head. Meanwhile, contact the hospital as soon as possible.

- If the wounded loses consciousness, his/her respiratory conditions and heartbeat shall be judged within 10 seconds. If neither breath nor arterial pulse is sensed, the wounded is deemed with a cardiac arrest. Give first aid immediately by cardiopulmonary resuscitation.

2.6 Personnel and work content requirements

2.6.1 Definition of personnel

There are three types of personnel:

- Operating personnel

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 safety zone and perform operations such as setting, teaching and programming on the robot.

- Maintenance personnel

The maintenance personnel can conduct robot operations, enter into the safety zone, 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 into the safety zone must accept and pass professional robot training in advance.

Warning

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

2.6.2 Personnel requirements

2.6.2.1 Operating personnel requirements

The operating personnel should meet the following conditions:

- The age of the operating personnel should fall within the age range of local employment laws.
- The operating personnel 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 operating personnel may not take items that may reduce mental level (such as medicines, alcohol and drugs) during work.
- The operating personnel 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 expertises (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 backup 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 safety zone, special attention should be given to the following issues:

- Carefully check the situation inside the safety zone and enter into it only after confirming no danger exists.
- Confirm the positions of all debugging personnel inside the safety zone.
- 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 safety zone.

2.6.3.3 Safety requirements for maintenance

- Carefully check the situation inside the safety zone and enter into it only after confirming no danger exists.
- Confirm the positions of all maintenance personnel inside the safety zone.
- 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 operating personnel, 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 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 operating personnel

The operating personnel may not enter the safety zone:

- Operate the robot outside the safety zone.
- A protective fence or safety door should be set up in order to prevent irrelevant personnel from entering the safety zone.
- 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 operating personnel.

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 into the working range of the robot.
- Before starting the robot, make sure that there are 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 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 the maintenance.
- Switch off the equipment power supply as much as possible before the

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 automatic running of the program when there are other personnel within the working range of the robot.
- During the maintenance, a person who is familiar with the robot system and is able to sense dangers should be present near the equipment so that he/she can press the emergency stop button in case of an emergency.
- During component replacement or reassembly, be careful to avoid 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 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 SR5-C is a next-generation 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 SR5-C:

Product name	Maximum payload	Maximum reach	Weight
xMate SR5-C	4 kg	919 mm	16.5 kg

3.2.2 Robot system

The new-generation flexible collaborative robot xMate SR5-C comprises a robot system (robot body and built-in controller), a handheld safety protection device, a power adapter and cables, and other interfaces and accessories. For details, see Figure 2:

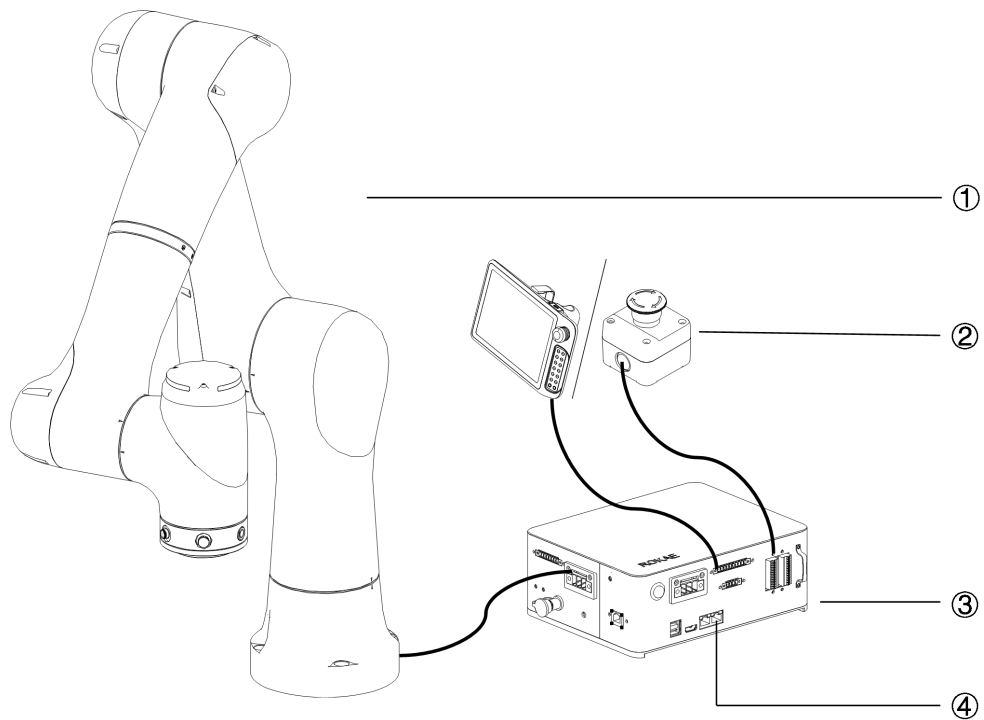


Figure 3-1 Robot system

No.	Name
1	xMate SR5-C robot body
2	Emergency stop button/Teach Pendant
3	Controller 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. 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 zero point is in the center of the flange face. The +Z axis points in the outward direction vertical to the flange surface. The X-axis direction is the same as that of the base coordinate system.

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, the A3 and A5 in the -Y direction, and the A2 in the +Y direction.

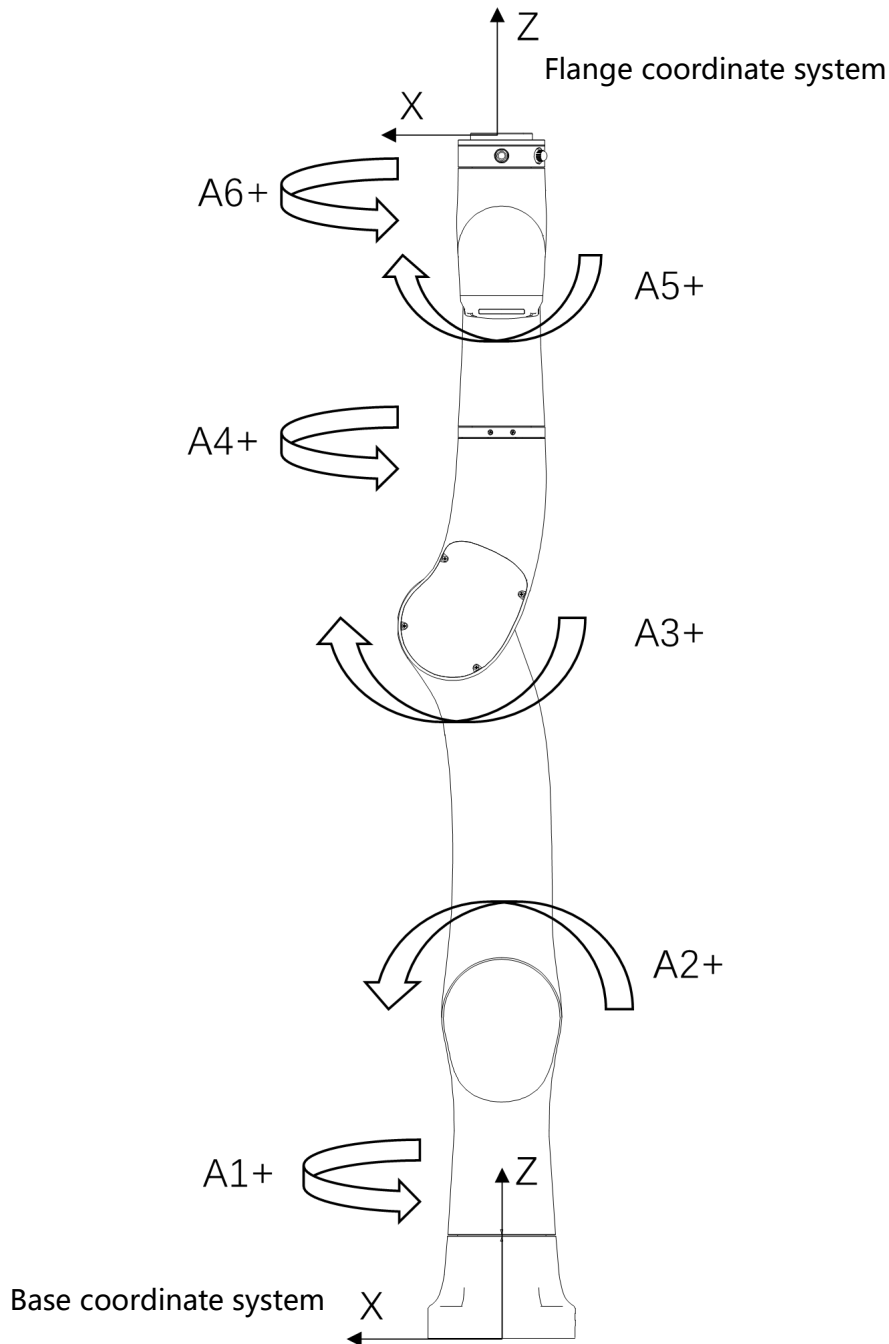


Figure 3-2 Definitions of robot rotation directions and coordinate systems

3.3 Robot Teach Pendant overview(Optional)

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

xPad2 is an optional accessory for xMate SR3-C.

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

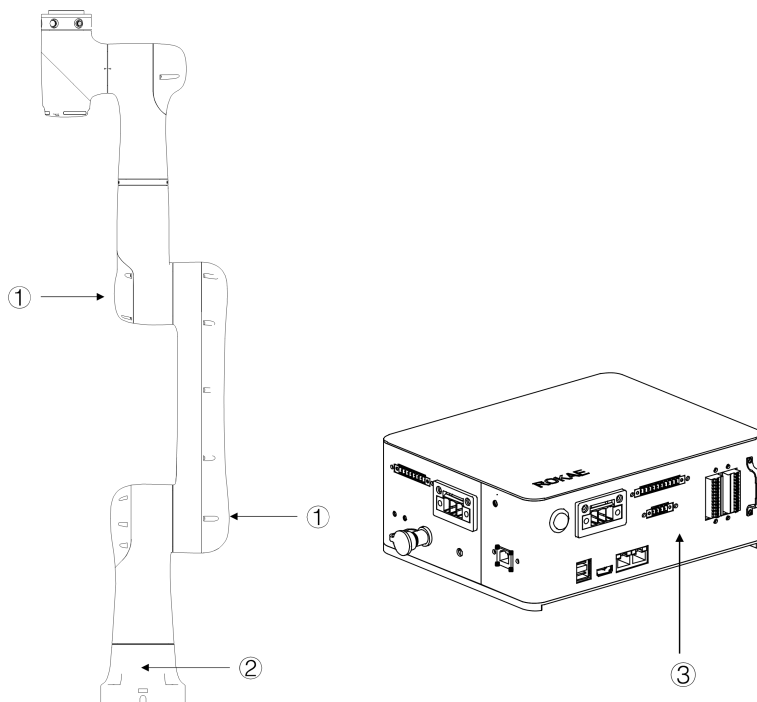


Figure 3-4 Symbols and labels

Position	Label type	Remarks
1	Arm body logo	
2	Product nameplate	Indicates product model and other product information.
3	Electrical hazard	Do not touch the electrical components inside

	symbol	a live robot to avoid the risk of electric shock.
--	--------	---

4 Technical Specifications

4.1 Introduction

This section describes the specifications of the xMate SR5-C flexible collaborative robot.

4.2 Model description

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

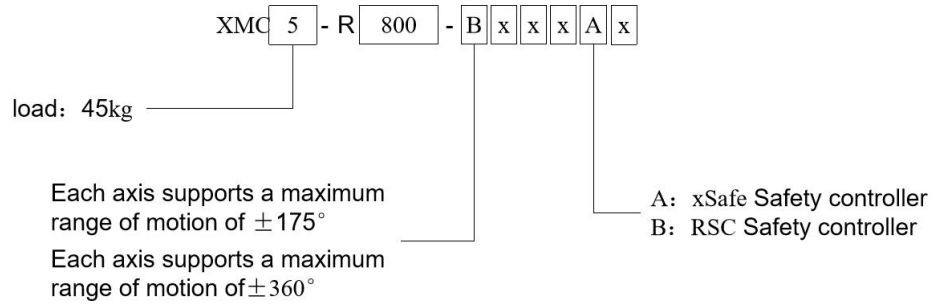


Figure 4-1. The model description of xMate SR5-C

4.3 Specifications

4.3.1 Data sheet

The following table applies to: XMS5-R800-BxxxAxC

Product name		xMate SR5-C
Number of axes		6
Maximum reach		919 mm
Repeatability		± 0.03 mm
Maximum payload		5 kg
Range of motion 50	Axis 1	$\pm 175^\circ$
	Axis 2	-160° to $+150^\circ$
	Axis 3	-170° to $+140^\circ$
	Axis 4	$\pm 175^\circ$
	Axis 5	$\pm 175^\circ$
	Axis 6	$\pm 175^\circ$
Maximum speed	Axis 1	$180^\circ/s$
	Axis 2	$180^\circ/s$
	Axis 3	$180^\circ/s$
	Axis 4	$180^\circ/s$
	Axis 5	$180^\circ/s$
	Axis 6	$180^\circ/s$
Operating temperature		0°C to $+50^\circ\text{C}$
Storage temperature		-10°C to $+55^\circ\text{C}$
Maximum humidity		0%~93%, non-condensing, non-frost
Protection level		IP54

Mounting method	At any angle
Weight	16.5 kg
Noise level	≤70 dB(A)

The following table applies to: XMS5-R800-W_{xxx}BxC

Product name		xMate SR5-C
Number of axes		6
Maximum reach		919 mm
Repeatability		±0.03 mm
Maximum payload		5 kg
Range of motion 50	Axis 1	±360°
	Axis 2	-160° to +150°
	Axis 3	-170° to +140°
	Axis 4	±360°
	Axis 5	±360°
	Axis 6	±360°
Maximum speed	Axis 1	180°/s
	Axis 2	180°/s
	Axis 3	180°/s
	Axis 4	180°/s
	Axis 5	180°/s
	Axis 6	180°/s
Operating temperature		0°C to +50°C
Storage temperature		-10°C to +55°C
Maximum humidity		0%~93%, non-condensing, non-frost
Protection level		IP54
Mounting method		At any angle
Weight		16.5 kg
Noise level		≤70 dB(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

xPad2 is an optional accessory for xMate SR5-C.

4.3.3 LightCab specifications

Product name		LightCab
Size		228.5 mm × 180 mm × 88 mm
Weight		2.4kg
Input Voltage		48VDC±10%
Protection level		IP20
Environment	Operating temperature	0°C~+45°C
	Storage temperature	-10°C~+55°C
	Maximum humidity for operation/storage	≤90%, non-condensing, non-frost

4.4 Working space

The working space of xMate SR5-C 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:

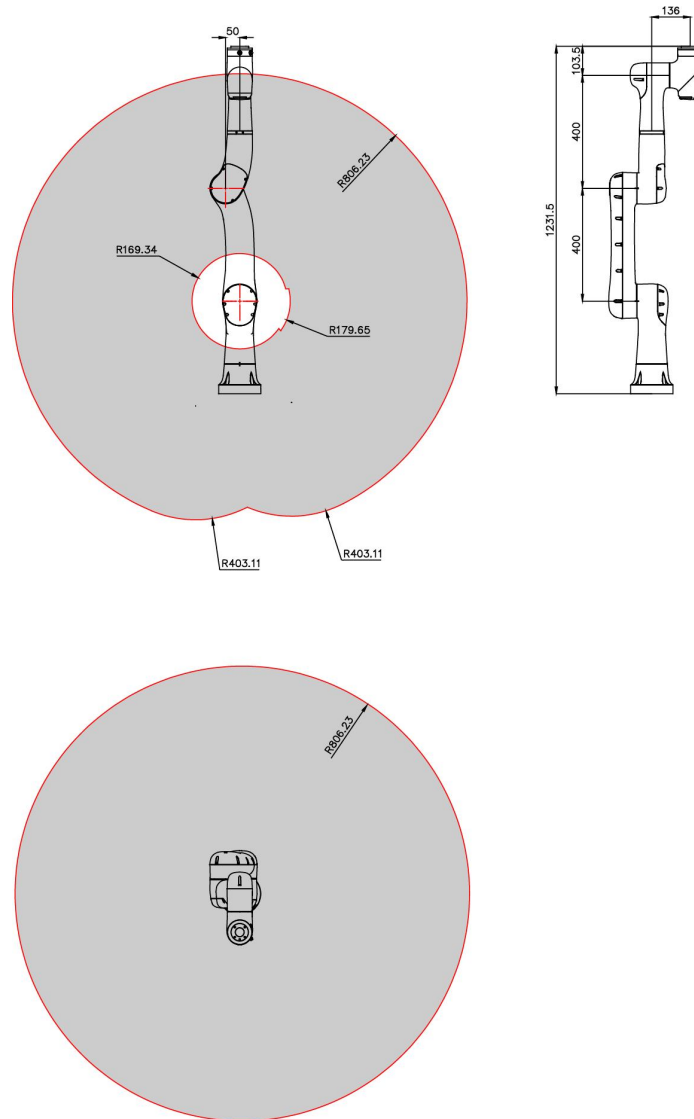


Figure 4-2 Working space of xMate SR5-C

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 SR3 are listed in the table below:

Axis	Allowable Torque (Unit: Nm)	Allowable Inertia (Unit: kg·m ²)
Axis 4	11.8	0.44
Axis 5	11.8	0.44
Axis 6	5.4	0.1



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.

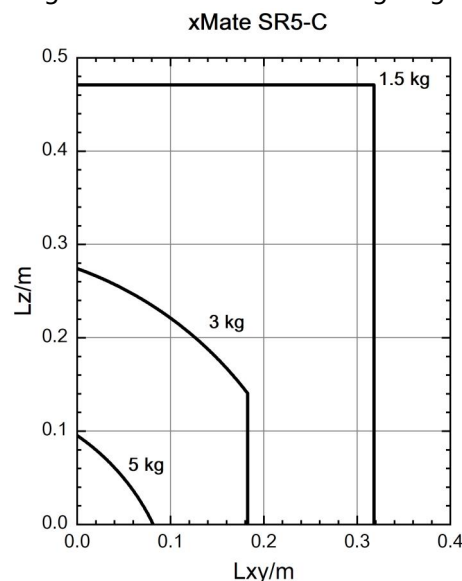


Figure 4-3. Maximum wrist payload and center-of-gravity shift



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 SR5-C 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	110
2	110
3	60
4	25
5	25
6	19

5 Unpacking and Installation

5.1 Introduction

This section contains instructions for unpacking and installing the xMate SR5-C 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	Transportation	
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 dust, soot, salt, iron chips, etc. Keep away from flammable and corrosive liquids

	<p>and gases. Do not bring into contact with water. Protect from shock and vibration. Keep away from sources of electrical interference.</p>
--	---

	<p>Warning Never place or use the robot in any explosive environment!</p>
	<p>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.</p>

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	M8 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:

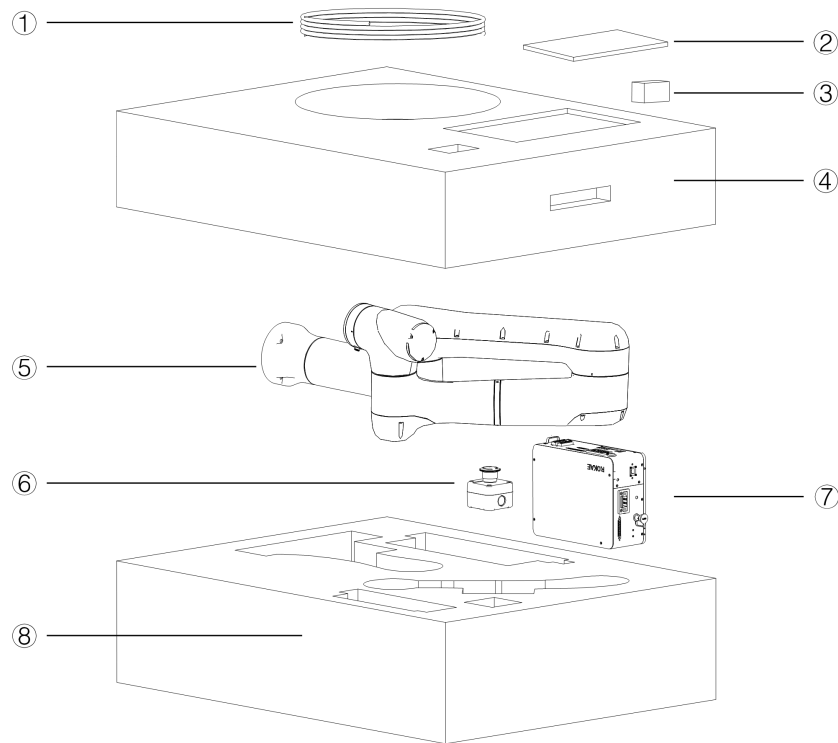


Figure 5-1 Unpacking

No.	Item	Quantity	Remarks
1	Tool I/O port cable	1	Black cabel conneting the tool I/O port
	Servo debug cable	1	Green cable with an RJ45 adapter at one end. Normal work without use, please keep properly, only for the manufacturer debugging.
2	USB drive	1	
3	xMate SR5-C Hardware Installation Manual	1	
4	Top liners	1	
5	xMate SR5-C	1	
6	Emergency stop switch	1	With cables
7	Controller	1	
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

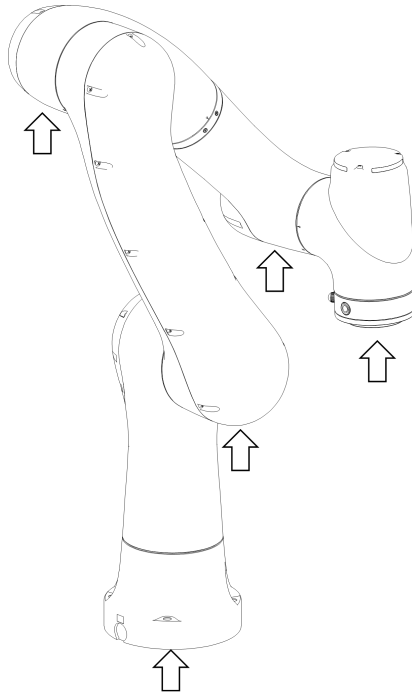



Figure 5-2 Robot pose and suggested points of force application during packing and transportation

A1	A2	A3	A4	A5	A6
0°	-30°	-165°	174.8°	45°	90°
 <p>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.</p>					

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

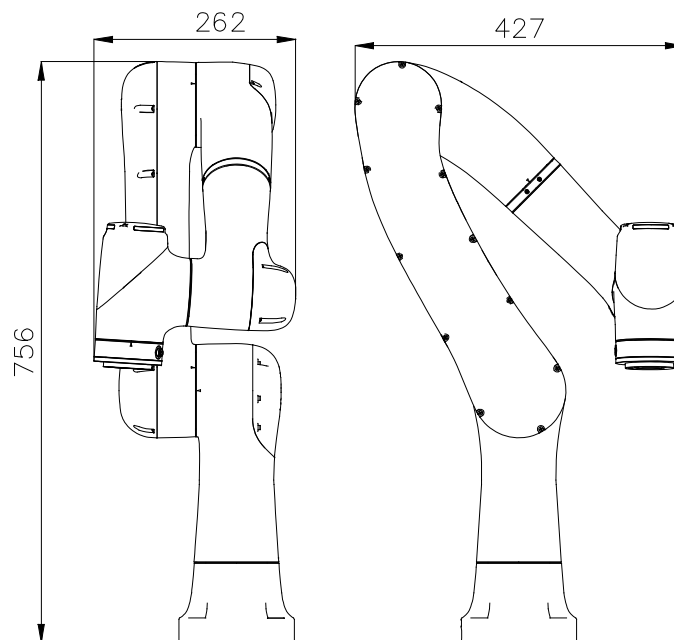


Figure 5-3 Reference transportation dimensions of the robot

5.5.2 Robot installation

5.5.2.1 Parts required for fixing

Part name	Description	Bracket installation
Socket head cap screw	4-M8x30 (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 M8x30 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 35 Nm to ensure that the robot is properly secured in place. Any unstable installation may result in accidents!

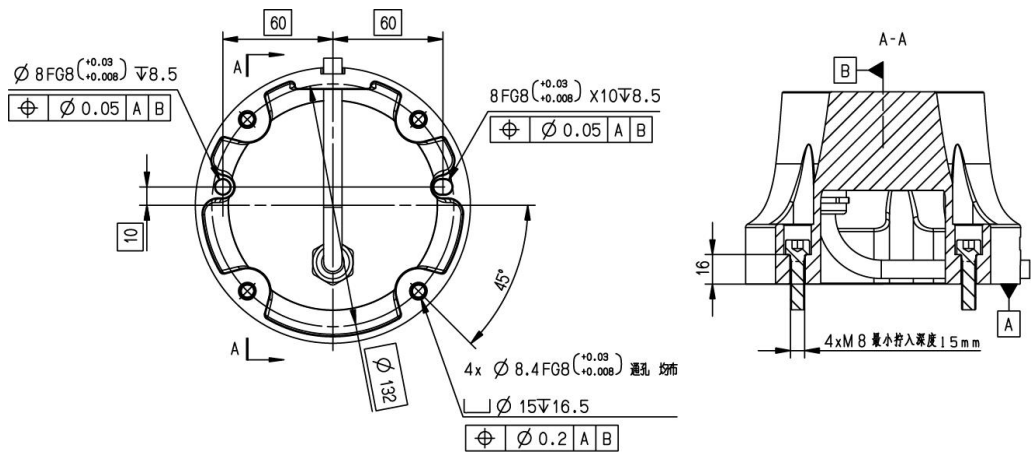


Figure 5-4 Reference bracket fixing method

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
Fxy/N	Force along any direction in the XY-plane
Fz/N	Force in the Z-plane
Mxy/Nm	Bending torque along any direction in the XY-plane
Mz/Nm	Bending torque in the Z-plane

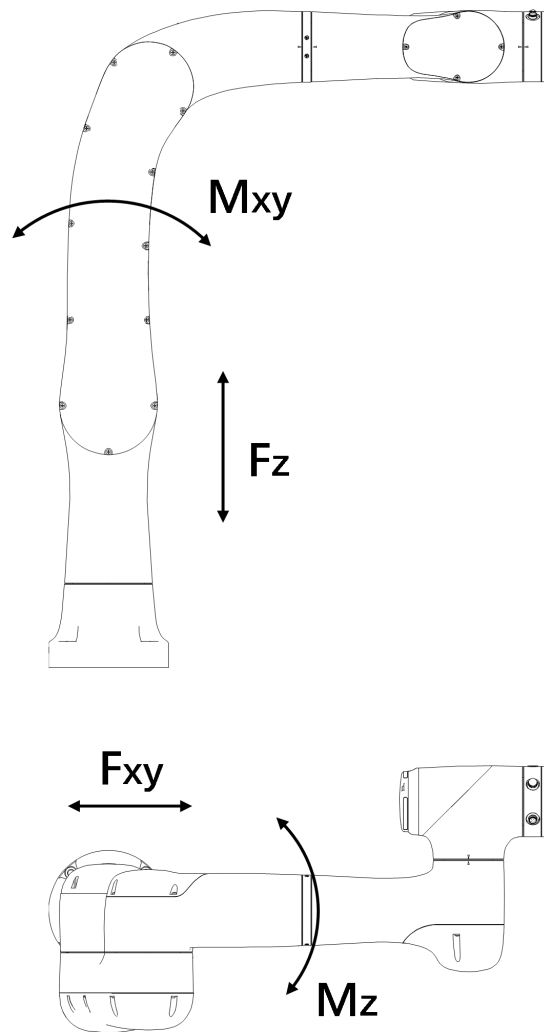


Fig 5-5 Supporting reaction force of the robot

Force	Max for SR5-C
F_{xy}/N	480
F_z/N	652
M_{xy}/Nm	120
M_z/Nm	151

i 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 four 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 15.6 Nm. See the figure below for the detailed dimensions.

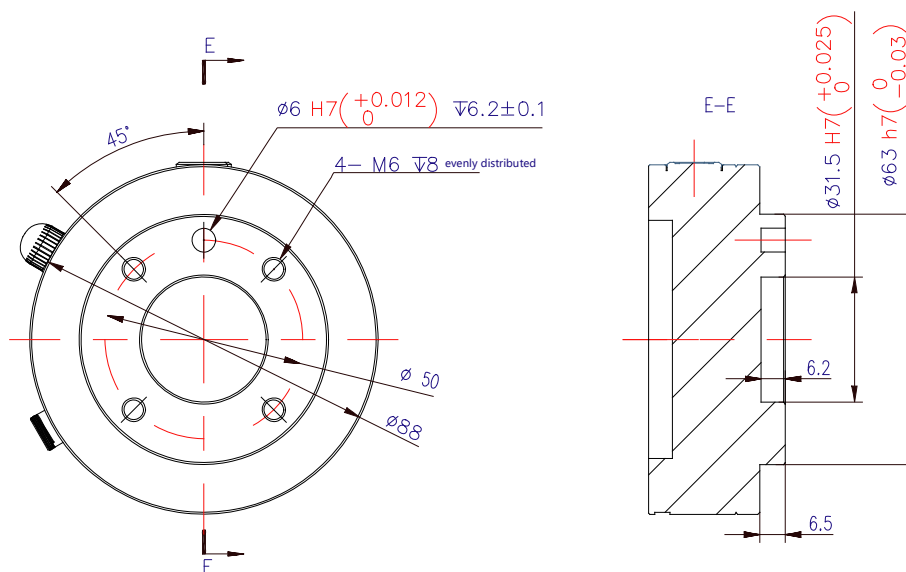


Figure 5-6 Tool flange installation

**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 Installation of Controller

The controller supports both horizontal and vertical installation, with a minimum clearance of 50 mm from each mounting surface for good heat dissipation. See the figure below for detailed dimensions of the controller.

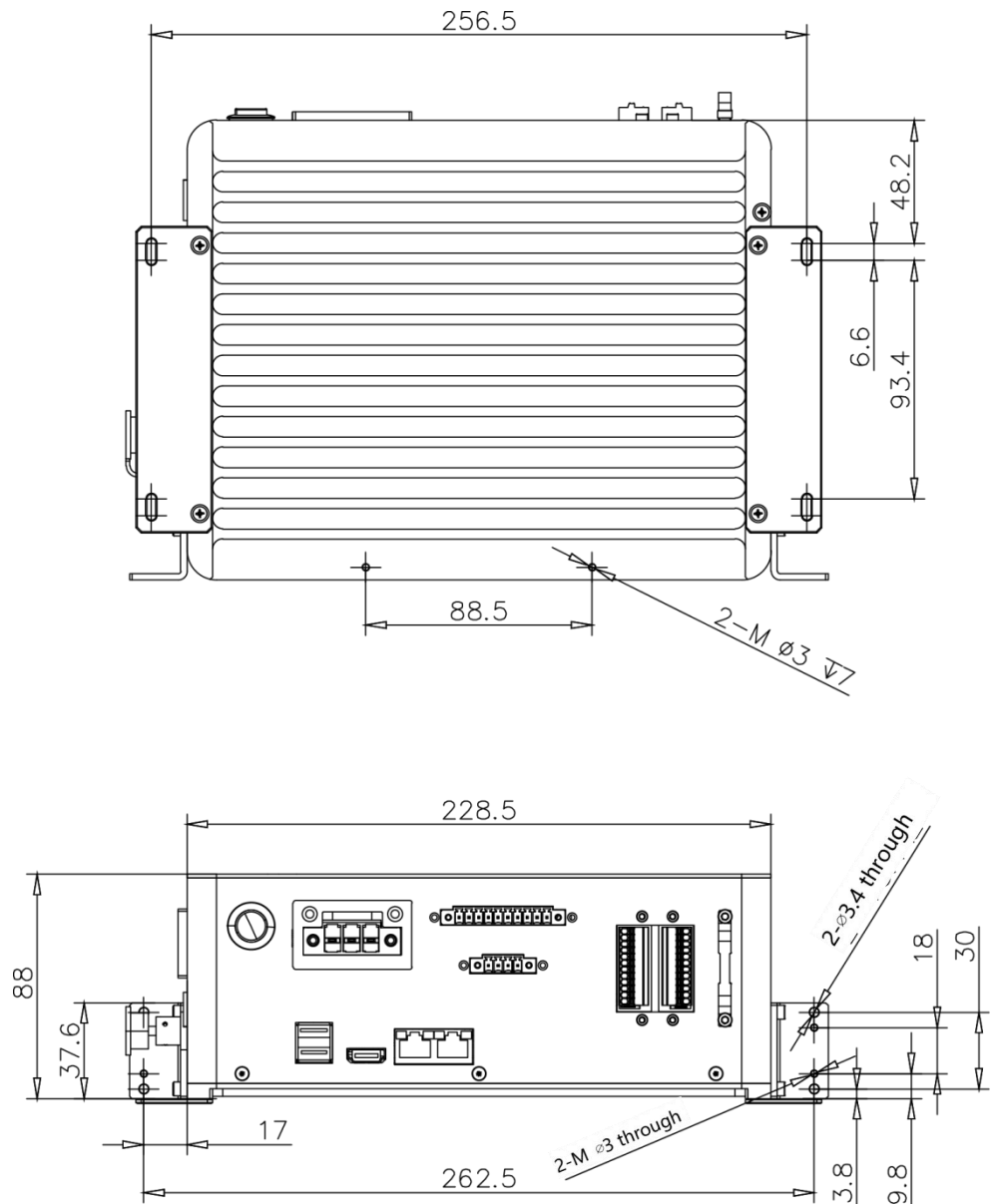


Figure 5-7 Horizontal installation

Horizontal installation

Install the horizontal mounting plate at the corresponding position at the bottom of the controller. Place the controller horizontally on a flat and stable mounting surface, and fix the controller on the mounting surface with four M3*8 screws through the waist-type holes on the horizontal mounting plate.

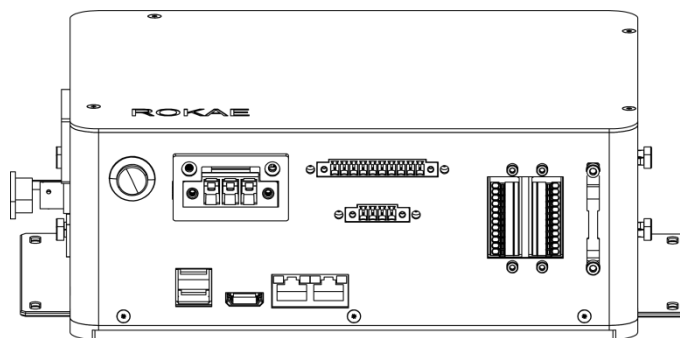


Figure 5-8 Horizontal installation diagram

Vertical installation

Install the vertical mounting plate at both sides of the controller. Place the controller vertically on a flat and stable mounting surface, and fix the controller on the mounting surface with four M3*8 screws through the screw holes on the vertical mounting plate.

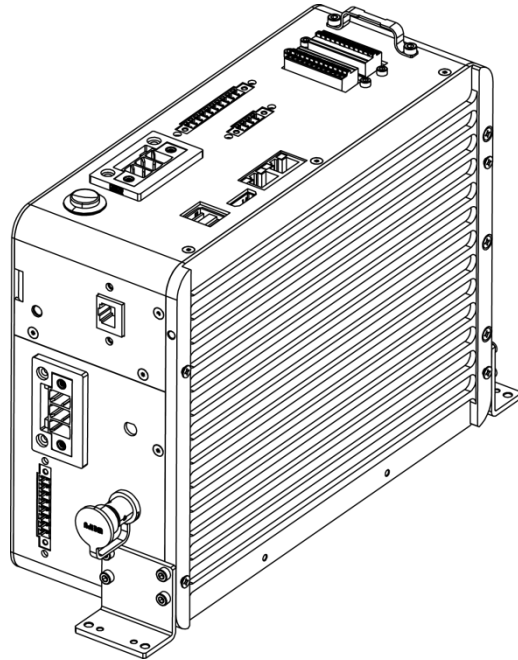


Figure 5-9 Vertical installation diagram

5.5.5 Teaching pendant installation (teaching pendant is optional)

For users who have an optional teaching pendant adapter kit, this chapter explains the installation method of the teaching pendant adapter kit.

5.5.5.1 Installation required parts and tools

The required materials and tools for installation are shown in the table below, among which the materials are included in the teaching pendant adapter kit. The tools section includes the necessary tools for installing the teaching pendant adapter kit.

Type	Number	Component Name	Specifications	Quantity
Material	1	Teaching pendant adapter cable	/	1
	2	Hexagonal socket head cap screw	M3X8	2
	3	Fixed sheet metal for teaching pendant	/	1
	4	High temperature resistant nylon zip ties	/	1
Tool	1	Cross screwdriver	PH 1	1
	2	Internal hexagonal wrench	2.5	1
	3	Adjustable wrench	10 inches	1

5.5.5.2 Installation steps

- (1) Use a Phillips screwdriver to remove the two screws on the top right side of the control cabinet.

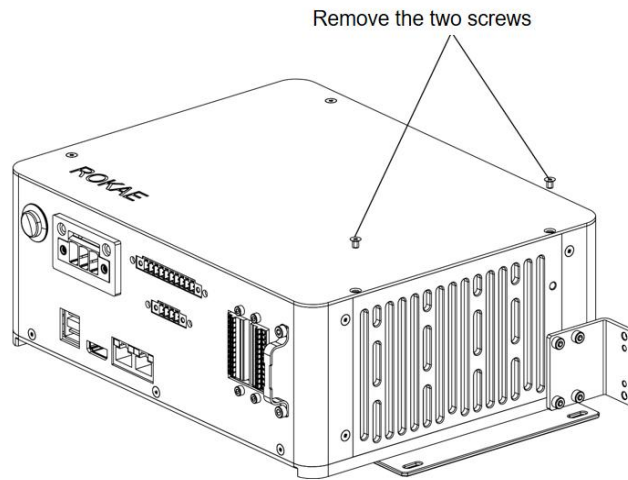


Figure 5-10 Removing screws

- (2) Use an Allen wrench to fix the two M3X8 screws together with the teaching pendant to the sheet metal, and fix them at the two holes of the removed screws as shown in the following figure.

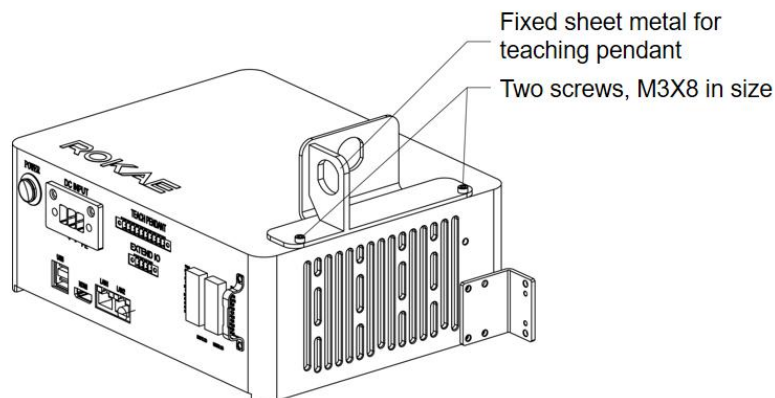


Figure 5-11 Installation of teaching pendant fixing sheet metal

- (3) Thread the connector of the teaching pendant adapter through the sheet metal and tighten the nut of the teaching pendant adapter with an adjustable wrench to secure the teaching pendant connector onto the sheet metal. As shown in Figure 5-12.

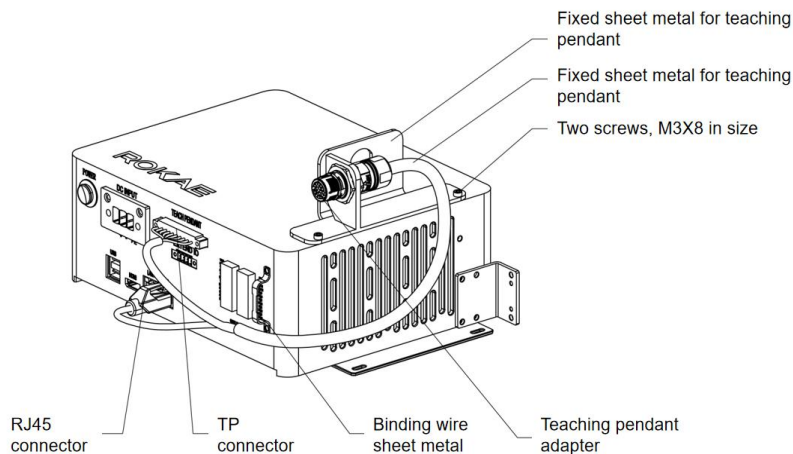


Figure 5-12 Installing the teaching pendant adapter harness

(4) The xPad connector and RJ45 connector of the teaching tool adapter cable are respectively connected to the TEACH PENDANT interface (original xPad interface) and LAN2 interface of the control cabinet (pay attention to the interface and do not plug it incorrectly), and the wiring harness of the plug accessory is fixed to the wire binding sheet metal next to the IO interface of the control cabinet with zip ties. The final effect is shown in Figure 5-12.

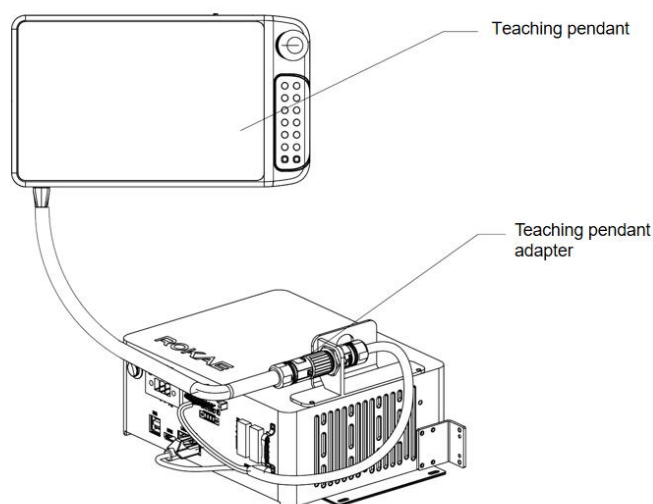


Figure 5-13 Schematic diagram of teaching pendant connection

(5) Connect the cable connector on the teaching pendant to the teaching pendant adapter shown in Figure 5-12 and lock it to use the teaching pendant normally. The schematic diagram of the teaching pendant connection is shown in the following figure.

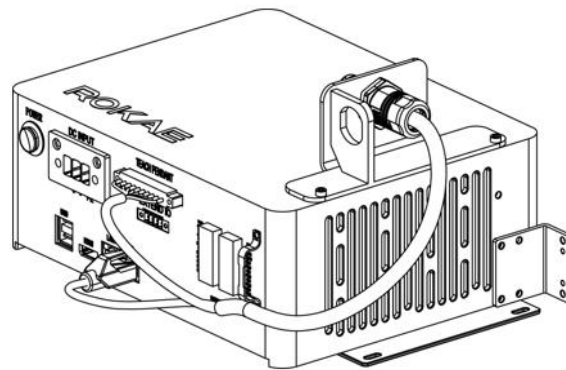


Figure 5-14 Left facing installation diagram

This solution is only intended for users who have an optional teaching pendant adapter kit. The teaching pendant adapter plug provides two installation methods, namely facing forward and facing left. Figure 5-12 shows the forward installation method, which is also the default installation method for the teaching pendant adapter kit. Refer to Figure 5-14 for the installation method facing left.

6 Electrical Connections

6.1 Electrical layout

This section describes the usage of all the electrical and operation interfaces of the xMate SR5-C robot and its related devices. The xMate SR5-C 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 SR5-C software installed for control and debugging of the robot.

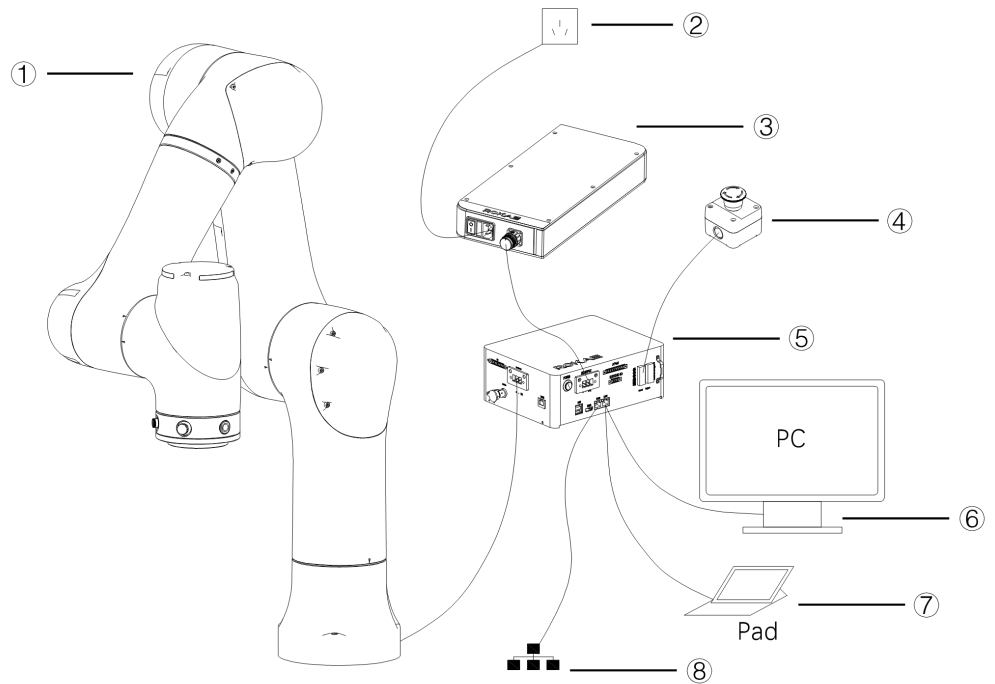


Figure 6-1 Electrical layout

No.	Name
1	xMate SR5-C robot body
2	External power supply
3	Power adapter
4	Emergency stop button/Teach Pendant
5	Controller
6	PC
7	Pad
8	External network



Notes

For information on how to control and use the xMate SR5-C robot, see the user manual of the robot software.

6.2 Controller Interfaces

This section describes all the inbound and outbound interfaces on the robot controller.

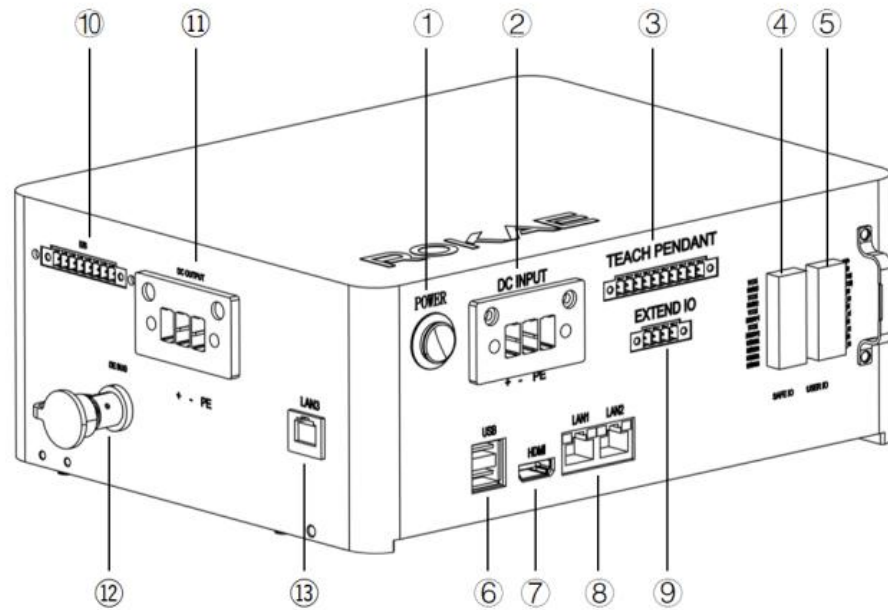


Figure 6-2 Controller interfaces

No.	Meaning	Mark
1	Power-on button (with indicator)	POWER
2	DC 48V power input	DC INPUT
3	XPad teaching pendant interface	TEACH PENDANT
4	Safety DIO	SAFE IO
5	General-purpose DIO	USER IO
6	USB interface	USB
7	HDMI interface	HDMI
8	EtherNet interface	LAN1, LAN2
9	Extend DIO	EXTEND IO
10	Ethercat/STO output	E/S
11	DC 48V power output	DC OUTPUT
12	Servo debug interface	DEBUG
13	EtherCAT expansion network interface	LAN3

6.2.1 Controller power input

The input power of the controller adopts a 7.62-3P Phoenix socket (pin-type). The electrical specifications of the power supply of the controller are listed below.

Parameter	Min	Typical	Max	Unit
Input voltage range	43.2	48	52.8	VDC
Power range	350	—	1000	W

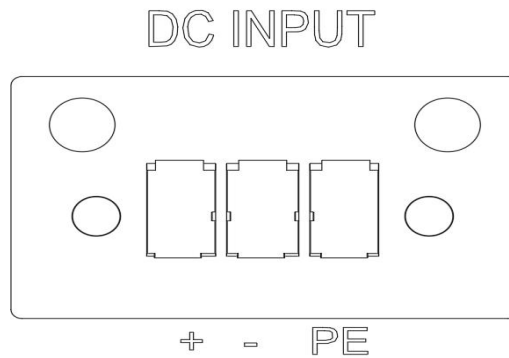


Figure 6-3 Power supply interface (side view for cables)

6.2.2 Powering on Controller

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

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

6.2.3 Teach Pendant interface

The TEACH PENDANT interface on the controller is used to connect the robot to a specific xPad2 Teach Pendant for direct teaching control.

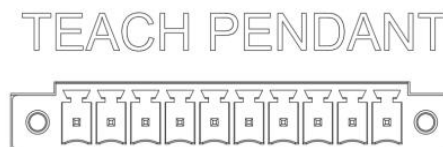


Figure 6-4 TEACH PENDANT interface

6.2.4 Extended I/O Interfaces

The EXTEND IOs on the controller are extended I/O interfaces for multiple DIDs.

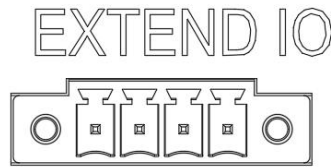


Figure 6-5 EXTEND IO interface

6.2.5 General-purpose DIO(normal)

The following table applies to: XMS5-R800-xxxxAxC

The xMate SR5-C provides 4 digital input and 4 digital output channels with its USER IO interfaces on the controller. 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.

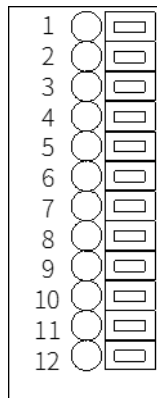


Figure 6-6 General-purpose DIO interfaces

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

6.2.5.1 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 21 for details on a PNP configuration.

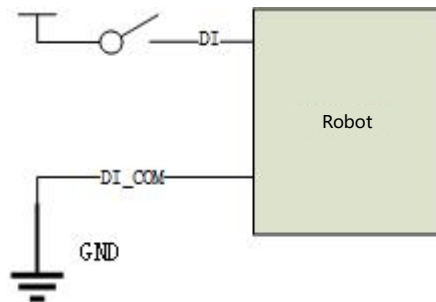


Figure 6-7 PNP input wiring diagram

NPN input

See Figure 22 for details on a NPN configuration.

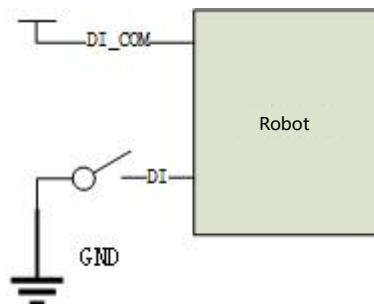


Figure 6-8 NPN input wiring diagram

6.2.5.2 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	0	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 23.

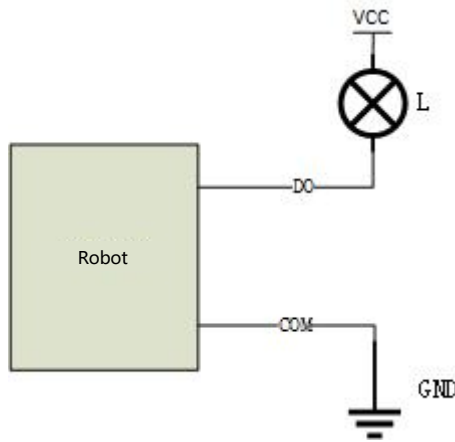


Figure 6-9 NPN output wiring diagram

PNP output

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

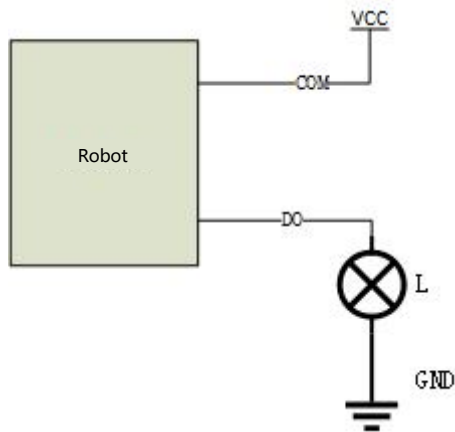


Figure 6-10 PNP output wiring diagram

6.2.6 Safety DIO(normal)

The following table applies to: XMS5-R800-xxxxAxC

XMate SR5-C supports dedicated safety inputs such as external emergency stop and safeguard stop (such as safety gate), and dedicated safety outputs (such as safety status feedback). The channels are located on the SAFE IO interfaces on the controller. 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	SGATE1
2	SGATE1
3	SGATE2
4	SGATE2
5	EXSTOP1
6	EXSTOP1
7	EXSTOP2
8	EXSTOP2
9	UR_STOP_STATE_00_A
10	UR_STOP_STATE_00_B
11	UR_STOP_STATE_01_A
12	UR_STOP_STATE_01_B

6.2.6.1 Safety DI

Safety DI interface

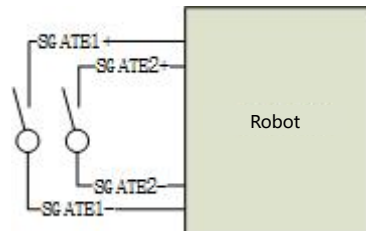


Figure 6-11 External emergency stop interface

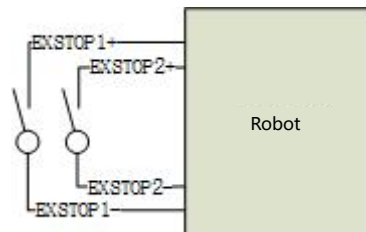



Figure 6-12 Safety gate interface

	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 dual-loop controlled. The external emergency stop and safeguard stop functions are connected to the emergency stop switch, as shown in Figure 26. They are not connected by default when leaving the factory.

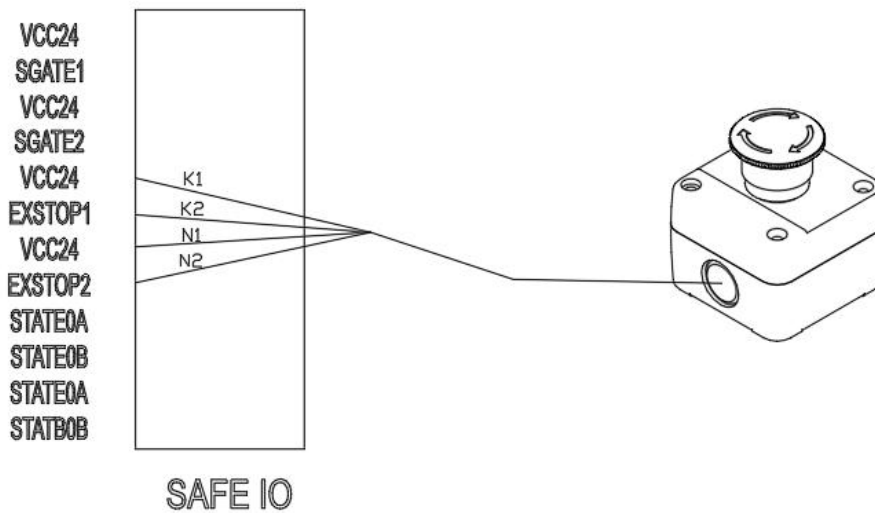


Figure 6-13 Emergency stop switch wiring diagram

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

6.2.6.2 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 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.

6.2.7 General-purpose DIDO(RSC)

The following table applies to: XMS5-R800-xxxxBxC

The xMate SR5-C provides 4 digital input and 4 digital output channels with its USER IO interfaces on the controller. 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.

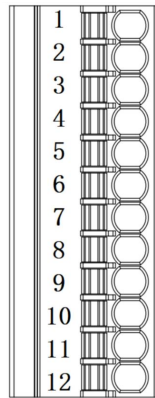


Figure 6-6 General-purpose DIO interfaces

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

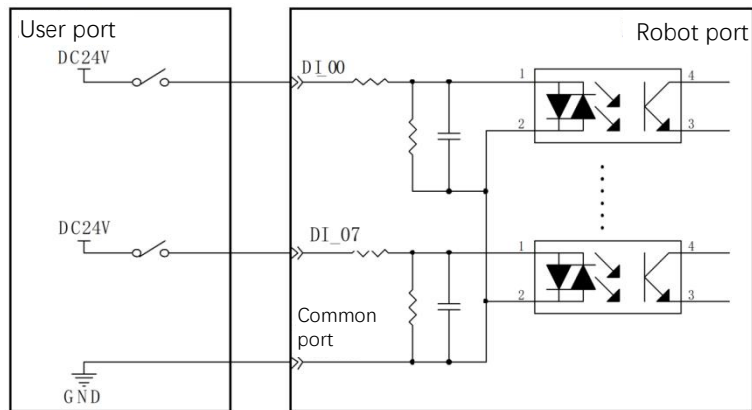
- Description of general-purpose DI ports

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:



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

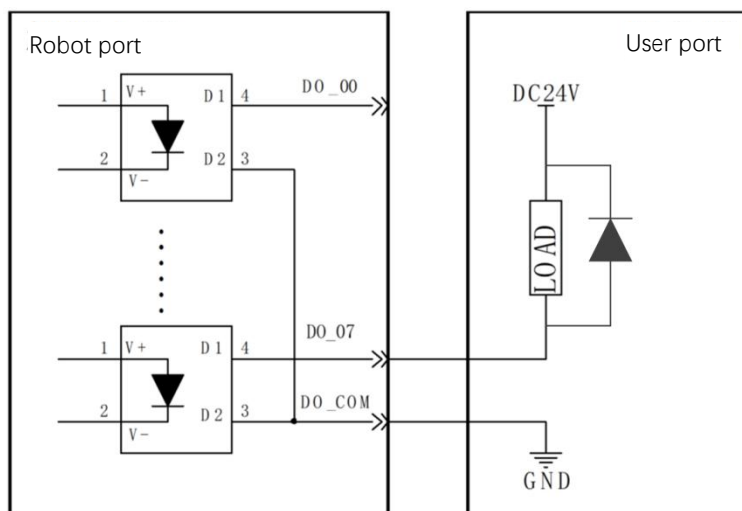
- Description of general-purpose DO ports

The 4 digital outputs include drain and source type, which can be configured to active high and active low, and the output parameters are as follows:

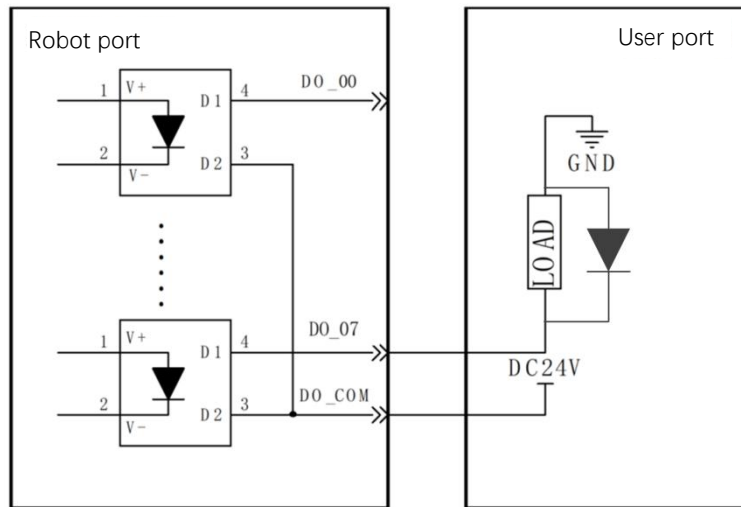
Item	Parameter
Load voltage range	≤28 VDC
Rated load current	Max. 300 mA (continuous load current cannot exceed the maximum)
Output impedance	≤2.5 Ω
Drain current	Max. 5 uA

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:



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



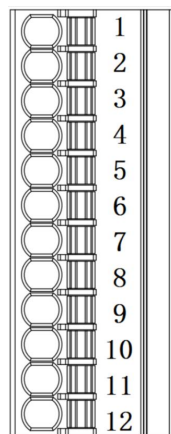
Notes

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

6.2.8 Safety DIO(RSC)

The following table applies to: XMS5-R800-xxxxBxC

XMate SR5-C supports dedicated safety inputs such as external emergency stop and safeguard stop (such as safety gate), and dedicated safety outputs (such as safety status feedback). The channels are located on the SAFE IO interfaces on the controller. 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.

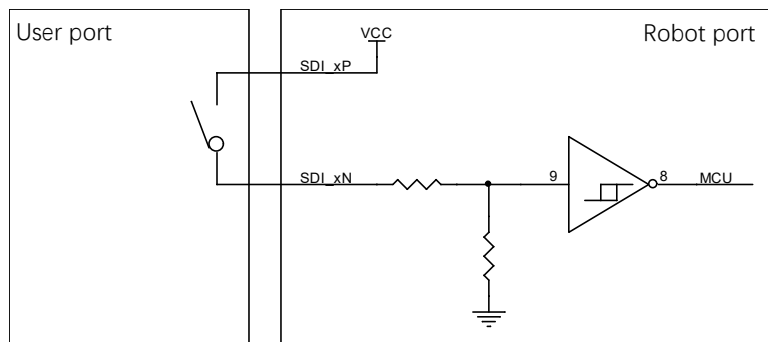


Port	Definition
1	Safety gate AP
2	Safety gate AN

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

6.2.8.1 Safety DI

● Description of safety input loop ports



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.

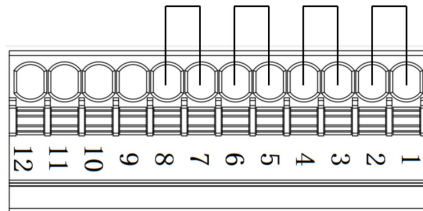
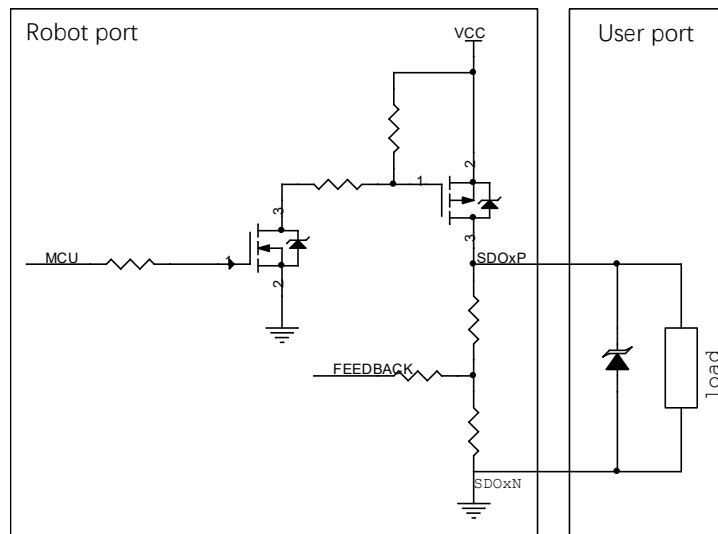


figure xxx Short circuit diagram

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.

6.2.8.2 Safety D0

- Description of safety output loop ports



i 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

6.2.9 Extended EtherNet interface

LAN1 and LAN2 are standard RJ45 interfaces that can be connected by a standard network cable. They support EtherNet communication, with a maximum communication speed of 1000 Mbps. You can connect the xMate SR5-C robot to a network device with XMate SR5-C software installed.

6.2.10 EtherCAT expansion network interface

LAN3, the EtherCAT expansion network interface, is a standard RJ45 interface that can be connected by a standard network cable.

6.2.11 USB interface

The controller has 2 standard USB3.0 interfaces (as shown in Figure 27), which are not enabled yet.

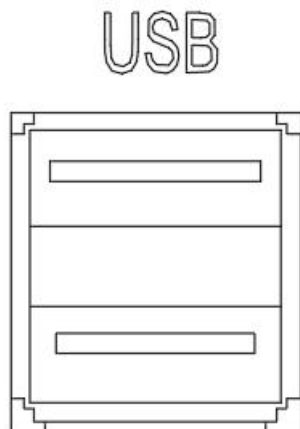


Figure 6-14 USB interfaces

6.2.12 HDMI interface

The controller has one HDMI interface (as shown in Figure 28), which is not enabled yet.



Figure 6-15 HDMI interface

6.2.13 EtherCAT servo drive debug interface

The DEBUG interface is a round M12 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.

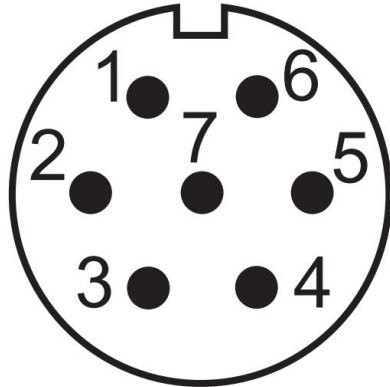


Figure 6-16 EtherCAT servo drive debug interface

6.2.14 Function buttons and interfaces on the wrist

The robot is equipped with function buttons and interfaces on its end effector, such as the 100-megabit Ethernet port, I/O interface and direct teaching control button, as shown in the figure below.

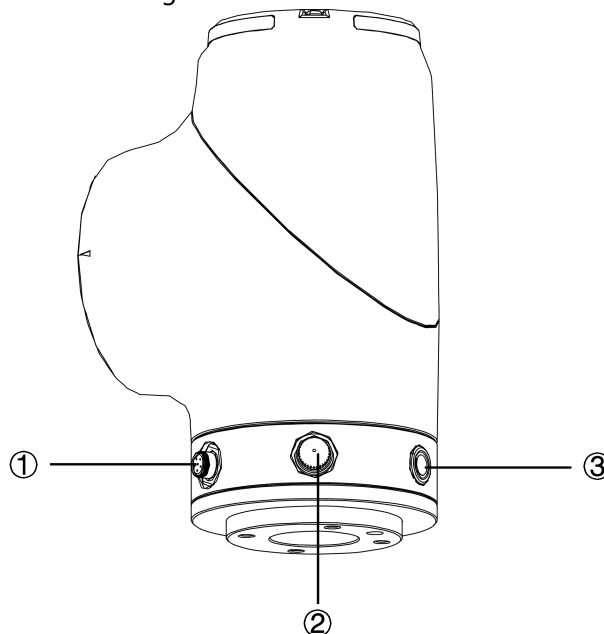


Figure 6-17 Wrist buttons

No.	Meaning
1	End effector 100-megabit Ethernet port(Optional)
2	End effector I/O interface
3	Direct teaching control button

6.2.14.1 End effector 100-megabit Ethernet port(Optional)

Adjacent to the tool flange on the robot wrist, a round connector is equipped to connect to the 100-megabit Ethernet port on the base, providing the robot's end effector with a 100-megabit Ethernet port. SA810/P6S-Weipu must be used with the connector.



Definition of pins:

No.	Definition
1	TX+
2	TX-
3	RX+
4	RX-
5	+5V
6	GND

6.2.14.2 Direct teaching control button

Adjacent to the tool flange on the robot wrist, a self-reset button is equipped to activate direct teaching control.

6.2.14.3 End effector I/O 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 SR5-C robot can be used as the end effector in this interface. It can be used with the user-specific connector M8-FS-8CON-PVC-2.0.

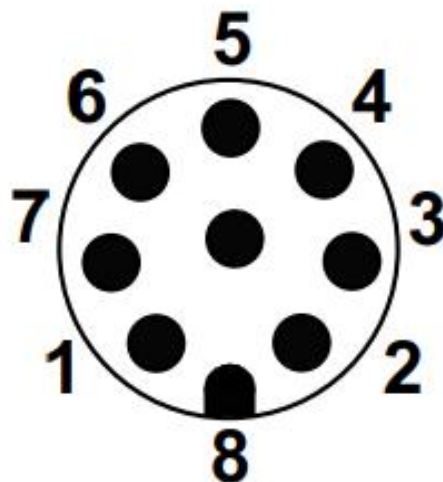


Figure 6-18 End effector round connector interfaces

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

6.2.14.4 Special-purpose tool IO

The xMate SR5-C 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.

6.2.14.5 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	0	12/24	24.8	V
Supply current	0	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, which can be configured as NPN or PNP outputs. The electrical principles and specifications of the tool digital output load to the user side are shown below.

NPN type	Default	Activated	Max	Unit
Output level	Suspended	Low	—	—
Continuous load current	0	—	100	mA

PNP type	Default	Activated	Max	Unit
Output level	Suspended	V_OUT	—	—
Continuous load current	0	—	100	mA

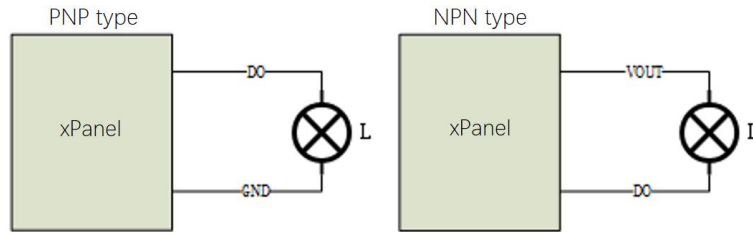



Figure 6-19 End effector output interface

 **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, which can be configured as NPN or PNP inputs. The electrical principles and specifications of the tool digital output load to the user side are shown below.

	Default	Activated	Max	Unit
Input level	Suspended	Low or high	—	—
Continuous load current	0	—	100	mA

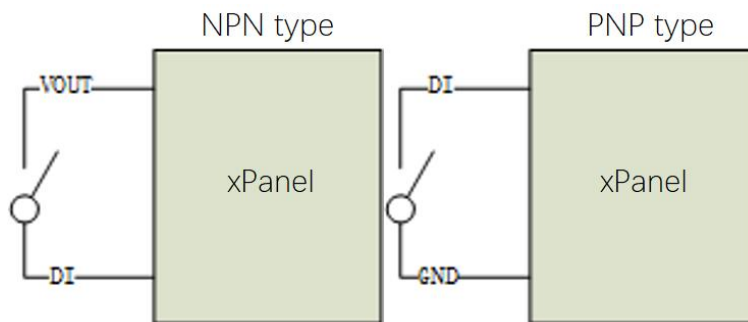


Figure 6-20 End effector input interface

Analog input:

The end effector provides two analog inputs, which can be configured as current/voltage mode simultaneously.

	Min	Typical	Max	Unit
Input voltage in voltage mode	-0.5	-	27	V
Input current in current mode	4mA	—	20	mA

Input voltage in current mode	-0.5	-	5	V
-------------------------------	------	---	---	---

Attention: The analog inputs in the tool are not current/voltage-limited. Overriding the specifications can cause permanent damage.

6.3 Power adapter

The power adapter is an optional accessory of the xMate SR5-C robot, which converts the mains to the DC power usable by the robot.

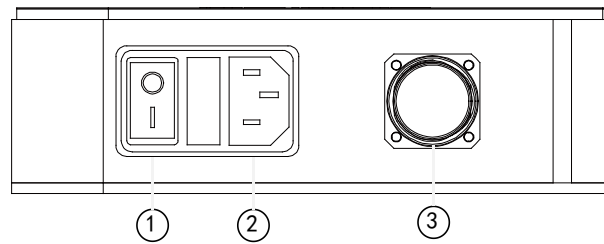


Figure 6-21 Power adapter interfaces

No.	Meaning
1	Power-on switch
2	AC 220V input
3	DC 48V 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 that serves as the main power switch.

Rotary switch (self-locking)	Adapter status
OFF	Not powered on
ON	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 electrical specifications of the input power are listed below.

ROKAE power adapter		
Output	DC voltage	48 V
	Rated current	21A
	Ripple and noise	150 mVp-p
Input	Voltage range	90 to 264 VAC
	Frequency range	47 to 63Hz
	Efficiency	90%
	Operating	-20 to +60°C

Environment	temperature	
	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

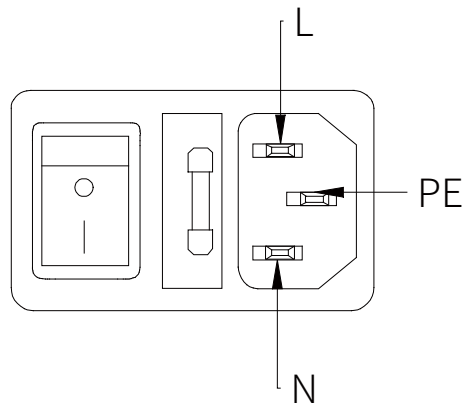


Figure 6-22 Power input interface

6.3.3 Power output

The power output connector of the adapter is a 7.62-3P male connector (hole type) that outputs the 48V DC voltage usable by the xMate SR5-C robot. It can be used to supply power to the robot controller.

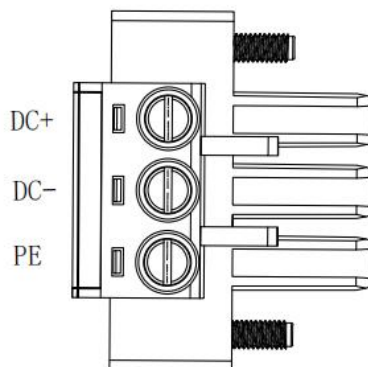


Figure 6-23 Power output interface

6.4 Teach Pendant

The Teach Pendant is an optional accessory of the xMate SR5-C robot.

6.4.1 Teach Pendant buttons

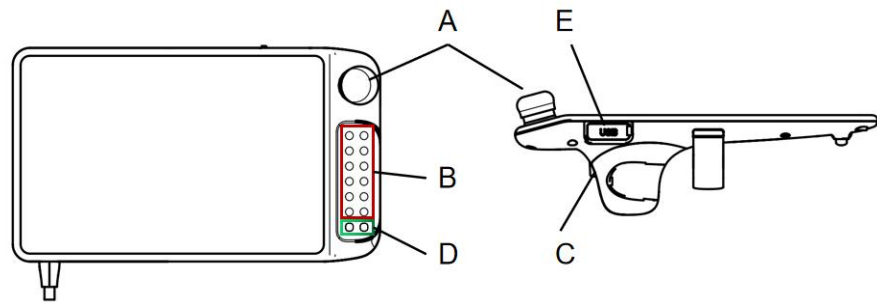


Fig 6-24 Teach Pendant buttons

	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:

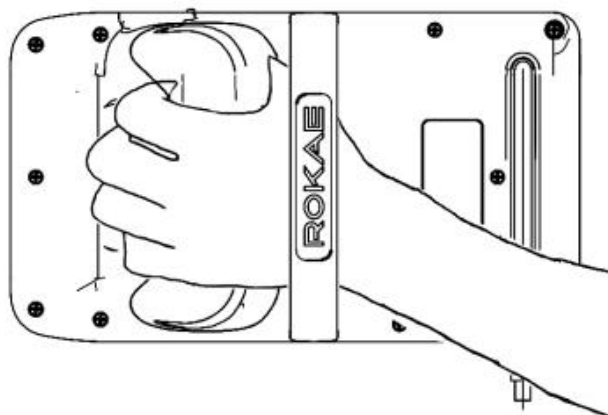


Fig 6-25 How to hold the Teach Pendant

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						
3	Encoder battery	Replace the battery if a low-battery error warning appears when the software starts up or once every 1.5 years.					

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 arrowhead calibration is adopted for the first axis to the sixth axis of the xMate SR5-C robot. Only one axis can be calibrated at a time, and the specific operation process is as follows.

Step 1: calibrate the first axis

Slowly rotate Axis 1. When the two calibrated arrowheads are aligned (as shown in the red box in Figure 35), the mechanical zero calibration of the axis is completed.

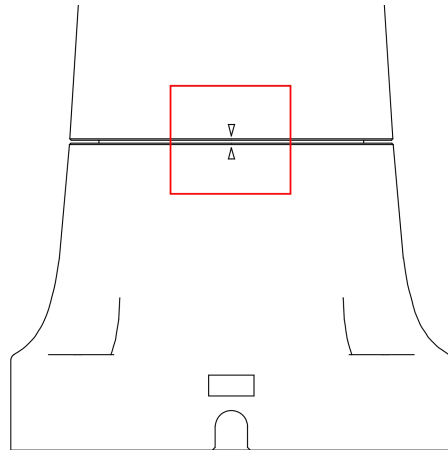


Figure 8-1 Step 1

Step 2: calibrate the second, third, fifth and sixth axis

Calibrate according to step 1.



Warning

After the mechanical zero calibration 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

ROKAE



ROKAE

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