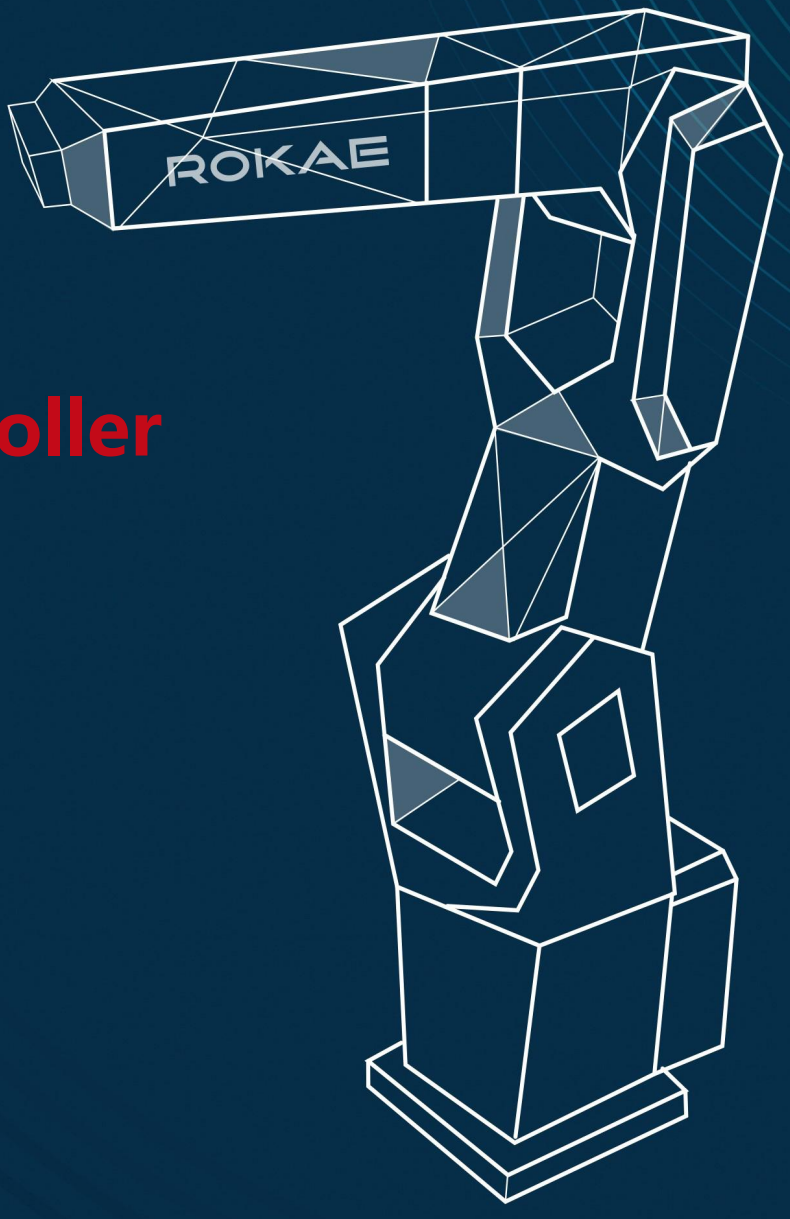
ROKAE 珞石



XBC5E Controller

Product Manual

More intelligent, more efficient

XBC5E Controller

Product Manual

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This manual is subject to update without prior notice.
We cannot foresee all possible dangers and consequences. Therefore, this manual cannot warn the user of all possible hazards.
If you find the contents of this manual wrong or in need of improvement or supplement, please contact us for correction.
This manual is originally written in Simplified Chinese. Other language versions are translated.
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Contents

1 Manual Overview

1.1 About this manual

Thank you for choosing the ROKAE robot system.

This manual contains the following instructions for correct installation and use of XBC5 controllers:

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

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 Contact

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

ROKAE Service Hotline: 400-010-8700

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 safety principles and processes that need to be noted when using the robot.

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 operations are carried out according to the safe operation instructions, we can not guarantee that our industrial robots will not cause personal and property losses.

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

2.1.2 Using the robot in compliance

The industrial 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 improper use is prohibited:

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

2.2 Safety terms

2.2.1 Safety symbols

2.2.1.1 About safety symbols

There may be different degrees of danger when operating the robot in accordance with this manual, so there will be a special safety symbol in the vicinity of dangerous operation instructions to remind the user to be careful. The contents include:

- An icon that indicates safety level and the corresponding name, such as warning, danger, and prompt;
- A brief description given to illustrate the possible consequences if the operator does not eliminate the danger;
- The operating instructions on how to eliminate dangers

2.2.1.2 Safety levels

Icon	Name	Explanation
	DANGER	For the contents that come with this sign, failure of following the rules in operation may cause serious or even fatal injury to personnel, and will/may cause serious damage to the robot. Operations related to such hazards include contacting high-voltage devices in the control cabinet, entering the working area when the robot is running, etc.
	Warning	For the contents that come with this sign, failure of following the rules in operation may cause serious and even fatal personal injury and will cause great damage to the robot.
	Alert	For those coming with this sign, failure of following the rules in operation may cause personal injury, and may cause damage to the robot.
	Tips	It is used to prompt some important information or prerequisites.

2.2.2 Hazard description

2.2.2.1 Hazards

Icon	Name	Explanation
	Squeezing	There may be an injury to the operators and maintenance personnel who enter into the motion range of the robot during debugging, repair, overhaul and tool installation.
	Hands Pinching	There may be a risk of hand pinching when the maintenance personnel approach the belt drive parts or other moving parts during maintenance.
	Strike	There may be a serious injury to the operators and maintenance personnel who enter into the motion range of the robot during debugging, repair, overhaul and tool installation.
	Friction	There may be an injury to the operators and maintenance personnel who enter into the motion range of the robot during debugging, repair, overhaul and tool installation.
	Parts Fly Out	There may be a serious injury to the operators and maintenance personnel who enter into the motion range of the robot during debugging, repair, overhaul and tool installation when tools or workpieces fly out due to loose clamping.
	Fire	Electrical short circuits, burning wires/devices may cause fire hazards, causing serious injuries.
	Hot Surface	During the maintenance and repair of the equipment, a burn may be caused if the maintenance personnel touch the

Icon	Name	Explanation
		robot's hot surface.
	Electric Shock Hazard	It indicates that the current operation may cause an electric shock hazard with a serious or even fatal injury.
	ESD	It indicates that the components involved in the current operation are sensitive to static electricity. Failure to operate according to specifications may cause damage.

Warning

Any robot in motion is a potentially fatal machine!

When the robot is running, it may execute undesirable or even unreasonable motions. In addition, the robot will carry huge energy when it is running. It will cause serious damage/injury to the personnel and equipment in its working area in case of collision.

2.2.2.2 Danger elimination

	Operation	Reference Information
1	Before running the robot, make sure that all safety protection devices have been properly configured and installed.	Safety protection devices include the emergency stop button, safety gate, safety grating, etc.
2	In the process of robot programming, the personnel who enter the robot working area must hold the Teach Pendant.	Personnel outside the working area must avoid using the Teach Pendant to operate the robot without observing the personnel inside the working area.
3	Before starting the robot program, make sure that there is no person in the robot working area.	
4	When programming the robot's motion, make sure to identify potential collision risks before the first commissioning.	

2.2.3 Safety features

2.2.3.1 Explanation

This robot system is equipped with a special safety controller for handling safety-related signals, and provides external safety symbol interfaces such as the safety gate and emergency stop button.

Signals processed or outputted by the safety controller include:

- Emergency stop button signal
- Safety gate signal
- Enabling switch signal
- Mode selection signal
- Emergency stop status signal

2.2.3.2 Applicable safety standards

The robot system is designed in accordance with the following relevant standards:

Standard	Description
2006/42/EC	Machinery directive
2014/30/EU	Electromagnetic compatibility directive
EN ISO 12100:2010	Safety of machinery - General principles for design - Risk assessment and risk reduction
EN ISO 10218-1:2011	Robots and robotic devices - Safety requirements for industrial robots - Part 1: Robots
EN ISO 13849-1:2015	Safety of machinery - Safety-related parts of control systems – Part 1: General principles for design
IEC 60204-1:2016	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
IEC 61508-2:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems
IEC 62061:2010	Safety of machinery - Functional safety of safety-related electrical/electronic/programmable electronic control systems
IEC 61000-6-2:2016	Electromagnetic compatibility - Generic standards - Immunity standard for industrial environments
IEC 61000-6-4:2011	Electromagnetic compatibility - Generic standards - Emission standard for industrial environments

2.2.4 Motion enabling and safe stop

2.2.4.1 Motion enabling

The motion control function of the robot control system should be enabled by the safety controller, which, when determining the safety level of the current environment through internal logic, controls on/off of drive STO (Safe Torque Off) via safety output signal. Manual operation of the robot by the user and automatic running of the program are not allowed by the control system before the safety controller determines that it is safe at the moment.

2.2.4.2 Safe stop

There are three ways to stop the robot, i.e. STOP 0, STOP 1 and STOP 2.

Safe stop refers to stop triggered by the safety controller, which only involves STOP 0 and STOP 1, while STOP 2 can only be triggered by the control system.

- STOP 0

As the stop method of the highest safety level, STOP 0 cuts off the power source of the motors and engages the band-type brakes of individual joints immediately. During the stopping process, however, the robot is uncontrolled and may deviate from the programmed path after it is stopped.

The following situations are classified as STOP 0:

1) Safe stops in the manual mode

2) Safe stops caused by mode switching in the automatic mode

● STOP 1

Once STOP 1 is triggered, the control system immediately executes the deceleration process along the programmed path. Thereafter, whether or not the robot comes to a complete stop, the safety controller will always cut off the power source of the motors and engage the band-type brakes of all joints. Since the stop is controlled, in most cases, the robot will finally stop on the programmed path. Therefore, This emergency stop method provides the best protection for nearby equipment.

The following situations are classified as STOP 1:

1) The safety gate/safety grating opens in the automatic mode.

2) Safe stops when the emergency stop button is pressed in the Automatic mode

● STOP 2

Once STOP 2 is triggered, the control system immediately executes deceleration along the programmed path until the robot stops completely. The power source of the motors is maintained and the band-type brakes are still disengaged, while the robot stays in the current position.

2.2.4.3 Emergency stop

As one of the safe stops, emergency stop is the function of the highest priority in the robot system. Pressing the emergency stop button triggers the emergency stop function. All other robot control functions will stop, the robot will stop movement, the power source of the motors of all joints will be cut off, and the control system will switch to the emergency stop state. Such state will be maintained until reset.

The emergency stop state means that, except the manual band-type brake release circuit, all other power supplies to the robot arm body will be cut off and the reset operation must be executed to restore the system to its normal condition.

> Tips
>
> Emergency stop is only used to stop the robot immediately in case of danger and cannot be used as a normal program; otherwise, extra and unnecessary abrasion will be caused to the band-type brake system and drive system of the robot to reduce the service life of the robot.

2.2.5 Safety devices

2.2.5.1 Emergency stop button

The emergency stop button is in red. The most common shape is a mushroom. In general, a yellow substrate, protective casing, or warning sign is also attached to the emergency stop button. The emergency stop button is mechanically locked when it is pressed. This is the safety lock mechanism for the button. The device must be reset through manual release. Most emergency stop buttons are released by rotation and the direction of rotation is indicated on the button surface. Some buttons also support releasing by upward pulling.

2.2.5.2 Enabling switch

The enabling device is a special switch with two segments of pressing and three positions, which is also called three-position enabling switch (hereinafter referred to as "enabling switch"), and is used to control the on and off of the power supply of the robot in the manual mode, thus realizing the motion enabling of the robot.

The enabling switch is installed on the back of the Teach Pendant, as shown in Fig. 1. The motor power supply is switched on only when the enabling switch is pressed and kept in the middle position, so that the robot is allowed to move, and you can perform Jog or run programs. Either releasing or pressing all the way down will cut off the motor power supply.

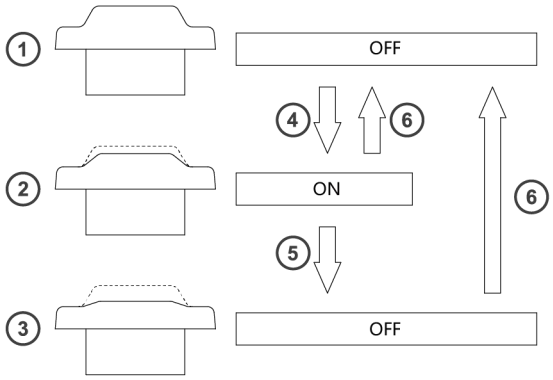


Fig. 1 Schematic diagram of the enabling switch

No.	Name
1	Position 1
2	Position 2
3	Position 3
4	Tap
5	Press tightly
6	Release

Warning

It is strictly prohibited to use any external devices to keep the enabling switch locked or stopped in the middle position!

Tips

Under any circumstances, ensure that the enabling switch can work properly.

During programming and debugging, the enabling switch should be released as soon as possible when robot motion is not required.

2.3 Safety precautions

2.3.1 Overview

2.3.1.1 About the robot

Regardless of the motion speed, the industrial robot poses great potential hazard. A quick and dangerous motion command may be performed following a pause or waiting during program running. Even if you have known the motion track and mode of the current robot, the motion track of the robot in the auto mode may still be changed by external signals without warning.

Therefore, one must observe the safety specification when entering the working range of the robot.

2.3.1.2 About this section

This section describes some basic safety specifications to the end users of the robot. However, it cannot cover each specific circumstance due to limited space.

2.3.2 About the user’ s own safety

2.3.2.1 General principles

To ensure safety when using the robot, the following principles must be observed strictly:

- The workers are only allowed to operate the robot in the manual mode when they are within the safety zone of the robot.
- You should hold the Teach Pendant in your hands when entering the safety zone of the robot to ensure that the robot is under your control.
- Pay attention to the active tools installed on the robot, such as the electric drill and electric saw. They shall be stopped when approaching the robot.
- Pay attention to the workpiece surface or the robot arm body. The motor and casing temperature of the robot may become very high after prolonged work.
- Watch out for grippers and objects gripped. If the gripper is opened, the workpiece could fall and cause personal injury or equipment damage. Moreover, the manipulator of the robot may be very powerful and may cause injury if it is not used according to the specification.
- Pay attention to the electrical components in the robot control cabinet. Even if the power supply is interrupted, the remaining power in the component is still very dangerous.

2.3.3 Safety precautions for operating the Teach Pendant

2.3.3.1 Safe storage of the Teach Pendant

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

2.3.3.2 Teach Pendant cable

The Teach Pendant and control cabinet 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.

2.3.3.3 Permission of using the Teach Pendant

The mode selection switch of a standard Teach Pendant is equipped with a key, i.e. switchover between manual/auto modes is only possible using the key. Please keep the key properly and carefully consider the user permission of the key. Generally, only those personnel who have completed safety training and basic operation training can have the permission to use the key.

> Warning
>
> The key to the mode selection switch on the Teach Pendant is designed for all Teach Pendants of the same model according to standard.
> Ensure that all keys are kept by qualified personnel to prevent misuse.

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.

2.3.3.4 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.

2.3.4 Safety precautions for using the control cabinet

2.3.4.1 Make sure that there is no conductive foreign objects in the control cabinet

After operations such as repair and component replacement on the control cabinet, make sure to check if there is any conductive foreign object in the cabinet. Such objects may cause short circuit in the control cabinet during use of the robot, thus resulting in other dangers.

2.3.4.2 Do not supply power to the control cabinet when the cabinet door is open

- Make sure that the cabinet door has been closed before switching on the robot control cabinet.
- Not all electrical devices or nodes in the control cabinet are protected. Therefore, do not use the control cabinet when the cabinet door is open to avoid fatal danger to the operator or equipment!
- The control cabinet cannot reach the claimed protection level when the cabinet door is open.
- When the cabinet door is open, components in the cabinet are more prone to electromagnetic interference and may generate excessive radiation to the outside, thus directly affecting the use of the robot system.

2.3.4.3 Do not use the control cabinet for other purposes

The control cabinet is only used to control motion of the robot arm body. Using it for any other purposes, such as standing on the cabinet body, working on the control cabinet and using the cabinet body as a ladder, is prohibited.

2.3.5 Emergency stop button test

The emergency stop button is the only means to trigger the emergency stop as well as the most important device to protect the safety of operators and equipment in case of emergency.

Therefore, when the robot is put into use for the first time and when the robot is started for the first time after an overhaul, you must first test the emergency stop button, including testing the external emergency stop button that the integrator has connected into the robot system, so as to confirm that pressing the emergency stop button can force the equipment to enter the emergency stop state and executing the reset operation can exit the emergency stop state.

Only after confirming the normal operation of the emergency stop button can you conduct configuration or programming on the robot.

2.3.6 Resetting the emergency stop

2.3.6.1 Explanation

When the system is in the emergency stop state, reset it to return to its normal state. The reset is a simple but important procedure. It ensures that the robot system is not returned to production in hazardous conditions.

2.3.6.2 Reset emergency stop button

All button-shaped emergency stop devices are equipped with one safety lock mechanism, which must be released manually after being pressed to reset the emergency stop status of the device. Most emergency stop buttons are released by rotation and the direction of rotation is indicated on the button surface. Some buttons also support releasing by upward pulling.

2.3.6.3 Operating procedures of resetting the emergency stop

No.	Operation
1	Confirm that the dangerous conditions causing the emergency stop have been

	handled and the hazards are removed.
2	Reset the safety device causing the emergency stop.
3	Press the reset button on the control cabinet or click the reset button on the Teach Pendant/PC interface to recover the system from the emergency stop state. In auto mode, you can also use the system input signal to reset the system emergency stop state. Caution! This operation depends on the control cabinet model. For specific operations, refer to the corresponding control cabinet product manual and control system operation manual.

2.3.7 Band-type brake test

When the system enters the emergency stop state, the power source of the motors will be cut off and the band-type brakes of all joints will engage. Therefore, the normal operation of the band-type brakes helps ensure the safety of the operator and reduces risks when the robot enters the emergency stop state.

During daily use of the robot, normal wear will occur to the band-type brakes of individual joints. It is very necessary to carry out band-type brake tests to ensure its functioning.

The testing method is as follows:

No.	Operation
1	In manual mode, run each axis to its maximum load position.
2	Press the enabling switch and keep it in the middle position. Then the motor power supply is switched on and the band-type brakes are disengaged.
3	Release the enabling switch to engage the band-type brakes. Observe if the robot arm body keeps its previous position. You can observe the angle value of each axis through the Teach Pendant to confirm that the position of each joint remains unchanged.
4	Test each axis one by one. If the position of each axis remains unchanged, it is believed that the band-type brake function works well.

2.3.8 Manual release of the band-type brake

When the robot is in the emergency stop state, all other power supplies to the robot arm body are cut off except the manual band-type brake release circuit. In case of emergency, you can move the robot arm body by manually releasing the band-type brake.

A band-type bake release button is installed on the standard control cabinet. When this function is not used, keep the protective cover of this button in place so as to prevent this function from being triggered mistakenly.

The band-type brake release button is also installed on some models of robot arm bodies. The method for triggering this function is different based on the models. Please carefully check the product manual of the corresponding arm body.

DANGER

Before manually releasing the band-type brake, make sure that the trapped person

and operator will not be injured during the process of moving the arm body!

Warning

When moving the robot arm body by manually releasing the band-type brake, please note:

For small-load models, you can manually move each axis of the arm body. For medium- and large-load models, a traveling crane, a hoist or other equipment should be used to help move each axis of the arm body.

2.3.9 Safety precautions in Manual mode

2.3.9.1 About the Manual mode

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

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

2.3.9.2 Speed limitation in Manual mode

The motion velocity of the robot end is limited to less than 250mm/s in manual mode. This means that the maximum motion velocity of the robot end will not exceed 250mm/s whether you perform Jog or run programs on the robot, regardless of the set velocity in the program.

2.3.9.3 Bypassing external safety signals

In manual mode, signals of external safety devices such as the safety door and safety grating will be bypassed, i.e. in manual mode, the system can still perform motor enabling operations even if the safety door is opened. The system will not prompt the safety door opening information for the convenience of debugging.

2.3.10 Safety precautions in Automatic mode

2.3.10.1 About the Automatic mode

The auto mode is used to run robot programs during the formal production process.

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

2.3.10.2 Enabling external safety signals

In auto mode, external safety devices such as the safety door and safety grating will be enabled. When the safety door is opened, the motor power supply will be switched off and the band-type brake will be engaged.

2.3.11 Safe handling on the production line

In most cases, the robot is a part of the production line. Therefore, robot failures do not only affect the robot itself, but may also affect the entire production line. Likewise, problems with other parts of the production line may also affect the robot. For this reason, a fault remedial plan should be designed by personnel who are very familiar with the entire production line in order to improve the safety of the whole system.

- Pay attention to other devices that interact with the robot
  For example, when a robot needs maintenance, you must first remove it from the production line, as well as remove other devices interacting with the robot, such as the robot loading it.
- 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 fails and in order to guarantee uninterrupted production, the conveyor belt may keep running while the robot is being repaired. The robot maintenance personnel must pay extra attention to safety, give advance consideration to the risks that might arise from the running conveyor belt and develop detailed safety measures for working in such environment.

2.3.12 Safe handling of fire accidents

2.3.12.1 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 (CO_2) fire extinguisher.

2.3.12.2 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.

2.3.13 Safe handling of electric shock accidents

2.3.13.1 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!

2.3.13.2 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.

2.4 Personnel and work content requirements

2.4.1 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, but may not enter into the safety zone.
- 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.

2.4.2 Personnel requirements

2.4.2.1 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.

2.4.2.2 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.

2.4.2.3 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.

2.4.3 Work content requirements

2.4.3.1 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 control cabinet storage device. In order to prevent data loss caused by accidents, it is recommended that the user makes data backup regularly.

2.4.3.2 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.

2.4.3.3 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.

2.5 Safety training

2.5.1 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.

2.5.2 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.

2.5.2.1 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 control cabinet 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.

2.5.2.2 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.

2.5.2.3 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 control cabinet, if it is necessary to touch the power supply unit or printed circuit board, make sure to switch off the power supply of the main circuit breaker of the control cabinet first to prevent electric shock.

3 Product Overview

3.1 Introduction

3.1.1 Overview of the robot system

A complete robot system consists of the robot arm body, a control cabinet, a Teach Pendant, a robot relay cable, control system software, etc. For details, see Figure 2.

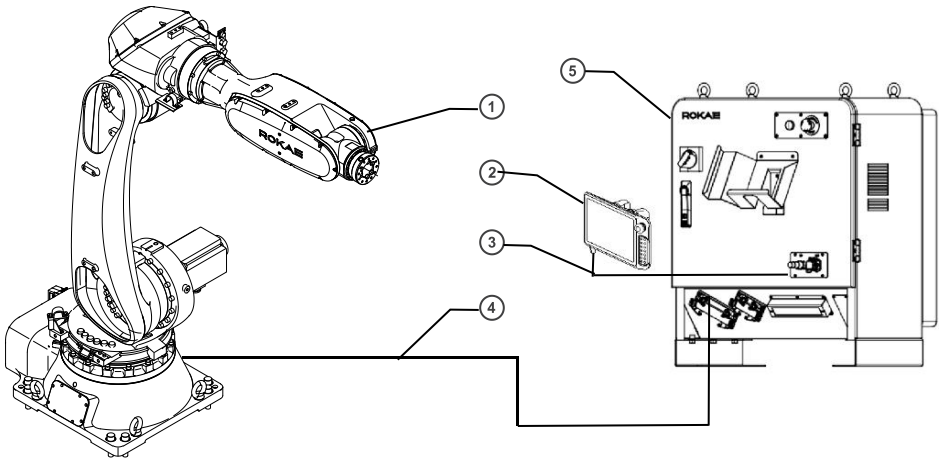


Figure 2 Robot system

No.	Name
1	Robot body
2	Teach Pendant
3	Teach Pendant cable
4	Cabinet cable
5	Controller

3.2 Robot control cabinet overview

3.2.1 Control cabinet overview

All the main components of the robot control system are installed in a control cabinet called XBC (short for xBot Control Cabinet). The model number on the nameplate of the robot control cabinet generally begins with XBC. The XBC5E control cabinet is shown in Figure 3.

Figure 3 XBC5E control cabinet

3.2.2 Control cabinet components

The XBC control cabinet consists of all the necessary components to control the robot motion, including:

- Strong current module - Controls the overall power supply and circuit protection of the control cabinet;
- Weak current module - Controls the power supply of weak current modules such as controllers and band-type brakes;
- Control module - Includes the main controller and the safety controller;
- IO module - Provides digital inputs and outputs for users;
- Drive module - Implements the motion planning of the main controller and drives the motor;
- Cooling module - Keeps the temperature in the cabinet within a suitable range;
- Braking module - Absorbs the energy generated by the motor during braking;
- Expansion module - Optional fieldbus.

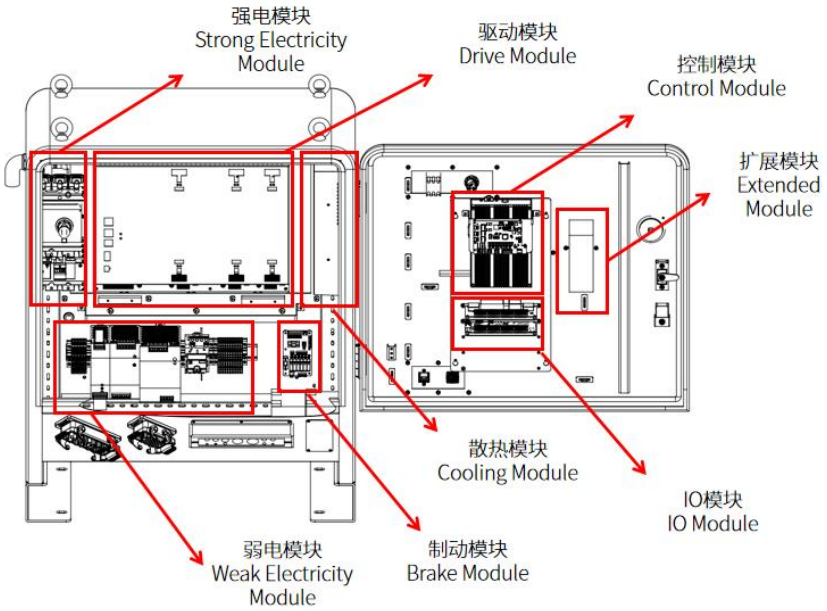


Figure 4 XBC5E layout

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 5 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

3.4.1 Control cabinet nameplate

The information on the control cabinet nameplate is shown in Figure 6.

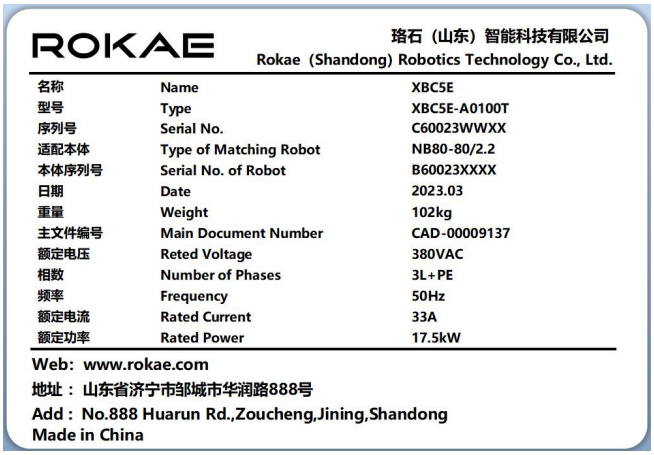


Figure 6 Control cabinet nameplate

3.4.2 Control cabinet IO wiring diagram

The wiring information of safety IO and general-purpose IO in the cabinet is shown in Figure 7. Please refer to the actual IO configuration in the control cabinet.

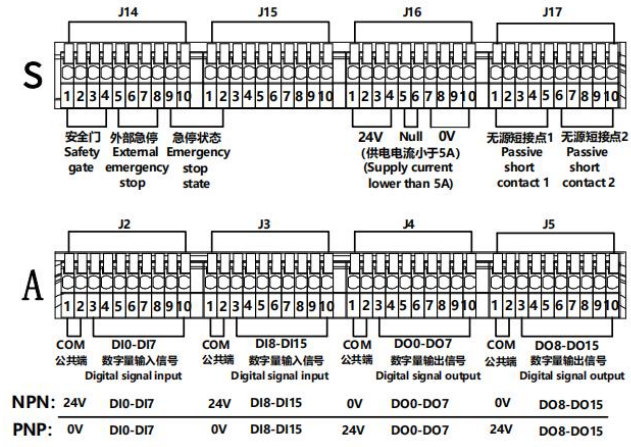


Figure 7 IO stickers in the cabinet

3.4.3 Teach Pendant nameplate

The information on the Teach Pendant nameplate is shown in Figure 8.

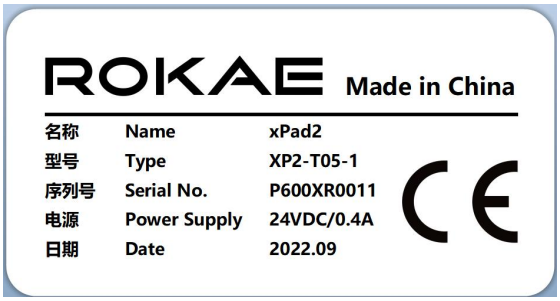


Figure 8 Teach Pendant nameplate

3.5 Variations and options

3.5.1 Optional relay cable configuration

Order No.	Relay Cable	Compatible Models
Z8	Body side front-outlet relay cable, length: 8m	NB80 Series, NB220 Series (standard)
Z15	Body side front-outlet relay cable, length: 15m	NB80 Series, NB220 Series, optional
Z25	Body side front-outlet relay cable, length: 25m	NB80 Series, NB220 Series, optional

Note: The outlet of the connector on the control cabinet is on the side.

3.5.2 Optional digital IO modules

Expansion Module	Description	Note
DI/DO Module	NPN/PNP, DI/DO: 16/16 inputs and outputs	Standard: 16 inputs and outputs, max. 64 inputs and outputs in the cabinet and max. 128 inputs and outputs in total

The function definition of the digital IO module's wiring points is shown in Figure 9:

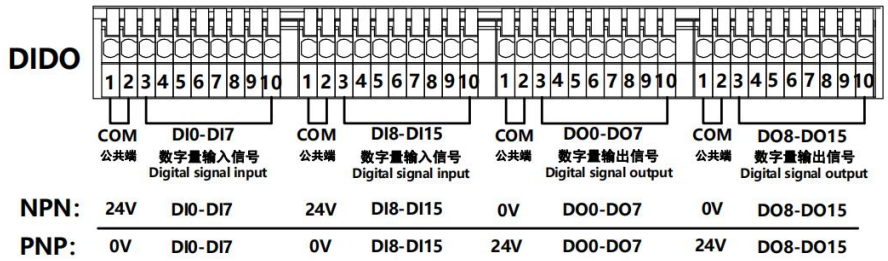


Figure 9 Function definition of digital IO module's wiring points

See the table below for the specifications of digital IO modules:

Parameter	Min	Rated	Max	Unit
Operating temperature	0	25	50	℃
Storage temperature	-20	25	85	℃

Input voltage range	15	24	36	V
DI input type	NPN or PNP configurable			
DI high-level voltage	15	24	28	V
DI low-level voltage	0	0	5	V
DO output type	NPN or PNP configurable. Max. operating voltage: 28 V			
DO current per channel	-	-	300	mA
Single board consumption	-	-	5	W
Single board dimensions	150 × 65			mm
Single board thickness	1.6			mm
Standard	IEC 61131-2:2017			
Power protection	The 24 V power supply is protected against reverse polarity and short circuits.			

The module's DO has no overcurrent protection. If the continuous load current exceeds the limit, an additional relay will be required to drive the system.

3.5.3 Optional analog IO modules

Expansion Module	Description	Note
AI/AO Module	4/4 AI/AO, voltage mode or current mode configurable	Optional, max. 8 AI/AO

The function definition of the analog IO module's wiring points is shown in Figure 10:

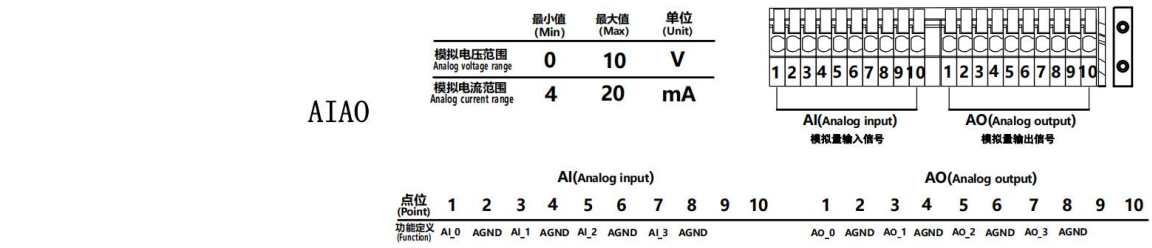


Figure 10 Function definition of analog IO module's wiring points

See the below table for the specifications of analog IO modules:

Parameter	Min	Rated	Max	Unit
Operating	0	25	50	℃

temperature				
Storage temperature	-20	25	85	℃
Input voltage range	15	24	36	V
Analog voltage input	0	-	10	V
Analog voltage output	0	-	10	V
Sampling accuracy	12			bits
Analog current input	4	-	20	mA
Analog current output	4	-	20	mA
Sampling accuracy	12			bits
Single board consumption	-	-	5	W
Single board dimensions	150 × 65			mm
Single board thickness	1.6			mm
Standard	IEC 61131-2:2017			

3.5.4 Plating Line Tracking (Optional)

This section describes the hardware that supports workpiece tracking on the plating line (hereinafter referred to as CTM01A board).

Expansion Module	Description	Note
CTM01A board	2 photoelectric switch interfaces and 2 incremental photoelectric encoder interfaces, suitable for application scenarios with two parallel conveyor belts.	Optional

The CTM01A board terminals are shown in Figure 11:

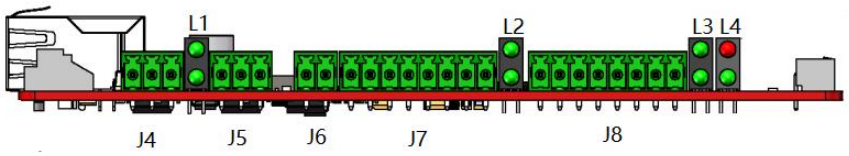


Figure 11 CTM01A board terminals

See the table below for the definition of pins J4 and J5 on the photoelectric switch interface:

J4	1	24VOUT	24 V power output terminal for photoelectric switch
	2	DIN1	Signal input terminal for photoelectric switch 1
	3	GND	Power supply negative terminal
J5	1	24VOUT	24 V power output terminal for photoelectric switch
	2	DIN2	Signal input terminal for photoelectric switch 2
	3	GND	Power supply negative terminal

The wiring diagram is shown in Figure 12:

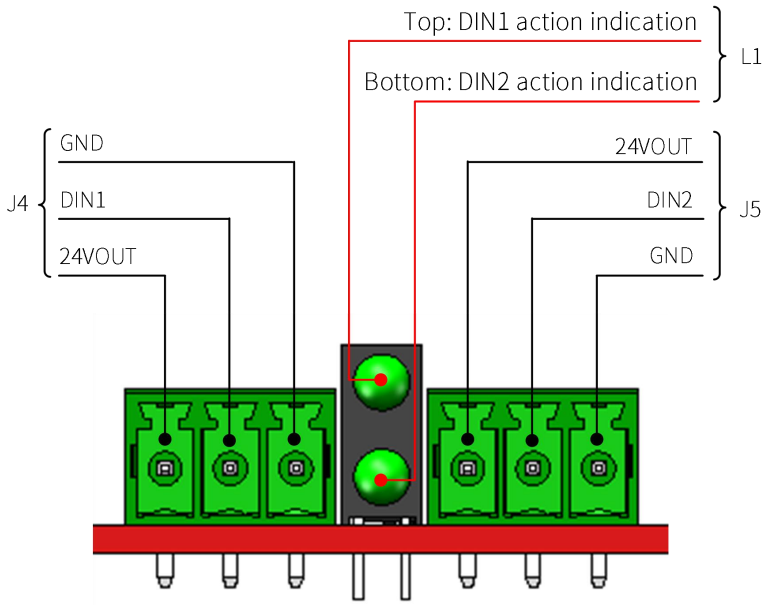


Figure 12 Wiring diagram

See the table below for the definition of pins J6, J7, and J8 on the encoder interface:

J6	1	GND	Power supply negative terminal
	2	ExtVIN	External input power, positive
J7	1	VENC1	Power output for encoder 1
	2	VENC1	Power output for encoder 1
	3	GND	Power supply negative terminal
	4	1A+	Phase A non-inverting terminal for encoder 1
	5	1A-	Phase A inverting terminal for encoder 1
	6	1B+	Phase B non-inverting terminal for encoder 1
	7	1B-	Phase B inverting terminal for encoder 1
	8	GND	Power supply negative terminal
J8	1	VENC2	Power output for encoder 2
	2	VENC2	Power output for encoder 2
	3	GND	Power supply negative terminal
	4	2A+	Phase A non-inverting terminal for encoder 2
	5	2A-	Phase A inverting terminal for encoder 2
	6	2B+	Phase B non-inverting terminal for encoder 2

	7	2B-	Phase B inverting terminal for encoder 2
	8	GND	Power supply negative terminal

The wiring diagram is shown in Figure 13:

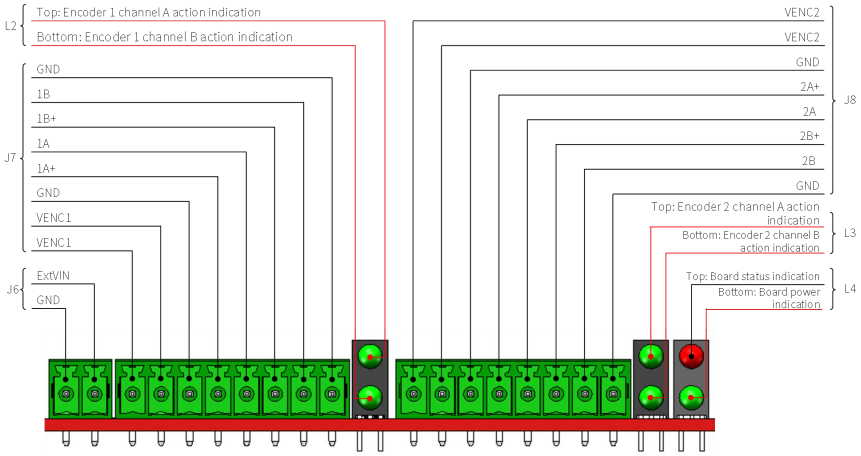


Figure 13 Wiring diagram

There are four groups of LED indicators on the CTM01A board, and each group has one at the top and one at the bottom. Their statuses are as follows:

L1	Top: DIN1 action indication	Turns on when photoelectric switch 1 connected to J4 acts; Turns off when not in action.
	Bottom: DIN2 action indication	Turns on when the photoelectric switch 2 connected to J5 acts; Turns off when not in action.
L2	Top: Encoder 1 channel A action indication	Turns on when channel A of encoder 1 connected to J7 acts; Turns off when not in action.
	Bottom: Encoder 1 channel B action indication	Turns on when channel B of encoder 1 connected to J7 acts; Turns off when not in action.
L3	Top: Encoder 2 channel A action indication	Turns on when channel A of encoder 1 connected to J8 acts; Turns off when not in action.
	Bottom: Encoder 2 channel B action indication	Turns on when channel B of encoder 1 connected to J8 acts; Turns off when not in action.
L4	Top: Board status indication	Turns off when the board is working properly; Turns on when the board is defective.
	Bottom: Board power indication	Turns on when the board is powered on; Turns off when the board is powered off.

See the table below for the specifications of the CTM01A board:

Parameter	Description
Power supply	Typical 24 VDC, min. 20 VDC, max. 28V DC
Operating current	⩽300 mA
Communication method	EtherCAT slaves
No. of photoelectric switches	2, compatible with NPN and PNP output
Photoelectric switch power supply	On-board 24 V/200 mA
No. of encoders	2, compatible
Encoder power supply	On-board 5 V/200 mA max. or external power supply (voltage range: 5 VDC to 30 VDC)
Dimensions	152.25mm (L) × 68mm (W) ×18.7mm (H)
Operating Condition	-10 C to +55°C, below 95% RH
Storage condition	-20°C to 65°C, below 95% RH

Typical applications of CTM01A board

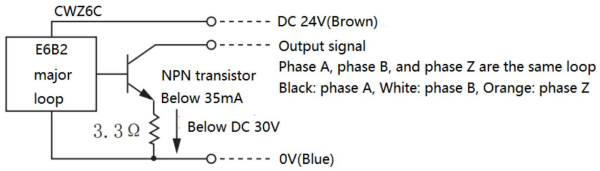
➢ Proximity switch

The CTM01A board does not distinguish the output type of the proximity switch. Both NPN and PNP can be directly connected to the board as per the pin definition.

➢ Photoelectric encoder

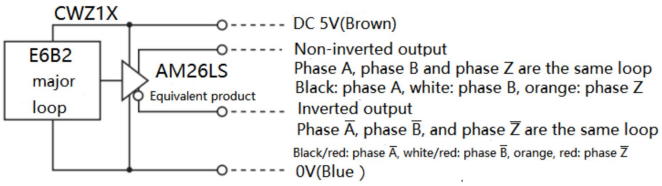
The photoelectric encoder interface of the CTM01A board only supports the A/B-phase signal of the incremental photoelectric encoder. The Z-phase signal is not connected to the CTM01A board. Different wiring methods are used for different encoder output types.

1) NPN open collector output



For this type of A/B-phase encoder outputs, connect the A/B-phase encoder signal to the pins A- and B-, and at the same time, short-circuit the pins A+ and B+ of the CTM01A board to the VENC pin.

2) Linear drive output



For this type of A/B-phase encoder outputs, connect the A+/A-/B+/B- encoder signals to the corresponding A+/A-/B+/B- pins of the CTM01A board.

3.5.5 Optional fieldbus

Expansion Module	Description	Note
Fieldbus	Profinet module	Requires the IPC communication network interface
	Ethernet/IP module	1 piece in the cabinet
	CC-Link module	1 piece in the cabinet
	Modbus	Requires the IPC communication network interface

3.5.6 Power cord

Product name	Description	Note
XBC5E power cord	Default length: 8m	Customized length available

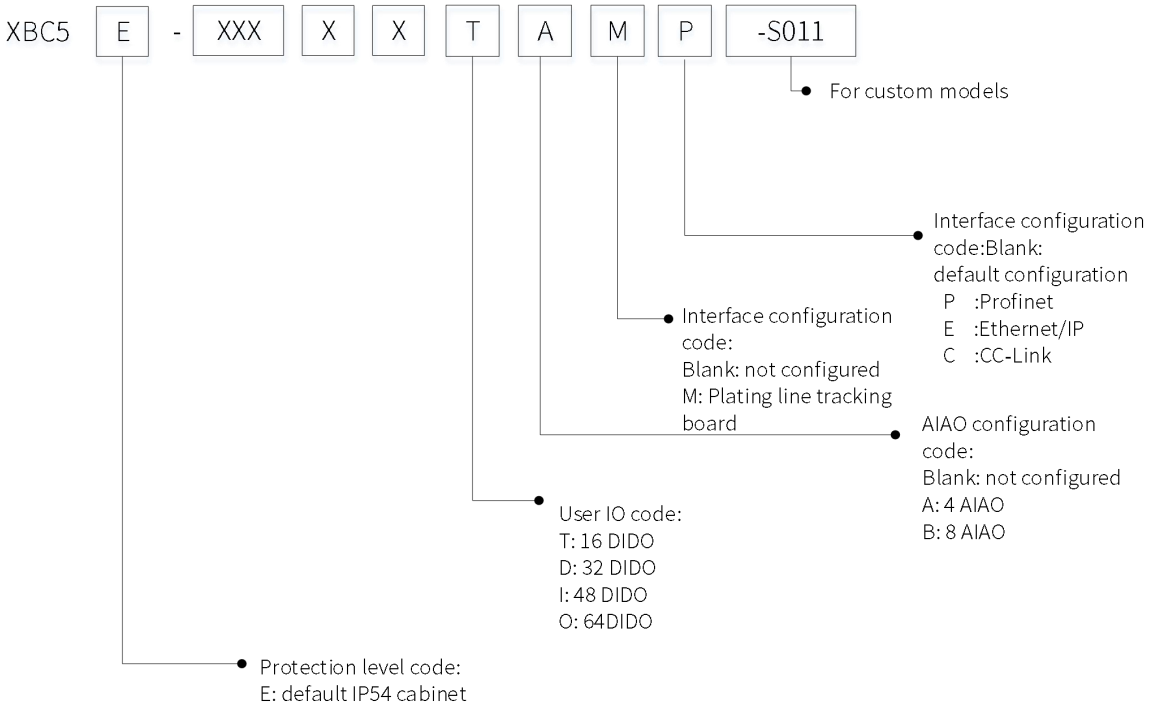
3.5.7 Optional features

Function	Note
Collision detection	Function enabled before use
Multi-task	Function enabled before use
External expansion AI/AO	Expansion modules installed inside or outside the control cabinet before use (optional)
Plating line tracking	Expansion modules installed inside or outside the control cabinet before use (optional)
Ethernet/IP	Expansion modules installed inside or outside the control cabinet before use (optional)
Profinet	Function enabled before use
CC-Link	Expansion modules installed inside or outside the control cabinet before use (optional)
Modbus	The function is enabled and ready for use by default

4 Specifications

4.1 Product model description

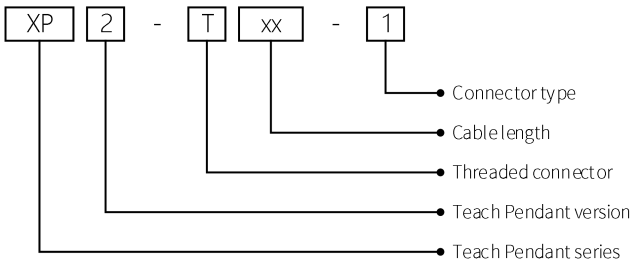
4.1.1 Controller model description



XBC5E product model description

4.1.2 xPad Teach Pendant model description

xPad2 Teach Pendant models are indicated as follows:



Teach Pendant model description

4.2 Control cabinet specifications

Product name		XBC5E
Standard number of axes		6
➢ Mounting method		➢ Floor mounting ➢ Ceiling mounting
Noise		⩽70 dB(A)
Protection level		IP54
Electrical connections	Power supply	3-phase 380 VAC, 50-60Hz; voltage fluctuation within -10% to +10%, frequency variation within ±2%
	Power consumption	17.5 kW (NB80 Series); 32.6 kW (NB220 Series)
	Maximum short circuit current	19 kVA
	Rated power and current	See the control cabinet nameplate
Operating temperature		0°C to +45°C
Storage temperature		-10°C to +55°C
Maximum humidity for operation/storage		⩽ 95%, non-condensing, non-frost
Operating Environment		Indoor installation Avoid exposure to sunlight Prevent water intrusion from all directions Do not transfer shock and vibration Keep away from sources of electrical interference Altitude: below 1000 m
Physical properties	Dimensions	690mm (L) × 514mm (W) × 835mm (H) (See Section 4.4 for details)
	Weight	Approx. 102 kg
	Cabinet color	Gray and white
User interface	Inputs and outputs (PNP, NPN)	Standard 16/16, expandable to 128/128
	Standard fieldbus	➢ EtherCAT ➢ Ethernet (Gigabit) ➢ USB
	Serial	➢ RS232

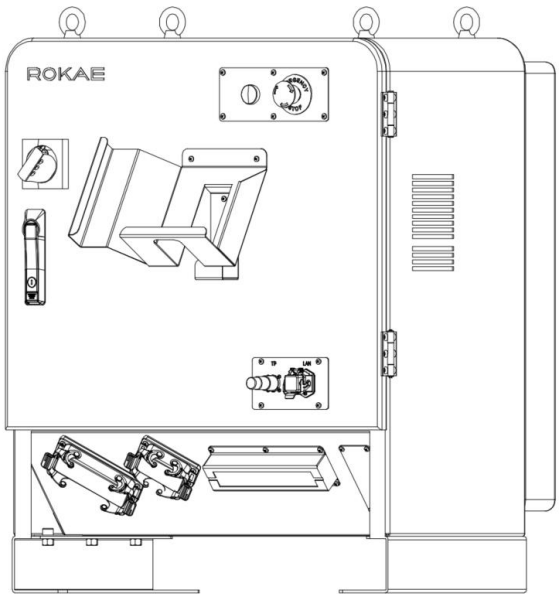
Product name		XBC5E
	communication interface	
	Optional fieldbus	➢ Ethernet/IP ➢ Profinet ➢ Modbus ➢ CC-Link
	DC output	Output voltage: 24 VDC Maximum current: 5 A

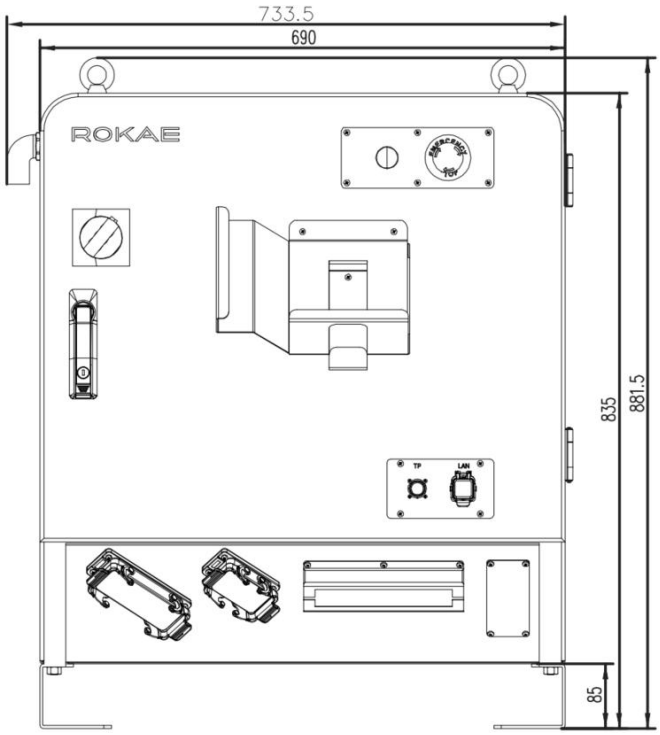
4.3 Teach Pendant specifications

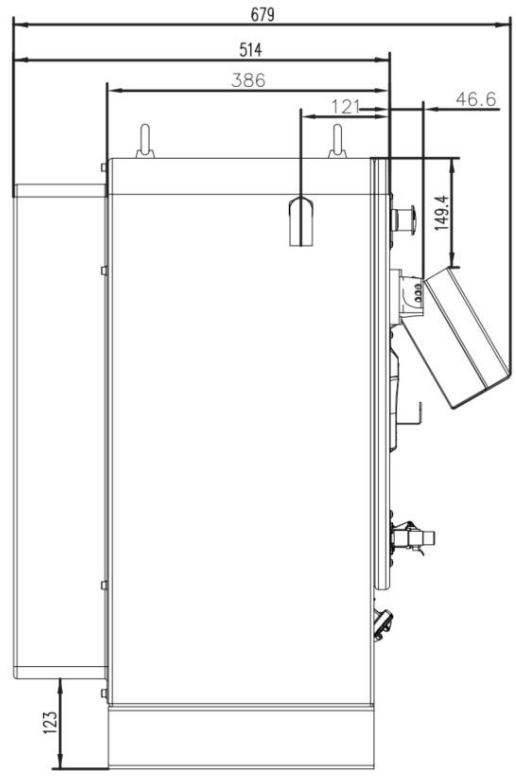
Product name		xPad2
Screen size		10.1 inches
Resolution		1920*1200
Dimensions		290×170×80 mm^3
Weight		840 g (excluding cable)
Minimum cable bending radius		77 mm
Protection level		IP54
External interface		USB 3.0
Environment	Operating temperature	0°C to +45°C
	Storage temperature	-25°C to +55°C
	Maximum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

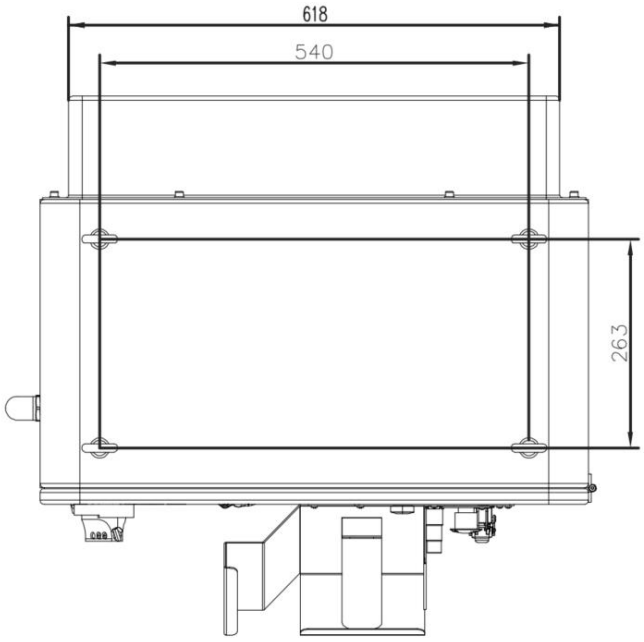
4.4 Product appearance and dimensions

The XBC5E controller appearance and dimensions are shown in Figure 14:


ROKAE


733.5
690
ROKAE
835
881.5
85


679
514
386
121
46.6
149.4
123


618
540
263

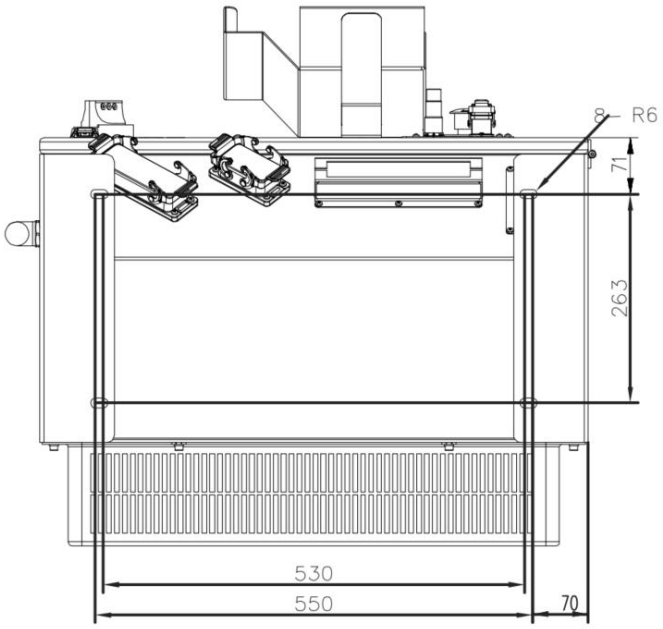


Figure 14 XBC5E appearance and dimensions

5 Installation

5.1 Environmental conditions

The controller must run in an environment that meets the conditions as follows:

XBC5E controller:

Item	Condition
Temperature	0°C to +45°C
Relative humidity	⩽ 95%, non-condensing
Environment	➢ Indoor installation ➢ Avoid exposure to sunlight ➢ Prevent water intrusion from all directions ➢ Do not transfer shock and vibration ➢ Keep away from sources of electrical interference ➢ Altitude: below 1000 m

5.2 On-site installation

5.2.1 Transportation

- The control cabinet is made of precision components. Make sure to avoid excessive shock and vibration during transportation.
- In order to ensure safe transportation and installation, remove all obstacles in advance to keep the passage clear.
- During transportation of the control cabinet:
  (1) Keep the ambient temperature within the range from −10 °C to 55 °C.
  (2) Keep the ambient humidity ⩽ 80%, non-condensing, non-frost.
  (3) Avoid excessive shock and vibration.

Danger

Be sure to turn off all power supplies, sources of hydraulic pressure, and air sources to the robot during transportation.

5.2.2 Installation

The XBC5E control cabinet is floor mounted. Please note the following during installation:

- To ensure effective heat dissipation and avoid overheating the control system, keep a space of no less than 300 mm in front and back of the control cabinet and no less than 100 mm to the left and right when placing the XBC control cabinet.

- Reserve a space for the cable outlet on the control cabinet. The bending radius of the relay cable should be 150 mm at least.
- The space for plugging and unplugging the Teach Pendant cable should be 77 mm at least, as shown in Figure Figure 15.

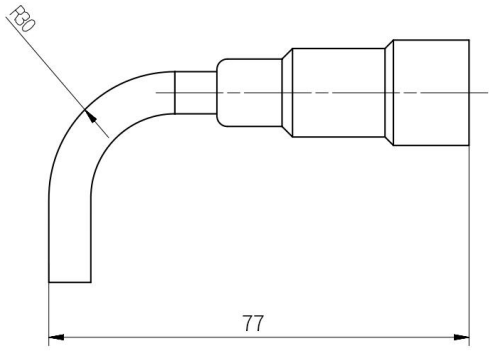


Figure 15 Bending radius of the Teach Pendant cable

Danger

The control cabinet contains high-voltage components. Unauthorized personnel is strictly prohibited from opening the cabinet case. Otherwise, severe or even fatal injuries may occur!

6 Electrical Connections

6.1 Interface description

6.1.1 Control cabinet interface description

The interfaces of the XBC5E control cabinet are shown in Figure Figure 16:

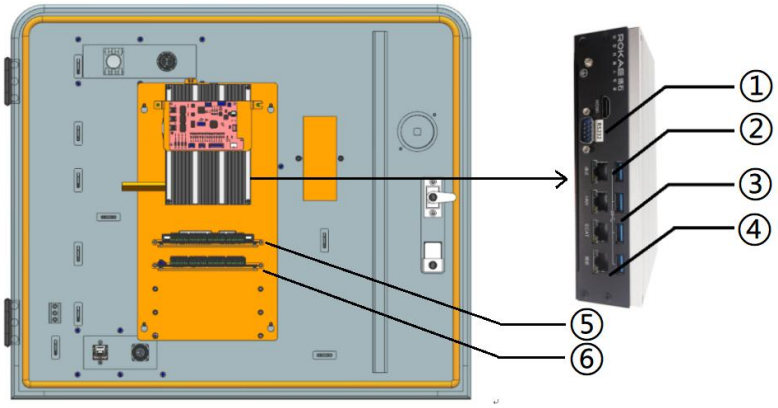


Figure 16 Interfaces of the XBC5E control cabinet

1	**RS232 interface,** used for RS232 serial communication or debugging.
2	**Debugging interface:** used for internal debugging by after-sales personnel
3	**USB interface**: used for internal debugging and data import/export
4	**Visual interface:** used for connecting an industrial camera with an RJ45 interface
5	**Safety IO wiring terminals**. Please refer to IO Interface Definitions for the detailed pin definition.
6	**General-purpose IO wiring terminals**. Please refer to IO Interface Definitions for the detailed pin definition.

Note: For general-purpose IO wiring terminals (item 6 in the above table), there are four groups of interface windows. One group of interface windows is reserved by default, and the other 3 groups are used as expansion windows, with up to 64 DI/DOs (4 × 16).

Danger

The control cabinet contains high-voltage components. Before opening the front door of XBC5E for wiring, make sure that the control cabinet is powered off. After wiring, make sure that the front door is closed before powering on the control cabinet. Live operation/hot-line job may cause damage to the components. Improper operation may result in severe or even fatal personal injuries!

- USB interface

  The XBC control cabinet features one USB interface by default, which is used for on-site debugging.

- Network interface

The XBC5E control cabinet has no external network interface. It is connected to the IPC. The interfaces on the IPC are shown in Figure 17:

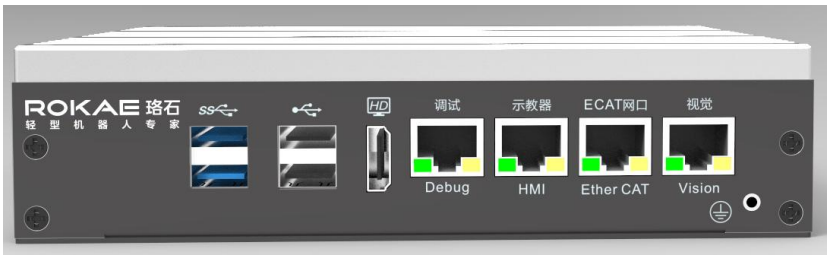


Figure. 17 IPC interfaces

The function of each IPC interface is shown in the table below:

Function Definition	Description
Debugging network interface	Used for development and debugging with the default IP address of 192.168.0.160
Teach Pendant network interface	Used to connect the Teach Pendant
ECAT network interface	Used for EtherCAT communication
Visual network interface	Used for visual communication with the default IP address of 192.168.2.160

The user can modify the debug IP and visual IP via Control Panel - Communication - External Communication. After the modification is completed, click Save to take effect immediately. The external communication interface is shown in Figure 18.

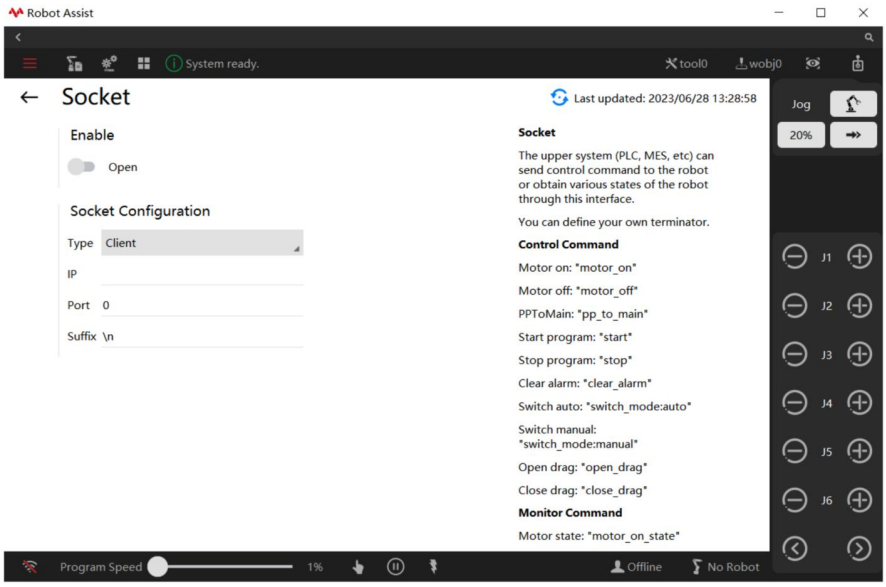


Figure 18 External communication interface

> **Warning**
>
> The debug IP and visual IP network segments cannot be 192.168.1.XXX and the debug and visual network segments cannot be repeated. For example, the visual IP and the debug IP cannot be 192.168.2.XXX at the same time.

6.1.2 Teach Pendant interface description

The Teach Pendant has a USB interface on the top.

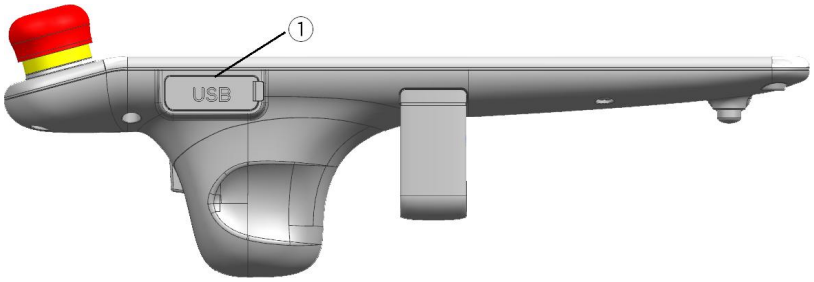


Figure 19 Teach Pendant interface

	Description
1	USB interface: used for connecting the USB drive and protected with a rubber cover

6.2 Electrical connections

6.2.1 Cable connection

The cables used in the robot system include:

No.	Name	Description
1	Teach Pendant cable	Fixed on the Teach Pendant, with an aviation plug
2	Robot relay cable	Combination cable for power and signal with a heavy-duty connector

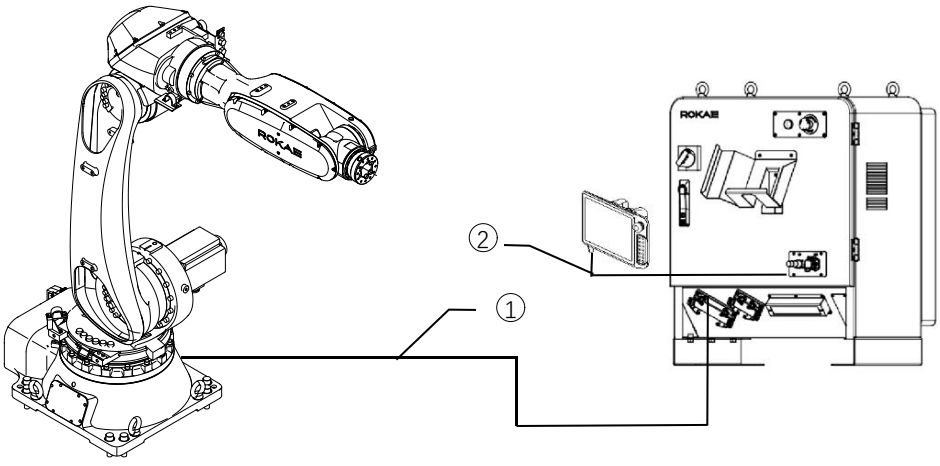


Figure 20 Robot system cable connection

- Connecting to the Teach Pendant

Please connect the Teach Pendant cable as shown in 图 21:

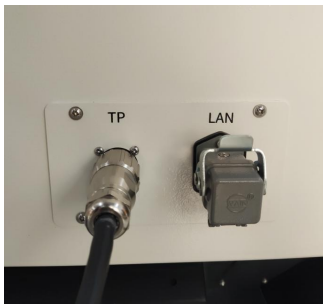


Figure 21 Teach Pendant cable connection

- Connecting to the robot

	Description
1	Heavy-duty socket on the robot
2	Heavy-duty connector of the relay cable's power line
3	Heavy-duty connector of the relay cable's encoder line

The XBC5E series control cabinet comes standard with a next-generation heavy-duty connector. Please connect the robot relay cable as shown in Figure 22. Item 1 in Figure 22 is the wiring panel on the rear side of the robot base, item 2 is the heavy-duty connector of the relay cable's power line, and item 3 is the heavy-duty connector of the relay cable's encoder line.

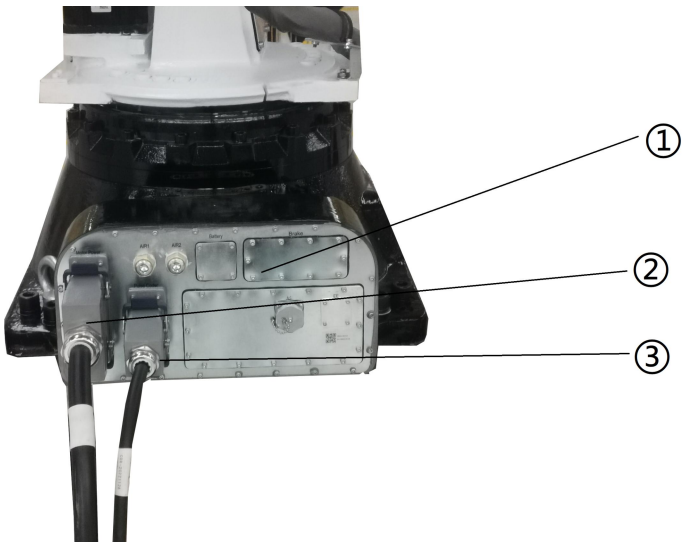


Figure 22 Connecting to the robot

Notes

The pins in the heavy-duty connector have a margin for movement, so please handle them gently when connecting the heavy-duty connector. Check whether the pins are skewed when encountering resistance, and make adjustments before proceeding to

avoid damaging the heavy-duty pins.

- Connecting the power supply

  The XBC5E control cabinet powered by three-phase 380 VAC comes standard with rod terminals for the user to connect the power plug.

  For external power cables, the cable definition is shown in the table below:

Model	Cable Color	Definition
XBC5E (380 VAC)	Brown	L1 (Phase A)
	Black	L2 (Phase B)
	Gray	L3 (Phase C)
	Yellow-Green	Ground (PE)

Power Supply Type	Compatible Robot Models	Note
Three-phase 380 VAC (3L+PE)	NB80 Series	

Warning

The overcurrent protection of the control cabinet power supply is to be provided by the user. The user shall cautiously choose the suitable overcurrent protection device according to the rated power of the purchased control cabinet.

6.2.2 User wiring

The wiring performed by the user includes:

- Robot body grounding wire
- Control cabinet power cord
- Custom IO signals (including safety IO and general-purpose IO)
- Custom network/communication signals

Warning

The wiring work must be carried out by certified workers or qualified personnel. If the wiring work is performed by someone who does not have the relevant knowledge, it may result in personal injury or equipment malfunction.

Danger

Before wiring, power off the controller and related devices, and place the warning sign (e.g. DO NOT turn on the power). Wiring under power-on conditions is

extremely dangerous and may cause electric shock or malfunction of the robot system.

Note: The wiring of the XBC5E control cabinet of high protection rating

The XBC5E control cabinet has an IP54 rating, and there is no interface window on the cabinet. The cables for custom IO signals (including safety IO and general-purpose IO) and network/communication signals need to be routed through the foam with pre-opened holes on the right lower side of the cabinet. Please select the holes with a suitable diameter for the cables to go through, and take measures to protect the outlets after wiring. The diameter of the pre-opened holes in the foam is shown in Figure 23:

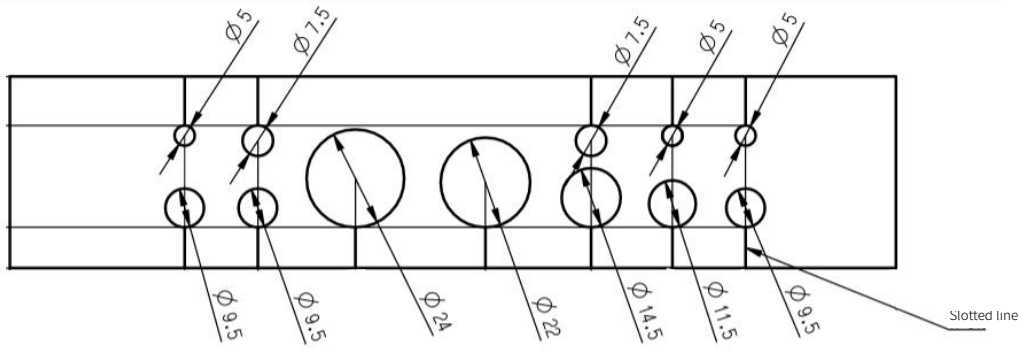


Figure 23 XBC5E control cabinet - size of cable outlets

The recommended wiring in the control cabinet is shown in Figure 24:

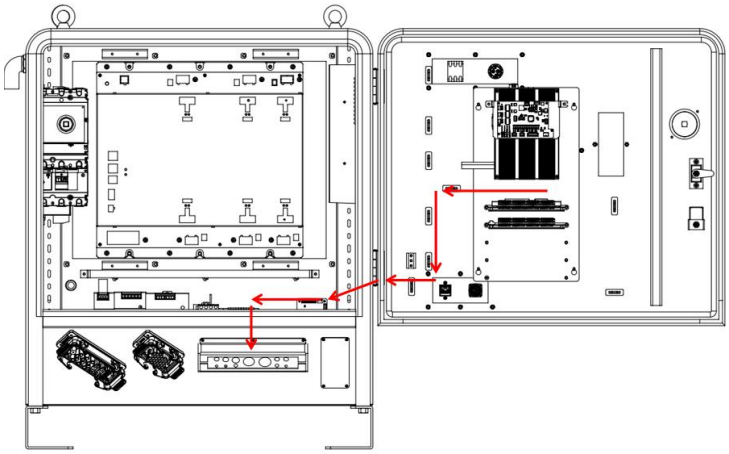


Figure 24 Control cabinet wiring diagramIO

When wiring the cables for the safety and general-purpose IO in the square frame, follow the path shown by the arrows in the figure with cable holders along the way. Fix the cables with cable ties, and keep the cable harness in the cabinet in good order.

6.2.3 Grounding instructions

The grounding circuit of the control cabinet is to be provided by the user, who shall properly ground the robot and the control cabinet with terminals and choose the ground circuit as short as possible according to the actual on-site situations and the available space to achieve D-type grounding (the grounding resistance should be less than 100Ω).

6.2.4 Definition of IO and wiring in the cabinet

The XBC5E control cabinet consists of safety IO and general-purpose IO. Please perform wiring properly as per the instructions on the sticker with the IO schematic diagram in the control cabinet.

> Warning
>
> The IO interface can only be wired when the controller cabinet is powered off. Otherwise, if there's any improper operation, the internal circuit board may be short-circuited and burnt out, disabling certain functions.

> Notes
>
> If the wiring of safety IO and general-purpose IO does not go well, check whether the terminals are crimped properly to avoid damage to the terminals.

Safety IO:

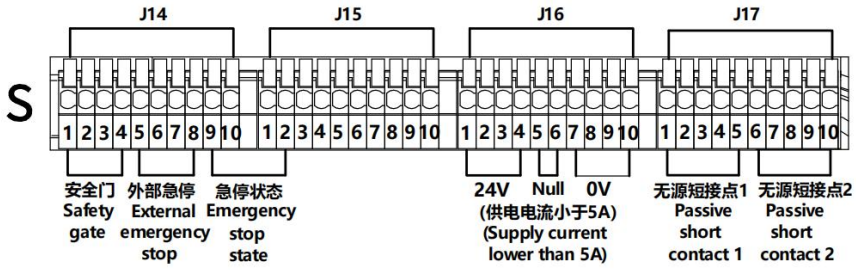


Figure 25 Safety IO terminals

Each safety input or output signal is controlled via two channels, so each signal contains two IO points of "circuit 1" and "circuit 2", with a total of 4 terminals, which should be wired as required in actual use.

Terminal No.	Function Definition	Description

J14-1	Safety gate 1	Safety gate circuit 1, short-circuited when not in use
J14-2	Safety gate 1	
J14-3	Safety gate 2	Safety gate circuit 2, short-circuited when not in use
J14-4	Safety gate 2	
J14-5	External emergency stop 1	External emergency stop circuit 1, short-circuited when not in use
J14-6	External emergency stop 1	
J14-7	External emergency stop 2	External emergency stop circuit 2, short-circuited when not in use
J14-8	External emergency stop 2	
J14-9	Emergency stop 1	Robot emergency stop output circuit 1, normally closed when emergency stop is not triggered
J14-10	Emergency stop 1	
J15-1	Emergency stop 2	Robot emergency stop output circuit 2, normally closed when emergency stop is not triggered
J15-2	Emergency stop 2	
J15-7 to J15-10	Reserved	
J16-1 to J16-4	24 V	24 V guest power, supply current lower than 5 A
J16-7 to J16-10	0 V	
J17-1 to J17-5	Passive short contact 1	The five terminals are conducted to each other and can be used as short contacts
J17-6 to J17-10	Passive short contact 2	The five terminals are conducted to each other and can be used as short contacts

General-purpose IO:

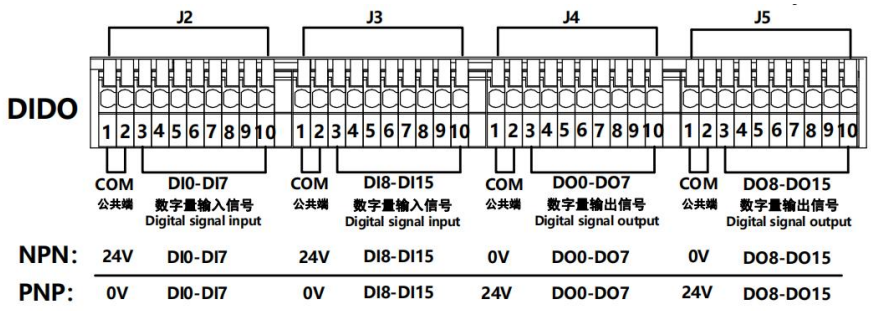


Figure 26 General-purpose IO terminals

The XBC5 control cabinet defaults to the ROKAE DI/DO board with 16 digital input and 16 digital output contacts. If more IO signals are needed on site, new IO modules can be expanded. The control cabinet supports up to 64 (4 × 16) IO. The overall system supports up to 128 (8 × 16) IO.

General-purpose IO cannot drive the load directly. Please decide whether to use an intermediate relay according to the on-site load. Among them, DI/DO can choose either NPN or PNP connection, and the capacity of each contact is 300 mA.

The detailed IO interface definition is shown in the following table:

Terminal No.	Function Definition	Description
J2-1	Common terminal	DI power, to be provided on site
J2-2	Common terminal	
J2-3	DI0	Custom
J2-4	DI1	Custom
J2-5	DI2	Custom
J2-6	DI3	Custom
J2-7	DI4	Custom
J2-8	DI5	Custom
J2-9	DI6	Custom
J2-10	DI7	Custom
J3-1	Common terminal	DI power, to be provided on site
J3-2	Common terminal	
J3-3	DI8	Custom
J3-4	DI9	Custom
J3-5	DI10	Custom
J3-6	DI11	Custom

Terminal No.	Function Definition	Description
J3-7	DI12	Custom
J3-8	DI13	Custom
J3-9	DI14	Custom
J3-10	DI15	Custom
J4-1	Common terminal	DO power, to be provided on site
J4-2	Common terminal	
J4-3	DO0	Custom
J4-4	DO1	Custom
J4-5	DO2	Custom
J4-6	DO3	Custom
J4-7	DO4	Custom
J4-8	DO5	Custom
J4-9	DO6	Custom
J4-10	DO7	Custom
J5-1	Common terminal	DO power, to be provided on site
J5-2	Common terminal	
J5-3	DO8	Custom
J5-4	DO9	Custom
J5-5	DO10	Custom
J5-6	DO11	Custom
J5-7	DO12	Custom
J5-8	DO13	Custom
J5-9	DO14	Custom
J5-10	DO15	Custom

The wiring diagram of DIDO PNP input is shown in Figure 27:

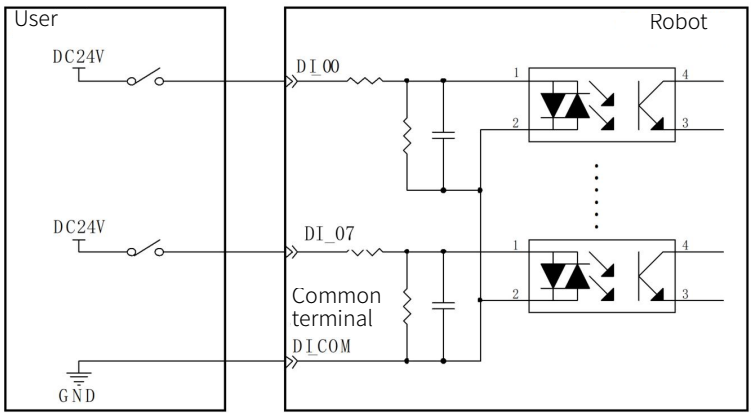


Figure 27 Wiring diagram of DIDO PNP input

The wiring diagram of DIDO NPN input is shown in Figure 28:

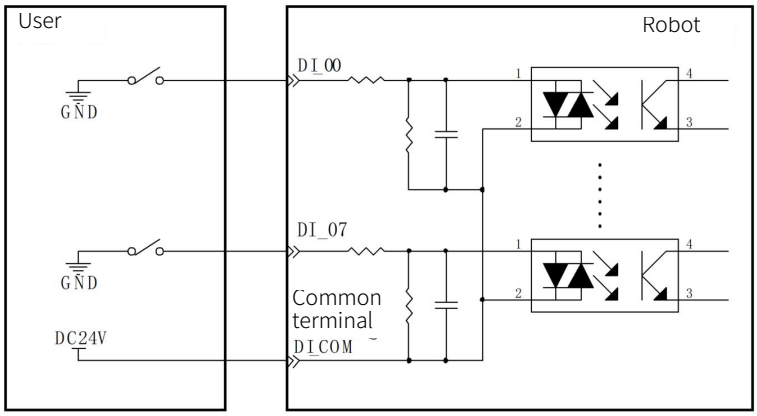


Figure 28 Wiring diagram of DIDO NPN input

The wiring diagram of DIDO PNP output is shown in Figure 29:

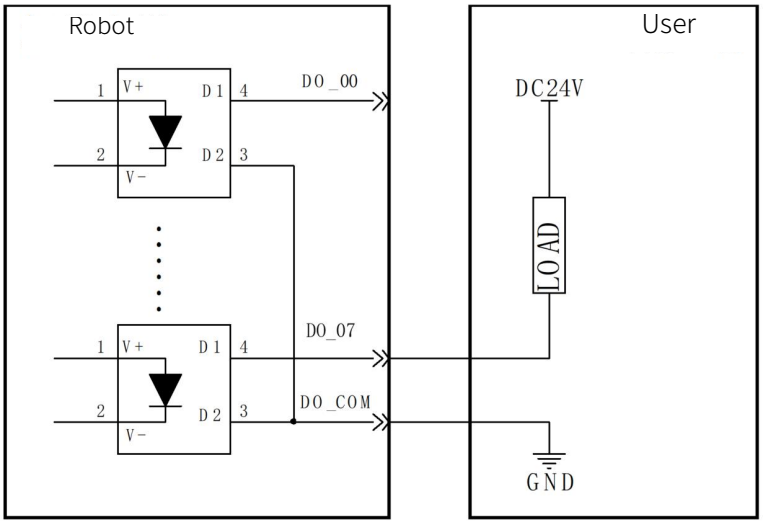


Figure 29 Wiring diagram of DIDO PNP output

The wiring diagram of DIDO NPN output is shown in Figure 30:

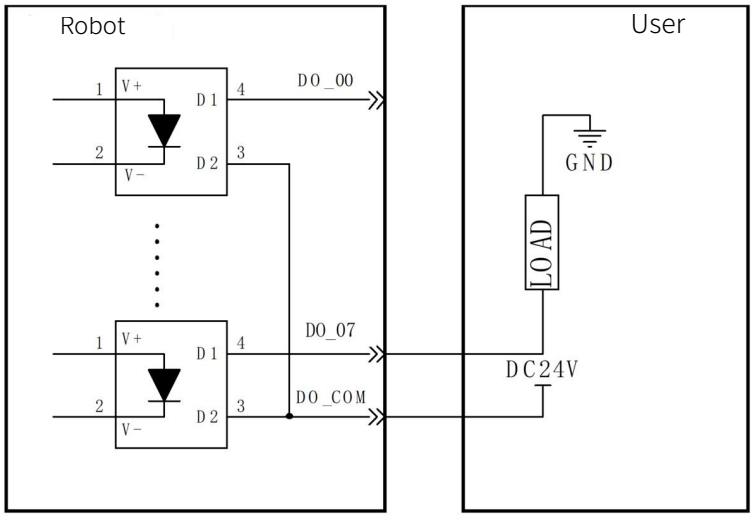


Figure 30 Wiring diagram of DIDO NPN output

Refer to the actual information for other IO modules.

7 Quick Operation Guide

7.1 Buttons and indicators

7.1.1 Control cabinet buttons and indicators

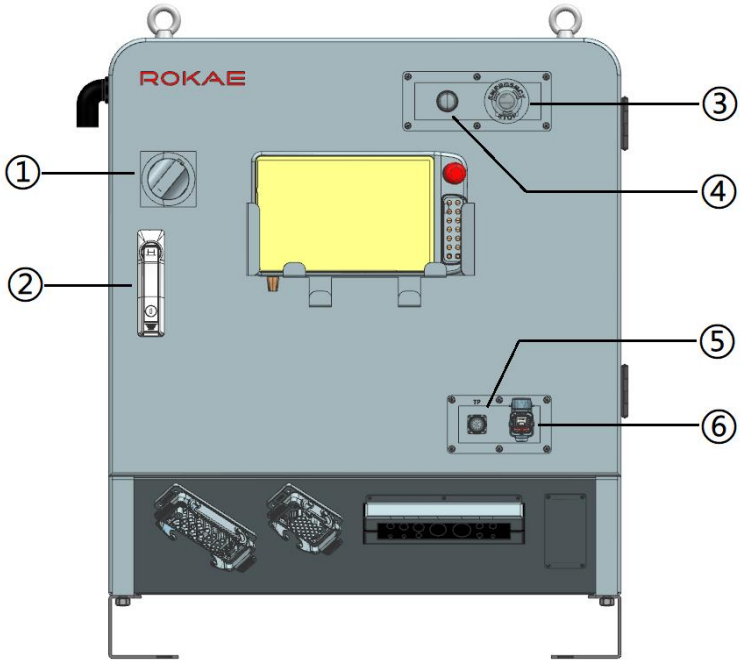


Figure 31 Panel of XBC5 control cabinet

No.	Description
①	Rotary power switch: Rotate the switch to power on the control cabinet.
②	Door Lock
③	Emergency stop button: The robot will be shut down immediately when it
④	Power indicator: The power indicator starts working (white light) after the
⑤	Teach Pendant socket
⑥	External debugging network interface

7.1.2 Teach Pendant buttons

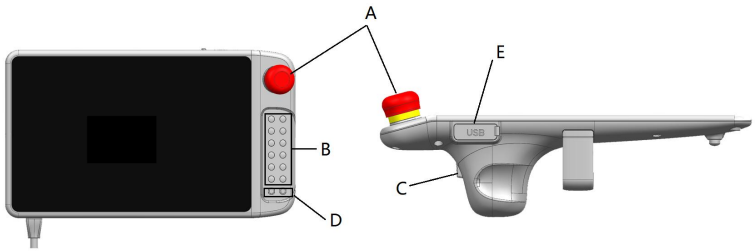


Figure 32 Teach Pendant buttons

	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 touchscreen

7.2 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 their left hand and operate the buttons and touchscreen with their right hand. It is recommended to hold the Teach Pendant in the way shown in the figure below:

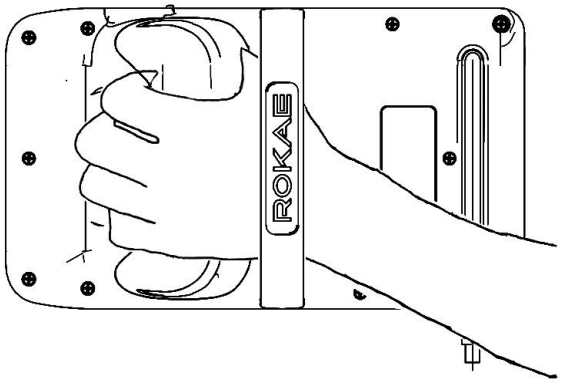


Figure 33 How to hold the Teach Pendant

7.3 Start the system

7.3.1 Start the system

After confirming the electrical connections, close the circuit breaker on the control cabinet, and start the system by pressing the power button. If everything is normal, the system will display a welcome interface on the Teach Pendant after startup. If the system alarms or cannot be started at all after the startup is completed, please refer to the relevant content in the chapter "Troubleshooting".

7.3.2 Confirming the emergency stop function

After startup, press the emergency stop buttons on the Teach Pendant and the control cabinet to check if an emergency stop alarm of the control system is triggered. Then pull the emergency stop button to check if the emergency stop alarm is successfully cleared and the system returns to normal.

Only after confirming the normal operation of the emergency stop function can you conduct configuration or programming on the robot.

For more information on the robot operating system, programming, and parameter settings, refer to the *Operation Manual of xCore Robot Control System*.

8 Maintenance

8.1 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 outside the safety fence after replacing the parts. 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.

Note:

Hazard of electric shock

Be sure to turn off the controller and related devices and unplug the power plug before performing maintenance, replacement, and wiring. Failure to do so may result in electric shock or malfunction.

8.2 Daily maintenance

8.2.1 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.

8.2.2 Interval

No.	Item	Position	Interval				
			Daily	1 month	3 months	6 months	12 months
1	Tighten the screws if they are	Externally visible screws on the	●				

No.	Item	Position	Interval				
			Daily	1 month	3 months	6 months	12 months
	loosened.	controller					
2	If the plug is loosened, secure it tightly.	External connectors on the robot and controller	●				
		Robot cables		●			
3	Check for external damage, and remove dust from the surface.	Control cabinet appearance	●				
		External cables		●			
4	Check safety functions.	Teach Pendant emergency stop, control cabinet emergency stop, external emergency stop, safety gate, and enabling switch			●		
5	Check the noise of the control cabinet and the dust of the filter cotton in the air inlet.	Filter cotton and fan in the air inlet	●				

8.3 Troubleshooting

When the robot fails, stop running. Contact the operator who has received the prescribed training immediately to perform a failure analysis to know the phenomenon and determine the failed components. If you need to replace parts, please contact our service department. Do not disassemble the robot by yourself.

8.3.1 Common faults

No.	Faults	Possible Causes	Recommended Operation
1	No system response. The indicator does not light up, and the cooling fan does not work.	➢ The power cord is not connected properly. ➢ The power supply voltage is out of specification. ➢ The air switch in the power supply circuit is opened. ➢ Electrical system failure	➢ Check if the power cord is connected properly. ➢ Check if the power supply voltage is in accordance with the specifications. ➢ Disconnect the external power supply of the control cabinet, and check the air switch in the power supply circuit of the cabinet. ➢ Contact after-sales personnel for part replacement.
2	The Teach Pendant prompts "Failed to connect to the main controller".	➢ Main controller IP setting error ➢ The Teach Pendant cable is not connected properly. ➢ The Teach Pendant cable is damaged.	➢ Enter the correct IP address. The default IP address of the Titanite main controller is 192.168.1.160. ➢ Check if the Teach Pendant cable is connected properly. ➢ Check if the Teach Pendant cable has visible damage on the surface. If yes, replace the Teach Pendant cable. ➢ If possible, connect the Teach Pendant to another control cabinet to exclude malfunctions caused by the controller.

No.	Faults	Possible Causes	Recommended Operation
3	Unable to turn on the Teach Pendant	➢ The Teach Pendant cable is damaged. ➢ The Teach Pendant power supply circuit in the control cabinet malfunctions. ➢ The Teach Pendant is damaged.	➢ Check if the Teach Pendant cable has visible damage on the surface. If yes, replace the Teach Pendant cable. ➢ Check the Teach Pendant power supply circuit in the control cabinet. ➢ Replace the Teach Pendant. ➢ If possible, connect the Teach Pendant to another control cabinet to exclude malfunctions caused by the controller.
4	Unable to jog the robot	➢ The robot is not in the manual mode. ➢ The actual state of the mode selector switch does not match that in the Teach Pendant software. ➢ Teach Pendant button malfunction ➢ Teach Pendant software malfunction	➢ Switch the robot to manual mode. ➢ Change the position of the mode selector switch to match the state in the Teach Pendant software. ➢ Replace the membrane keyboard. ➢ Restore the Teach Pendant using the recovery USB drive.
5	The robot is unable to maintain its position and falls down after it is powered off.	➢ The motor's band-type brake is damaged. ➢ Power supply circuit malfunction of the motor's band-type brake	➢ Contact after-sales personnel for motor replacement. ➢ Check and fix the power supply circuit malfunction.
6	Unable to open the	➢ The band-type	➢ Check if the band-type

No.	Faults	Possible Causes	Recommended Operation
	robot's band-type brake, the robot is overloaded or there is low-frequency intermittent noise	brake in the cabinet is damaged. ➢ Power supply circuit malfunction of the motor's band-type brake	brake is burned down. ➢ Check if the fuse of the band-type brake is normal and replace it. The fuse is located on the front door of the control cabinet.
7	No voltage at the 24 V output of the control cabinet	➢ Power supply failure of the adaptation plate ➢ The output fuse is burned down.	➢ Check if the adaptation plate is burned down. ➢ Check if the fuse of the adaptation plate is normal and replace it. The fuse is located on the front door of the control cabinet.

8.3.2 Troubleshooting

There are two ways to troubleshoot the robot system:

Troubleshooting according to the faults: If an error occurs during the system startup or no log is generated, perform troubleshooting according to the faults. For details, please refer to the chapter "Common faults".

Troubleshooting according to the log number: If a log is generated in the system when a fault occurs, check the detailed description of the log on the HMI interface of the Teach Pendant for troubleshooting. For details, please refer to the chapter Log number and faults.

8.3.3 Log number and faults

Troubleshooting according to the log number:

Only the log numbers of some common faults are listed in the section. Please check the detailed description of the log on the HMI interface of the Teach Pendant for troubleshooting.

Log Number	Log Information	Possible Causes	Solutions
13003	Teach Pendant communication error	The Teach Pendant communication cable or the Teach Pendant system malfunctions, or the Teach Pendant is accidentally unplugged.	1. If the Teach Pendant is accidentally unplugged, reconnect the Teach Pendant to the control cabinet. 2. Check the Teach Pendant and related cables. Replace damaged

Log Number	Log Information	Possible Causes	Solutions
			parts.
20010	Emergency stop state	Attempt to control the robot when the system is in an emergency stop state	Power on the system with the power-on (reset) button on the control cabinet.
20224	Enabling device conflict	The signals of two enabling devices conflict with each other.	1. Press and release the enabling switch again to reset the enabling module in the safety unit. 2. Check the Teach Pendant cable and its connections. 3. Replace the damaged Teach Pendant or its cable, if applicable.
37056	Control cabinet cooling fan failure	The cooling fan stops working or works at a low speed.	1. Check the cable of the cooling fan. 2. Replace the damaged fan.
37069	Backup power failure	The backup battery is damaged, the wiring is incorrect, or the charger is damaged.	1. Check the cable and plug of the backup battery. 2. Check the backup battery. 3. Check if the power supply is normal. 4. Replace the damaged parts.
38008	Bus scan failure	The configuration fails due to mismatched EtherCAT configuration files.	Re-import the configuration files, and restart the control system. 2. Check the connection of the network cables in the cabinet.
38009	The number of configured slaves does not match that of scanned slaves	1. The configuration fails due to inconsistency between the EtherCAT configuration and the actual network topology. 2. The hardware of the EtherCAT slave devices malfunctions.	1. Re-import the configuration files, and restart the control system. 2. Check the wiring of the slave devices. 3. Contact ROKAE Technical Support.
38010	Failed to enable the EtherCAT bus	The configuration fails due to mismatched EtherCAT configuration files.	Re-import the configuration files, and restart the control system.
38011	Internal axis servo initialization failure	The driver malfunctions.	Check whether the servo drivers are disconnected from each other.

Log Number	Log Information	Possible Causes	Solutions
38012	IO slave initialization failure	1. The IPC and general-purpose IO modules are disconnected from each other. 2. The general-purpose and safety IO modules are disconnected from each other.	1. Check and fix the hardware connections between the IPC and general-purpose IO modules. 2. Check and fix the hardware connections between the general-purpose and safety IO modules.
50055	Excessive load on the joints	1. Incorrect load data configuration 2. Improperly high acceleration configured 3. Excessive external force 4. Low temperature or hardware malfunction	1. Check the load data. 2. Decrease the acceleration or speed. 3. Check the hardware.
60054	Absolute encoder battery low-voltage	The absolute encoder battery is low, and the line resistance is high.	1. Replace the encoder battery. 2. Check the operating temperature of the robot, or place the robot in the room for some time until it returns to room temperature. 3. Log in as Administrator, clear the alarms, and re-calibrate the zero point.

Revision History

Version	Date	Revision
A	02/15/2023	Initial version

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