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IR-U4&U6&U8&U13&U18 Series Collaborative Robots

User Guide - Manipulator

Industrial Automation | New Energy Vehicle | Intelligent Elevator | Intelligent Robot | Digital Energy | Rail Transit

Data code PS00020012A06

Legal Information

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Due to continuous updates and improvements of products and technologies, the content of this documentation may not fully match the actual products. In the event of any discrepancies, the actual products shall prevail.

The contents are subject to change without notice due to product upgrade.

Waste Disposal

The storage, use, and disposal of this product (including optional accessories) must comply with local laws and regulations.

Qualified Personnel

The product/system described in this documentation may be operated only by personnel qualified for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel can identify the risks of the product/system and prevent possible dangers.

Proper Use of the Product

Proper transportation, storage, assembly, installation, commissioning, operation, and maintenance are required to ensure the safe operation of the product without any problems. The required ambient conditions must be met. All operations must follow the guidelines provided in this documentation.

Preface

Introduction

The IR-U4&U6&U8&U13&U18 robots are stable, flexible, and intelligent 6-DOF collaborative robots launched by Inovance, featuring a modular design. They support graphical programming and drag teaching, enabling users to get started quickly without complex programming or operational knowledge, thereby greatly reducing the difficulty of use. In addition, their compact and lightweight design allows a single person to quickly deploy them, significantly improving production line changeover and deployment efficiency.

This guide is the user guide for Inovance collaborative robots. It covers installation guidance, electrical interfaces, basic maintenance, and other information to support your mechanical and electrical design of the collaborative robots.

More Data

Data name	Data code	Description
Collaborative Robot Safety Guide	PS00019992	Introduces the safety information, functional safety instructions, safety parameter commissioning, and maintenance of the product.
IR-TP200 Series Industrial Robot Teach Pendant User Guide	19012798	Introduces software-related operations of the robot teach pendant. Contact Inovance technical support to obtain this guide.
IR-U4&U6&U8&U13&U18 Series Collaborative Robots User Guide - Manipulator (this guide)	PS00020012	Introduces the general specifications, installation and wiring, care and maintenance, electrical interfaces, and common hardware startup issues of the product.

Revision History

Revision date	Version	Revision
September 2026	A06	New: Added coverage of the U6 series collaborative robots and updated related content. • Updated *"1.3 Emergency Stop" on page 17*. • Updated *"2.2 Response Time and Stop Distance" on page 21*. • Updated *"3.1 Model and Nameplate" on page 25*. • Updated *"3.3 Technical Specifications" on page 34*. • Updated *"3.4 Product Dimensions" on page 39*. • Updated *"3.7 Maximum Robot Payload" on page 50*. • Updated *"5.3.1 Packaging Posture" on page 64*. • Updated *"6.1.4 Installation Base Table Requirements" on page 73*. • Updated *"9.1 Robot Startup and Shutdown" on page 163*. • Updated *"10.4.2 Zero Point Calibration of Each Joint" on page 172*.
June 2026	A05	• Updated *"6.1.2 Installation Tool Preparations" on page 70*. • Updated *"6.1.5 Installation Space Requirements" on page 75*.
May 2026	A04	New: Added coverage of the U4 & U13 & U18 series collaborative robots and updated related content. Added coverage of the 48V controller and updated the related content. Update: • Updated *"1.2 General Safety Instructions" on page 10*. • Updated *"4.2 Unpacking" on page 55*. • Updated *"4.3 Post-Unpacking Inspection" on page 57*. • Updated *"4.4 Handling" on page 58*. • Updated *"5.3.1 Packaging Posture" on page 64*. • Updated *"5.3.2 Packaging Procedure" on page 67*.

Revision date	Version	Revision
March 2026	A03	New: Added *"10.1 Maintenance Precautions" on page 168*. Update: • Updated all controller appearance drawings to include a padlock mechanism on the controller front panel. • Updated *"3.1 Model and Nameplate" on page 25* to include nameplate descriptions and an updated manipulator nameplate. • Updated *"3.2 Components" on page 27* to include the newly added padlock mechanism on the controller. • Updated *"3.3 Technical Specifications" on page 34* to state that Modbus-RTU is supported only as a slave, not as a master. • Updated *"10.2 Manipulator Maintenance Guide" on page 168* to include maintenance instructions.
December 2025	A02	• Changed the guide title to "IR-U8 Series Collaborative Robot User Guide". • Made minor corrections.
November 2025	A01	Updated *"8.2.4 Teach Pendant Interface" on page 109* to include WiFi-related signal descriptions for WiFi CE certification.
June 2025	A00	Initial release.

Access to the Guide

This guide is not delivered with the product. You can obtain the PDF version in the following ways:

- Visit *https://www.inovance.com/global*, and choose Service&Support > Support > Documentation Download.
- Scan the QR code on the product with your smart phone.
- Scan the QR code below to install My Inovance app, where you can search for and download user guides.



Warranty Disclaimer

Inovance provides warranty service within the warranty period (as specified in your order) for any fault or damage that is caused by proper operation of the user. Maintenance will be charged after the warranty period expires.

Within the warranty period, maintenance will be charged for the following damage:

- Damage caused by operations not following the instructions in the user guide
- Damage caused by fire, flood, or unusual voltage
- Damage caused by unintended use of the product
- Damage caused by use beyond the specified scope of application of the product
- Damage or secondary damage caused by force majeure (such as natural disaster, earthquake, and lightning strike)

The maintenance is charged according to the latest Price List of Inovance. If otherwise agreed upon, the terms and conditions in the agreement shall prevail.

For details, see the "Inovance Robot Product Warranty Card".

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1 Safety Specifications

1.1 Responsibilities and Risks

Responsibilities

- The information in this guide does not cover all applications for designing, installing, and operating the robot, nor does it cover all peripheral devices that may affect the safety of the robot system.
- You are responsible for ensuring compliance with relevant and applicable national laws and regulations, and for ensuring that no significant hazards exist in the complete robot application.
- All safety-related information in this guide shall not be construed as a guarantee by Inovance. Even if all safety instructions are followed, injury to operators or damage to equipment may still occur.
- Inovance is committed to continuously improving the performance and reliability of its robots and reserves the right of final interpretation of this guide.

Risks

When operators interact with the robot, direct or indirect physical contact is inevitable. You must be adequately aware of your own safety during contact. When using Inovance robots, you must carefully assess the operating conditions. The following are possible risks:



- Risk of personal injury caused by the robot falling during handling.
- Risk of personal injury caused by loose robot mounting screws.
- Risk of pinched fingers or personal injury caused by collision during robot operation.
- Risk of personal injury caused by failure to repair robot faults in a timely manner.
- Risk of personal injury when using sharp end effectors or tool connection ends.
- Risk of personal injury when the robot operates in toxic or corrosive environments.
- Potential risk when the robot operates in strong magnetic fields.

1.2 General Safety Instructions

Safety Disclaimer

- This chapter presents essential safety instructions for a proper use of the equipment. Before operating the equipment, read through the guide and comprehend all the safety instructions. Failure to observe the safety instructions may result in death, severe personal injuries, or equipment damage.
- "DANGER", "WARNING", and "CAUTION" items in this guide do not indicate all safety instructions that need to be followed; instead, they just supplement the safety instructions.
- Use this product according to designated environment requirements. Damage caused by improper use is not covered by warranty.
- This product is a standard industrial robot intended for general civil applications. It has not been certified under national safety standards for the specialized handling of high-energy explosives. The electrical system does not meet the nominal requirements stipulated by regulations applicable to high-energy explosives, and the robot is not designed with any functionality for explosive handling. Use in any operations involving explosives is strictly prohibited.
- This product is designed for conventional industrial environments and is not radiation-hardened. In environments where the ionizing radiation dose exceeding 5 x 10^4 Gy (Si), its performance may degrade significantly or fail completely. Operation under such conditions is strictly prohibited.
- Inovance shall take no responsibility for any personal injuries or property damage caused by improper usage.

Safety Levels and Definitions



Indicates that failure to comply with the notice will result in severe personal injuries or even death.



Indicates that failure to comply with the notice may result in severe personal injuries or even death.



Indicates that failure to comply with the notice may result in minor or moderate personal injuries or equipment damage.

Safety Instructions

- The drawings in the guide are sometimes shown without covers or protective guards. Remember to install the covers or protective guards as specified first, and then perform operations in accordance with the instructions.

- Operators must take mechanical precautions to protect personal safety and wear protective equipment, such as safety shoes, safety clothing, safety glasses, protective gloves, and protective sleeves.

Unpacking
 • Do not install the equipment if you find damage, rust, or signs of use on the equipment or accessories upon unpacking. • Do not install the equipment if you find water seepage or missing or damaged components upon unpacking. • Do not install the equipment if you find the packing list does not conform to the equipment you received.
 • Before unpacking, check whether the outer package is intact, damaged, wet, damped, or deformed. • Unpack the package in the correct layered sequence. Do not strike the package violently. • Check whether there is damage, rust, or injuries on the surface of the equipment and equipment accessories before unpacking. • Check whether the package contents are consistent with the packing list before unpacking.

Storage and Transportation



- Large-scale or heavy equipment must be handled by qualified professionals using specialized hoisting equipment. Failure to comply may result in personal injuries or equipment damage.
- Before hoisting the equipment, ensure that components such as the front cover and terminal blocks are secured firmly with screws. Loosely-connected components may fall off and result in personal injuries or equipment damage.
- Never stand or stay below the equipment when the equipment is being hoisted by the hoisting equipment.
- When hoisting the equipment with a steel rope, ensure the equipment is hoisted at a constant speed without suffering from vibration or shock. Do not turn the equipment over or let the equipment stay hanging in the air. Failure to comply may result in personal injuries or equipment damage.



- Handle the product with care and mind your steps to prevent personal injuries or product damage.
- When handling the equipment with bare hands, hold the equipment casing firmly with care to prevent the equipment from falling and impact damage. Failure to comply may result in personal injuries.
- Store and transport the equipment based on the storage and transportation requirements. Failure to comply will result in equipment damage.
- Avoid storing or transporting the equipment in environments with water splash, rain, direct sunlight, strong electric field, strong magnetic field, and strong vibration.
- Avoid storing the product for more than 3 months. When the product needs to be stored for an extended period, take more strict protection and necessary inspection.
- Pack the equipment strictly before transportation. Use a sealed box for long-distance transportation.
- Never transport the equipment with other equipment or materials that may harm or have negative impacts on this equipment.

Installation

DANGER

- The equipment can only be operated by professionals with electrical knowledge. Non-professionals are not allowed to operate on the equipment.

WARNING

- Read through the guide and safety instructions before installation.
- Do not install the equipment in places with strong electric or magnetic fields.
- Before installation, check that the mechanical strength of the installation site can bear the weight of the equipment. Failure to comply may result in mechanical hazards.
- Do not wear loose clothes or accessories during installation. Failure to comply may result in an electric shock.
- When installing the equipment (such as controller) in a closed environment (such as a cabinet or casing), use a cooling device (such as a fan or air conditioner) to cool the environment down to the required temperature. Failure to comply may result in equipment over-temperature or a fire.
- Do not retrofit the equipment.
- Do not loosen the fixing bolts of the product parts and components.
- When the equipment (such as controller) is installed in a cabinet or final assembly, a fireproof enclosure providing both electrical and mechanical protections must be provided. The IP rating must meet IEC standards and local laws and regulations.
- Before installing devices with strong electromagnetic interference, such as a transformer, install a shielding device for the equipment to prevent malfunction.
- Install the product on an incombustible object such as metal and do not touch or attach the product to combustibles. Failure to comply can result in fire accident.

Caution

- Cover the top of the equipment (such as controller) with a piece of cloth or paper during installation. This is to prevent unwanted objects such as metal chippings, oil, and water from falling into the equipment and causing faults. After installation, remove the cloth or paper on top of the equipment to prevent over-temperature caused by poor ventilation due to blocked ventilation holes.

Wiring



- Equipment installation, wiring, maintenance, inspection, or component replacement must be performed only by professionals.
- Before wiring, disconnect the power supplies of all equipment. Wait for at least the time designated on the equipment warning label before further operations because residual voltage still exists after power-off. Measure the direct voltage of the main circuit and ensure that the voltage is within the safety range. Failure to comply can result in an electric shock.
- Do not perform wiring, remove the equipment cover, or touch the circuit board with power ON. Failure to comply can result in an electric shock.
- Check that the equipment is grounded properly. Failure to comply can result in an electric shock.



- Do not connect the input power supply to the output side of the equipment. Failure to comply can result in equipment damage or even a fire.
- When connecting a drive to the motor, check that the phase sequences of the drive and motor terminals are consistent to prevent reverse motor rotation.
- Cables used for wiring must meet cross sectional area and shielding requirements. The shield of the cable must be reliably grounded at one end.
- Tighten the terminal screws with the tightening torque specified in the user guide. Improper tightening torque may result in overheat, damage to the connecting parts, or a fire.
- After wiring is done, check that all cables are connected properly and no screws, washers or exposed cables are left inside the equipment. Failure to comply may result in electric shock or equipment damage.



- Follow the electrostatic discharge (ESD) procedure and wear an anti-static wrist strap to perform wiring. Failure to comply may result in damage to the equipment or to the internal circuit.
- Use shielded twisted pairs for the control circuit. Connect the shield to the grounding terminal of the equipment for grounding purpose. Failure to comply can result in equipment malfunction.

Power-On



- Before power-on, check that the equipment is installed properly with reliable wiring and the motor can be restarted.
- Check that the power supply meets equipment requirements before power-on to prevent equipment damage or a fire.
- Do not open the cabinet door or protective cover of the product, touch any wiring terminal of the product, or remove any part of the product with power on. Failure to comply can result in an electric shock.



- After the completion of wiring and parameter setting, perform a robot test run to confirm that the robot can operate safely. Failure to comply may result in personal injuries or equipment damage.
- Before power-on, check that the rated voltage of the equipment is consistent with that of the power supply. Failure to comply may result in fire accident.
- Before power-on, check that no one is near the equipment, motor, or machine. Failure to comply may result in death or personal injuries.

Operation



- The equipment must be operated only by professionals. Failure to comply can result in death or personal injuries.
- Do not touch any connecting terminals or disassemble any unit or component of the equipment during operation. Failure to comply can result in an electric shock.



- Do not touch the equipment enclosure, fan, or resistor with bare hands. Failure to comply may result in burns.
- Prevent metal or other objects from falling into the equipment during operation. Failure to comply may result in a fire or equipment damage.
- The robot generates noise during operation. Be sure to wear hearing protection such as ear muffs or earplugs to prevent hearing damage.

Maintenance



- Equipment installation, wiring, maintenance, inspection, or component replacement must be performed only by professionals.
- Do not maintain the equipment with power ON. Failure to comply can result in an electric shock.
- Before maintenance, cut off all the power supplies of the equipment and wait for at least the time designated on the equipment warning label.
- When a permanent magnet motor is used, do not touch the motor terminals immediately after power-off because the motor terminals can generate induced voltage during rotation even after the equipment is powered off. Failure to comply can result in an electric shock.



- Perform routine and regular inspection and maintenance on the equipment in accordance with maintenance requirements and keep a record.

Repair



- Equipment installation, wiring, maintenance, inspection, or component replacement must be performed only by professionals.
- Do not maintain the equipment with power ON. Failure to comply can result in an electric shock.
- Before inspection and repair, cut off all the power supplies of the equipment and wait for at least the time designated on the equipment warning label.



- Submit a request for repair services in accordance with the product warranty agreement.
- When the fuse is blown or the circuit breaker or earth leakage circuit breaker (ELCB) trips, wait for at least the time designated on the equipment warning label before power-on or further operations. Failure to comply may result in death, personal injuries or equipment damage.
- Troubleshooting and repair must be performed by professionals in accordance with the repair instructions, with repair records kept properly.
- Replace quick-wear parts of the equipment in accordance with the replacement instructions.
- Do not operate on damaged equipment. Failure to comply may result in death, personal injuries, or severe equipment damage.
- After the equipment is replaced, check the wiring and set parameters again.

Disposal
WARNING • Dispose of retired equipment in accordance with local regulations and standards. Failure to comply may result in death, personal injuries, or property damage. • Recycle retired equipment in accordance with industry waste disposal standards to avoid environmental pollution.

Safety Label

For safe operation and maintenance, comply with the safety labels on the equipment. Do not damage or remove the safety labels. See the following table for descriptions of the safety labels.

Safety label	Description
	• Read through the safety instructions before operating the equipment. Failure to comply may result in death, personal injuries, or equipment damage. • Do not touch the terminals or remove the cover with power ON or within 10 min after power-off. Failure to comply can result in an electric shock.

1.3 Emergency Stop

When an emergency occurs, pressing the emergency stop button immediately stops all robot motion. Note that the emergency stop is not a risk reduction measure, but rather a secondary protective device to be used only in critical situations. Under normal conditions, use other methods to stop robot motion. If it is necessary to add an emergency stop button after risk assessment, ensure that it complies with the IEC 60947-5-5 standard.

WARNING

When the emergency stop button is pressed, the robot system disconnects power from the robot manipulator. In this situation, although the brakes on each axis are automatically engaged, the manipulator may still move downward slightly due to gravity, posing a risk of pinching or impact to personnel.

1.4 Personal Safety Instructions

Moving the robot may cause fatal consequences.

Before attempting to operate the robot, make sure that the emergency stop device has been correctly installed and connected. Make sure that no personnel are within the robot's working range before pressing the start button.

During robot operation, unexpected or improper movements can generate substantial force, which may cause serious personal injury or damage to the robot equipment.

Initial trial operation may cause personal injury or equipment damage

Before the initial trial operation after installation or maintenance work has been completed, the following conditions must be met:

- Before turning on the power, ensure that the robot is properly secured in place with screws.
- Install all safety devices and ensure that they function properly.
- After maintenance or repair, pay particular attention to the function of the repaired parts.
- All personnel must maintain a safe distance from the robot.

Rescuing personnel trapped by the robot arm

During robot operation, if an abnormality (such as a collision) occurs and causes the robot to jam and trap a person, resulting in personal injury, use the brake release switch to help release the jam or rescue the injured person. Do not try the rescue through the teach pendant, as doing so may cause secondary injury. Ensure that the controller is connected to the power supply. If the robot is not connected to the controller, or the controller is powered off, be sure to connect an external power supply to the robot base connector.

For collaborative robots, the connection and operating procedures for the brake release switch are as follows:

1. See the "Emergency Drive" section of the "PS00019992 Collaborative Robot Safety Guide" to release the brakes of each axis separately.
2. Manually rotate the robot arm to move it away from he collision object.

CAUTION

- For system safety, perform brake release operation on a single axis!
- Before releasing the brake, ensure that the weight of your arm does not increase the pressure on the trapped person, thereby increasing any risk of injury.
- When releasing the brake, it should be noted that the robot arm may fall due to gravity, resulting in injury, pinching, or equipment damage or malfunction.
- The J2 and J3 axes belong to the gravity axis. Fix them with slings before releasing the brake, otherwise there is a risk of falling and injury!

Fire extinguishing

CAUTION

In the event of a fire, ensure that all personnel have evacuated safely before attempting to extinguish the fire, and attend to injured personnel first.

When electrical equipment (such as the robot or controller) catches fire, use a carbon dioxide fire extinguisher. Never use water or foam.



1.5 Industrial Information Security

The product provides interfaces for network connection and data transmission. To protect factories, systems, machines, and networks from cyberattacks, it is essential to implement proper protection mechanism for industrial security.

Customers are responsible for providing and maintaining a secure connection between the product and their network or any other network to protect their factories, systems, machines, and networks from unauthorized access. Such systems or machines can be connected to an enterprise network or the Internet only when a secure connection is

established and appropriate security measures (such as using antivirus software or installing firewalls) are in place.

Inovance continuously develops and improves products and solutions to enhance safety. It is strongly recommended that you update the product promptly and always use the latest version.



Malware (such as viruses, Trojans, and worms) can bring the device into an unsafe operating state, resulting in death, serious injury, and property damage. Observe the following precautions:

- Always use the latest software version. If the product version is no longer supported or the latest version is not used, you will be exposed to increased risk of cyber attacks.
- Develop and maintain appropriate protective measures (including but not limited to antivirus software, firewalls, WAF, IPS/IDS, situational awareness system, identity authentication, and data encryption) to prevent the files in mobile storage devices from being damaged by malware, and to protect the products, networks, systems, and interfaces from unauthorized access, tampering, hacking, data leakage, or information theft.
- Check all safety-related interfaces and settings after commissioning.

2 Safety Function

2.1 Stop Category

According to standard IEC 60204-1, Inovance collaborative robots can be configured for three stop categories: category 0 stop (Cat. 0 Stop), category 1 stop (Cat. 1 Stop), and category 2 stop (Cat. 2 Stop).

- Category 0 Stop: Cut off power to the manipulator.
- Category 1 Stop: Decelerate the robot in a controlled manner to a standstill; after standstill, cut off motor power.
- Category 2 Stop: Decelerate the robot in a controlled manner to a standstill; after standstill, maintain drive power.

Stop category	Robot motion status	Joint motor status	Joint motor brake status	Program execution
Category 0 stop	Stopped immediately	Disabled immediately	Engaged immediately	Interrupted; reset required before execution
Category 1 stop	Stopped after deceleration	Disabled after deceleration	Engaged after deceleration	Interrupted; reset required before execution
Category 2 stop	Stopped after deceleration	Enabled after deceleration	Released	Paused; reset required before execution

2.2 Response Time and Stop Distance

Response time is the time required from triggering a stop command until robot motion stops. Stop distance is the distance the robot moves during the stop response time. Since the robot is still in motion during the stop response time, it may still cause personal injury or damage to other equipment. Therefore, system integrators shall consider the robot's stop response time and stop distance during risk assessment.

The stop response time and stop distance specifications for collaborative robot models U4, U6, U8, U13, and U18 are as follows:

Model	Stop Category	Response time	Stop distance
U4	Category 0 stop	200 ms	• J1: < 35° • J2: < 35° • J3: < 20°
	Category 1 stop	1000 ms	• J1: < 40° • J2: < 40° • J3: < 25°
	Category 2 stop	1000 ms	• J1: < 40° • J2: < 40° • J3: < 25°
U6	Category 0 stop	200 ms	• J1: < 35° • J1: < 35° • J3: < 15°
	Category 1 stop	1000 ms	• J1: < 40° • J2: < 40° • J3: < 30°
	Category 2 stop	1000 ms	• J1: < 40° • J2: < 40° • J3: < 30°
U8	Category 0 stop	200 ms	• J1: < 35° • J1: < 35° • J3: < 15°
	Category 1 stop	1000 ms	• J1: < 40° • J2: < 40° • J3: < 30°
	Category 2 stop	1000 ms	• J1: < 40° • J2: < 40° • J3: < 30°
U13	Category 0 stop	200 ms	• J1: < 45° • J2: < 45° • J3: < 25°
	Category 1 stop	1000 ms	• J1: < 50° • J2: < 50° • J3: < 35°
	Category 2 stop	1000 ms	• J1: < 50° • J2: < 50° • J3: < 35°
U18	Category 0 stop	200 ms	• J1: < 35° • J2: < 35° • J3: < 25°
	Category 1 stop	1000 ms	• J1: < 45° • J2: < 40° • J3: < 35°
	Category 2 stop	1000 ms	• J1: < 45° • J2: < 40° • J3: < 35°

2.3 Mode

The safety system has two configurable modes: normal mode and reduced mode. When reduced mode is not triggered, safety monitoring uses the safety thresholds of normal mode. When reduced mode is triggered, safety monitoring uses the safety thresholds of reduced mode. The thresholds of the safety monitoring functions can be configured independently in both modes. Reduced mode is active when the robot tool/end effector enters an interference zone or when reduced mode is triggered by a safety input.

- Using an interference zone to trigger reduced mode:
  When the trigger method is set to reduced mode L1/L2 and the robot tool/end effector enters the interference zone, reduced mode is triggered immediately. When the robot tool/end effector leaves the interference zone, the system exits reduced mode and returns to normal mode. It takes up to 1000 ms before the safety limits under reduced mode are applied. You should consider this response time during risk assessment.
- Using a safety input to trigger reduced mode:
  When a safety input is used to trigger reduced mode, it takes up to 1000 ms before the safety limits under reduced mode are applied. You should consider this response time during risk assessment.

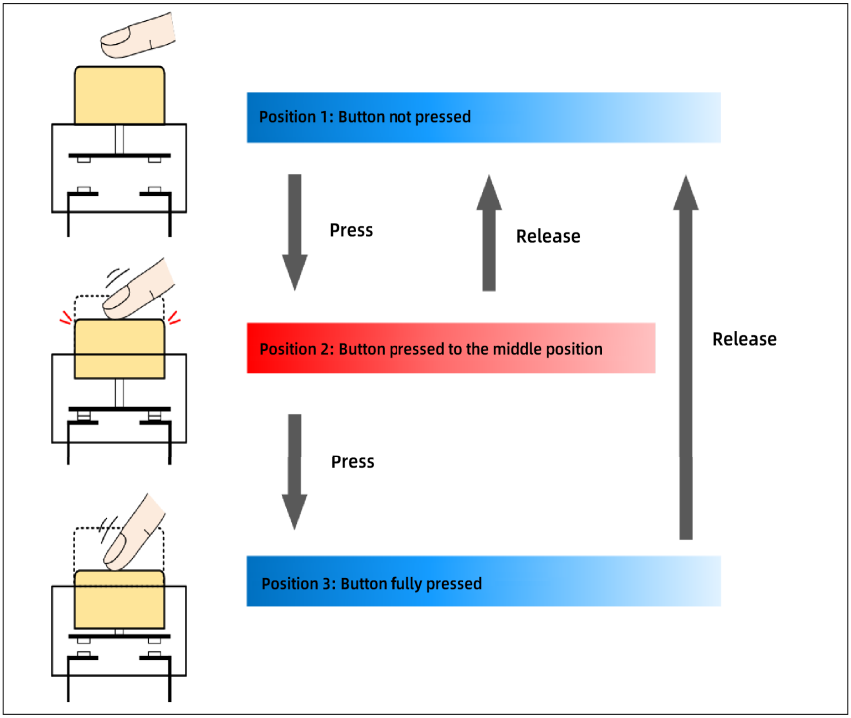
2.4 Three-Position Enable Switch

Inovance collaborative robots support a three-position enable switch function, which must be used with the teach pendant. The teach pendant is optional. Equip it according to your actual application and after a risk assessment. When the three-position enable switch on the teach pendant is used, the robot can only be moved while the switch is in the middle position.

Robot motion status corresponding to different statuses of the three-position enable switch:

Three-position enable switch status	Robot status	Manual mode	Auto mode
Released	Protective stop	Robot motion not allowed	Three-position enable switch function disabled in auto mode
Pressed to the middle position	Enabled	Robot motion allowed	
Fully pressed	Protective stop	Robot motion not allowed	

The operation of the three-position enable switch is illustrated below:


Position 1: Button not pressed
Press
Release
Release
Position 2: Button pressed to the middle position
Press
Position 3: Button fully pressed

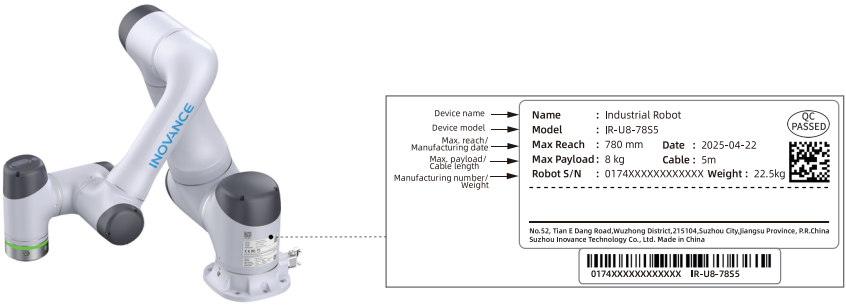
3 Product Information

3.1 Model and Nameplate

Manipulator

IR-U8-78S5
① ② ③ ④ ⑤ ⑥

① **Product family** INOVANCE Robot	④ **Arm length** 60: 625 mm 78: 780.5 mm 91: 915.5 mm 100: 1046 mm 130: 1301 mm
② **Series** U: Collaborative robot	⑤ **Installation environment** S: Standard
③ **Load** 4: 4 kg 6: 6 kg 8: 8 kg 13: 13 kg 18: 18 kg	⑥ **Cable length** 5: 5 m standard cable 10: 10 m standard cable 20: 20 m standard cable



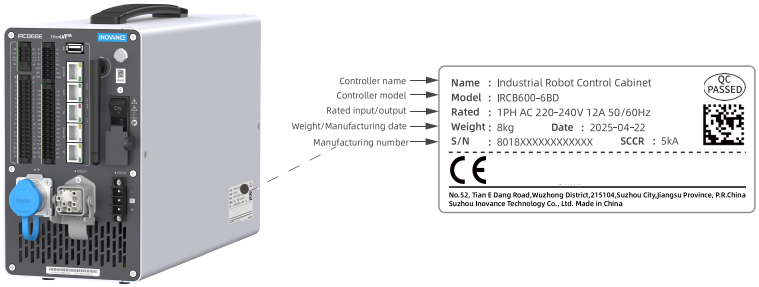
Note

The certification information in the above nameplate is for illustrative purposes only; Refer to the actual product certification for specific details.

Controller series

IR ① CB ② 600 ③ - 6 ④ B ⑤ D ⑥

① **Product family** INOVANCE Robot	④ **Number of servo axes** 6: 6 axes
② **Product type** Cabinet	⑤ **Power supply module power** A: 0 kW (without power supply module) B: 2 kW C: 3.2 kW
③ **Product series** 600: First-generation collaborative controller, ARM control	⑥ **Input voltage** C: 48 VDC D: Single-phase 220 VAC



Note

The certification information in the above nameplate is for illustrative purposes only; Refer to the actual product certification for specific details.

Collaborative robot teach pendant (optional)

IR ① - TP ② 1000 ③ - H1 ④

① **Product family** INOVANCE Robot	③ **Product series** 1000: Collaborative robot teach pendant
② **Product type** Teach Pendant	④ **Hardware configuration** H1: Redmi PAD SE

3.2 Components

Manipulator

- **Manipulator**

  The manipulator consists of six motion joints and two arm links: the upper arm and the forearm. The end of J6 is equipped with a ring-shaped indicator light for indicating the robot operating status and an end I/O aviation connector. The rear cover of J6 is equipped with three end I/O buttons.

  The Inovance robot manipulator is shown in the figure below.

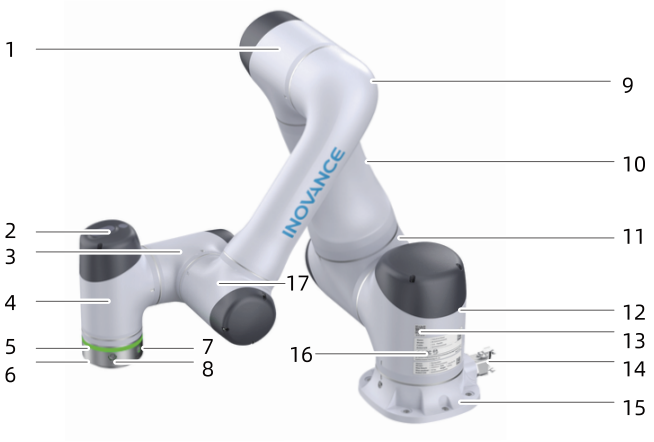


Table 3-1 Components of the manipulator

No.	Name	No.	Name
1	J3	10	Upper arm
2	End button	11	J2
3	J5	12	J1
4	J6	13	QR code
5	Indicator ring	14	Manipulator connection aviation connector
6	End assembly	15	Base
7	6-pin EtherCAT aviation connector	16	Nameplate
8	8-pin I/O aviation connector	17	J4
9	Forearm	-	

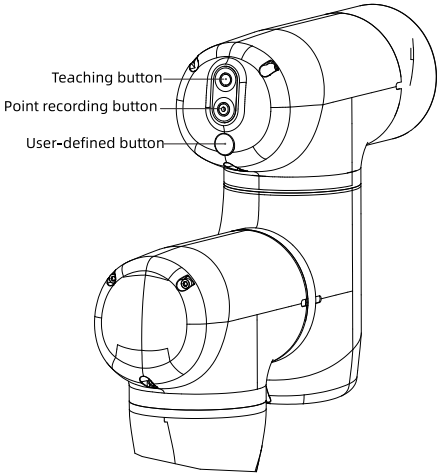
- **End I/O**

  The end I/O provides the mounting structure for the robot end effector. For specific mounting dimensions and hole positions, see *"6.2.2 Installing an End Effector" on page 81*. Two aviation connectors are provided on the side of the end I/O flange,

serving as user tool I/O interfaces. They provide digital inputs, digital outputs, analog input sampling, and EtherCAT slave expansion (not currently supported). For detailed descriptions of the user tool I/O interfaces, see *" Pin Definitions of the End I/O Interface" on page 94*.

End I/O buttons

The end I/O is equipped with three buttons: a drag teaching button, a point recording button, and a custom button, as shown in the figure below.



You can press and hold the drag teaching button to put the robot into drag teaching mode and then perform the relevant teaching tasks on the robot.

You can press the point recording button to have the software record the robot's current point information.

Note

The custom button function has not been developed yet.

- **Manipulator indicator**
  The collaborative robot manipulator status indicator can display four colors: red, green, blue, and yellow. It uses different flashing patterns to indicate various robot operating states and alarms. The specific indicator signal definitions are as follows:

Scenario	Color	Operation state	Duration
Basic definitions	Steady red	Fault alarm; immediate operator intervention required; robot stops	Until fault cleared
	Steady yellow	Warning; robot does not stop	Until warning cleared
	Steady green	Robot in an enabled and running state	Until process ends
	Steady blue	Robot hardware powered on, not enabled	Until process ends
Communication connection	Blue - running light	Communication being established between the manipulator and controller	Until process ends
	Blue - two quick flashes	Connection established between the host computer and controller	Until two quick flashes are completed
Special scenario (drag teaching and point recording)	Green - breathing light	Robot in drag teaching state	Until process ends

Controller

The controller is the control center of the collaborative robot. It contains the following component types: control board, safety board, power board, switching power supply, safety protection device, and fan. It provides external electrical interfaces such as aviation connectors, heavy-duty connectors, I/O, and buses, as well as wireless Wi-Fi communication.

The components of the controller are described in detail as shown in the figure below.

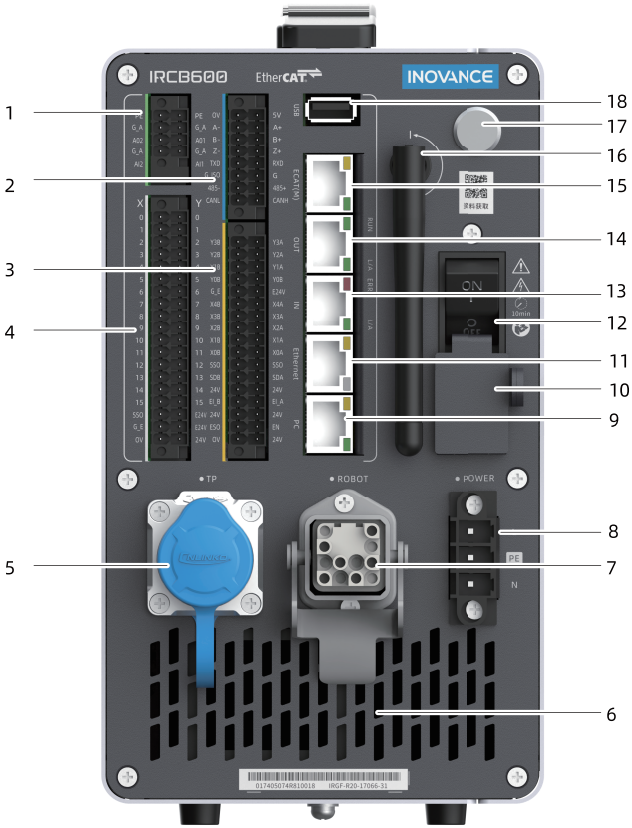


Figure 3-1 IRCB600-6BD & IRCB600-6CD controllers

Table 3–2 Components of the IRCB600-6BD & IRCB600-6CD controllers

No.	Name	No.	Name
1	AI/AO interface	10	Padlock mechanism
2	ABZ, RS232/RS485, and CAN interface	11	Ethernet interface
3	Safety I/O interface	12	Power switch
4	DI/DO interface	13	EtherCAT slave IN interface
5	Teach pendant aviation connector	14	EtherCAT slave OUT interface
6	Heat dissipation holes	15	EtherCAT master interface

No.	Name	No.	Name
7	Manipulator heavy-duty cable interface	16	Wi-Fi antenna
8	AC input interface	17	Controller system status indicator
9	PC interface	18	USB interface

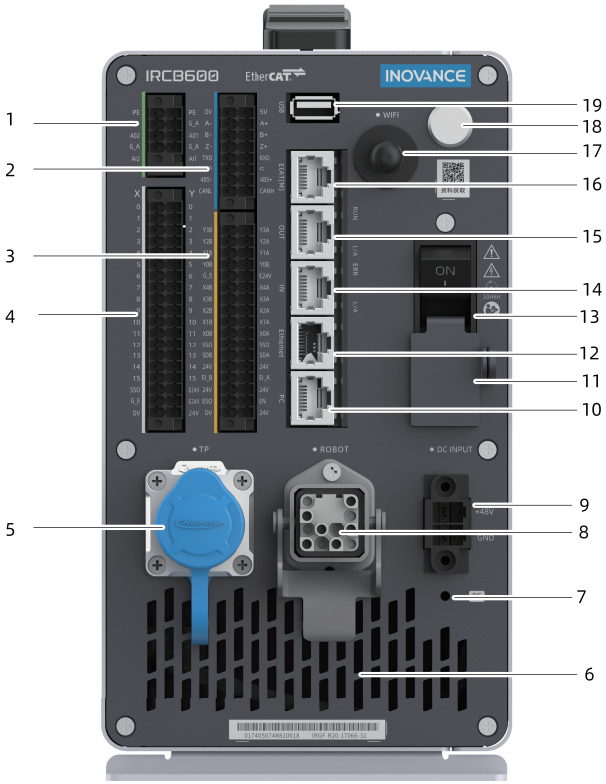


Figure 3-2 Components of the IRCB600-6AC controller

Table 3–3 Components of the IRCB600-6AC controller

No.	Name	No.	Name
1	AI/AO interface	11	Padlock mechanism
2	ABZ, RS232/RS485, and CAN interface	12	Ethernet interface
3	Safety I/O interface	13	Power switch
4	DI/DO interface	14	EtherCAT slave IN interface
5	Teach pendant aviation connector	15	EtherCAT slave OUT interface

No.	Name	No.	Name
6	Heat dissipation holes	16	EtherCAT master interface
7	Grounding hole	17	Wi-Fi antenna
8	Manipulator heavy-duty cable interface	18	Controller system status indicator
9	DC input interface	19	USB interface
10	PC interface	-	

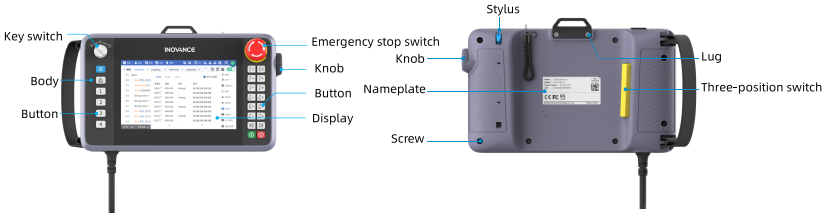
- **Controller indicator**
  The controller status indicator can display four colors: red, green, blue, and yellow. It uses different flashing patterns to indicate different controller states and alarms. The specific indicator signal definitions are as follows:

Scenario	Color	Operation state	Duration
Controller power-on	Steady yellow	Startup process indication: • Controller starting up; U-Boot stage. • Steady yellow during the kernel stage. • Steady yellow during service startup preparation.	Until process ends
	Yellow - quick flash (500 ms/ flash)	File system loading	
	Yellow - slow flash (1000 ms/flash)	File system loading completed	
	Blue- slow flash (1000 ms/flash)	Software startup; connecting to the manipulator	
	Steady blue	Startup successful (as in power-on success in basic definitions)	
	Steady blue	Robot hardware powered on, not enabled	Until process ends
Controller firmware flashing	Blue- slow flash (1000 ms/flash)	Flashing process: U-Boot stage flashing	Until process ends
	Steady blue for 5s to 7s	U-Boot flashing completed and kernel startup in progress (the indicator cannot immediately switch to slow flash after the kernel starts)	
	Blue- slow flash (1000 ms/flash)	Entered file system and firmware flashing continues	
	Steady red	SD flashing failed	Until process ends
	Yellow - steady on (robot requires restart and is unavailable)	SD flashing successful	Until process ends

Options

- **Hand-held teach pendant IR-TP200**
  The collaborative robot supports a hand-held teach pendant. The hand-held teach pendant provides visual programming, configuration, and other operations. You can use it to test, program, and simulate the robot.

The components of the hand-held teach pendant are described in detail as shown in the figure below.



3.3 Technical Specifications

Table 3–4 Technical specifications of the manipulator

Level 1 parameter name	Level 2 parameter name	IR-U4-60S5	IR-U6-90S5	IR-U8-78S5	IR-U13-130S5	IR-U18-100S5
Structure	Structure	Vertical multi-articulated	Vertical multi-articulated	Vertical multi-articulated	Vertical multi-articulated	Vertical multi-articulated
Number of joints	Number of joints	6	6	6	6	6
Maximum wrist load	Maximum wrist load	4 kg	6 kg	8 kg	13 kg	18 kg
Maximum reach	Maximum reach	625 mm	915.5 mm	780.5 mm	1301 mm	1046 mm
Repeatability	Repeatability	±0.02 mm	±0.03 mm	±0.02 mm	±0.03 mm	±0.03 mm
Maximum motion range	J1	±360°	±360°	±360°	±360°	±360°
	J2	±175°	±175°	±175°	±175°	±175°
	J3	±155°	±160°	±160°	±165°	±160°
	J4	±360°	±360°	±360°	±360°	±360°
	J5	±180°	±180°	±180°	±180°	±180°
	J6	±360°	±360°	±360°	±360°	±360°
Maximum speed	J1	210°/s	180°/s	180°/s	120°/s	120°/s
	J2	210°/s	180°/s	180°/s	120°/s	120°/s
	J3	223°/s	180°/s	180°/s	180°/s	180°/s
	J4	210°/s	210°/s	210°/s	210°/s	210°/s
	J5	210°/s	210°/s	210°/s	265°/s	265°/s
	J6	210°/s	210°/s	210°/s	265°/s	265°/s
Allowed wrist torque	J4	9.5 N·m	16.9 N·m	16.9 N·m	29 N·m	46 N·m
	J5	9.5 N·m	16.9 N·m	16.9 N·m	29 N·m	46 N·m
	J6	9.5 N·m	16.9 N·m	16.9 N·m	29 N·m	46 N·m

Level 1 parameter name	Level 2 parameter name	IR-U4-60S5	IR-U6-90S5	IR-U8-78S5	IR-U13-130S5	IR-U18-100S5
Allowed wrist inertia	J4	0.5 kg·m²	0.5 kg·m²	0.5 kg·m²	2.4 kg·m²	2.4 kg·m²
	J5	0.5 kg·m²	0.5 kg·m²	0.5 kg·m²	2.4 kg·m²	2.4 kg·m²
	J6	0.5 kg·m²	0.5 kg·m²	0.5 kg·m²	2.4 kg·m²	2.4 kg·m²
User interface	Wiring	End 8-pin I/O aviation connector End 6-pin EtherCAT network aviation connector	End 8-pin I/O aviation connector End 6-pin EtherCAT network aviation connector	End 8-pin I/O aviation connector End 6-pin EtherCAT network aviation connector	End 8-pin I/O aviation connector End 6-pin EtherCAT network aviation connector	End 8-pin I/O aviation connector End 6-pin EtherCAT network aviation connector
	Tubing	/	/	/	/	/
Mounting method	Mounting method	Any orientation	Any orientation	Any orientation	Any orientation	Any orientation
Manipulator weight (excluding cables)	Manipulator weight (excluding cables)	16 kg	23.5 kg	22.5 kg	39.5 kg	37.5 kg
Installation environment	Environment type	Standard	Standard	Standard	Standard	Standard
	IP rating	IP54	IP54	IP54	IP54	IP54
Environment	Operating temperature[1]	0°C to 50°C	0°C to 50°C	0°C to 50°C	0°C to 50°C	0°C to 50°C
	Operating humidity	5% RH to 95% RH (without condensation)	5% RH to 95% RH (without condensation)	5% RH to 95% RH (without condensation)	5% RH to 95% RH (without condensation)	5% RH to 95% RH (without condensation)
Noise level	Noise level[2]	$L_{Aeq} \leq 70$ dB(A)	$L_{Aeq} \leq 70$ dB(A)	$L_{Aeq} \leq 70$ dB(A)	$L_{Aeq} \leq 70$ dB(A)	$L_{Aeq} \leq 70$ dB(A)
Matching controller (standard)	Matching controller (standard)	IRCB600-6BD(IP20) IRCB600-6AC(IP20)	IRCB600-6BD(IP20) IRCB600-6AC(IP20)	IRCB600-6BD(IP20) IRCB600-6AC(IP20)	IRCB600-6CD(IP20) IRCB600-6AC(IP20)	IRCB600-6CD(IP20) IRCB600-6AC(IP20)

Note

[1] When used in a low-temperature environment approximating the lowest allowable temperature, or when idle for a long period of time due to holidays and nighttime, it is recommended to warm up the product at low speed before operating it.

[2] Measured in front of the robot at a distance of 1000 mm from its operating area and at least 50 mm above the base mounting surface with six joints operating at 100% speed and acceleration, with a duty cycle of 50%.

Technical specifications of the IRCB600 series controller

Model	IRCB600-6BD	IRCB600-6CD	IRCB600-6AC
Motion mode	PTP, CP	PTP, CP	PTP, CP
Program storage space	• Maximum number of lines per program: 100,000 • Maximum number of points: 10,000 • Maximum number of point files: 128 • Tree programming nodes: 10,000 lines • Multi-tasking: Supports 1 main task, 14 dynamic and static tasks, and 1 xqt task	• Maximum number of lines per program: 100,000 • Maximum number of points: 10,000 • Maximum number of point files: 128 • Tree programming nodes: 10,000 lines • Multi-tasking: Supports 1 main task, 14 dynamic and static tasks, and 1 xqt task	• Maximum number of lines per program: 100,000 • Maximum number of points: 10,000 • Maximum number of point files: 128 • Tree programming nodes: 10,000 lines • Multi-tasking: Supports 1 main task, 14 dynamic and static tasks, and 1 xqt task
Retentive memory	Interval between power off and on: 2s Amount of saved data (128 KB): Supports 256 B, R, D, PR and some other system data	Interval between power off and on: 2s Amount of saved data (128 KB): Supports 256 B, R, D, PR and some other system data	Interval between power off and on: 2s Amount of saved data (128 KB): Supports 256 B, R, D, PR and some other system data
Standard I/Os	• 16x DIs • 16x DOs • 2x AIs • 2x AOs	• 16x DIs • 16x DOs • 2x AIs • 2x AOs	• 16x DIs • 16x DOs • 2x AIs • 2x AOs
Safety I/O	• 1x emergency stop input (dual-circuit) • 1x safety door input (dual-circuit) • 5x configurable safety DIs • 4x configurable safety DOs	• 1x emergency stop input (dual-circuit) • 1x safety door input (dual-circuit) • 5x configurable safety DIs • 4x configurable safety DOs	• 1x emergency stop input (dual-circuit) • 1x safety door input (dual-circuit) • 5x configurable safety DIs • 4x configurable safety DOs
Encoder	1x ABZ encoder	1x ABZ encoder	1x ABZ encoder

Model	IRCB600-6BD	IRCB600-6CD	IRCB600-6AC
Bus type	TCP/IP, Modbus-TCP (slave), Modbus-RTU (slave), EtherNet/IP (slave), EtherCAT (master, slave)	TCP/IP, Modbus-TCP (slave), Modbus-RTU (slave), EtherNet/IP (slave), EtherCAT (master, slave)	TCP/IP, Modbus-TCP (slave), Modbus-RTU (slave), EtherNet/IP (slave), EtherCAT (master, slave)
EtherNet	2x, with a rate of 100 Mbps, one for hand-held teach pendant or PC-based teach pendant: ① Both the PC and Ethernet ports support Modbus-TCP slave. ② Only Ethernet port supports EtherNet/IP master/slave: 8 slaves supported when used as a master; 1 master supported when used as a slave.	2x, with a rate of 100 Mbps, one for hand-held teach pendant or PC-based teach pendant: ① Both the PC and Ethernet ports support Modbus-TCP slave. ② Only Ethernet port supports EtherNet/IP master/slave: 8 slaves supported when used as a master; 1 master supported when used as a slave.	2x, with a rate of 100 Mbps, one for hand-held teach pendant or PC-based teach pendant: ① Both the PC and Ethernet ports support Modbus-TCP slave. ② Only Ethernet port supports EtherNet/IP master/slave: 8 slaves supported when used as a master; 1 master supported when used as a slave.
EtherCAT master	1x, EtherCAT(M), frame sending jitter ≤ 30 μs (not currently supported)	1x, EtherCAT(M), frame sending jitter ≤ 30 μs (not currently supported)	1x, EtherCAT(M), frame sending jitter ≤ 30 μs (not currently supported)
EtherCAT slave	2x, IN, OUT, sync signal jitter < 1 μs	2x, IN, OUT, sync signal jitter < 1 μs	2x, IN, OUT, sync signal jitter < 1 μs
USB2.0	1x	1x	1x
RS232	1x (reserved)	1x (reserved)	1x (reserved)
RS485	1x, standard Modbus-RTU protocol supported, baud rate 4800 bps to 115200 bps	1x, standard Modbus-RTU protocol supported, baud rate 4800 bps to 115200 bps	1x, standard Modbus-RTU protocol supported, baud rate 4800 bps to 115200 bps
CAN bus	1x, maximum rate 1M (not currently supported)	1x, maximum rate 1M (not currently supported)	1x, maximum rate 1M (not currently supported)
Max. output power	2.6 kW	3.6 kW	3.6 kW
Input voltage range	220 VAC to 240 VAC (-15% to +10%) 50/60 Hz	220 VAC to 240 VAC (-15% to +10%) 50/60 Hz	48 VDC (43.2 V to 58.4 V)
Input current range	0 A to 12 A	0 A to 18 A	0 A to 18 A
IP rating	IP20	IP20	IP20

Model	IRCB600-6BD	IRCB600-6CD	IRCB600-6AC
Operating temperature	0°C to 50°C	0°C to 50°C	0°C to 50°C
Operating humidity	5% RH to 95% RH (30°C) (without condensation)	5% RH to 95% RH (30°C) (without condensation)	5% RH to 95% RH (30°C) (without condensation)
Altitude	1000 m	1000 m	1000 m
Certification	CE, functional safety (functional safety complies with standard ISO 13849-1 PLd Cat. 3)	CE, functional safety (functional safety complies with standard ISO 13849-1 PLd Cat. 3)	-
Noise level	$L_{Aeq} \leq 60$ dB(A)	$L_{Aeq} \leq 60$ dB(A)	$L_{Aeq} \leq 60$ dB(A)
Dimensions (W x D x H)	126 mm x 215 mm x 340 mm	126 mm x 215 mm x 340 mm	126 mm x 215 mm x 340 mm
Weight	8 kg	8 kg	8 kg
Applicable manipulator model	IR-U4-60S5, IR-U6-90S5, IR-U8-78S5	IR-U13-130S5, IR-U18-100S5	IR-U4-60S5, IR-U6-90S5, IR-U8-78S5, IR-U13-130S5, IR-U18-100S5

Technical specifications of the option (IR-TP200 hand-held teach pendant)

Classification	Name	Description
Display	Display	7-inch TFT LCD screen
	Resolution	800 x 480
Panel	Touch panel	4-wire resistive touchscreen
	Button	22 function buttons
Power supply		Controller rated voltage: 24 VDC Input voltage range: 24 VDC ±20%
Processor	MCU	Cortex-A7 Quad-core 1.2 GHz
Storage	RAM	512 MB DDR3L
	ROM	512 MB
Communication	USB Host	USB 2.0 (Type A)
	Ethernet	1x 10/100M auto-negotiation
Electrical components	-	Three-position enable switch, emergency stop button, three-position key switch, scroll wheel

Classification	Name	Description
Operating environment	IP rating	IP54, IP54 not met if USB plug is removed or not securely inserted
	Storage temperature	-25°C to +55°C
	Operating temperature	-40°C to +70°C
Certification (INT model)		CE certification, CR certification, cSGSus certification, WEEE certification

3.4 Product Dimensions

Manipulator

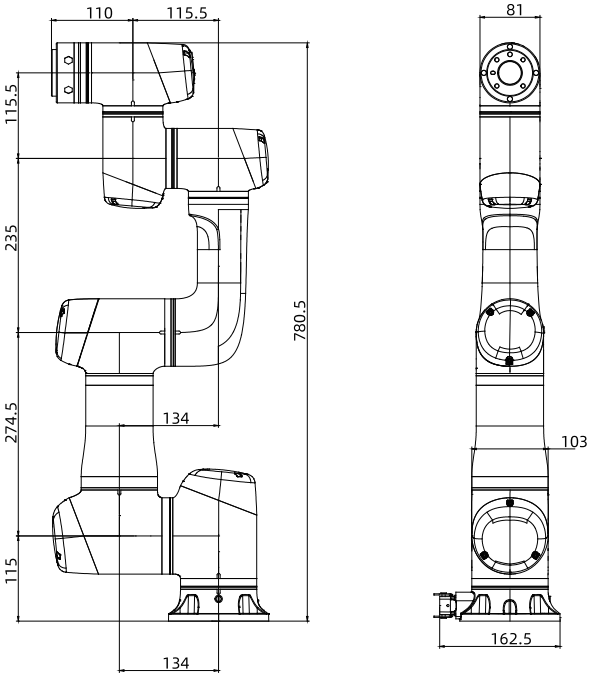


Figure 3-3 Dimensions of IR-U4 robot (unit: mm)

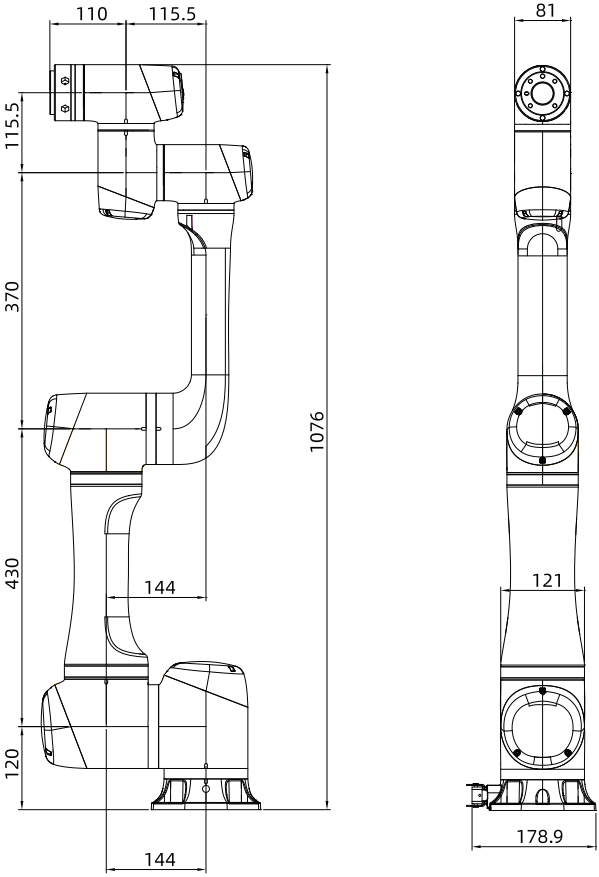


Figure 3-4 Dimensions of IR-U6 robot (unit: mm)

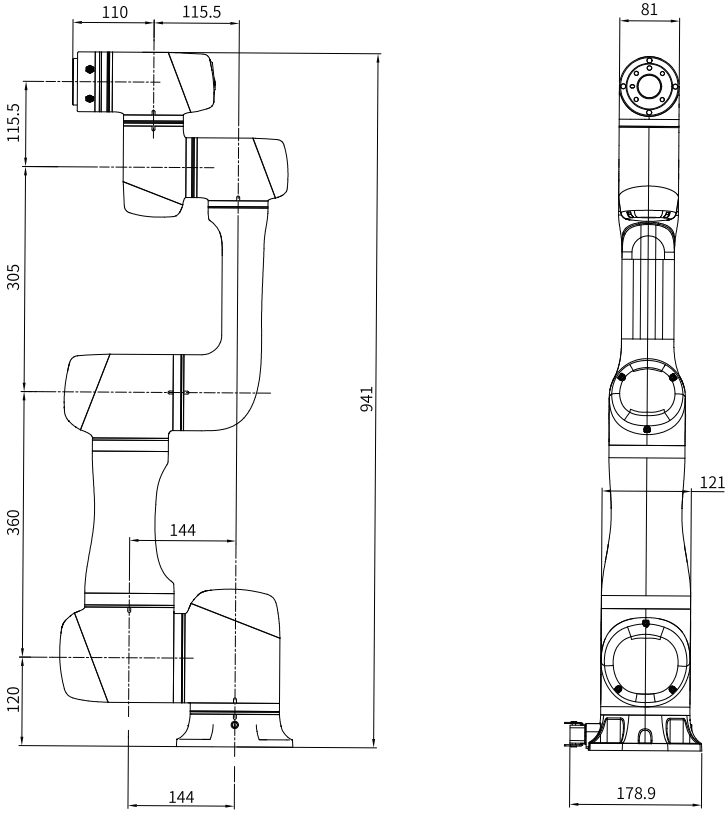


Figure 3-5 Dimensions of IR-U8 robot (unit: mm)

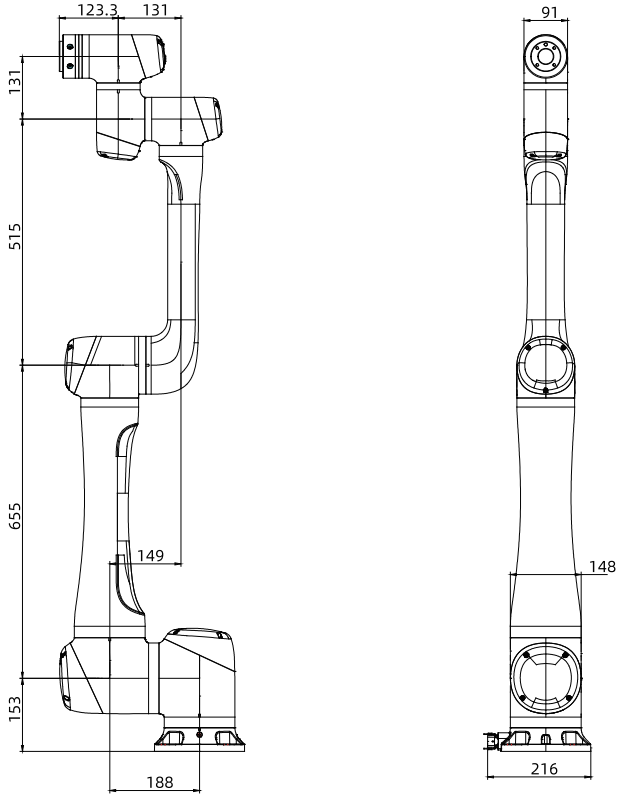


Figure 3-6 Dimensions of IR-U13 robot (unit: mm)

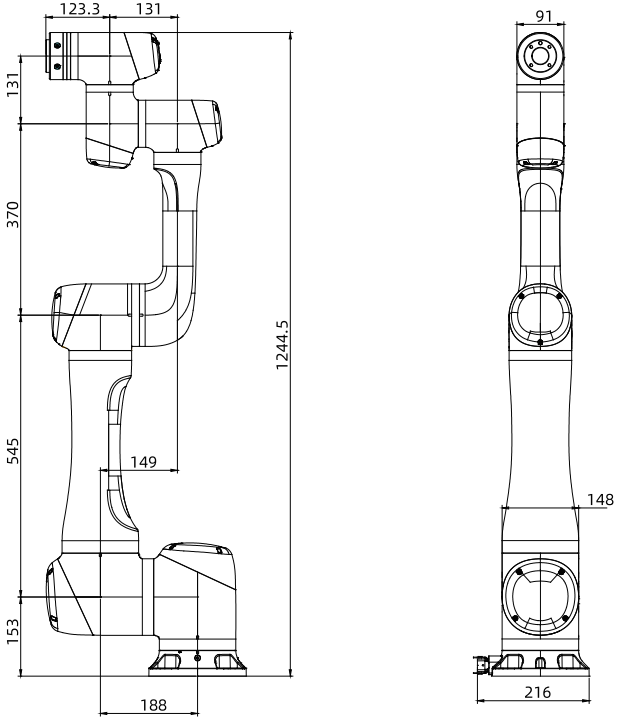


Figure 3-7 Dimensions of IR-U18 robot (unit: mm)

Controller series

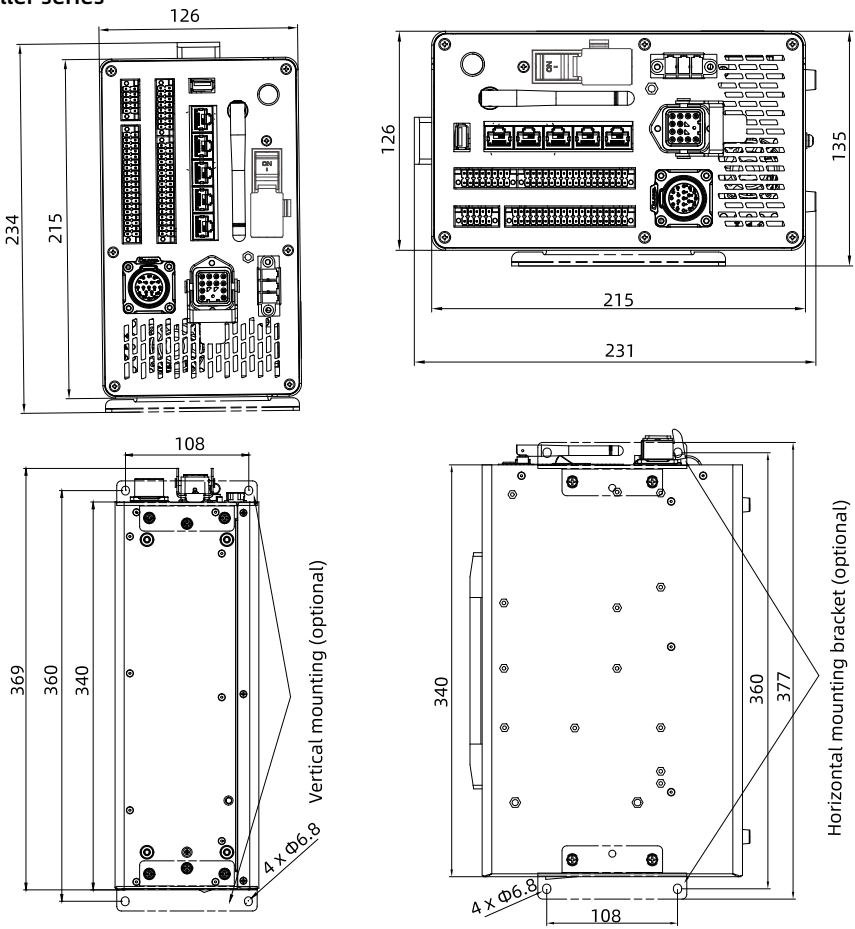


Figure 3-8 Dimensions of IRCB600 series controller (unit: mm)

3.5 Rotating Direction

The rotation direction of the respective axis is shown below.

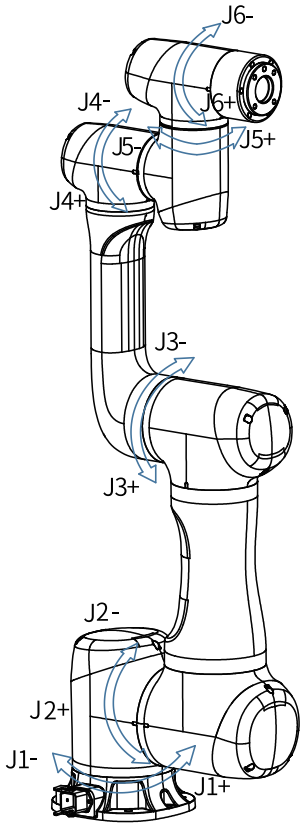


Figure 3-9 Rotation direction of each axis

3.6 Motion Range

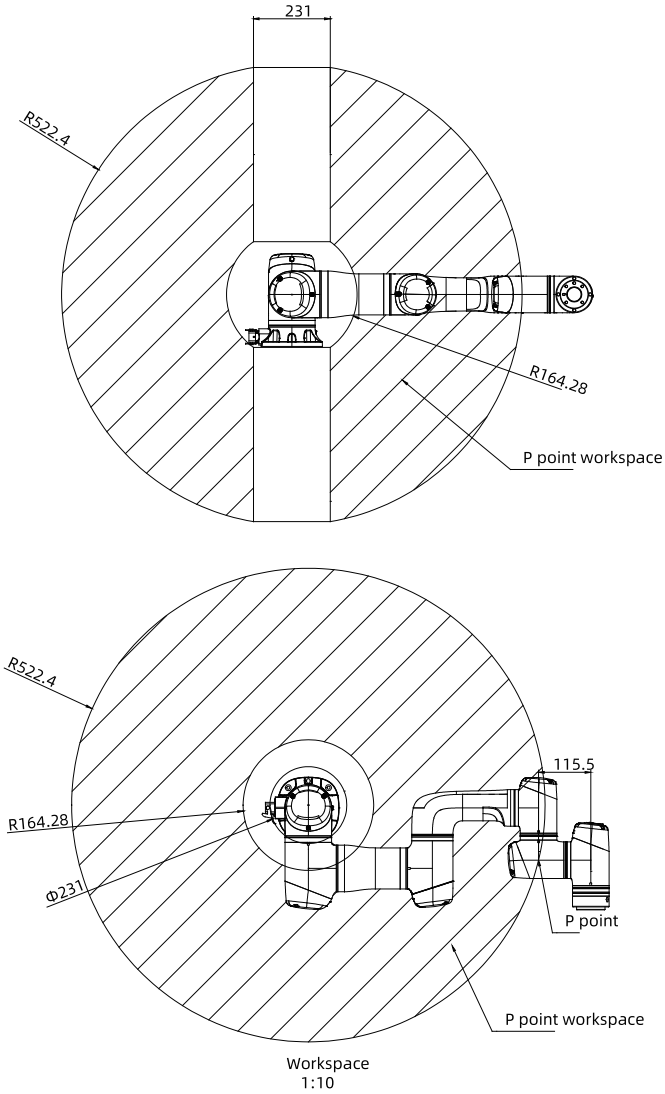


Figure 3-10 Motion range of IR-U4 robot (unit: mm)

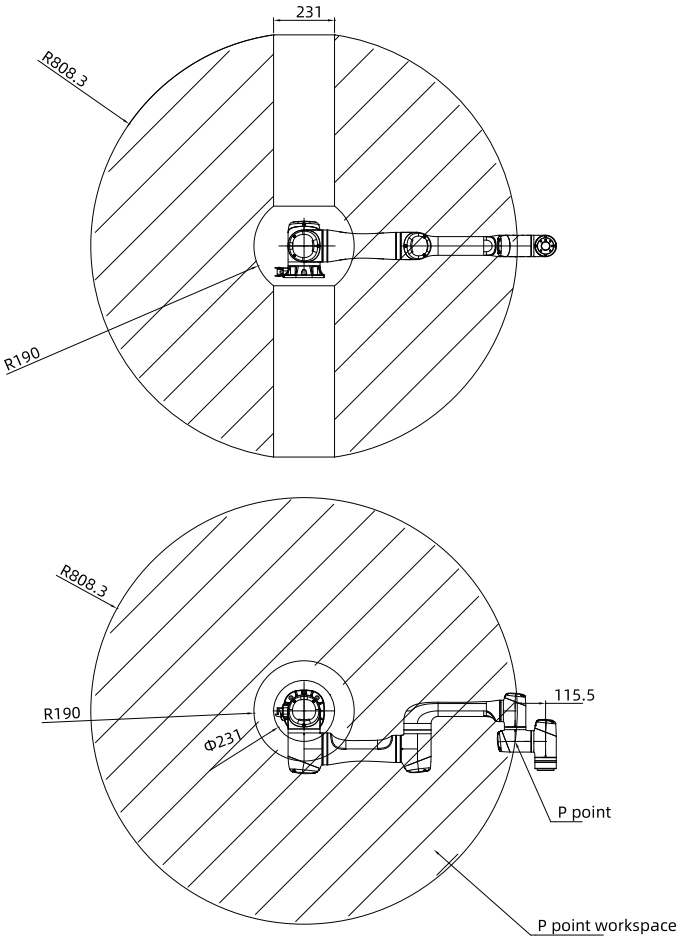


Figure 3-11 Motion range of IR-U6 robot (unit: mm)

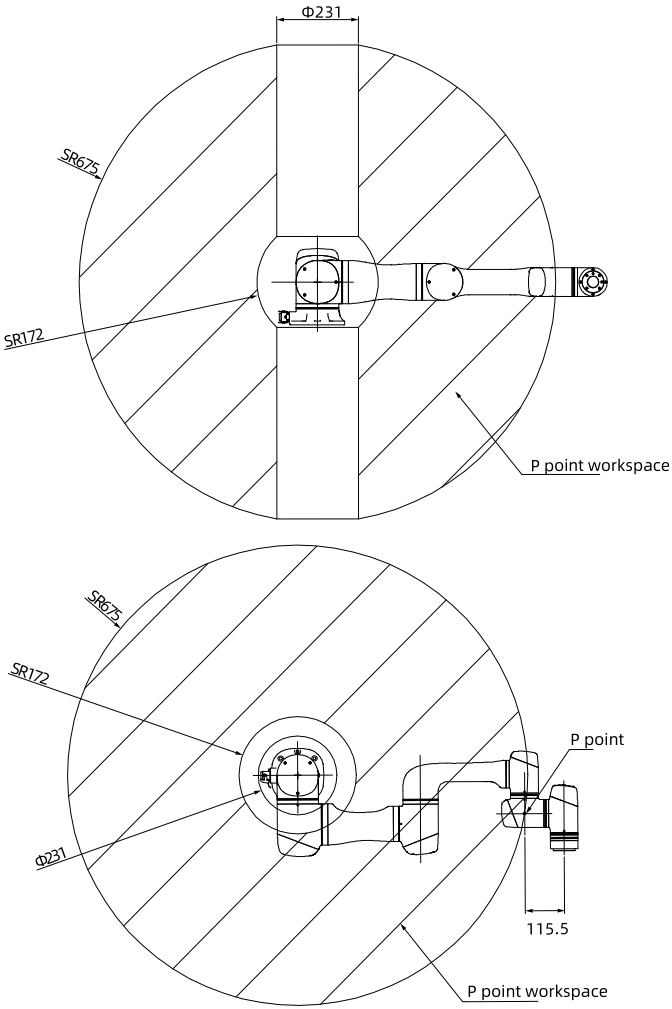


Figure 3-12 Motion range of IR-U8 robot (unit: mm)

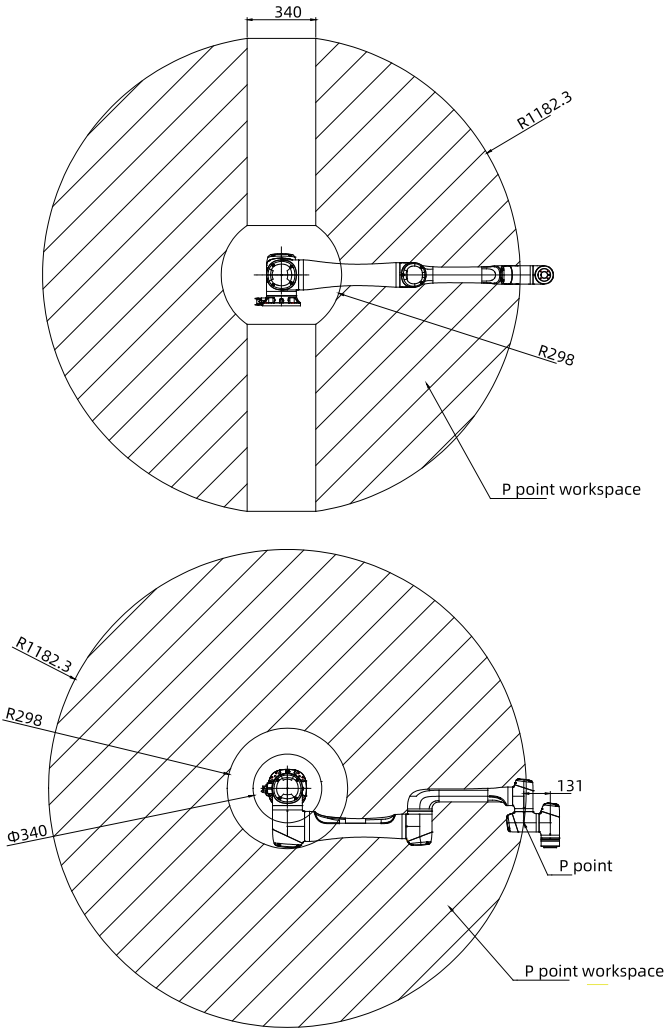


Figure 3-13 Motion range of IR-U13 robot (unit: mm)

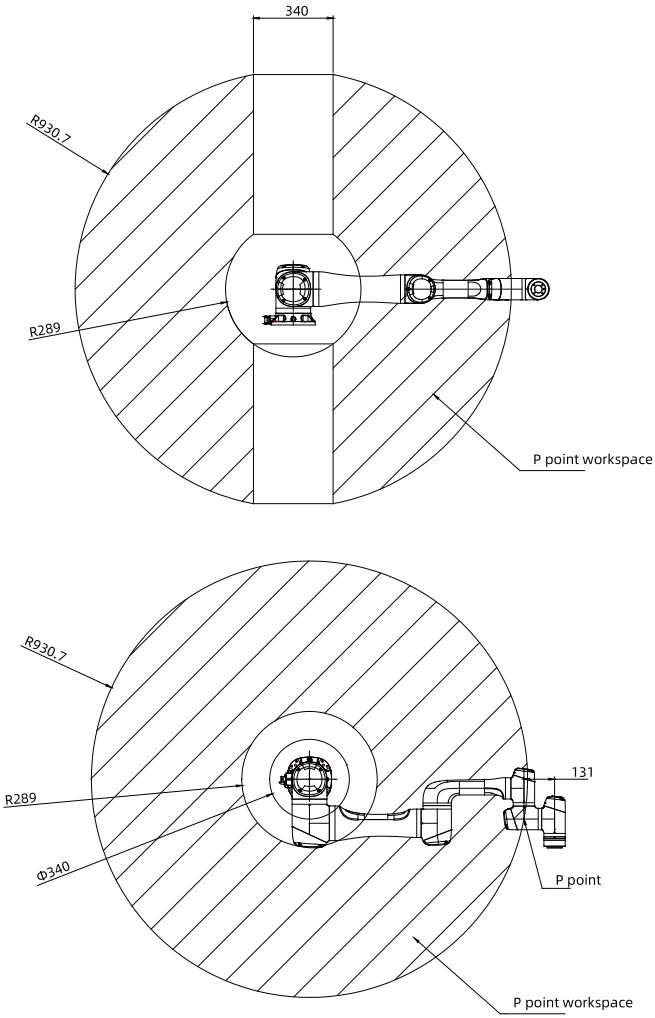


Figure 3-14 Motion range of IR-U18 robot (unit: mm)

3.7 Maximum Robot Payload

The allowable wrist load torque and allowable wrist load inertia are shown in the table below. Any external force applied to the robot shall not exceed the values in the table below.

Wrist load		IR-U4	IR-U6	IR-U8	IR-U13	IR-U18
Allowed wrist torque (unit: N·m)	J4	9.5	16.9	16.9	29	46
	J5	9.5	16.9	16.9	29	46
	J6	9.5	16.9	16.9	29	46
Allowed wrist inertia (unit: kg·m²)	J4	0.5	0.5	0.5	2.4	2.4
	J5	0.5	0.5	0.5	2.4	2.4
	J6	0.5	0.5	0.5	2.4	2.4

CAUTION

- During the use of the robot, define the correct load and correct the robot's payload. Incorrectly defined load data may cause the robot to be overloaded. Using incorrect load data or using load data other than those shown in the load chart may result in damage to motors, gears, and mechanical structures due to overload.
- Robots operating with incorrect load data or with loads other than those shown in the load chart will not be covered by the robot warranty.

The payload capacity at the robot end is affected by the offset distance of the load center of gravity relative to the center of the end flange. The load conditions for the robot system shall be within the range shown in the figure. The wrist load curve is shown in the figure below:

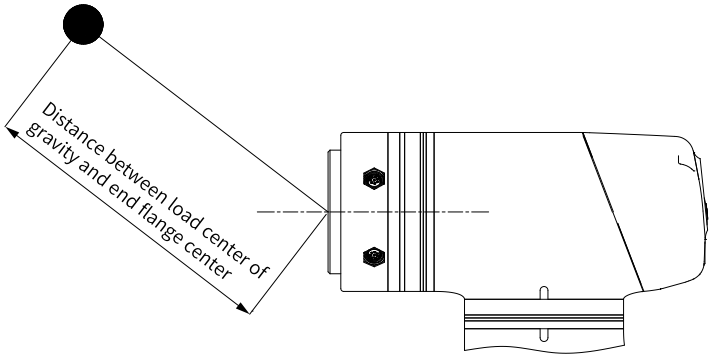


Figure 3-15 Offset distance of the load center of gravity relative to the center of the end flange

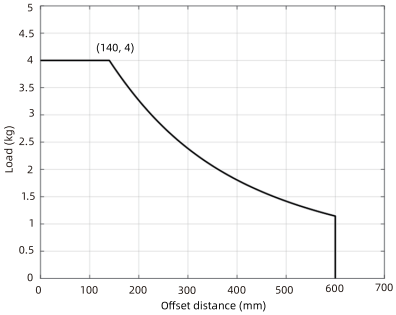


Figure 3-16 Load curve of IR-U4 robot

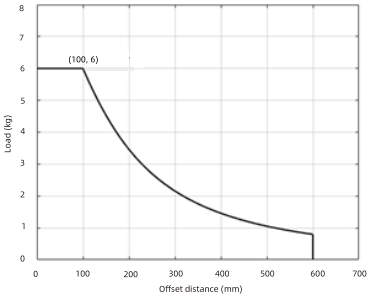


Figure 3-17 Load curve of IR-U6 robot

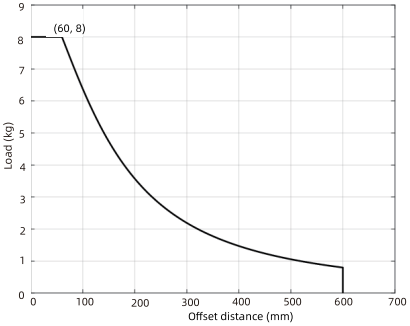


Figure 3-18 Load curve of IR-U8 robot

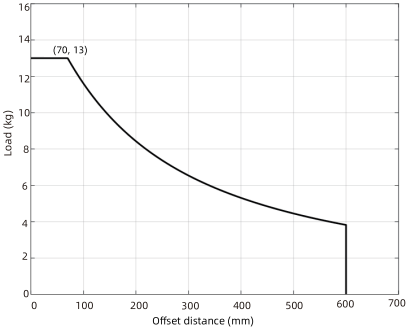


Figure 3-19 Load curve of IR-U13 robot

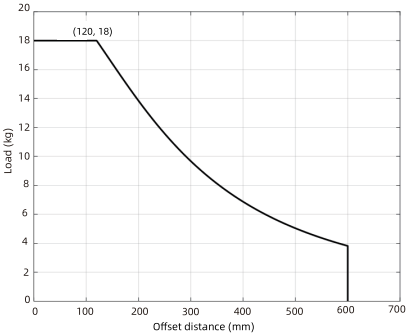


Figure 3-20 Load curve of IR-U18 robot

4 Unpacking and Handling

4.1 Precautions

Precautions for Unpacking



- Before unpacking, check that the outer package is intact and free from damage, water soaking, moisture, deformation, or other abnormalities.
- Unpack the package in the correct layered sequence. Do not strike the package violently.
- Check whether there is damage, rust, or injuries on the surface of the equipment and equipment accessories before unpacking.
- Check whether the package contents are consistent with the packing list before unpacking.



- Do not install the equipment if you find damage, rust, or indications of use on the equipment or accessories upon unpacking.
- Do not install the equipment if you find water seepage, component missing or damage upon unpacking.
- Do not install the equipment if you find the packing list does not conform to the equipment you received.
- Unpack the packing box according to the direction instructed.

Precautions for Handling

Note

Only qualified personnel are allowed to carry out handling work including rigger operation, hoisting by crane, and forklift driving.



- Keep the equipment in its original package when handling with a hoist or forklift.
- Wear personal protective equipment (PPE) when handling with a hoist or forklift. Prohibit personnel from standing or staying in the handling route.
- Stabilize the equipment with hands when hoisting it. Unstable hoisting may result in the equipment falling over. This may cause severe bodily injury or equipment damage.



- Store and transport this equipment based on the storage and transportation requirements for humidity and temperature.
- Avoid storing or transporting the equipment in environments with water splash, rain, direct sunlight, strong electric field, strong magnetic field, and strong vibration.
- Pack the equipment strictly before transportation. Use a sealed box for long-distance transportation.
- Never transport this equipment with other equipment or materials that may harm or have negative impacts on this equipment.
- If condensation occurs on the equipment during transportation or storage, remove the condensation before turning on the power.

4.2 Unpacking

Unpacking preparation: scissors, gloves, and safety shoes.

1. Unpack the carton.

   Wear protective gloves. Use scissors to cut the packing straps around the carton, and then remove the top cover and the carton.

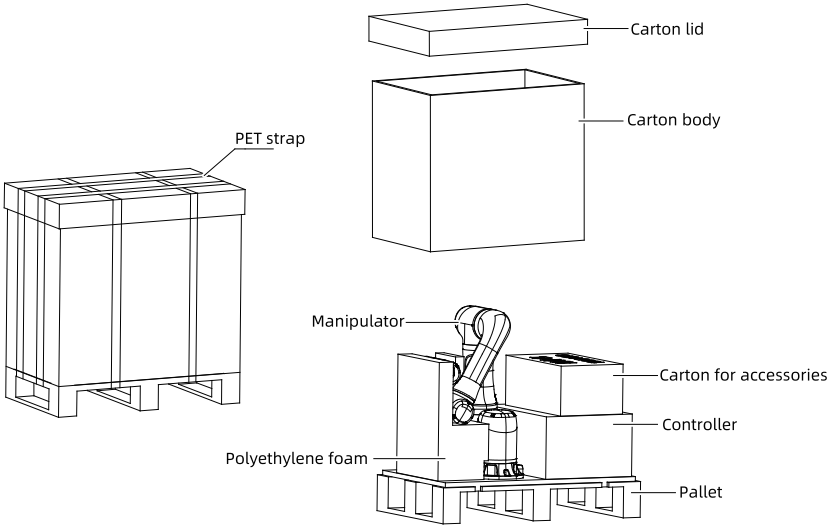
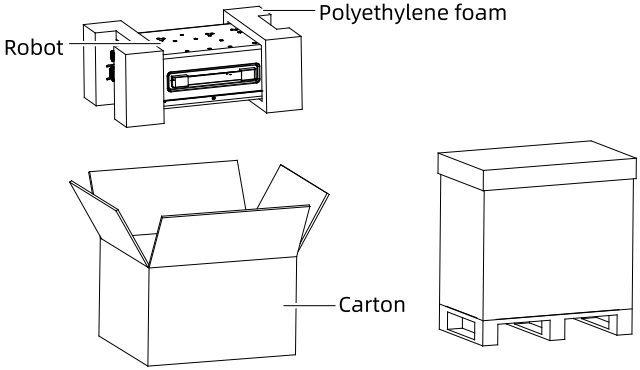


Figure 4-1 Unpacking the carton

2. Unpack the controller.

- Cut off the packing straps that fix the cartons for controller and accessories.
- After removing the carton for accessories, move the carton for controller to the open ground. Pay attention to the direction indication on the carton.
- Cut the sealing tape on the surface of the carton, and then open the carton.
- Remove the polyethylene foam on both sides of the controller, firmly grasp the hand holes on both sides of the controller or hold the bottom of the controller, take the controller out of the packing box, and move it to the destination.



3. Remove the robot body.

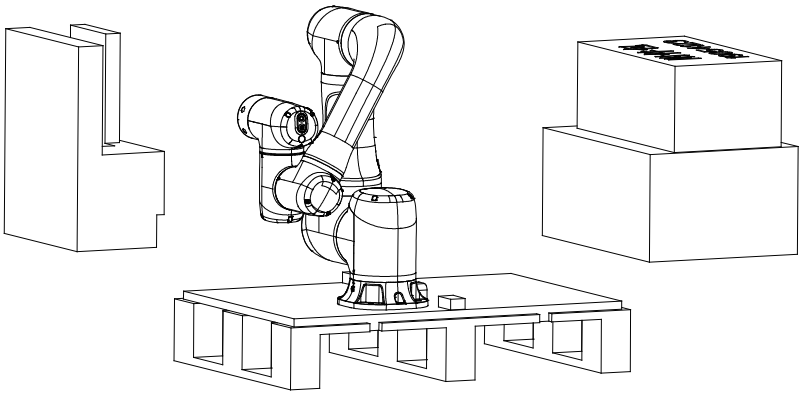


Figure 4-2 Packaging diagram

4. Take out the robot body.

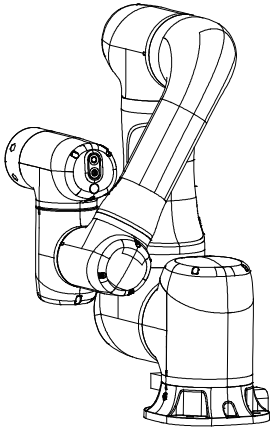


Figure 4-3 Taking out the robot body

4.3 Post-Unpacking Inspection

Check the products and accessories against the packing list after unpacking.

Table 4–1 Packing list of the IR-U4 series

Name	Quantity (PCS)
Manipulator	1
Robot controller	1
Trailing cable between manipulator and controller	1
Controller cable connection kit	1

Name	Quantity (PCS)
Inovance Robot Product Warranty Card	1
List of zero point information	1
Packing list	1
Fastener - Hexagon socket cap head screw - GB/T70.1-M6x30-12.9 grade	4
Spring washer (GB/T93-1987)-6	4
Flat washer (GB/T97.1-2002)-6	4

Table 4-2 Packing list of the IR-U6 & U8 & U13 & U18 series

Name	Quantity (PCS)
Manipulator	1
Robot controller	1
Trailing cable between manipulator and controller	1
Controller cable connection kit	1
Inovance Robot Product Warranty Card	1
List of zero point information	1
Packing list	1
Hexagon socket cap head SEMS screw M8 x 30-15 x 1.5	4

4.4 Handling

Handling the manipulator

- **Pre-handling preparation**
  Follow safe operation during the handling process. For details, see the handling preparation instructions in the "General Safety Instructions" section. Prepare safety shoes, protective gloves, and other equipment. At least two people are required for handling.
  - Before handling a newly shipped robot, keep it in the factory-set posture. For details about the joint angles, see *"5.3.1 Packaging Posture" on page 64*.
  - If the robot has been used and needs to be moved to another location, complete the following steps before handling:

    1. Adjust the robot to the posture for handling.
    2. Disconnect all power supplies of the equipment.
    3. Disconnect the power and signal cables from the controller.
    4. Remove the bolts fixing the robot to the base and then remove the robot from the installation base.

5. Secure the robot to the handling equipment.

- **Handling procedure**

Note

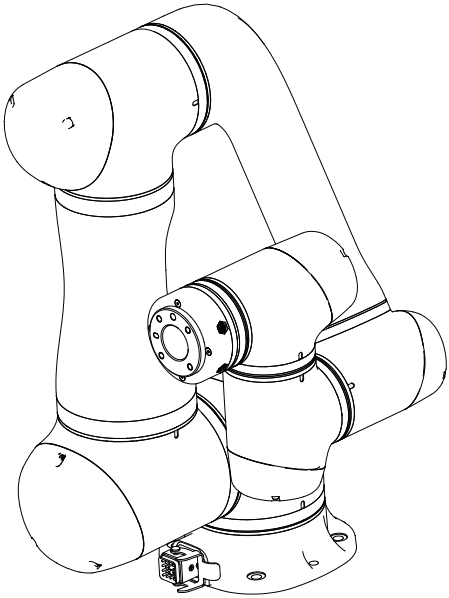
- The equipment is heavy and manual handling is strictly prohibited.
- Wear safety shoes for handling and at least two people are required.
- Wear protective equipment and ensure that the lifting area is safe enough to avoid collision hazards.



- Take care when lifting the robot with a crane or forklift. When placing the robot on the ground, avoid any strong collision between the robot mounting face and the ground.
- Before handling the robot, remove the end effector and the pallet. When it is necessary to handle the robot with the pallet installed, observe the following precautions.
- The end effector may oscillate due to vibration during transportation and excessive loads may be applied to the robot.
- When handling the robot with the pallet installed, lift the pallet rather than the robot directly.

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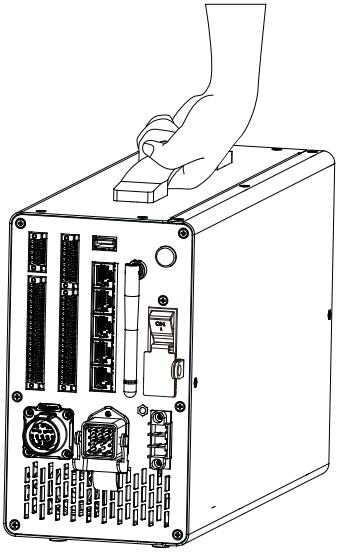
1. Wear safety shoes and protective gloves.
2. Use both hands when handling.



Handling the controller

Pre-handling preparation: Follow safe operation during the handling process. For details, see the handling preparation instructions in the "General Safety Instructions" section. Prepare safety shoes, protective gloves, and other equipment.

1. Wear safety shoes and protective gloves.
2. You can carry the controller by the handle.



CAUTION

Grasp the controller firmly to prevent it from falling and being damaged.

5 Transportation Protection

5.1 Overview

The main shipping methods for industrial robots are sea freight, air freight, and land transport. During long-distance transportation, complex conditions and external environmental factors (including long distances, long transit times, high humidity, severe vibration, temperature fluctuations, and salt spray corrosion) can easily cause damage to equipment components, electronic component failures, or structural deformation, increasing the risk of transport damage.

To avoid the above risks, the robot packaging method must be optimized and reinforced to improve safety and reliability during transportation. Protection measures fall into two main aspects:

- Product impact and scratch protection.

To prevent surface scuffing and scratching of the equipment during transportation, place anti-scratch protective pads (such as EPE foam or EVA sheets) between the upper arm and forearm of the robot.

- Dust, moisture, and rust protection.

Seal the product together with desiccant in a highly sealed PE bag to provide dust, moisture, and rust protection.

Based on differences between product series and customer site requirements, the following two packaging methods are used:

- The robot is packaged and transported separately.
- The robot is packaged and transported together with customer equipment.

Before shipping the manipulator, controller, or any spare parts, observe the following precautions:

Note

- Before shipment, remove external tools and external electrical connections. If third-party products cannot be safely removed, or if the required post-repair tests is prohibited, Inovance reserves the right to refuse to accept the returned items. Inovance assumes no liability for returns or exchanges of third-party goods.
- Before shipment, confirm that the manipulator, controller, spare parts, and other items have been packed according to the standard. Return Inovance products in their original Inovance packaging.
- Software and firmware may be upgraded during repair. Therefore, after installing the repaired or replaced manipulator, controller, or other parts, check the software version and upgrade it as needed.
- If the manipulator, controller, or parts have come into contact with hazardous chemicals or materials, or have been operated in an environment containing hazardous chemicals or materials, they must be cleaned before shipment.

5.2 Bill of Materials

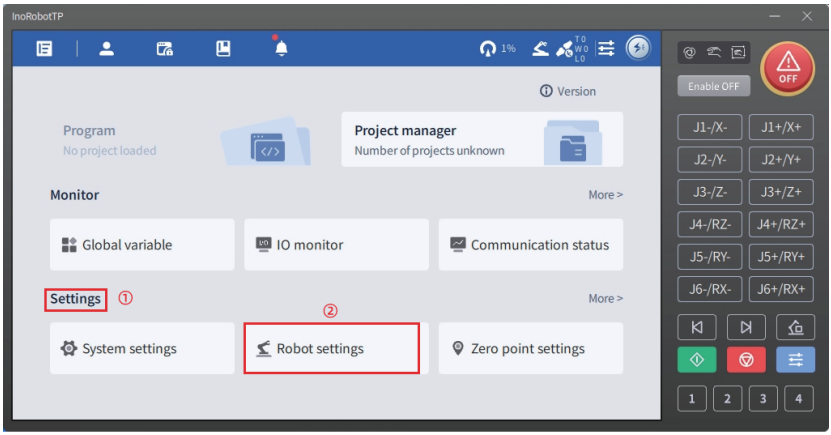
Name	Code	Quantity (PCS)	Description
Carton for accessories	19054123	1	For packing accessories
Desiccant	24060662	8	-
Desiccant	19033053	2	-
PET packing strap	19033036	0.01	-
PE bag	19033007	1	For packing the controller
PE bag	19070015	1	For packaging the manipulator
PE bag 2	19033005	1	For packing loose parts
Bubble wrap	19033066	0.01	For protecting cable plugs
Nylon tie	21021096	4	For protecting cable plugs
Wooden pallet	19038521	1	-
Carton box	19054652	1	For packing the complete robot
Carton	19055045	1	For packing the controller
Polyethylene foam	19082164	1	-
Polyethylene foam	19082433	1	For packing the controller

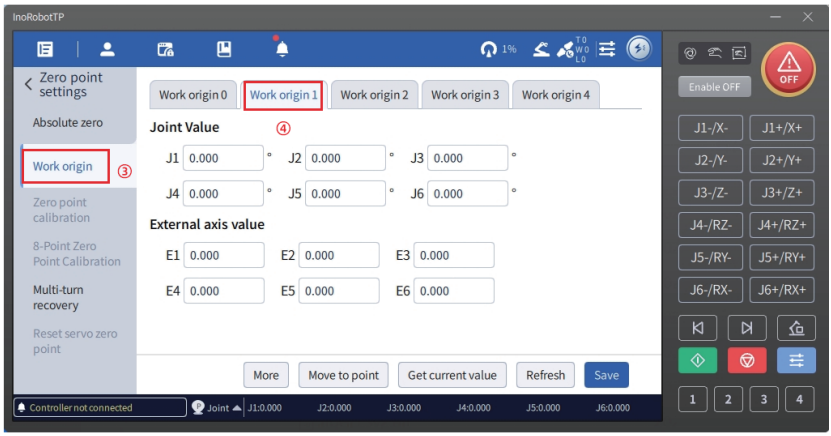
5.3 Packaging Guide

5.3.1 Packaging Posture

Posture settings

1. When the robot is enabled, press and hold the initial pose button. The robot starts moving to the initial pose. The robot stops moving if you release the button during movement or when the movement is complete. The initial pose value can be set in "Settings" > "Zero point settings" > "Work origin" > "Work origin 1".





2. When the robot is enabled, press and hold the zero pose button. The robot starts moving to the packaging posture. The robot stops moving if you release the button during movement or when the movement is complete.
3. After ensuring the environment is safe, enable the robot and move it to the packaging posture.

4. Disable and power off the robot, disconnect the controller power supply, and disconnect all connections.
5. Place the robot and controller into the original packaging box, and ensure that they are positioned correctly.

Transport Pose

The robot must be placed in the transport pose before transportation.

The angle of each joint is as follows:

Robot series	J1	J2	J3	J4	J5	J6
IR-U4	90°	0°	-150°	150°	0°	0°
IR-U6	90°	12°	-150°	130°	0°	0°
IR-U8	90°	0°	-150°	150°	0°	0°
IR-U13	90°	12°	-160°	148°	0°	0°
IR-U18	90°	12°	-150°	138°	0°	0°

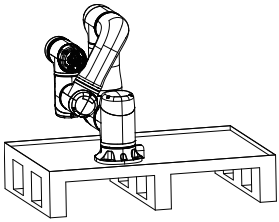


Figure 5-1 Factory-set posture of the IR-U4 robot

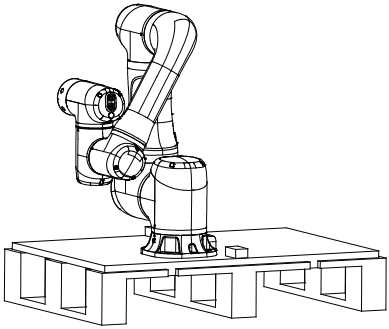


Figure 5-2 Factory-set posture of the IR-U6 & U8 robots

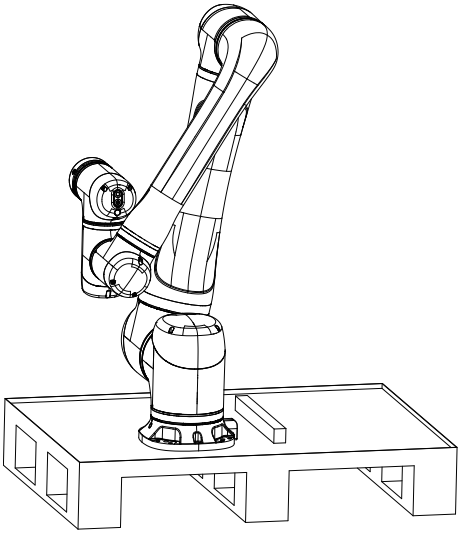
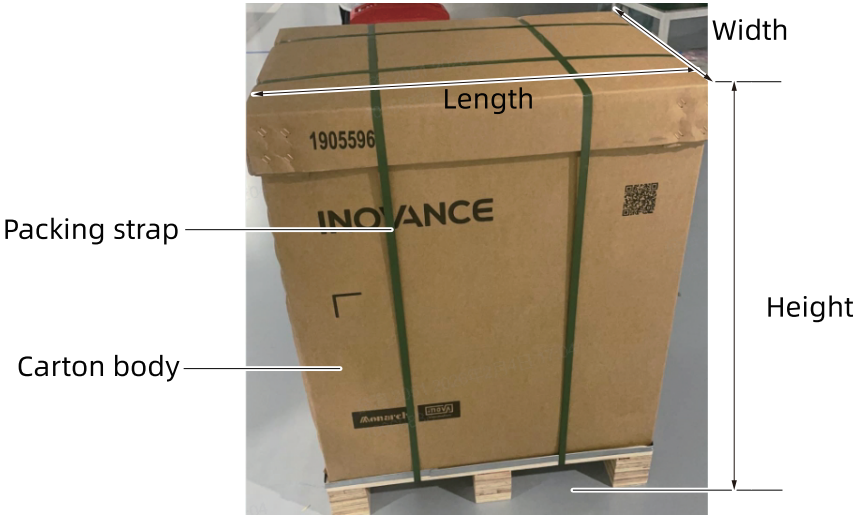


Figure 5-3 Factory-set posture of the IR-U13 & U18 robots

Package dimensions

Table 5–1 Package dimensions for robot (unit: mm)

Model	Arm length	Height	Width	Length
IR-U4-60	625	755	500	720
IR-U6-90	915.5	815	500	720
IR-U8-78	780.5	755	500	720
IR-U13-130	1301	1040	580	800
IR-U18-100	1046	1040	580	800



Note

- The factory dimensions (manipulator + controller) above are for customer reference only.
- After the product is fully packaged according to the manufacturer's standard packaging requirements, the total mass as shipped is approximately 38.5 kg for IR-U4, 44 kg for IR-U6, 42.5 kg for IR-U8, 68 kg for IR-U13, and 66 kg for IR-U18. The above weights are theoretical reference values only, and the actual weighing results shall prevail.

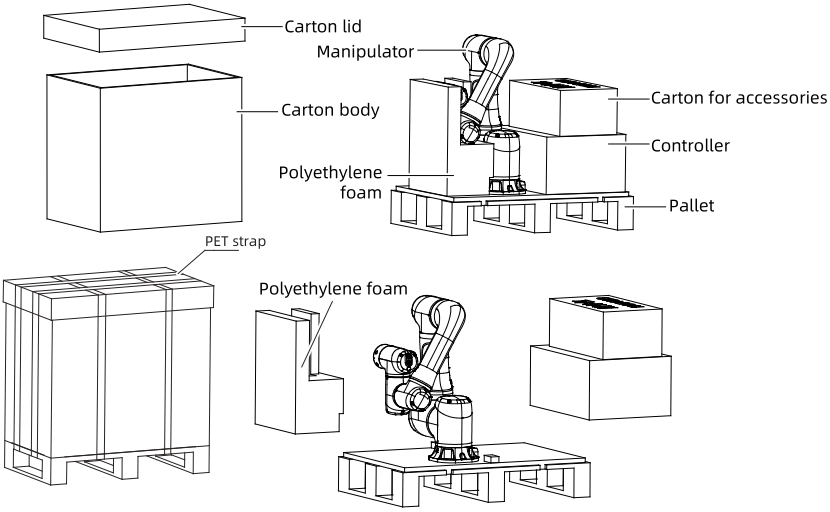
5.3.2 Packaging Procedure

1. Adjust the collaborative robot to the specified position and angle according to the relevant parameters, and place a piece of polyethylene foam under the arm at J5 to provide support.
2. Lay a PE bag under the manipulator, and then secure the manipulator to the four mounting holes on the packaging pallet using the supplied bolts.
3. Place desiccant packs, and then pull the PE bag upward from the bottom to enclose the manipulator. Place protective polyethylene foam, and then wrap the manipulator and polyethylene foam tightly with stretch film.
4. Place the robot's cable set (with both ends wrapped in bubble wrap, coiled into a bundle measuring 300 mm x 200 mm x 60 mm and secured with nylon cable ties), the guide, and other accessories into the carton for accessories.
5. Place the robot controller together with desiccant into a plastic bag. Fold the bag flat and seal the opening with transparent adhesive tape.

6. Fit polyethylene foam over both ends of the collaborative robot controller, and then place it into the carton.
7. Wrap the controller with polyethylene foam and pack it in the carton, then place desiccant packs inside the carton.
8. Attach the guide, zero point information attachment, etc., to the inner side of the carton.
9. Place the carton for accessories on top of the carton for controller, and secure it with PET packing straps.
10. Fit the carton body over, and close the lid to hold the paper corner protectors in place.
11. Use PET straps to seal the carton in a grid pattern ("#"-shape).
12. Each carton contains 1 piece of product.



- Place the product together with desiccant into a plastic bag. Fold the bag flat and seal the opening with transparent adhesive tape.
- Place the product in a carton box and protect both ends of the product with polyethylene foam.
- Attach the guide, zero point information attachment, etc., to the inner side of the carton box.
- Place desiccant and cover with a PE bag to prevent dust and rust.
- Prevent collisions and scratches throughout the entire process.
- It is not recommended to transport with a load (tooling or fixture) for secondary transportation.
- During packaging and transportation, the robot's gravity axis should be locked (the method is not specified, but it must ensure that there is no possibility of downward movement).


Carton lid
Manipulator
Carton body
Carton for accessories
Controller
Polyethylene foam
Pallet
PET strap
Polyethylene foam

6 Installation and Wiring

6.1 Pre-installation Preparation

6.1.1 Installation Personnel Requirements

- Ensure that the installation personnel have obtained mechanics knowledge or received mechanics training in advance to understand various dangers and risks in the installation process.
- The installation personnel must be familiar with the installation requirements and relevant technical information.
- Product installation, wiring, maintenance, inspection, or component replacement must be performed only by professionals.

6.1.2 Installation Tool Preparations

Table 6–1 Installation tools for the IR-U4 robot

Tool	Quantity (PCS)
M6 inner hexagon wrench	1
Scissors	1
Safety shoes	1
Protective gloves	1

Table 6–2 Installation tools for the IR-U6&U8&U13&U18 robots

Tool	Quantity (PCS)
M8 inner hexagon wrench	1
Scissors	1
Safety shoes	1
Protective gloves	1

Mounting method

- Manipulator mounting method
  The manipulator supports any mounting method. The mounting methods are shown in the table below:

Model	Mounting method	Accessory	Tool	Recommended torque
IR-U4	Any orientation	M6 x 30 hexagon socket head cap SEMS screw	Torque wrench and hexagon screwdriver bit	15 N·m
IR-U6&U8&U13&U18	Any orientation	M8 x 30 hexagon socket head cap SEMS screw	Torque wrench and hexagon screwdriver bit	40 N·m

- Controller mounting method
  The controller supports two mounting methods: horizontal mounting and vertical mounting. The two mounting methods are shown in the table below:

Mounting method	Accessory	Tool	Recommended torque
Horizontal mounting	Standard M5 x 12 cross recessed hexagon head SEMS bolt with indentation	Phillips screwdriver or electric screwdriver	2.8 N·m
	Standard M6 x 12 cross recessed hexagon head SEMS bolt with indentation	Phillips screwdriver or electric screwdriver	4.8 N·m
Vertical mounting	Standard M5 x 12 cross recessed hexagon head SEMS bolt with indentation	Phillips screwdriver or electric screwdriver	2.8 N·m
	Standard M6 x 12 cross recessed hexagon head SEMS bolt with indentation	Phillips screwdriver or electric screwdriver	4.8 N·m

6.1.3 Installation Environment Requirements

Set up the robot system in an environment that complies with the following conditions in order to maximize and maintain the performance of the equipment and to use it safely.

- Install it indoors.
- Avoid installation and use in environments with conductive dust (e.g., metal dust, graphite dust), conductive fibers (e.g., carbon fiber filaments, metal filaments), explosive dust, flammable gases, water mist/oil mist, corrosive dust, salt particles,

corrosive gases (e.g., sulfur dioxide, hydrogen sulfide, chlorine, ammonia), or vibration/impact.

- Avoid use in an enclosed environment, as this might cause overheating of the controller and hence shorten its service life.
- Avoid direct sunlight.
- Avoid impacts and vibrations, etc.
- Keep it away from heating sources such as a heating stove.
- Keep it away from sources of electrical interference such as large inverters, high-power high-frequency generators, large contactors, welding machines, etc.

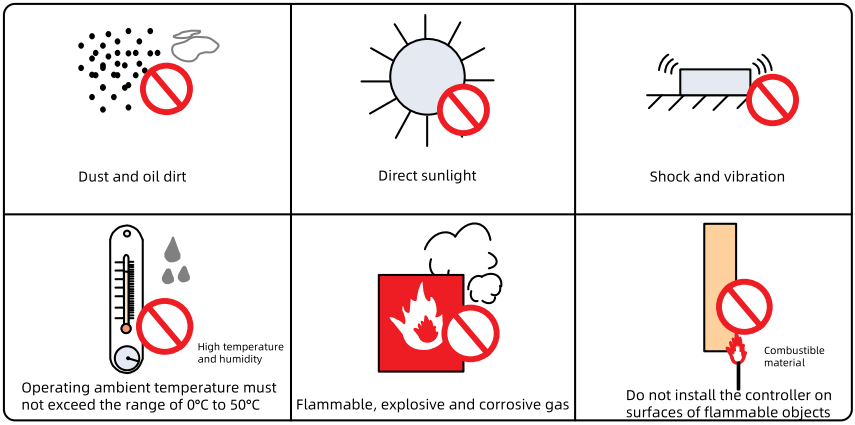


Figure 6-1 Installation environment requirements

Table 6–3 Ambient condition

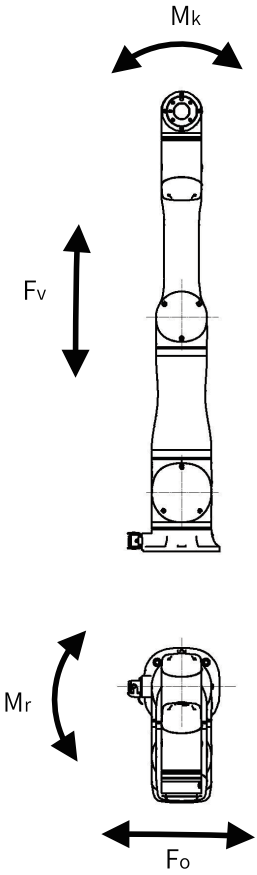
Item	Manipulator environmental requirements	Controller environmental requirements
Operating temperature/ humidity	• Temperature: 0°C to 50°C (air temperature change gradient less than 1.5°C/min) • Humidity: 5% RH to 95% RH (without condensation)	• Temperature: 0°C to 50°C (standard-power models) • Humidity: 5% RH to 95% RH (without condensation)
Storage temperature and humidity	• Temperature: -10°C to +55°C • Humidity: ≤ 95% RH (without condensation)	• Temperature: -10°C to +55°C • Humidity: ≤ 95% RH (30°C) (without condensation)
Transportation temperature and humidity	• Temperature: -25°C to +55°C • Humidity: ≤ 95% RH (without condensation)	• Temperature: -25°C to +55°C • Humidity: ≤ 95% RH (40°C) (without condensation)

Item	Manipulator environmental requirements	Controller environmental requirements
Vibration	• Compliant with IEC 60068-2-6 (GB/T 2423.10) Vibration frequency: 5 Hz to 55 Hz; vibration displacement: 0.15 mm; 5 cycles in each of the X/Y/Z axes. • Compliant with IEC 60068-2-64 (GB/T 2423.56) (5–100) Hz: 0.01 g^2/Hz; 200 Hz: 0.001 g^2/Hz; Grms = 1.14 g. • Without packaging: the manipulator is kept in the packaging posture and vibrated for 30 min in each of the X/Y/Z axes. With packaging: vibrated for 60 min in the Z axis.	• Compliant with IEC 60068-2-6 (GB/T 2423.10) Vibration frequency: 5 Hz to 55 Hz; vibration displacement: 0.15 mm; 5 cycles in each of the X/Y/Z axes. • Compliant with IEC 60068-2-64 (GB/T 2423.56) (5–100) Hz: 0.01 g^2/Hz; 200 Hz: 0.001 g^2/Hz; Grms = 1.14 g. • Without packaging: the manipulator is kept in the packaging posture and vibrated for 30 min in each of the X/Y/Z axes. With packaging: vibrated for 60 min in the Z axis.
Shock	Compliant with IEC 60068-2-27 (GB/T 2423.5) Half-sine wave: 15 g/11 ms; 3 shocks in each direction.	Compliant with IEC 60068-2-27 (GB/T 2423.5) Half-sine wave: 15 g/11 ms; 3 shocks in each direction.
Altitude	≤ 1000 m	≤ 1000 m
IP rating	IP54	IP20

6.1.4 Installation Base Table Requirements

You need to make a base table to secure the robot. The shape and size of the base table vary depending on the purpose of the robot system. You may refer to the following requirements when designing a base table.

- The base table supports not only the weight of the robot, but also the dynamic forces produced by the robot when it moves at maximum acceleration. Ensure that the base table has sufficient bearing capacity by reinforcing it with materials like connecting beams.
- Use M8 or M6 threaded holes on the base table to mount the robot. Use screws with a strength equivalent to the performance level of Grade 12.9 specified in GB/T 3098.1.
- To suppress the vibration, use a steel plate that meets the following requirements as the mounting surface of the robot: thickness > 30 mm; surface roughness < 25 μm; flatness < 0.2 mm.
- Secure the base table firmly on the ground.
- Keep the Z-axis of the robot perpendicular to the horizontal plane during installation.
- Take the storage space of the controller into account when designing the base table. For detailed data, see the "Controller Installation Space Requirements" in *"6.1.5 Installation Space Requirements" on page 75*.
- Consider the following torques and reaction forces produced by movements of the robot.



Robot series	Max. vertical reaction force F_v (N)	Max. horizontal reaction force F_o (N)	Max. horizontal torque M_r (N·m)	Max. vertical torque M_k (N·m)
IR-U4	1360	1050	520	650
IR-U6	1880	1460	1070	1320
IR-U8	1800	1400	1020	1260
IR-U13	3100	2400	2320	2860
IR-U18	3000	2300	2320	2860

6.1.5 Installation Space Requirements

Controller installation space requirements

Reserve the installation clearances as shown in the following figure to ensure sufficient space for heat dissipation.

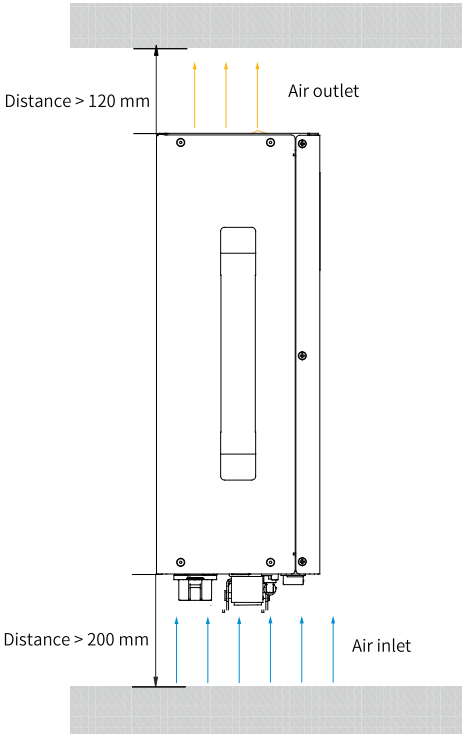


Figure 6-2 Controller installation space requirements

Manipulator installation space requirements

- Installation Space

  1. In addition to the space required for the manipulator, controller, and peripherals, ensure the following minimum required spaces:
     - Space for teaching (prepare before installation)
     - Space for maintenance and inspection (for mounting fixtures)
     - Space for cables
  2. For the minimum bending radius of power cables and signal cables, see *"6.3.2.3 Cable Hole Dimensions" on page 89*. When installing the robot, pay attention to the distance from obstacles. Reserve enough space for cable

bending radius to avoid cable damage or breakage caused by extreme bending of the cables.

- Installation dimensions
  For the installation dimensions of the robot base, see *"3.4 Product Dimensions" on page 39*.

6.2 Installation

6.2.1 Installing the Manipulator

Installing the U4 series robot manipulator

Follow the following steps to install the manipulator:

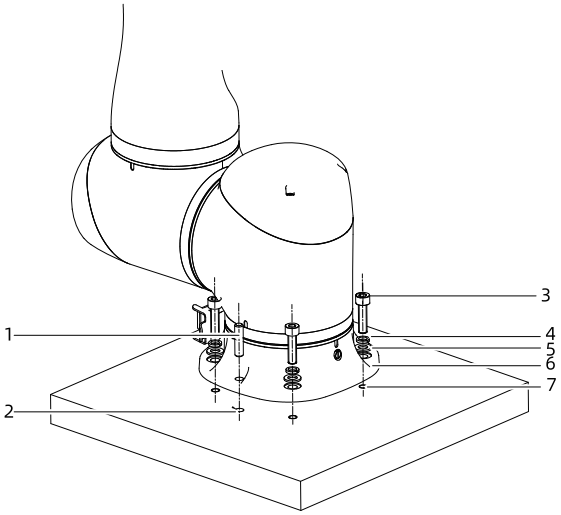
1. Disconnect power to all devices.
2. Clean the mounting surface for the manipulator.

Note

To suppress vibration, it is recommended that the mounting surface for the robot be a steel plate with a thickness of at least 30 mm and a surface roughness of less than 25 μm.

---

3. Move the manipulator near the mounting surface.
4. Align the robot base with the two positioning pin holes.
5. Install the two positioning pins.
6. Install four spring washers and four plain washers, and fix the base with four M6 x 30 hexagon socket head cap screws (tightening torque: 15 N·m). Use screws with a strength equivalent to the performance level of Grade 12.9 specified in GB/T 3098.1.



No.	Name
1	Two parallel pins (GB/T119.1-2000)-Φ8 x 32
2	Mounting pin holes (depth: > 20 mm)
3	Four M6 x 30 hexagon screws (GB/T70.1-2000, Grade 12.9)
4	Four spring washers (GB/T93-1987 6)
5	Four flat washers (GB/T97.1-2002 6)
6	Robot base
7	Threaded mounting holes (depth: > 23 mm)

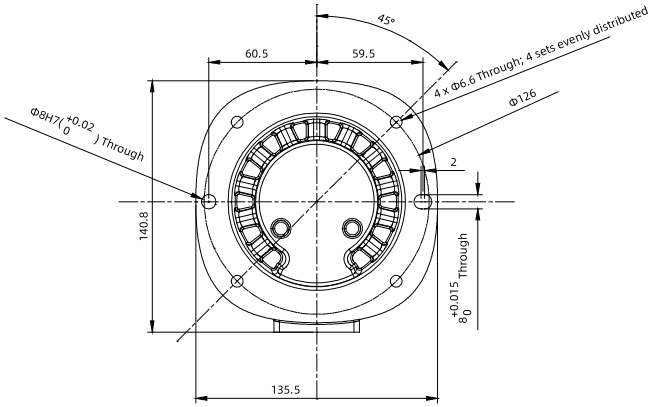


Figure 6-3 U4 robot base mounting dimensions (unit: mm)

Installing the U6/U8/U13/U18 series robot manipulator

Follow the following steps to install the manipulator:

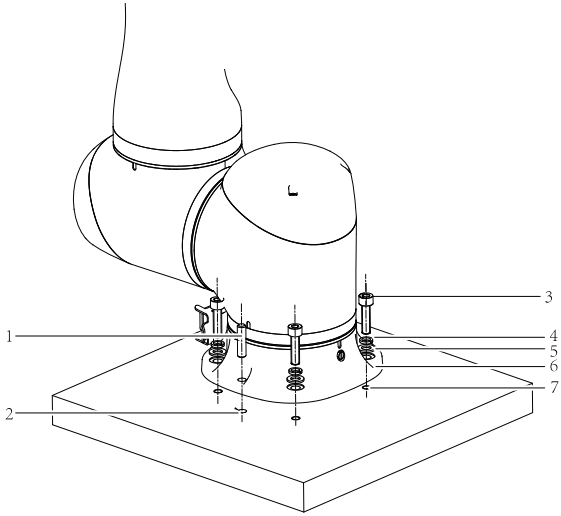
1. Disconnect power to all devices.
2. Clean the surface onto which the manipulator is to be mounted.

Note

To suppress vibration, it is recommended that the mounting surface for the robot be a steel plate with a thickness of at least 30 mm and a surface roughness of less than 25 μm.

---

3. Move the manipulator near the mounting surface.
4. Align the robot base with the two positioning pin holes.
5. Install the two positioning pins.
6. Install four spring washers and four plain washers, and fix the base with four M8 x 30 hexagon socket head cap screws (tightening torque: 40 N·m). Use screws with a strength equivalent to the performance level of Grade 12.9 specified in GB/T 3098.1.



No.	Name
1	Two parallel pins (GB/T119.1-2000)-Φ8 x 32
2	Mounting pin holes (depth: > 20 mm)
3	Four M8 x 30 hexagon screws (GB/T70.1-2000, Grade 12.9)
4	Four spring washers (GB/T93-1987 8)
5	Four flat washers (GB/T97.1-2002 8)

No.	Name
6	Robot base
7	Threaded mounting holes (depth: > 22 mm)

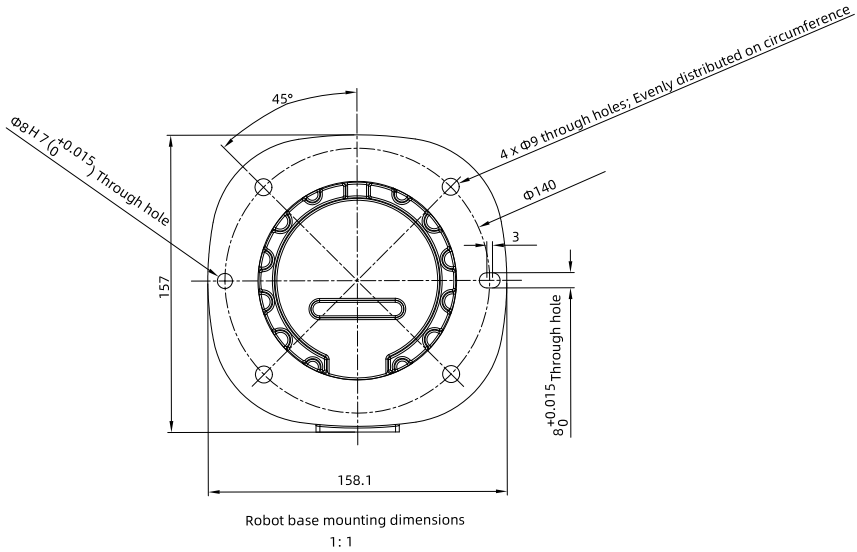


Figure 6-4 U6 & U8 robot base mounting dimensions (unit: mm)

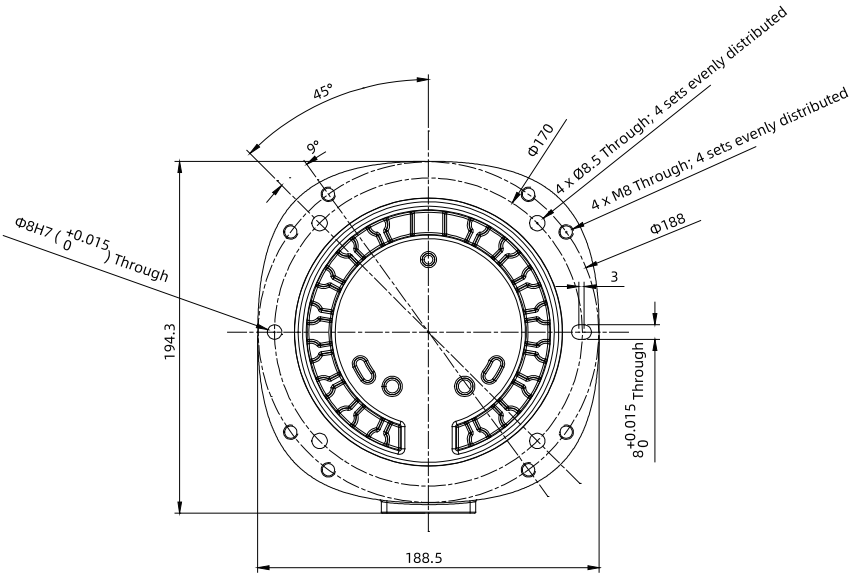
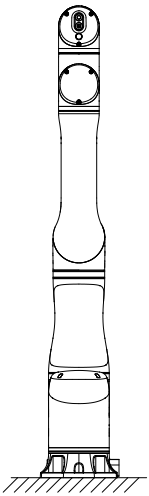


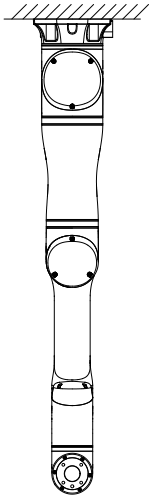
Figure 6-5 U13 & U18 robot base mounting dimensions

Mounting method

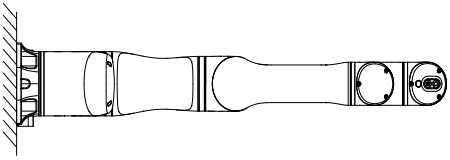
The manipulator supports mounting in any orientation.



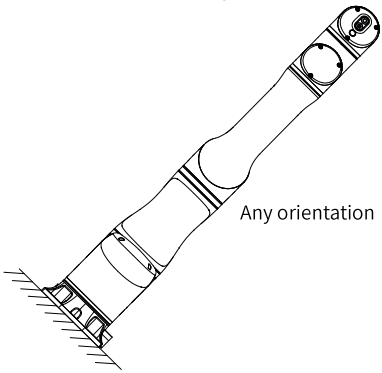
Floor-mounted



Ceiling-mounted



Wall-mounted



Any orientation

6.2.2 Installing an End Effector

Customers shall prepare end effectors. Observe the following precautions when installing an end effector.

CAUTION

- Perform wiring and air tubing of the chuck only when the power supply is disconnected and the workobject is not placed. If the emergency stop switch is pressed when the power is still connected, the workobject may be released, resulting in damage to the robot system and workobject.
- Pay attention to the interference area of the end effector during system layout design. After the end effector is installed, the end effector or workobject may come into contact with the robot body during motion due to the outer diameter of the end effector, the size of the workobject, or the position of the robot arm, which may cause damage to the robot system and the workobject.

Connect the end effector to the end flange by using M6 screws (Grade 12.9). The recommended screw tightening torque is 10 N·m.

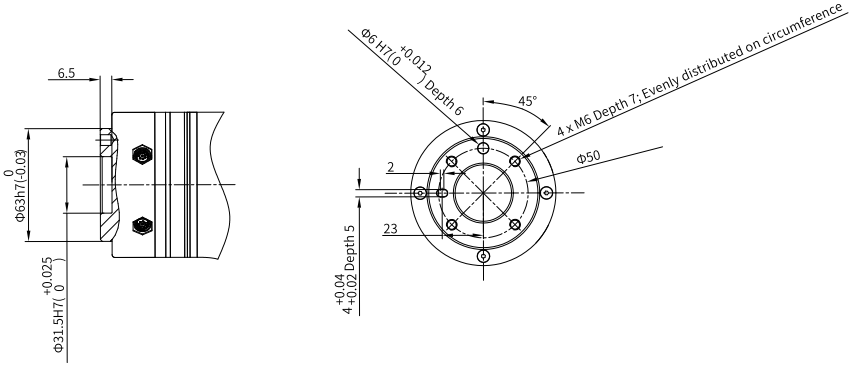


Figure 6-6 End flange mounting dimensions for U4 & U6 & U8 series robots (unit: mm)

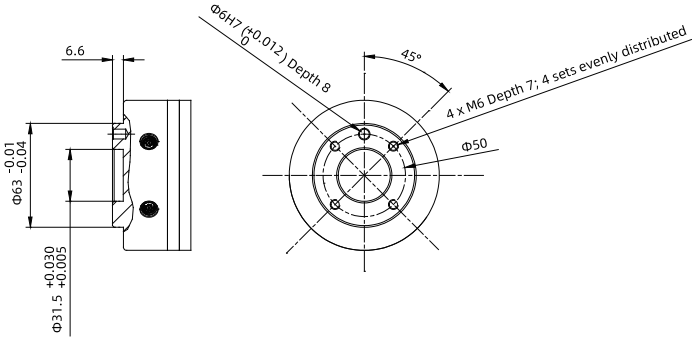
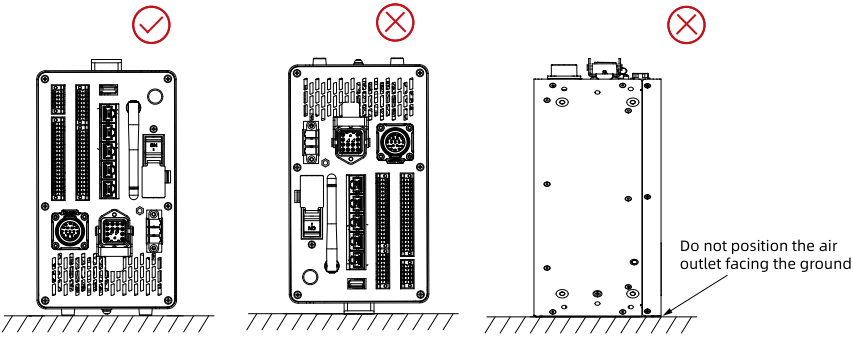


Figure 6-7 End flange mounting dimensions for U13 & U18 series robots (unit: mm)

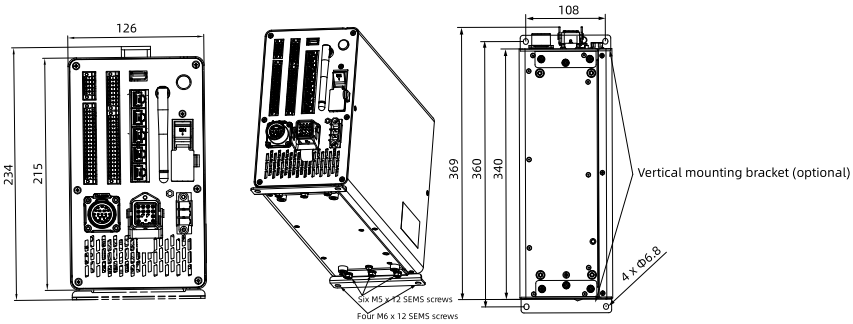
6.2.3 Installing the Controller

6.2.3.1 Vertical Mounting

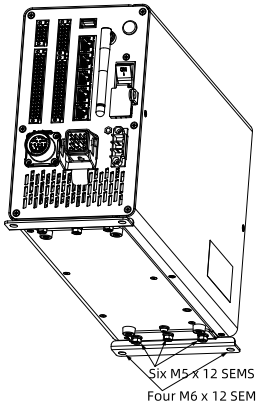
This is the standard mounting scenario. Place the controller stably on the table top, with a height between 0.6 m to 1.9 m above the ground. The table top must be flat and not inclined or deformed.



The mounting dimensions are shown below:



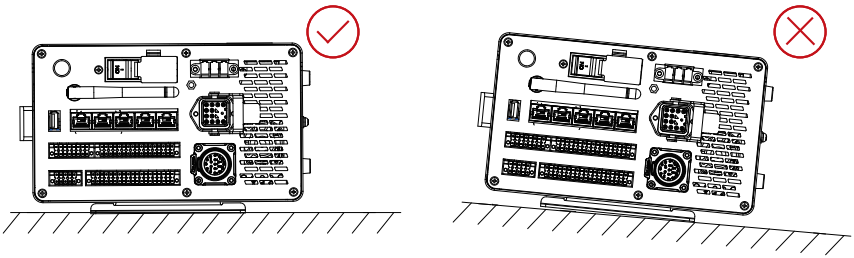
1. Use M5 x 12 SEMS screws (recommended tightening torque: 2.5 N·m) to secure the two mounting brackets to the bottom of the controller, as shown in the figure below. (The mounting brackets are not included with the controller at the factory and can be selected as an option according to requirements.)



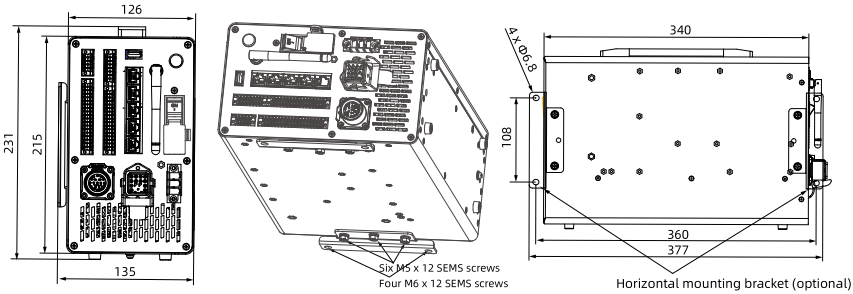
2. Place the controller on a flat mounting surface and use M6 x 12 SEMS screws (recommended torque: 4.5 N·m) to secure the mounting bracket onto the mounting surface.

6.2.3.2 Horizontal Mounting

This is the standard mounting scenario. Place the controller stably on the table top, with a height between 0.6 m to 1.9 m above the ground. The table top must be flat and not inclined or deformed.

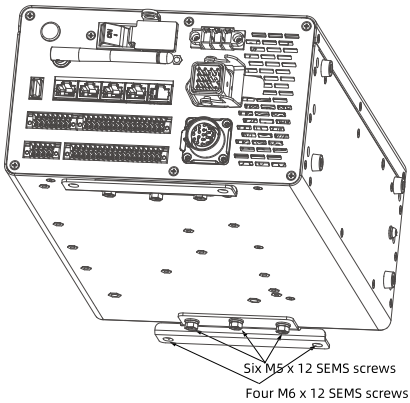


The mounting dimensions are shown below:



1. Use M5 x 12 SEMS screws (recommended tightening torque: 2.5 N·m) to secure the two mounting brackets to the side of the controller, as shown in the figure below. (The

mounting brackets are not included with the controller at the factory and can be selected as an option according to requirements.)



2. Place the controller on a flat mounting surface and use M6 x 12 SEMS screws (recommended torque: 4.5 N·m) to secure the mounting bracket onto the mounting surface.

6.3 Cable Connection

6.3.1 Connecting the Power Supply Cable and Signal Cable

Note

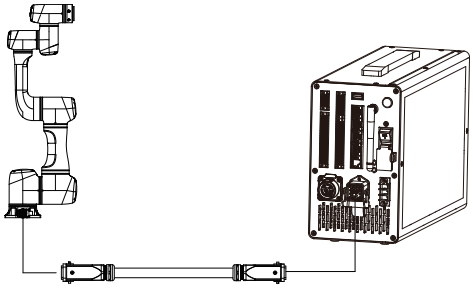
- Equipment installation, wiring, maintenance, inspection, or component replacement must be performed only by professionals.
- Always disconnect the power supply before wiring. Failure to comply will result in electric shock or system fault.
- Before wiring, disconnect the power supplies of all equipment. After disconnecting the power supply, wait for at least 10 minutes before further operations because residual voltage still exists in the internal capacitor even after power-off.
- Ensure that the safety input signals, such as the emergency stop switch and safety door switch are connected correctly before wiring. Otherwise, the safety protection will not work properly in emergency cases, causing serious injury or damage.
- Check that the equipment is grounded properly. Failure to comply may result in an electric shock.
- Follow the electrostatic discharge (ESD) procedure and wear an anti-static wrist strap to perform wiring. Failure to comply may result in damage to the equipment internal circuit.



- Connect the cables securely. Do not lay heavy objects on the cables, or bend or pull the cables forcibly. Failure to comply will result in cable damage, wire breaking, or poor contact, causing electric shock or system fault.
- Cables used for wiring must meet cross sectional area and shielding requirements. The shield of the cable must be reliably grounded at one end.
- Make the connections in correct sequence. Otherwise, the system may not work properly, which may cause safety hazards.
- After wiring, ensure that no dropped screws or exposed cables remain inside the equipment.
- Be careful not to confuse the male and female ends of the heavy-duty connector.

Connecting method:

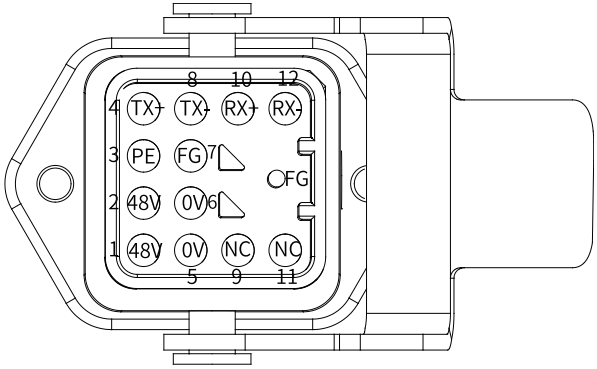
- Connect the heavy-duty connector of the user cable to the heavy-duty connector of the robot base.
- Connect the power connector of the user cables to the controller.



6.3.2 Connecting the Robot and Controller

6.3.2.1 Manipulator Heavy-Duty Interface

The manipulator heavy-duty interface is used for power supply and communication with the manipulator. The interface definitions are as follows:

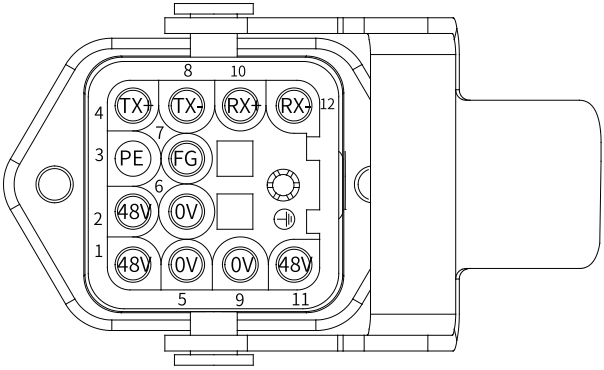


Pin	Pin name	Pin description
1	48V	Positive terminal of the manipulator 48 V power supply
2	48V	Positive terminal of the manipulator 48 V power supply
3	PE	Ground
4	TX+	100Mbps Ethernet differential signal, transmit positive
5	0V	Negative terminal of the manipulator 48 V power supply

Pin	Pin name	Pin description
6	0V	Negative terminal of the manipulator 48 V power supply
7	FG	100Mbps Ethernet shielding layer
8	TX-	100Mbps Ethernet differential signal, transmit negative
9	NC	-
10	RX+	100Mbps Ethernet differential signal, receive positive
11	NC	-
12	RX-	100Mbps Ethernet differential signal, receive negative

The manipulator heavy-duty interface is compatible with the Inovance-specified power cable (code: 1504RC74)

6.3.2.2 Controller Heavy-Duty Interface



Pin	Definition	Description
1	48V	Positive terminal of the manipulator 48 V power supply
2	48V	Positive terminal of the manipulator 48 V power supply
3	PE	Ground
4	TX+	100M Ethernet differential signal, transmit positive
5	0V	Negative terminal of the manipulator 48 V power supply
6	0V	Negative terminal of the manipulator 48 V power supply
7	FG	100M Ethernet shielding layer

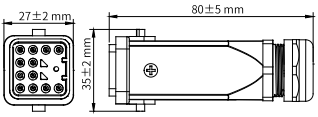
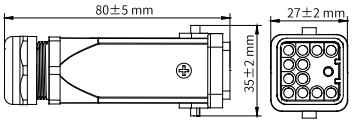
Pin	Definition	Description
8	TX-	100M Ethernet differential signal, transmit negative
9	0V	Negative terminal of the manipulator 48 V power supply
10	RX+	100M Ethernet differential signal, receive positive
11	48V	Positive terminal of the manipulator 48 V power supply
12	RX-	100M Ethernet differential signal, receive negative

For controller wiring, see *"6.3.1 Connecting the Power Supply Cable and Signal Cable" on page 86*.

6.3.2.3 Cable Hole Dimensions

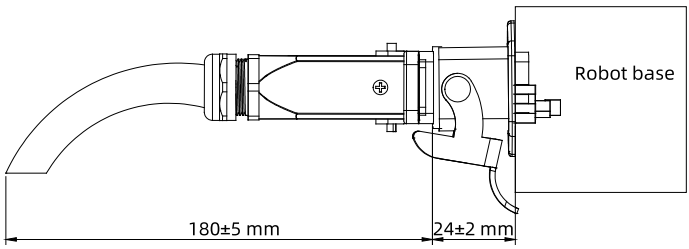
Heavy-duty connector dimensions

When cutting cable holes on the base table, refer to the following heavy-duty connector dimensions.

Name	Heavy-duty connector (robot side)	Heavy-duty connector (controller side)
Dimensions		
	80 mm x 35 mm x 27 mm (L x W x H)	80 mm x 35 mm x 27 mm (L x W x H)

Cable bending radius

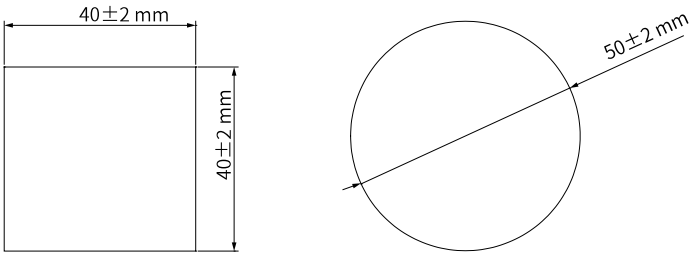
The reserved space for the manipulator cable (connector size+cable bending radius) is 180 mm, and the bending radius of the cable is 100 mm, as shown in the figure below (unit: mm).



WARNING

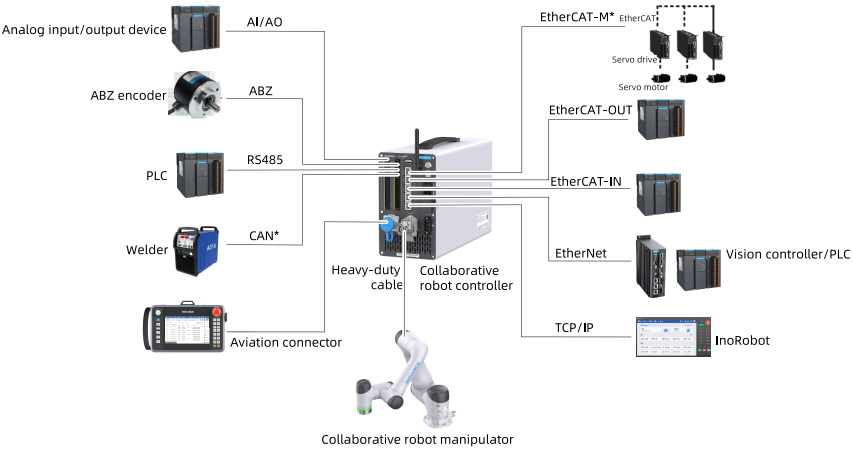
- Connect the male heavy-duty connector straight to the female connector to avoid damaging the guide pin or contact.
- Never violently connect heavy-duty connectors (male and female) to avoid pin displacement or bending.
- During cable connection, reserve a margin for cables at turns and do not pull the cables tight. The cable bending radius should be about 10 times the cable diameter.
- Do not coil the excess power cables into more than two coils. Otherwise, the cables may be damaged due to poor heat dissipation and overheating.
- The clips on the heavy-duty connectors are only used to fasten the connectors.

Recommended cable hole dimensions (round hole and square hole) are shown in the figure below (unit: mm).



7 System Connections

The collaborative robot system connections are shown in the figure below:



Note

* indicates a reserved function that is not currently supported.

Inovance collaborative robots support multiple communication bus types, enabling convenient communication, interaction, and operation with robot components or customer equipment. The key components used during robot operation include:

- Collaborative robot manipulator: a 6-axis robot arm, the main moving component that performs the intended motions. The end of the manipulator is also equipped with a ring-shaped indicator light for indicating robot status, buttons for drag teaching and programming, and a tool I/O interface for connecting tools.
- Collaborative controller: The core computing and control unit of the collaborative robot, as well as electrical interfaces such as aviation connectors, heavy-duty connectors, I/O, and buses, and a wireless Wi-Fi module.
- Teach pendant: A device for visual programming, configuration, and other operations. You can use the teach pendant to test, program, and simulate the robot.

Supported external devices include:

- Vision controller: Supports Inovance vision controllers and third-party vision controllers, connected via Ethernet.
- PLC: Supports Inovance AM600 series PLCs, connected via Modbus; supports third-party PLCs, connected via EtherNet/IP.
- Welder: Supports third-party peripherals with a CANopen interface (reserved function, not currently supported).

- Servo drive: Supports connecting to Inovance and third-party servo drives and I/O modules with EtherCAT interfaces via an EtherCAT master (reserved function, not currently supported).
- Encoder: Only supports viewing encoder values.
- Analog input/output device: Supports analog input/output devices, connected via AI/AO interfaces.

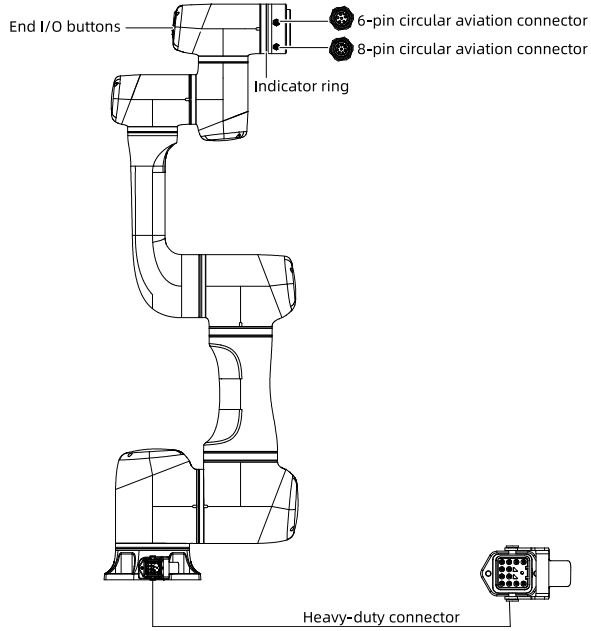
Note

For specific information about supported third-party peripherals, consult the manufacturer.

8 Electrical Interface

8.1 Manipulator Interfaces

The manipulator interfaces are divided into the end I/O interface and the manipulator heavy-duty cable interface, as shown in the figure below:



The end I/O interface includes the following parts:

8-pin circular aviation connector - user I/O interface	• Supports external 24 V power supply. • Provides DI, DO, AI, and other I/O channels. • Can be used with user fixtures that match the corresponding interface. • AI channels can be configured as an RS485 communication interface (under development).
6-pin circular aviation connector - communication expansion interface	• Supports external 24 V power supply. • Provides EtherCAT slave expansion (function under development). • Can be used with user fixtures that support EtherCAT communication.
End I/O buttons	Includes three buttons, which are used for drag teaching and robot point recording. For definitions and descriptions of the end I/O buttons, see *"3.2 Components" on page 27*.

Note

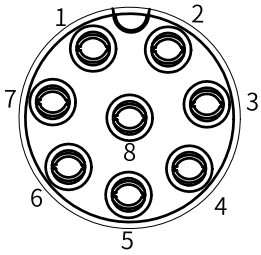
The power cable connector supplies 48 V power to the manipulator. For specific pin definitions and detailed descriptions of the interface, see *"6.3.2.1 Manipulator Heavy-Duty Interface" on page 87*.

8.1.1 Pin Definitions of the End I/O Interface

8.1.1.1 User I/O Interface

The user I/O interface is located on the side of the end I/O flange. It uses an 8-pin circular aviation connector.

The user I/O interface is shown in the figure below:



User I/O interface pin definitions:

Pin	Pin name	Pin description
1	24V	Positive terminal of the 24 V power supply output
2	DI1	Digital input 1, NPN (sink type)
3	DI2	Digital input 2, NPN (sink type)
4	DO1	Digital output 1, NPN (sink type)
5	DO2	Digital output 2, NPN (sink type)
6	AI_0/RS485+	Analog input 1, voltage type, detection range 0 V to 10 V; Can be configured via the host computer to be multiplexed as the RS485 data positive terminal (function not currently available)

Pin	Pin name	Pin description
7	AI_1/RS485-	Analog input 2, voltage type, detection range 0 V to 10 V; Can be configured via the host computer to be multiplexed as the RS485 data negative terminal (function not currently available)
8	AI/RS485-GND	Reference ground for 24 V external power output, AI inputs, and RS485 communication

The user I/O interface is only compatible with the standard cable provided by Inovance (code: 15051397). The plug-end pin layout and cable definitions are as follows:

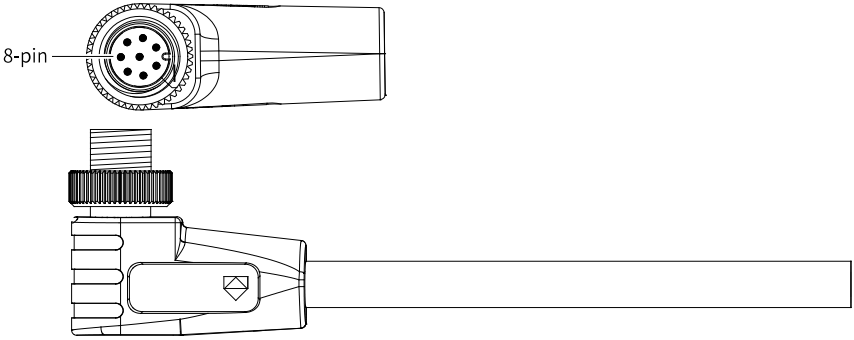


Table 8-1 Cable definition (code: 15051397)

Pin	Color	Signal name
8	Blue	AI/RS485-GND
	Blue	0V
1	Red	24V
2	White	DI1
3	Brown	DI2
4	Black	DO1
5	Yellow	DO2
6	Orange	AI_0/RS485+
7	Green	AI_1/RS485-

CAUTION

Pin 8 serves as the reference ground. The supplied cable provides two wires for user use, as follows:

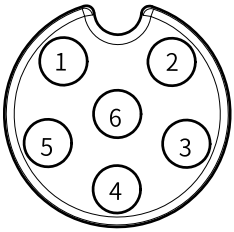
- Reference GND for external analog signals and RS485 communication:Connect to the wire marked "AI/RS485-GND".
- Reference GND for the 24 V power supply output:Connect to the wire marked "0V".

For the electrical specifications and wiring instructions of the user I/O interface, see *" Electrical Specifications of the End I/O Interface" on page 97*.

8.1.1.2 Communication Expansion I/O Interface

The communication expansion I/O interface is located on the side of the end I/O flange. It uses a 6-pin circular aviation connector.

The communication expansion I/O interface is shown in the figure below:



The end I/O supports EtherCAT communication expansion (not currently supported) and can be connected to external EtherCAT slave-type robot end effectors. The pin definitions of the corresponding communication expansion I/O interface are as follows:

Pin	Pin name	Pin description
1	24V	Positive terminal of the 24 V power supply output
2	GND	Reference ground for the 24 V power supply output
3	TX+	100M Ethernet differential signal, transmit positive
4	TX-	100M Ethernet differential signal, transmit negative

Pin	Pin name	Pin description
5	RX+	100M Ethernet differential signal, receive positive
6	RX-	100M Ethernet differential signal, receive negative

The communication expansion I/O interface is only compatible with the standard cable provided by Inovance (code: 15051400). The plug-end pin layout and cable definitions are as follows:

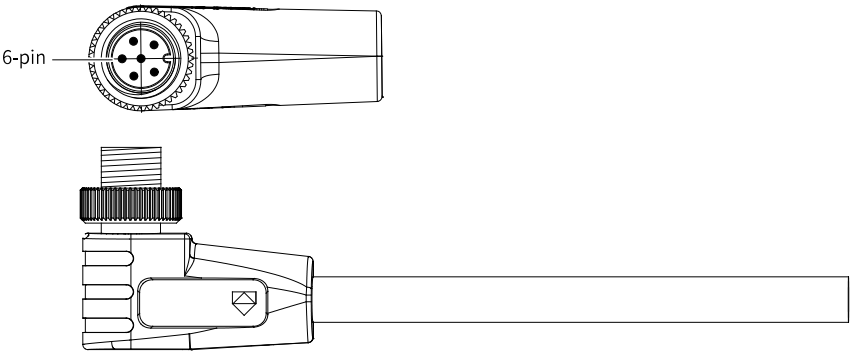


Table 8-2 Cable definition (code: 15051400)

Pin	Color	Signal name
1	Yellow	24V
2	Black	GND
3	White	TX+
4	Brown	TX-
5	Red	RX+
6	Blue	RX-

For the electrical specifications and wiring instructions of the communication expansion I/O interface, see *" Electrical Specifications of the End I/O Interface" on page 97*.

8.1.2 Electrical Specifications of the End I/O Interface

8.1.2.1 Electrical Specifications of the User I/O Interface

The user I/O interface at the end of the manipulator supports a 24 V power supply output for external devices. It supports digital input, digital output, and analog input functions. The power supply has output overcurrent protection. The detailed specifications are as follows.

The power supply output specifications of the user I/O interface are as follows:

Output power supply	24 V power supply for the user I/O interface
Output voltage range	22 V to 26 V
Output current	1 A continuous output, 2 A short-time output (≤ 1s)
Overcurrent protection	Yes
Isolation	Non-isolated



- The power supply at the end serves as an output. Do not connect it to an external power supply, as doing so may cause hardware damage.
- The two 24 V power supplies at the end can each operate at full load, but must not be connected in parallel, as doing so may cause abnormal overcurrent protection and damage the hardware.

The user I/O interface at the end of the manipulator provides two channels. The detailed specifications are as follows:

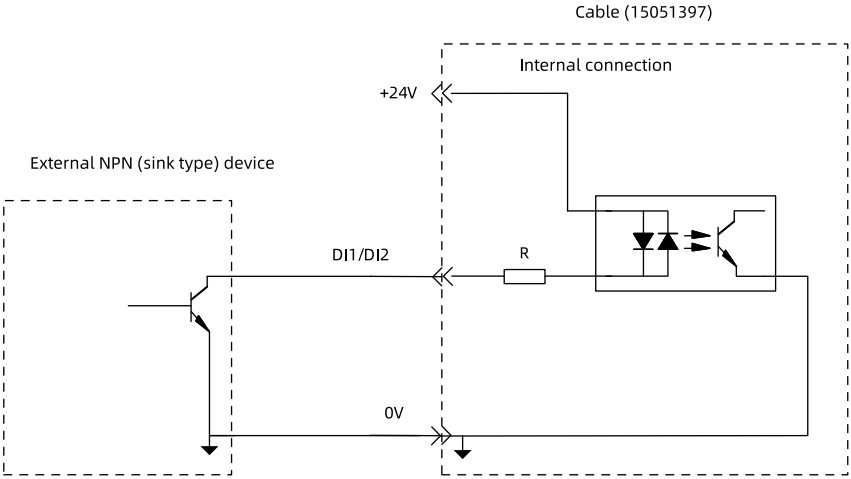
DI interface	Specification
Number of channels	2
Input type	NPN (sink type)
Input voltage class	24 VDC ±10%
Input current	3.5 mA (typical at 24 V)
Input impedance	6.6 kΩ
Input voltage when input is ON	≤ 9 V
Input voltage when input is OFF	≥ 19 V
Hardware response time	500 μs (OFF->ON, ON->OFF)
Digital filter time	Host controller software setting[1]
Maximum input frequency	500 Hz

Note

[1]: See the "IR-TP200 Series Industrial Robot Teach Pendant User Guide".

Wiring method

The DI channel of the user I/O interface is internally hardwired to 24V. For the cable definition (code: 15051397), see *" Pin Definitions of the End I/O Interface" on page 94*. The following figure shows the typical wiring method:

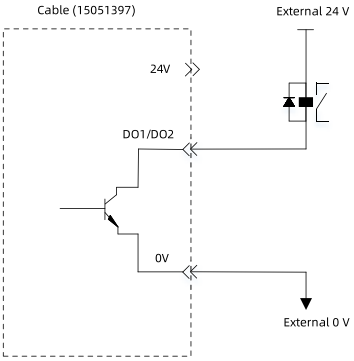


The user I/O interface at the end of the manipulator provides two DO channels. The detailed specifications are as follows:

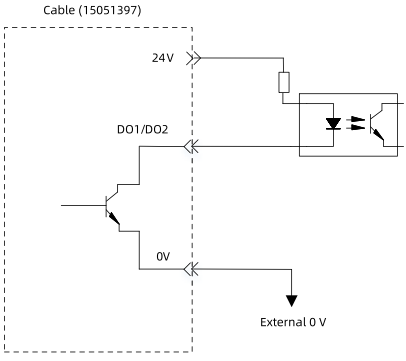
DO interface	Specification
Number of channels	2
Output type	NPN (sink type)
Voltage class	24 VDC ±10%
Output load (resistive load)	0.5 A/point; 1 A/2 points
Output load (inductive load)	7.2 W/point; 12 W/2 points
Output load (lamp load)	5 W/point; 9 W/2 points
Hardware response time	< 500 μs (OFF->ON), < 500 μs (ON->OFF)
Leakage current	≤ 10 μA at 24 V operating voltage
Isolation	No
Short circuit protection	Supported independently per channel
Maximum output frequency	• Resistive load: 500 Hz • Inductive load: 0.5 Hz • Lamp load: 10 Hz

Wiring method

The DO channels of the user I/O interface can drive different types of loads. The loads can also be powered directly by the 24 V power supply of the end I/O interface. For the cable definition (code: 15051397), see *" Pin Definitions of the End I/O Interface" on page 94*. The following figure shows the typical wiring method:



DO Wiring - Using external 24 V



DO Wiring - Using 24 V from end I/O

The user I/O interface at the end of the manipulator provides two AI channels by default. The detailed specifications are as follows:

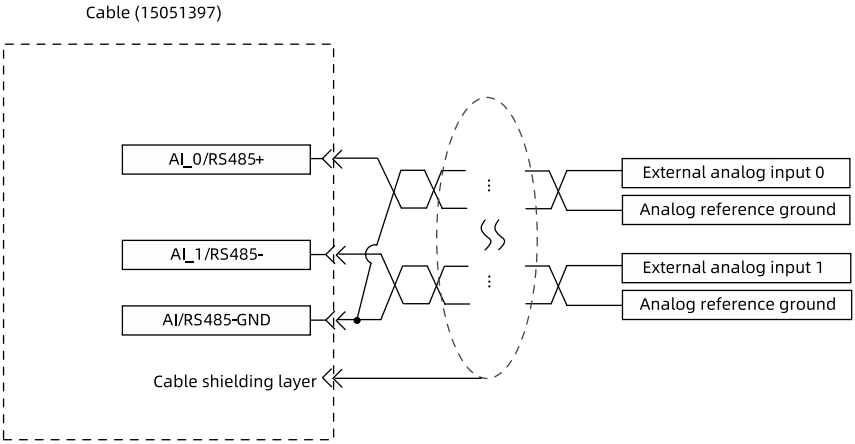
AI interface	Specification
Number of channels	2
Input mode	Voltage
Resolution	12-bit
Voltage input range	0 V to 10 V
Voltage input impedance	≥ 61 kΩ
Voltage input accuracy (over the full temperature range)	±1% (full scale)
Maximum allowable input voltage	10.8 V
Isolation	Non-isolated

CAUTION

If you need to sample current-type analog signals, use the analog input interface on the controller side. For details, see *"8.2.6.1 AI" on page 121*.

Wiring method

For the cable definition (code: 15051397) of the AI channel of the user I/O interface, see *" Pin Definitions of the End I/O Interface" on page 94*. The following figure shows the typical wiring method:



The AI channel of the user I/O interface can be configured as an RS485 communication interface. When configured as an RS485 communication interface, the detailed specifications are as follows:

RS485 interface	Specification
Number of channels	1
Supported communication protocol	Under development
Physical layer	RS485 standard interface
Duplex mode	Half-duplex
Termination resistor	120 Ω
Transmission rate	1 Mbps, 0.5 m cable
Transmission medium	Shielded twisted pair cable
Isolation	Non-isolated

CAUTION

The factory-supplied cable is relatively short. You can make your own extension cables based on the supplied cable according to your actual application. Ensure that the cable must be twisted pair and properly shielded. The RS485 communication rate will degrade to some extent as the cable length increases.

For the RS485 communication wiring method, see *"8.2.13.2 RS485 Wiring Method" on page 158*.

8.1.2.2 Electrical Specifications of the Communication Expansion I/O Interface

Note

The communication expansion I/O interface is a reserved interface and is not currently supported.

The communication expansion I/O interface at the end of the manipulator supports a 24 V power supply output for external devices. The power supply has output overcurrent protection. The detailed specifications are as follows.

The power supply output specifications of the communication expansion I/O interface are as follows:

Output power supply	Communication Expansion I/O Interface
Output voltage range	22 V to 26 V
Output current	0.75 A continuous rated output, 1.5 A short-time transient output (≤ 1s)
Overcurrent protection	Yes
Isolation	Non-isolated



- The power supply at the end serves as an output. Do not connect it to an external power supply, as doing so may cause hardware damage.
- The two 24 V power supplies at the end can each operate at full load, but must not be connected in parallel, as doing so may cause abnormal overcurrent protection and damage the hardware.

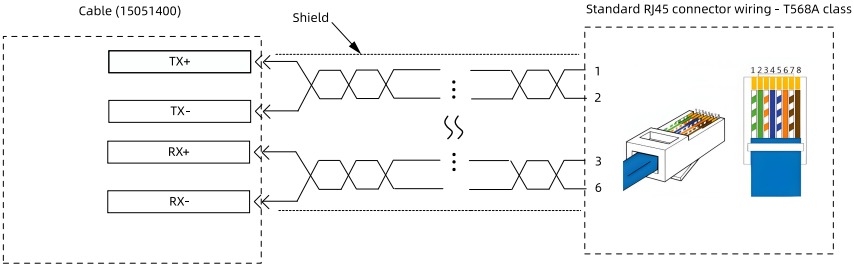
You can connect EtherCAT slave-type robot end effectors through the communication expansion I/O interface (function under development). The interface specifications are as follows:

Item	Specification
Communication protocol	EtherCAT protocol
Service supported	CoE (PDO, SDO)
Synchronization mode	DC (Distributed Clock)
Physical layer	100Base-TX
Baud rate	100 Mbps (100Base-TX)
Duplex mode	Full duplex
Topology	Linear

Item	Specification
Transmission medium	Shielded cables of Cat 5e or higher
Transmission distance	Less than 100 m between two nodes (with proper environment and cables)
EtherCAT frame length	44 bytes to 1498 bytes
Process data	Maximum 1486 bytes per Ethernet frame

Wiring method

The typical wiring method for the communication expansion interface is as shown below. For the cable definition (15051400), see *" Pin Definitions of the End I/O Interface" on page 94*.



CAUTION

- If the external device does not have a standard RJ45 connector, wire the cable according to the interface description of the external device, or contact Inovance for technical support.
- The factory-supplied cable is relatively short. You can make your own extension cables based on the supplied cable according to your actual application. Ensure that TX+ and TX- form a twisted pair, and RX+ and RX- form a twisted pair.

8.2 Controller Interfaces

8.2.1 Controller Interface Overview

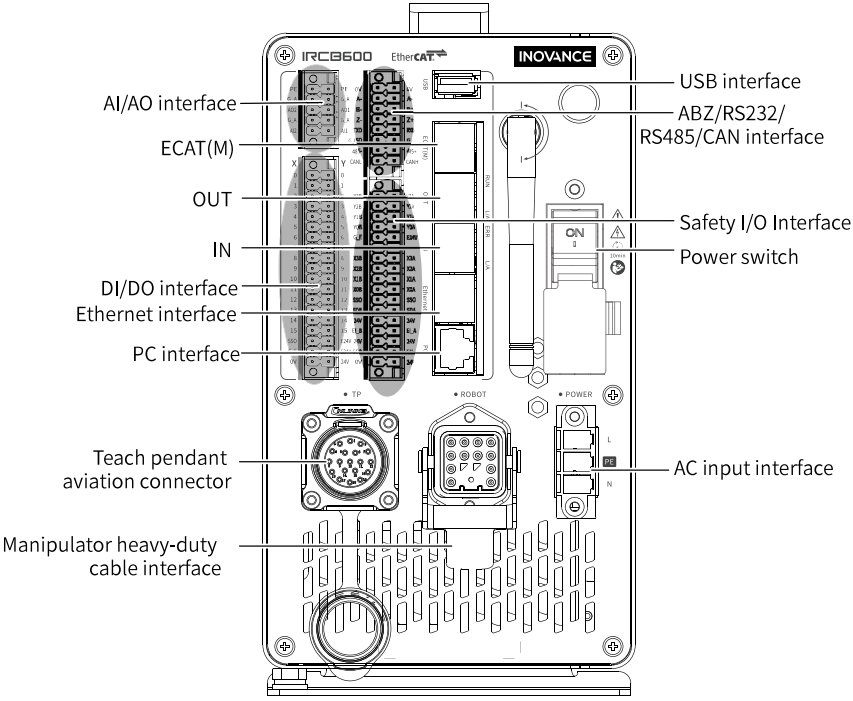


Figure 8-1 IRCB600-6BD & IRCB600-6CD controller interface overview

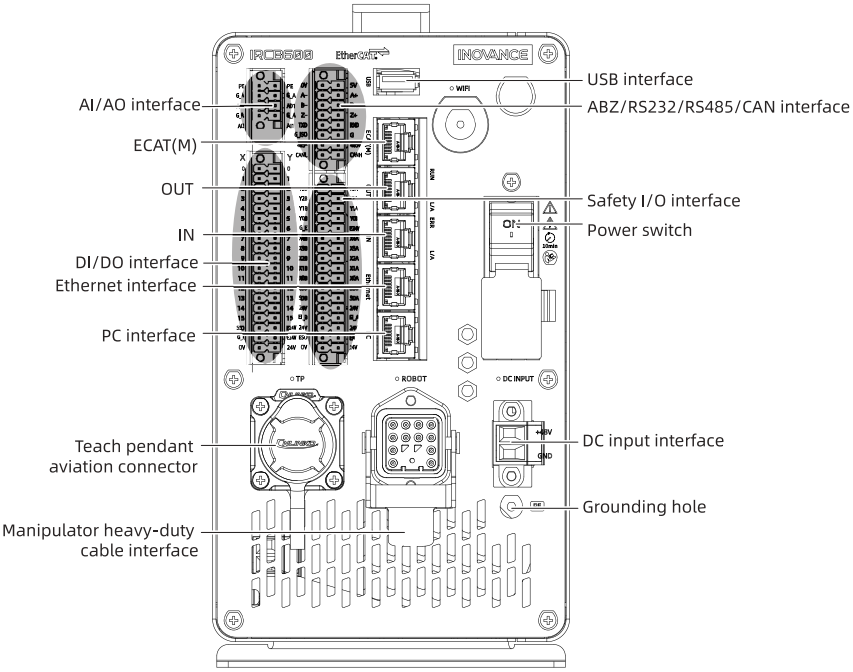


Figure 8-2 IRCB600-6AC controller interface overview

8.2.2 Power Input Interface

Installation, wiring, maintenance, or inspection must be carried out by personnel who have received necessary electrical training and experience. For details, see *"1.2 General Safety Instructions" on page 10*.

WARNING

- Only qualified personnel can perform the operation.
- To prevent electric shocks, ground the controller properly.
- Always use a plug or a disconnecting device that conforms to local safety standards for power connecting cable. Do not connect the controller directly to a factory power source.
- Before the grounding operation, cut off the power supply of the controller.

Follow the steps below to prepare the power cables and ensure correct wiring.

Customer-supplied cables must comply with the relevant safety specifications.

For the standard-power models, use 3-core cables with a cross-sectional area of at least ≥ 1.5 mm^2. Recommended specification of external circuit breaker: Rated current ≥ 16 A, Class C trip curve

There is a warning label attached below the PE marking of the terminal block. When wiring, make sure to follow the requirements of the warning label and connect the PE wire to the PE port.

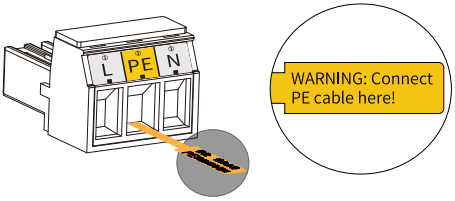


Figure 8-3 Power wiring for IRCB600-6BD & IRCB600-6CD controllers

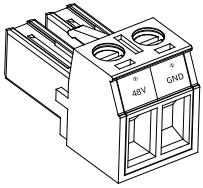


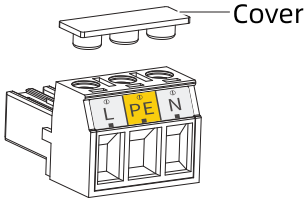
Figure 8-4 Power wiring for IRCB600-6AC controller

Note

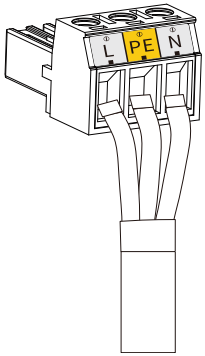
If the DC power supply of the IRCB600-6AC controller requires a PE connection, connect it to the PE grounding hole on the panel.

Wiring procedure:

1. Open the cover above the terminal block, as shown in the figure below.



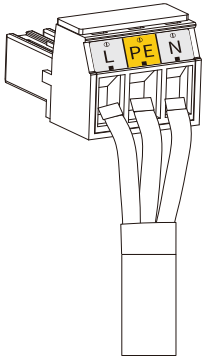
2. Loosen the screws under the cover, connect the three lines of the power cable to the corresponding terminals of the 3-pin terminal block in the order of L/PE/N from left to right according to the terminal markings, and tighten the screws. It is recommended to use a PH1 (1#) Phillips screwdriver.



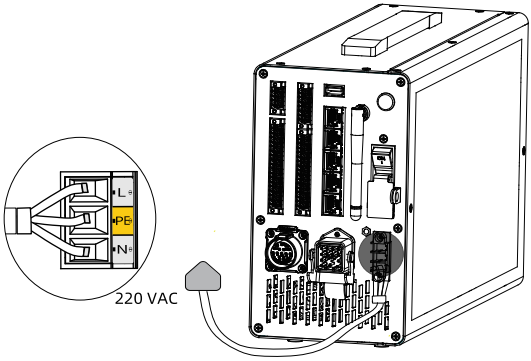
Note

- Crimping terminal is required, recommended model: E1512.
- Strip the wire for 12 mm, insert the stripped wire into the terminal block and fix it with screws.

3. After connecting the power cable, close the cover above the terminal block.



4. Plug the input terminal block into the power input of the controller.



As shown in the figure above, connect the three lines of the power cable to the corresponding terminals of the 3-pin power input terminal block in the order of L/PE/N from top to bottom according to the terminal markings.

Note

Strictly follow the order of L/PE/N when making the power cable to avoid possible short circuit and electric shock.

8.2.3 Grounding Hole Interface

Function

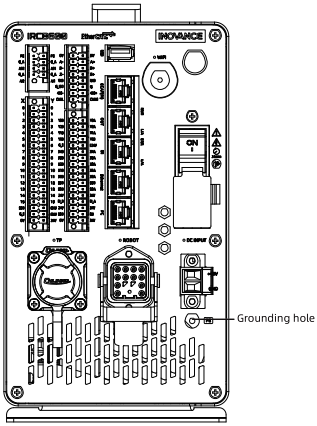
- Safety: To prevent electric shock hazards and ensure personnel safety.
- Functionality/Interference resistance: To prevent communication errors or servo alarms caused by external interference and electrical noise.

Material requirements

- Grounding cable: Two-color (yellow and green) insulated copper wire, with a cross-sectional area of ≥ 4 mm² or ≥ 12 AWG.
- Terminal: Ring terminal. The grounding cable must be securely crimped or welded to the terminal.

Installing the grounding cable

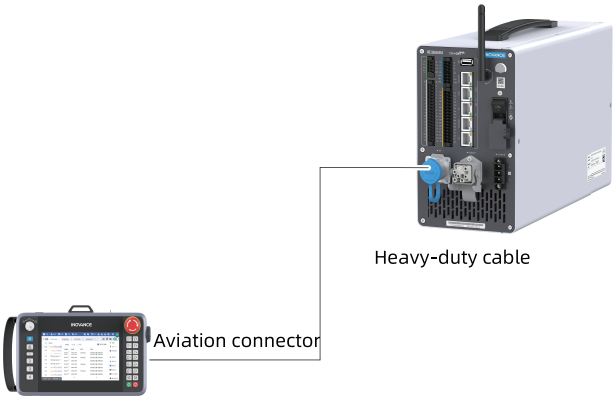
1. Inspect and clean the grounding hole on the robot controller, ensuring it is free from rust and dirt.
2. Use the M3 x 1 screws to securely fasten the grounding terminal to the grounding hole on the robot controller.
3. Connect the other end of the grounding cable securely to the factory's dedicated grounding electrode (grounding rod).



8.2.4 Teach Pendant Interface

The collaborative robot can be equipped with a hand-held teach pendant. You can use it for robot teaching and programming, and it adds a physical emergency stop button and enabling switch to the production site, improving safety and operability. For operation of the teach pendant, see the "IR-TP200 Series Industrial Robot Teach Pendant User Guide".

The wiring between the hand-held teach pendant and the controller is shown in the figure below.

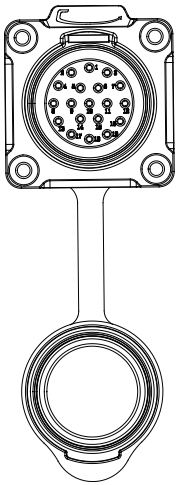


Note

The PC interface can be used to connect a PC or other devices, but it is mutually exclusive with the aviation connector interface. Only one of the two interfaces can be used at a time. When both are connected at the same time, the system gives priority to the aviation connector interface.

Teach pendant aviation connector

The pin definitions of the teach pendant aviation connector are as follows:



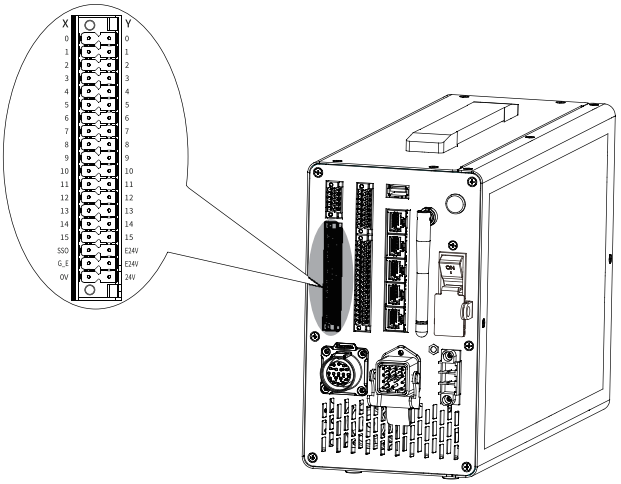
No.	Definition	Description	No.	Definition	Description
1	PE	Outer shield	11	GND	Power supply GND
2	24V	24 V power supply	12	PE	Ethernet cable shield
3	ES_OUT1	Emergency stop 1-B terminal	13	TP_TX+	Ethernet data TX+
4	GND	Power supply GND	14	TP_TX-	Ethernet data TX-
5	ES_OUT2	Emergency stop 2-B terminal	15	TP_RX+	Ethernet data RX+
6	ES_IN2	Emergency stop 2-A terminal	16	TP_RX-	Ethernet data RX-
7	ES_IN1	Emergency stop 1-A terminal	17	AH1	Mode switchover 1
8	DMS_NO1	Normally open contact 1 of hand pressure switch	18	AH2	Mode switchover 2

No.	Definition	Description	No.	Definition	Description
9	24V	24 V power supply	19	TP_LAN	Teach pendant network port selection control
10	DMS_NO2	Normally open contact 2 of hand pressure switch	-	-	-

8.2.5 Common Digital I/O

8.2.5.1 DI

DI interface definition



Definition	I/O Number	Name
X0	DI0	Common input 0
X1	DI1	Common input 1
X2	DI2	Common input 2
X3	DI3	Common input 3
X4	DI4	Common input 4
X5	DI5	Common input 5
X6	DI6	Common input 6
X7	DI7	Common input 7
X8	DI8	Common input 8
X9	DI9	Common input 9
X10	DI10	Common input 10
X11	DI11	Common input 11

Definition	I/O Number	Name
X12	DI12	Common input 12
X13	DI13	Common input 13
X14	DI14	Common input 14
X15	DI15	Common input 15
SSO	-	Common terminal of DI0 to DI15
24V	-	The controller outputs 24 V ±20%, with a maximum allowable current of 0.8 A, which can supply power to DIs and DOs through external wiring.
0V	-	

Note

DI/DO power supply wiring instructions:

- DI and DO ports share one terminal.
- 24V and 0V are the 24 V power supply output from the controller to the outside, E24V and G_E are used to supply the external 24 V power supply to the DO port in the controller.
- The two E24V on the actual terminal are internally connected together. Just connect one of them when in use.

DI/DO power supply specifications:

- 24V and 0V are the 24 V ±20% power supply output from the controller to the outside, with a maximum allowable current of 0.8 A, which can supply power to DIs and DOs through external wiring.
- E24V and G_E are the external power supply interface of DO circuit, with built-in overvoltage and overcurrent protection circuit.

Specifications

The controller includes 16 DIs. The specifications are described below.

Item	Specification
Number of input channels	16 (X0 to X15)
Input connection method	Crimping wiring terminal
Input type	Digital, NPN or PNP input selected via the common terminal
Maximum input voltage	30 VDC
Input current (typical at 24 V)	Approx. 5 mA
Input impedance	> 4 kΩ
ON voltage range	18 VDC to 30 VDC
OFF voltage range	0 VDC to 3 VDC
Maximum input signal frequency	1 kHz

Item	Specification
Isolation mode	Optoelectric isolation
Hardware response time	< 250 μs (OFF->ON, ON->OFF)

Wiring procedure

- **Wiring rules**
  The terminal SSO is the common terminal for the 16-channel DI input.
  - When SSO is connected to 24V and X* is connected to 0V, the input signal is active (optocoupler ON).
  - When SSO is connected to 0V and X* is connected to 24V, the input signal is active (optocoupler ON). The NPN or PNP I/O device can be connected.
- **Difference between NPN output and PNP output**
  - NPN type (sink type) output (negative common terminal)
    When the load current flows into the output (Y) terminal, this type of output is called an NPN type output, which is a low-level output.

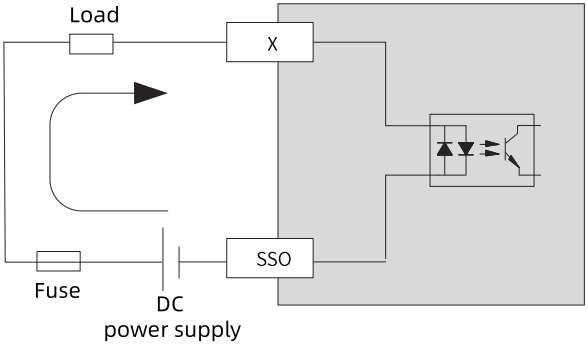


Figure 8-5 NPN output

  - PNP type (source type) output (positive common terminal)

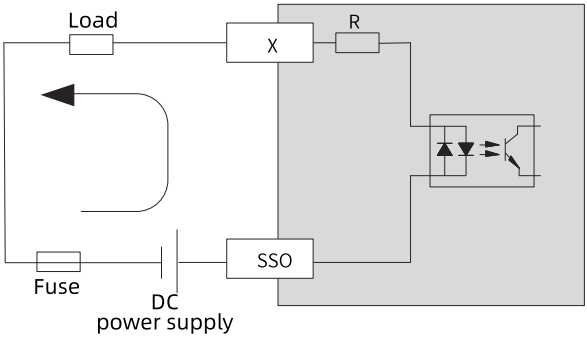


Figure 8-6 PNP output

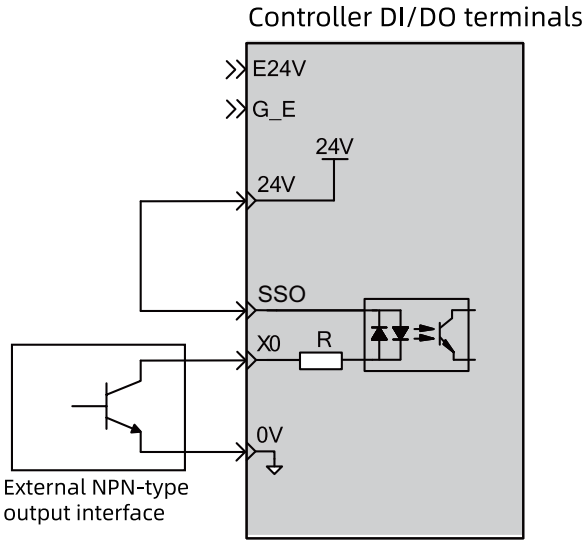
Note

NPN output is low level, while PNP output is high level.

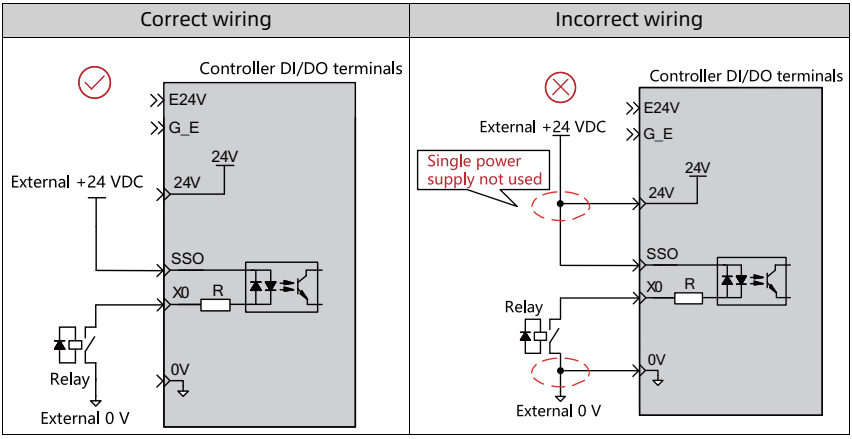
- **Wiring diagram**
  Here we take X0 as an example (X1 to X15 are the same as X0). It is recommended to use an external power supply.

  The host controller provides relay output:

  1. Using 24 V power supply provided by the controller

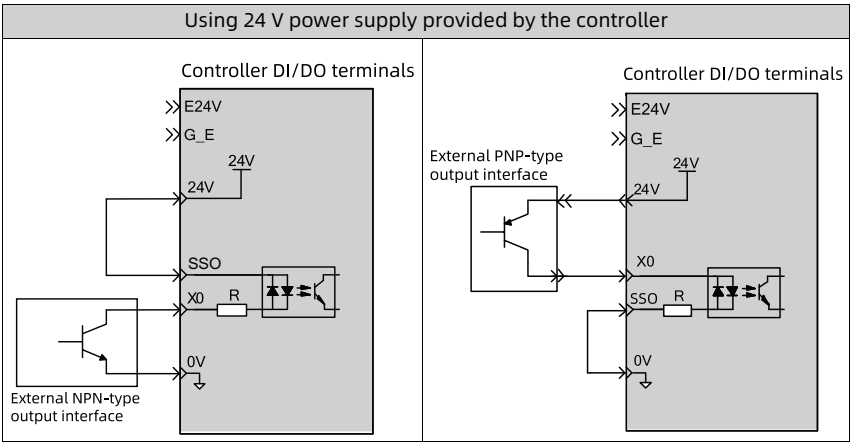


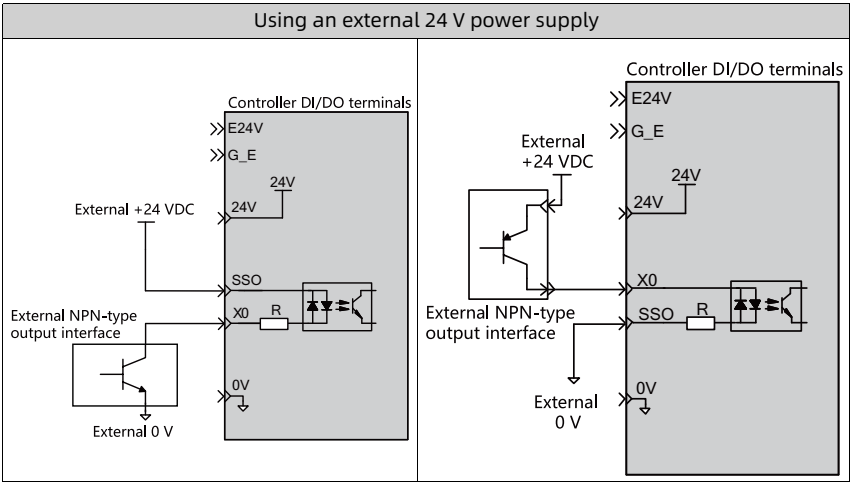
  2. Using an external 24 V power supply



- If an external 24 V power supply is used to power DI and the DO function is not needed, then E24V and G_E connections are optional.
- If the DO function is needed, it is necessary to perform wiring according to the DO wiring instructions.

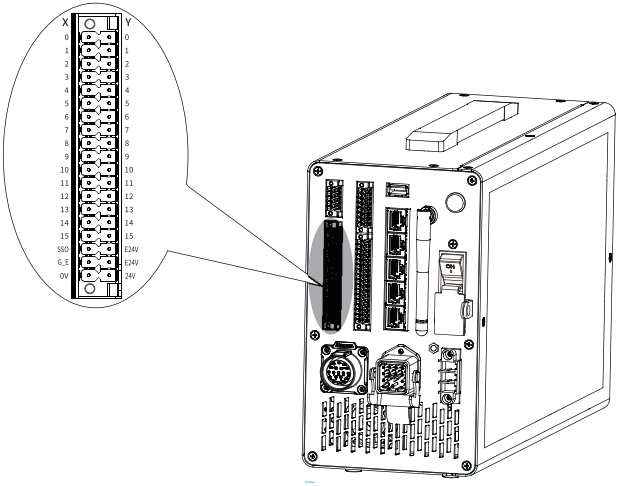
When the host controller provides open-collector output:





8.2.5.2 DO

DO interface definition



Definition	I/O Number	Name
Y0	DO0	Common output 0
Y1	DO1	Common output 1
Y2	DO2	Common output 2
Y3	DO3	Common output 3
Y4	DO4	Common output 4
Y5	DO5	Common output 5
Y6	DO6	Common output 6

Definition	I/O Number	Name
Y7	DO7	Common output 7
Y8	DO8	Common output 8
Y9	DO9	Common output 9
Y10	DO10	Common output 10
Y11	DO11	Common output 11
Y12	DO12	Common output 12
Y13	DO13	Common output 13
Y14	DO14	Common output 14
Y15	DO15	Common output 15
24V	-	The controller outputs 24 V ±20%, with a maximum allowable current of 0.8 A, which can supply power to DIs and DOs through external wiring.
0V	-	
E24V	-	External power supply interface of DO circuit, with built-in overvoltage and overcurrent protection circuit
G_E	-	

Note

DI/DO power supply wiring instructions:

- DI and DO ports share one terminal.
- 24V and 0V are the 24 V power supply output from the controller to the outside, E24V and G_E are used to supply the external 24 V power supply to the DO port in the controller.
- The two E24V on the actual terminal are internally connected together. Just connect one of them when in use.

DI/DO power supply specifications:

- 24V and 0V are the 24 V ±20% power supply output from the controller to the outside, with a maximum allowable current of 0.8 A, which can supply power to DIs and DOs through external wiring.
- E24V and G_E are the external power supply interface of DO circuit, with built-in overvoltage and overcurrent protection circuit.

Specifications

Item	Specification
Number of output channels	16
Output connection mode	Crimping wiring terminal
Output type	NPN (sink type)
Operating voltage range of Y0 to Y15	0 VDC to 30 VDC
24V_E and GND_E power supply	24 V ±20%/0.2 A

Item	Specification
Single-channel drive current	0.4 A
Maximum leakage current at OFF	< 200 μA
Maximum output switching frequency	1 kHz
Isolation mode	Optocoupler isolation
Protective functions	Current limiting protection (0.8 A)
Hardware response time	< 500 μs (OFF->ON), 500 μs (ON->OFF)

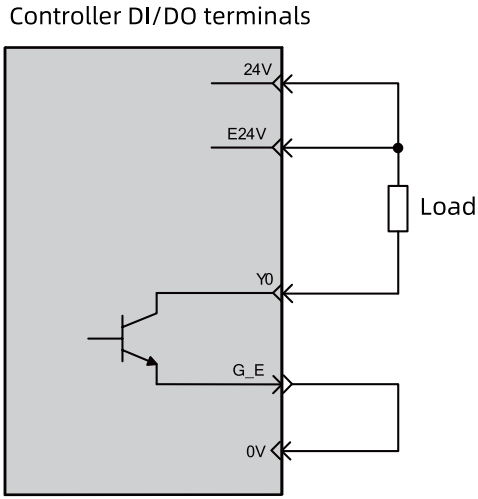
Wiring procedure



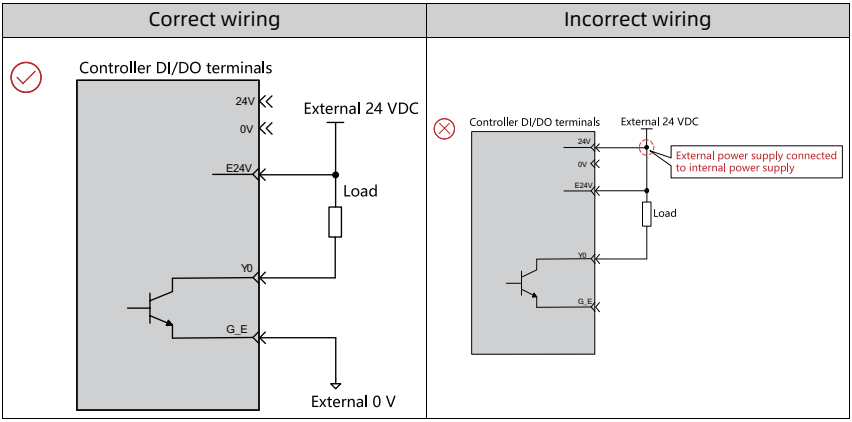
- Do not short-circuit outputs Y0-Y15 directly to +24V.
- Do not connect outputs Y0-Y15 to 0V or G_E to +24V of the power supply.
- The connected load voltage of outputs Y0-Y15 should be less than 29 V.

Failure to comply with the above three requirements may damage the circuit.

- **Wiring rules**
  E24V and G_E must be connected to 24 V power supply to ensure that the DOs work properly.
  - If the load power supply of the DOs uses the 24V/0V controller power supply, note that the total continuous output current of the 16 DOs must not exceed 0.8 A; otherwise, use an external power supply.
  - If an external 24 V power supply is used, connect the positive and negative terminals of the external power supply to E24V and G_E terminals respectively. Note that the maximum driving current for each DO is 0.4 A. If the single output current exceeds 0.8 A, an alarm occurs.
- **Wiring of the power supply**
  - Using 24 V power supply provided by the controller



- Using an external 24 V power supply



- **Wiring example**

  Here we take the external power supply as an example. When the power is supplied by controller, the same method applies.

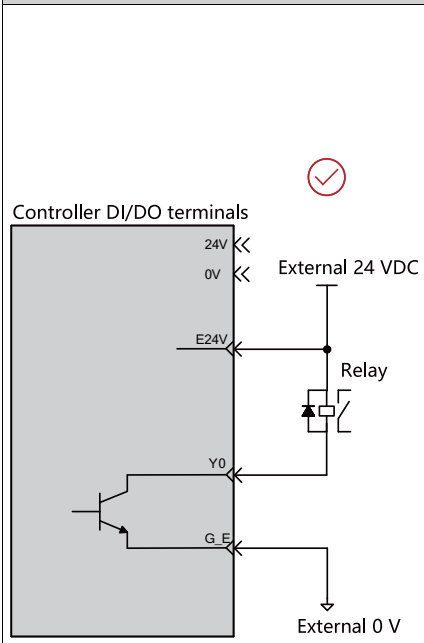
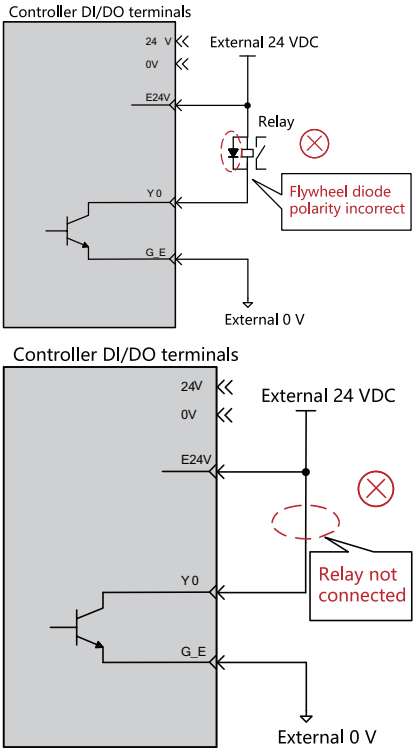
  - Inductive load:

Note

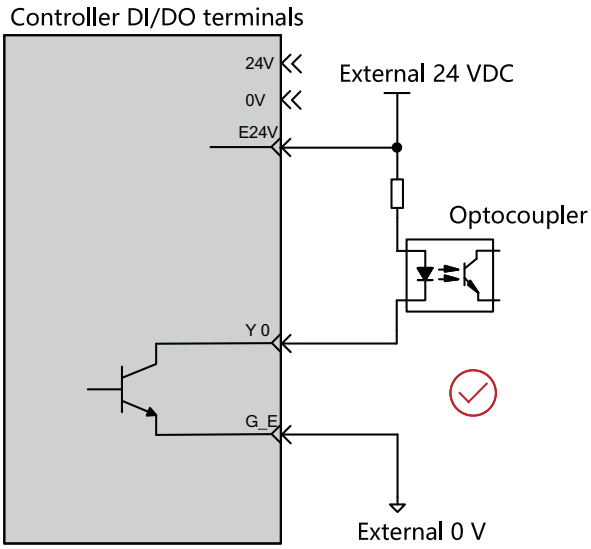
When the inductive load is applied, large back EMF will be produced between contacts and arc discharge is also caused when the inductive load stops. This may result in contact failure or contact sag, shortening the contact lifetime. Therefore, you can use a parallel flywheel diode with the load to extend the lifetime of the product.

The flywheel diode must meet the following requirements:

- Reverse voltage: 5 to 10 times the load voltage
- Forward current: greater than the load current

Correct wiring	Incorrect wiring
	

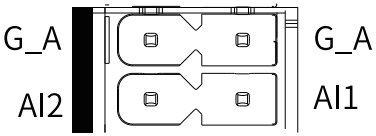
- Driving optocoupler load



8.2.6 Analog I/O

8.2.6.1 AI

AI interface definition



No.	No.	Definition
G_A	G_A	Analog input/output reference ground
AI2	AI1	Analog input interface

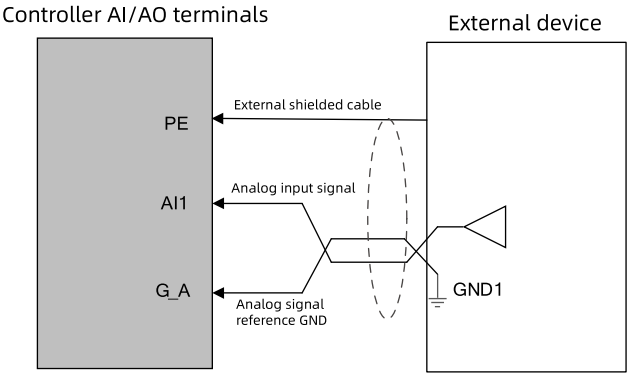
Specifications

Item	Specification
Input type	Analog input
Input mode	Voltage/Current
Input channels	2
Resolution	12-bit
Conversion time	6 ms/channel

Item	Specification
Output accuracy (room temperature)	±1%; ±3% over the full temperature range
Voltage input range	0 V to 10 V
Voltage input impedance	200 kΩ
Voltage input accuracy (at 25°C)	±1% (full scale)
Voltage input accuracy (over the full temperature range)	±3% (full scale)
Voltage input signal frequency	< 10 Hz
Voltage input diagnosis	Wire breakage detection not supported
Current input range	0 mA to 20 mA
Current sampling impedance	250 Ω
Current input accuracy (at 25°C)	±1% (full scale)
Current input accuracy (over the full temperature range)	±3% (full scale)
Current input limit	20 mA
Current input diagnosis	Only configurable to 0 mA to 20 mA; wire breakage detection not supported
Isolation	Non-isolated
Input indicator	None
Input derating	None

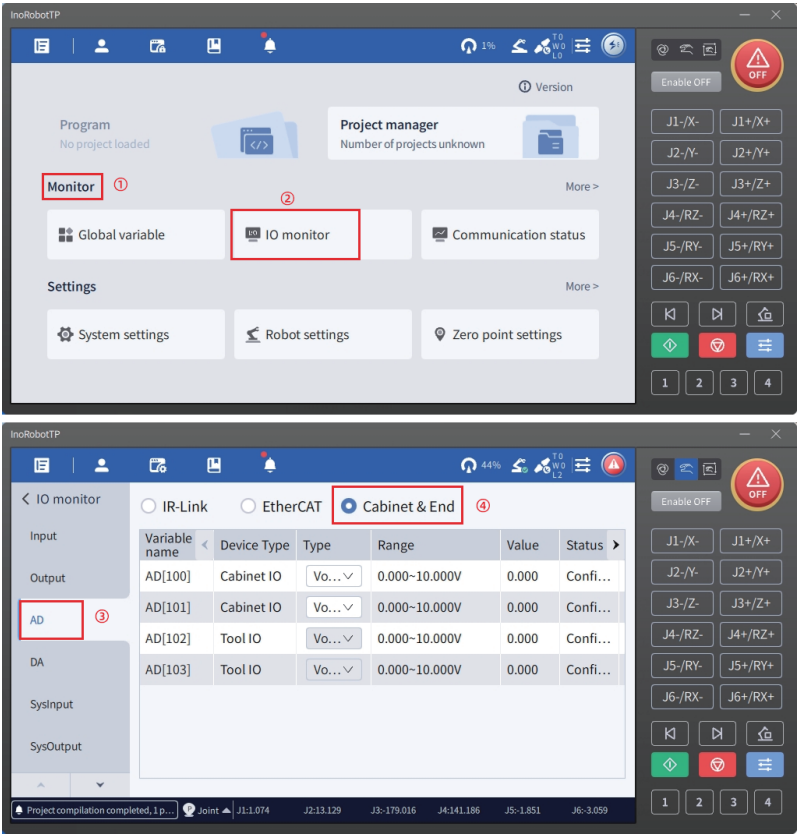
Wiring procedure

- G_A must be connected to a reference ground signal to ensure that the AIs work properly. No internal or external power supply is required. The input signal voltage must not exceed 10 V, and the current must not exceed 20 mA.
- Do not bundle the expansion cable together with power cables (with high voltage, large current) that produce strong interference signals; otherwise, the expansion cable may be influenced by noise, surge, and induction. Separate it from other cables and avoid cabling in parallel.
- Use recommended cables and adapter boards for connection. It is recommended that shielded twisted pair cables be used as expansion cables to enhance anti-interference capacity.
- Apply single-point grounding for the shielding of shielded cable and solder sealed cable.



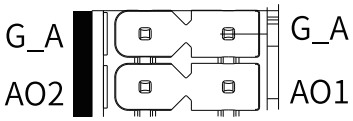
AI voltage and current mode switching instructions

- The AI function is enabled by default and set to voltage input.
- To switch the AI function to current mode, use the teach pendant or the PC application. Specifically, go to "Monitor" > "IO Monitor" > "AD" > "Cabinet & End" and select "Current" to set the input mode to current.



8.2.6.2 AO

AO interface definition



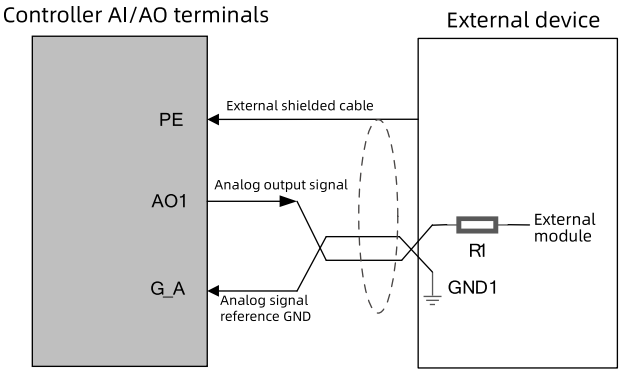
No.	No.	Definition
G_A	G_A	Analog input/output reference ground
AO2	AO1	Analog output interface

Specifications

Item	Specification
Output type	Analog output
Output mode	Voltage/Current
Output channel	2
Resolution	12-bit
Conversion time	1 ms/channel
Output accuracy (room temperature)	±1%; ±3% over the full temperature range
Voltage output range	0 V to 10 V
Voltage output load	2kΩ
Voltage output accuracy (at 25°C)	±1% (full scale)
Voltage output accuracy (over the full temperature range)	±3% (full scale)
Voltage output diagnosis	Not supported
Current output range	0 mA to 20 mA
Current output load	0 Ω to 500 Ω
Current output accuracy (at 25°C)	±1% (full scale)
Current output accuracy (over the full temperature range)	±3% (full scale)
Current output diagnosis	Not supported
Isolation	Non-isolated
Output indicator	None
Output derating	None

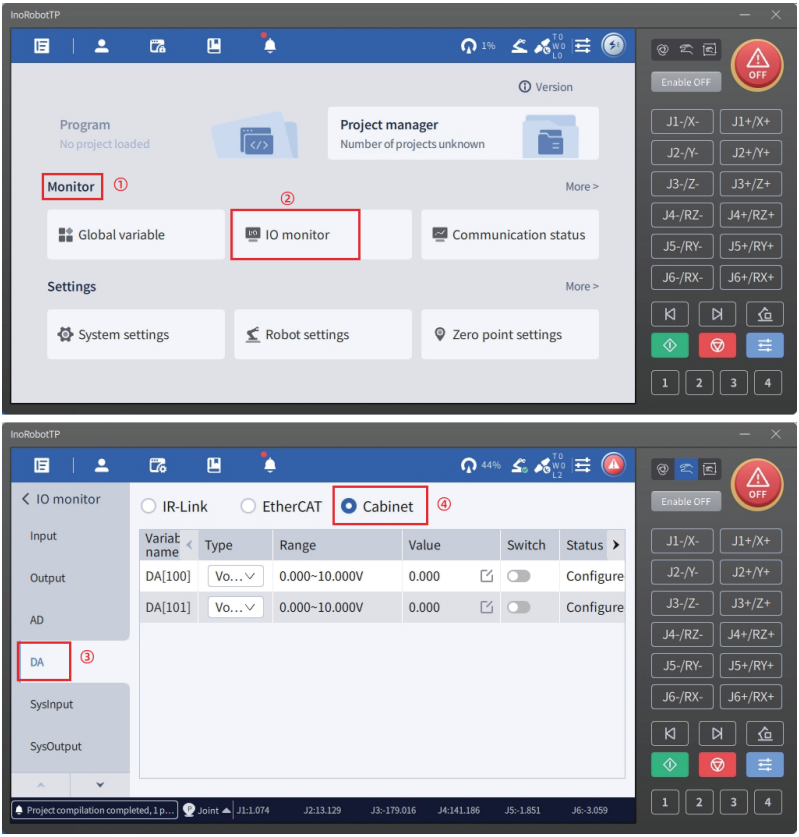
Wiring procedure

1. G_A must be connected to a reference ground signal to ensure that the AOs work properly. No internal or external power supply is required. The input signal voltage must not exceed 10 V, and the current must not exceed 20 mA.
2. Do not bundle the expansion cable together with power cables (with high voltage, large current) that produce strong interference signals; otherwise, the expansion cable may be influenced by noise, surge, and induction. Separate it from other cables and avoid cabling in parallel.
3. Use recommended cables and adapter boards for connection. It is recommended that shielded twisted pair cables be used as expansion cables to enhance anti-interference capacity.
4. Apply single-point grounding for the shielding of shielded cable and solder sealed cable.



AO voltage and current mode switching instructions

- The AO function is disabled by default. To enable it, use the teach pendant or the PC application. Specifically, go to "Monitor" > "IO Monitor" > "DA" > "Cabinet" and click "ON" to enable the AO function.
- After the AO function is enabled, the default output type is voltage. To switch to current mode, go to the "Type" option in the above application screen and select "Current" to set the output mode to current.



8.2.7 Safety I/O

This section mainly describes the hardware wiring related to safety functions. For the software parameter configuration of safety functions, see the "PS00019992 Collaborative Robot Safety Guide".

8.2.7.1 Safety I/O Interface

- The safety I/O interface includes input terminals for functions such as external emergency stop, external safety door, and start confirmation. To ensure the safe operation of the robot system, always use these input terminals.
- The emergency stop function is used in emergency situations, usually connected in series with normally closed switches (such as mushroom shaped emergency stop switches). In case of emergency, you can stop the robot system urgently by pressing the emergency stop switch.

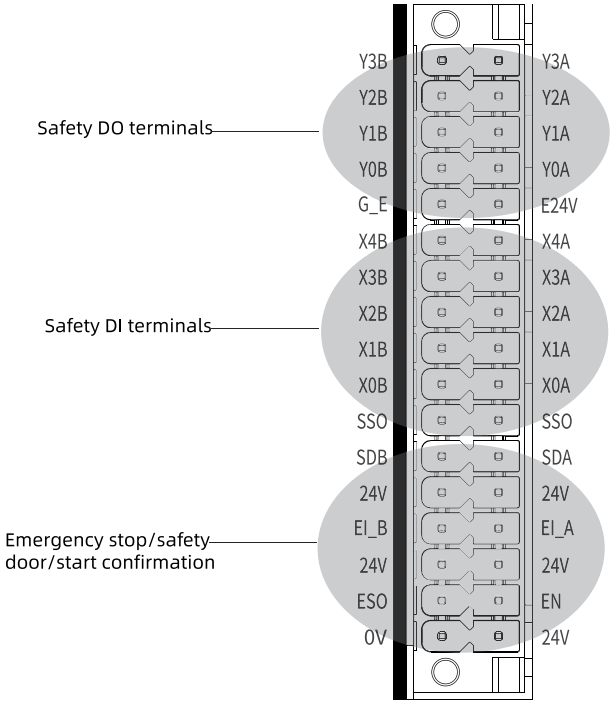
- The safety door function ensures the safe operation around the robot system by connecting peripheral gratings and switches. If you want to enter the safe range, you need to disconnect the gratings and switches installed on the periphery.
- The start confirmation function ensures that the robot system safely enters the fully automatic mode operation.



CAUTION

- Connect safety door switch, emergency stop switch, and start confirmation switch, etc., to the safety I/O interface to ensure safety. If the safety I/O interface is not required on site, maintain the factory default wiring. Companies and individuals that establish safety-related systems must conduct a risk assessment of the system according to relevant safety standards to ensure that it meets the required safety integrity level. In addition, companies and individuals that establish safety-related systems must take full responsibility for system installation and commissioning. If no safety connection is made or the safety connection is incorrect on the safety I/O interface, the robot system will not function properly.
- For the signal pairs X0A/X0B to X4A/X4B, Y0A/Y0B to Y3A/Y3B, SDA/SDB, and EI_A/EI_B, the A and B signals use functional safety dual-channel redundant logic. They must be connected to the same load and must not be used as two separate single channels.

The specific safety terminal assignments for the emergency stop, safety door, and start confirmation functions are as follows.



No.		Description
Y3B	Y3A	Safety output DO
Y2B	Y2A	
Y1B	Y1A	
Y0B	Y0A	
G_E	E24V	External power supply interface of DO circuit, with built-in overvoltage and overcurrent protection circuit
X4B	X4A	Safety input DI
X3B	X3A	
X2B	X2A	
X1B	X1A	
X0B	X0A	
SSO	SSO	Common terminal of safety DI; must be connected only to ground
SDB	SDA	Dual-circuit safety door input interface
24V	24V	Positive terminal of the 24 V power supply for emergency stop (maximum output current: 60 mA; must not be used for driving an external load)
EI_B	EI_A	Dual-circuit emergency stop input interface

No.		Description
24V	24V	Positive terminal of the 24 V power supply for emergency stop (maximum output current: 60 mA; must not be used for driving an external load)
ESO		Common terminal for the emergency stop, safety door, and start confirmation; must be connected only to ground
EN		Start confirmation input interface
0V		Negative terminal of the 24 V power supply for emergency stop
24V		Positive terminal of the 24 V power supply for emergency stop (maximum output current: 60 mA; must not be used for driving an external load)

8.2.7.2 Safety DO

Safety DO interface definition

Definition		Name
Y3B	Y3A	Safety output DO
Y2B	Y2A	
Y1B	Y1A	
Y0B	Y0A	
G_E	E24V	External power supply interface of DO circuit, with built-in overvoltage and overcurrent protection circuit

Interface specifications

Item	Specification
Number of output channels	4
Input connection method	Crimping wiring terminal
Output type	NPN (sink type)
Input voltage range	0 VDC to 30 VDC
E24V and G_E power supply	24 VDC ±20%/0.2 A
Maximum load current of each output	0.4 A
Voltage between Y and G_E when ON, V(Y-G_E)	< 1 V
Leakage current	Maximum 10 μA at 24 V
Maximum output switching frequency	1 kHz
Isolation mode	Optocoupler isolation
Protection	Current limiting protection (0.8 A)
Hardware response time	< 500 μs (OFF->ON), 500 μs (ON->OFF)

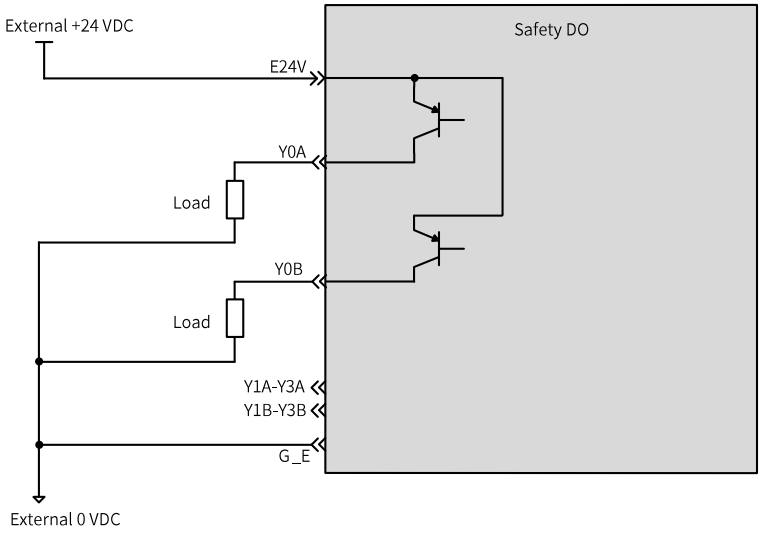
Wiring and topology diagram

WARNING

- E24V and G_E must be connected to 24 V power supply to ensure that the DOs work properly.
- If an external 24 V power supply is used, connect the positive and negative terminals of the external power supply to E24V and G_E terminals respectively. Note that the maximum driving current for each DO is 0.3 A. If the single output current exceeds 0.4 A, an over-current alarm occurs.
- Do not short-circuit outputs directly to +24V.
- Do not connect outputs to 0V or G_E to +24V of the power supply.
- The input voltage of the external power supply should be less than 29 V.

Failure to follow the above precautions may damage the circuit or cause the safety DO to fail to output.

- Wiring of the power supply
  Here we take Y0A and Y0B as an example (Y1A to Y4A and Y0B to Y4B are the same as Y0A). It is recommended to use an external 24 V power supply. Due to functional safety requirements, dual output circuits are required for connection of load. For example, Y0A and Y0B are in one group, as shown in the figure below:



- Wiring example
  - When driving an inductive load:

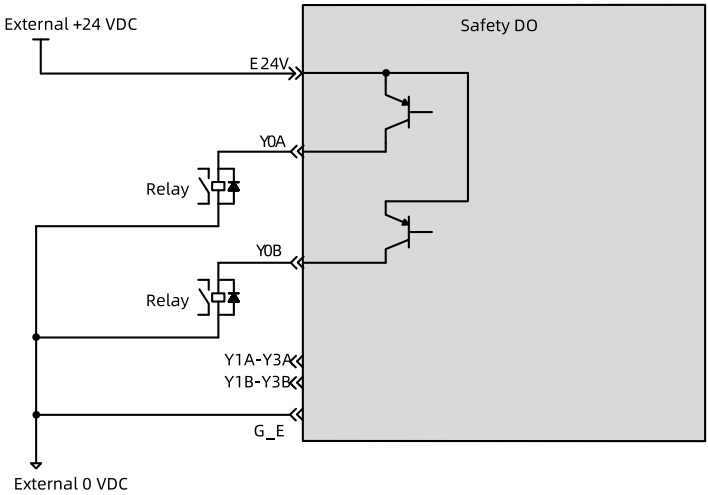
Note

- When the inductive load is applied, large back EMF will be produced between contacts and arc discharge is also caused when the inductive load stops. This may result in contact failure or contact sag, shortening the contact lifetime. Therefore, you can use a parallel flywheel diode with the load to extend the lifetime of the product.
- If the safety DO is connected to a relay (customer), when monitoring of the relay (customer) status is required, see *"8.2.7.3 Safety DI" on page 135*.

The flywheel diode must meet the following requirements:

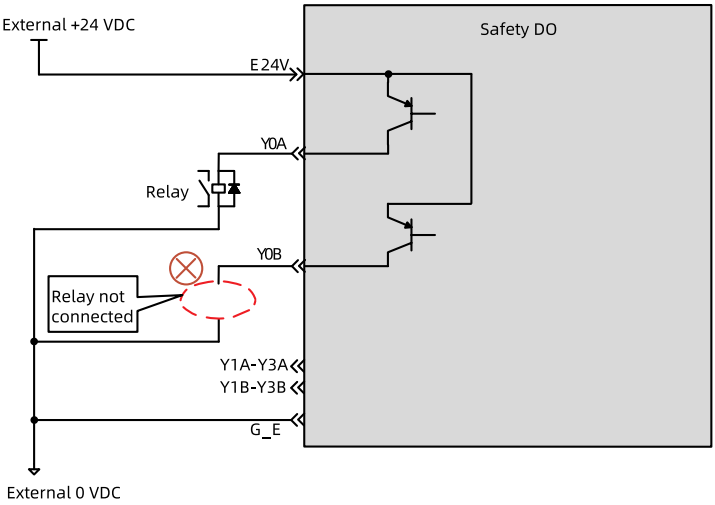
- Reverse voltage: 5 to 10 times the load voltage
- Forward current: greater than the load current

The correct wiring is shown in the figure below:

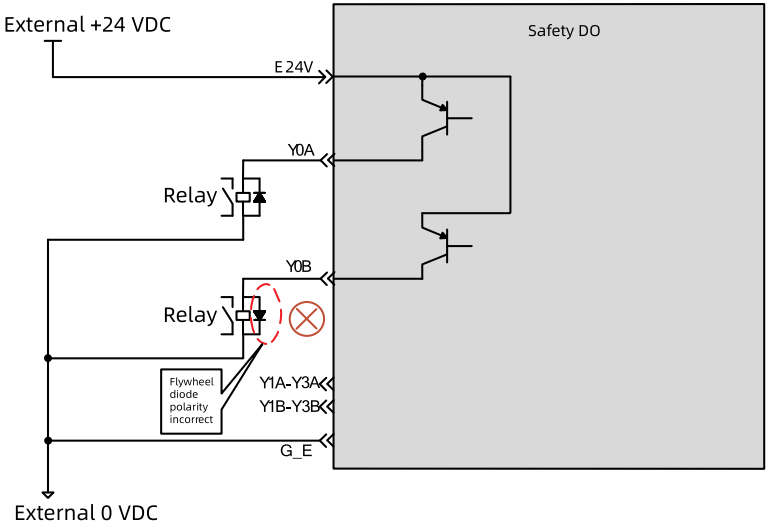


The incorrect wiring is shown in the figure below:

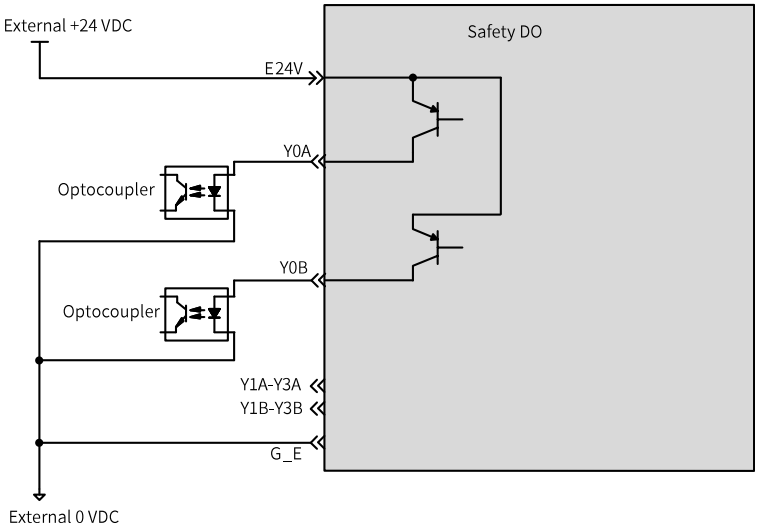
1. Either circuit is not connected to a relay or both circuits are not connected to a relay:



2. The polarity of the freewheeling diode of either relay is incorrect or the polarity of the freewheeling diode of both relays is incorrect:



- When driving an optocoupler load:



- Topology and wiring for the safety I/O interface/safety DO
  Before wiring according to the following topology and wiring diagram for the safety I/O interface/safety DO, read all the precautions in *"8.2.7.3 Safety DI" on page 135*.

  Topology and wiring for the safety I/O interface/safety DO:

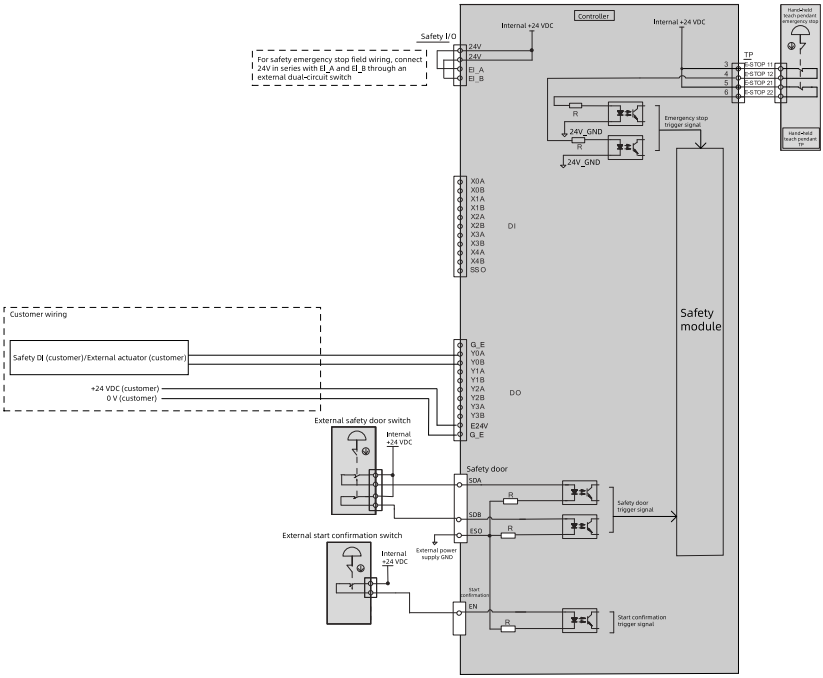


Figure 8-7 Topology and wiring for the safety I/O interface/safety DO

8.2.7.3 Safety DI

Safety DI interface definition

Definition		Name
X4B	X4A	Safety input DI
X3B	X3A	
X2B	X2A	
X1B	X1A	
X0B	X0A	
SSO	SSO	Common terminal of safety DI

Interface specifications

Item	Specification
Number of input channels	5
Input connection method	Crimping wiring terminal
Input type	PNP (source type)
Maximum input voltage	30 VDC
Input current	Approx. 5.3 mA (typical at 24 V)

Item	Specification
Input impedance	SI0 to SI4: 4.4 kΩ
ON voltage range	18 VDC to 30 VDC
OFF voltage range	0 VDC to 3 VDC
Maximum input signal frequency	SI0 to SI4: 1 kbps
Isolation mode	Optoelectric isolation
Hardware response time	< 250 μs (OFF->ON, ON->OFF)
Digital filter time	Default: 0.2 μs; 0.2 μs to 1000 μs
Allowable duty cycle deviation	≤ ±10%

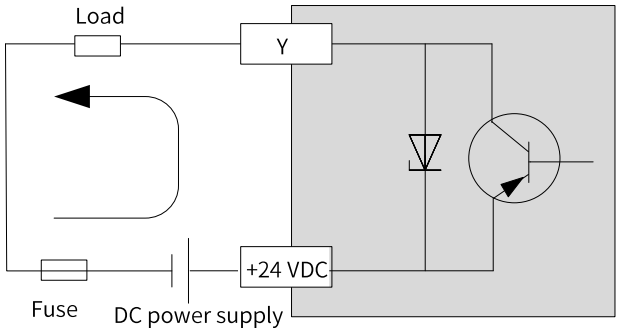
Wiring and topology diagram

- Wiring rules
  The terminal SSO is the common terminal for the 16-channel DI input. When SSO is connected to 0V and the X*A/X*B is connected to 24V, the input signal is active (the on-board optocoupler is turned on; SSO must be connected to 0V only). Therefore, the DI input is connected to the PNP-type output I/O devices.

  The description of the PNP-type output is as follows:

  PNP type (source type) output (positive common terminal)

  The load current flows from the output (Y) terminal, and such output is called a PNP type output, which is a high-level output. See the figure below:



CAUTION

- PNP output is high level.
- The terminal SSO is the common terminal for the 16-channel DI input. When SSO is connected to 0V and the X*A/X*B is connected to 24V, the input signal is active (the on-board optocoupler is turned on; SSO must be connected to 0V only). Therefore, the DI input is connected to the PNP-type output I/O devices.

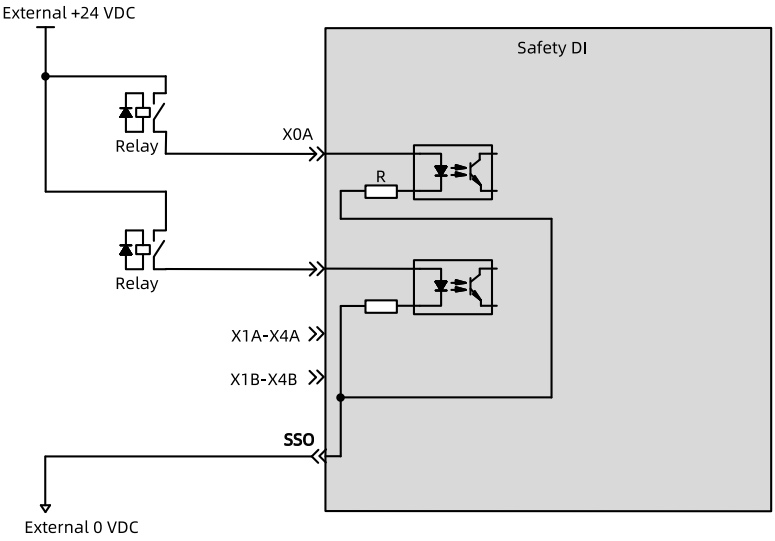
- Wiring diagram

  Here we take X0A and X0B as an example (X1A to X7A and X0B to X7B are the same as X0A). It is recommended to use an external 24 V power supply.

  Due to functional safety requirements, dual input circuits are required for connection of load. For example, X0A and X0B are in one group. If only X0A is connected, an alarm occurs.

  If an external 24 V power supply is used to power DI and the DO function is not needed, then E24V and G_E connections are optional. If the DO function is needed, it is necessary to perform wiring according to the DO wiring instructions.

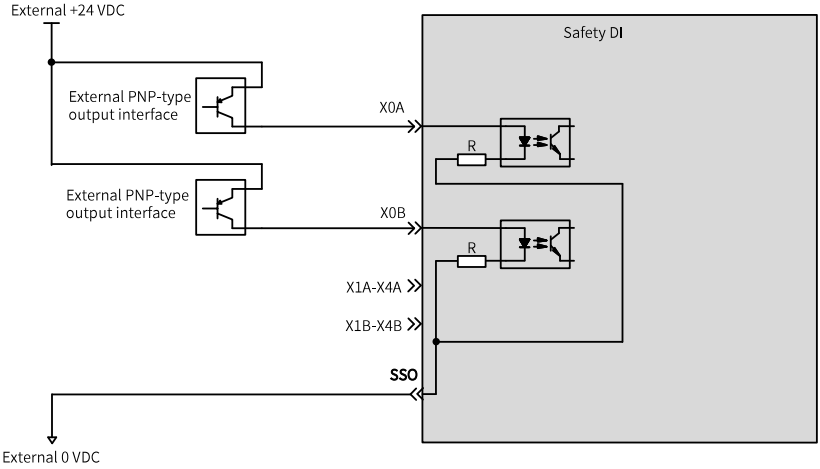
  - When the host controller provides relay output, the wiring is shown below:



Note

If on-site monitoring of the relay (customer) status is required, the safety DI dual-channel must be connected to the feedback signal of the relay (customer), and the safety DI should be configured as "relay status monitoring". For the configuration of the safety DI, see the corresponding section. To complete the corresponding wiring of the relay (customer), see *"8.2.7.2 Safety DO" on page 130* for wiring details. When on-site wiring is required to monitor the status of the relay (customer), note that the safety DI will be occupied. Meanwhile, the relay (customer) must meet relevant safety standard requirements.

- When the host controller provides open-collector output, the wiring is shown below:



Note

Due to functional safety requirements, dual input circuits are required for connection of load. For example, X0A and X0B are in one group. If only X0A is connected, an alarm occurs. Safety settings must also be configured in the safety I/O configuration. For details, see the "Safety I/O" section of the "PS00019992 Collaborative Robot Safety Guide" and the wiring precautions corresponding to this section.

- Topology and wiring for the safety I/O interface/safety DI
  Before wiring according to the following topology and wiring diagram for the safety I/O interface/safety DO, read all the precautions in the "Safety I/O" section of the "PS00019992 Collaborative Robot Safety Guide"
  - Wiring for the safety I/O interface/safety DI:

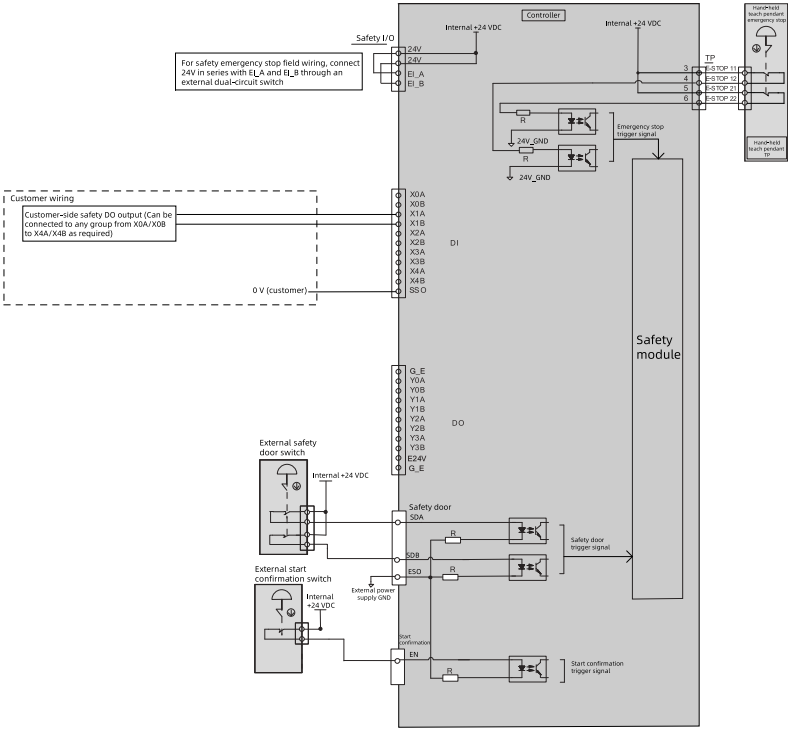


Figure 8-8 Wiring for the safety I/O interface/safety DI

- Wiring for the safety I/O interface/safety DI (relay status monitoring):

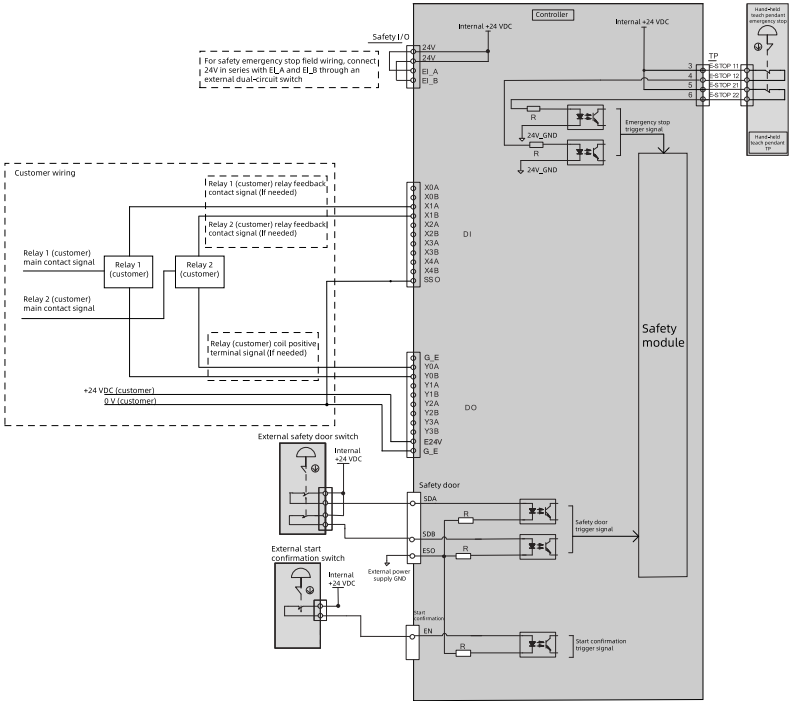


Figure 8-9 Wiring for the safety I/O interface/safety DI (relay status monitoring)

8.2.7.4 Emergency Stop/Safety Door/Start Confirmation

Emergency stop/safety door/start confirmation interface definition

Definition		Name
SDB	SDA	Dual-circuit safety door input interface
24V	24V	Positive terminal of the 24 V power supply for emergency stop (maximum output current: 60 mA; must not be used for driving an external load)
EI_B	EI_A	Dual-circuit emergency stop input interface

Definition		Name
24V	24V	Positive terminal of the 24 V power supply for emergency stop (maximum output current: 60 mA; must not be used for driving an external load)
ESO		Common terminal for the emergency stop, safety door, and start confirmation; must be connected only to ground
EN		Start confirmation input interface
0V		Negative terminal of the 24 V power supply for emergency stop
24V		Positive terminal of the 24 V power supply for emergency stop (maximum output current: 60 mA; must not be used for driving an external load)

I/O specifications

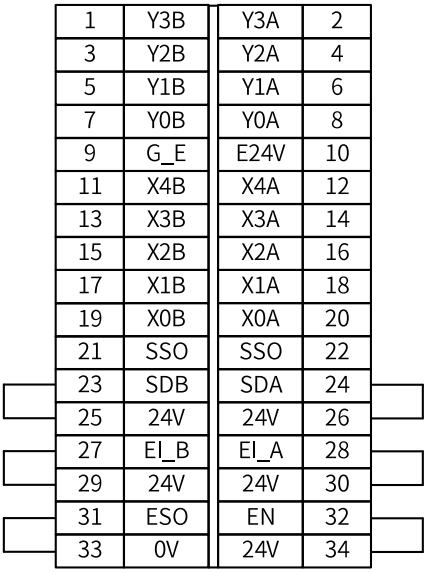
The specifications of I/Os for emergency stop input, safety door and start confirmation are described below.

Input channels	
Item	Specification
Number of input channels	5 (dual-channel for emergency stop and safety door; single-channel for start confirmation)
Input connection method	Crimping wiring terminal
Input type	Digital; common terminal connected to ground
Maximum input voltage	30 VDC
Input current (typical at 24 V)	3.5 mA
Input impedance	> 4 kΩ
ON voltage range	18 VDC to 30 VDC
OFF voltage range	0 VDC to 3 VDC
Maximum input signal frequency	1 kHz
Isolation mode	Optoelectric isolation
Controller internal output power supply	24 V ±20%/60 mA

CAUTION

- 24V is the 24 V power supply output from the controller, with a maximum output current of 60 mA and can only supply power to the safety I/O interface. 0V is its reference ground.
- If this power supply is used, the safety I/O interface supports passive switch-type devices.
- When an external emergency stop device is connected in series, it must not cause the voltage of 24V to drop below 18 V. Otherwise, the emergency stop function may fail after the button is pressed, causing the robot to trigger an alarm and shut down.
- When external wiring causes a short circuit or the output current exceeds 60 mA for a long time, the overcurrent self-locking protection of the 24 V power supply inside the controller will be triggered, and the power supply will enter a no-output state. The specific wiring method is described in the "Emergency stop wiring" below.
- When connecting an external emergency stop device to the safety I/O terminals:
  - Connect the first contact of the external emergency stop device in series to EI_A/EI_B, and the second contact in series to 24V.
  - An external emergency stop device typically uses a normally closed switch.
  - When the external emergency stop signal is triggered by the safety DO (PNP type) of an external mechanism/device, it is recommended to connect the external emergency stop signal to the safety DI. For the related wiring, follow the safety DI wiring instructions. For the corresponding safety DI configuration, see the related section of the "PS00019992 Collaborative Robot Safety Guide".

The default wiring diagram for the safety I/O interface of the collaborative robot controller is shown below.



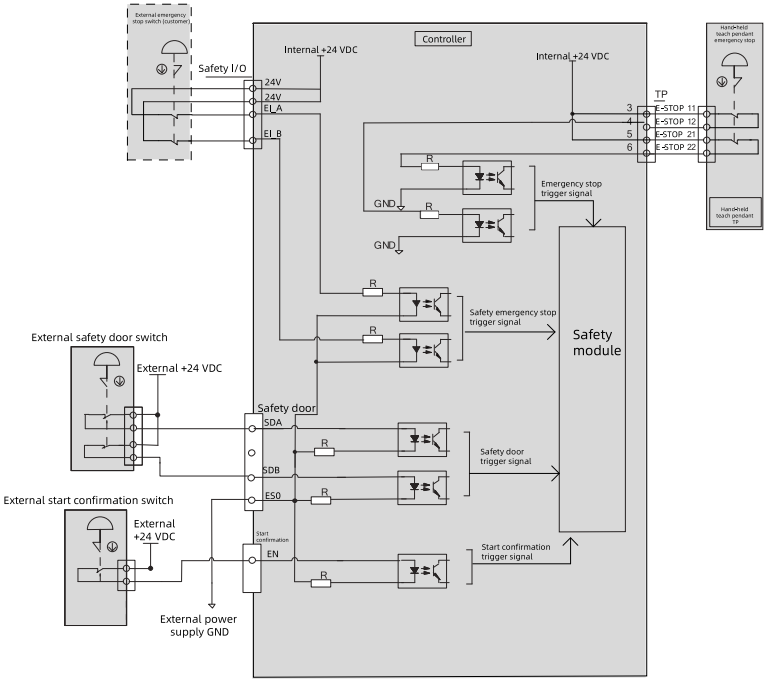
1	Y3B	Y3A	2
3	Y2B	Y2A	4
5	Y1B	Y1A	6
7	Y0B	Y0A	8
9	G_E	E24V	10
11	X4B	X4A	12
13	X3B	X3A	14
15	X2B	X2A	16
17	X1B	X1A	18
19	X0B	X0A	20
21	SSO	SSO	22
23	SDB	SDA	24
25	24V	24V	26
27	EI_B	EI_A	28
29	24V	24V	30
31	ESO	EN	32
33	0V	24V	34

Wiring and topology diagram

Emergency stop wiring

- Emergency stop is a normally closed contact connection, with a dual circuit structure. The disconnection of any circuit will trigger the emergency stop function. For different emergency stop wiring, note the corresponding precautions. The safety I/O interface only accepts passive emergency stop normally closed contact signal.
- Once the hand-held teach pendant aviation connector is properly connected to the controller aviation connector, the hand-held teach pendant emergency stop is considered connected. The hand-held teach pendant emergency stop is connected in parallel with the EI emergency stop interface on the safety I/O terminal, and the wiring of the two does not affect each other.

The wiring and topology diagram for the emergency stop, safety door, and start confirmation functions is shown below.

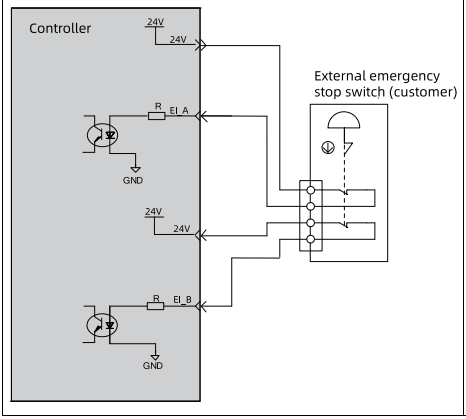
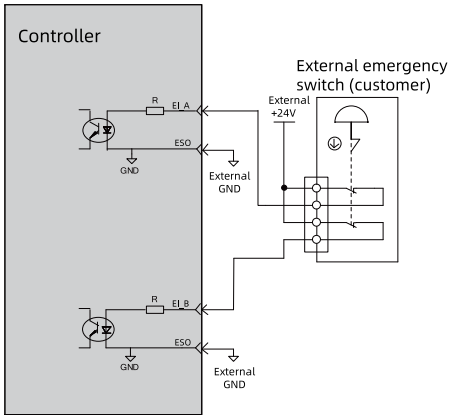


CAUTION

- During normal robot operation, minimize the use of the emergency stop function for non-emergency situations. Emergency stop may cause the robot stop trajectory to deviate from the normal operation trajectory, and the emergency stop shock can reduce the service life of the robot reducer and increase the wear and tear of the motor brake pads.
- If you want to enter the emergency stop state, first set the robot speed to 0, and then press the emergency stop button.
- In case of an emergency, press the emergency stop button directly to enter the emergency stop state.

For the connection using both external emergency stop switch (customer) and robot side (teach pendant/controller) emergency stop (dual-circuit (A/B) interlocking mechanism), see the table below.

Table 8-3 Connection of external emergency stop switch (customer) + teach pendant/controller emergency stop switch

Using 24 V power supply provided by the controller	Using an external 24 V power supply
	

Safety door wiring

The safety door function is used to control the safeguard or safety door during robot operation. The robot controller provides safety door interface terminals (SDA/SDB) for triggering the safety door function. When the safety door is opened, the safety door signal input is at a low level, the safety door function is activated, and the robot performs a safety stop.

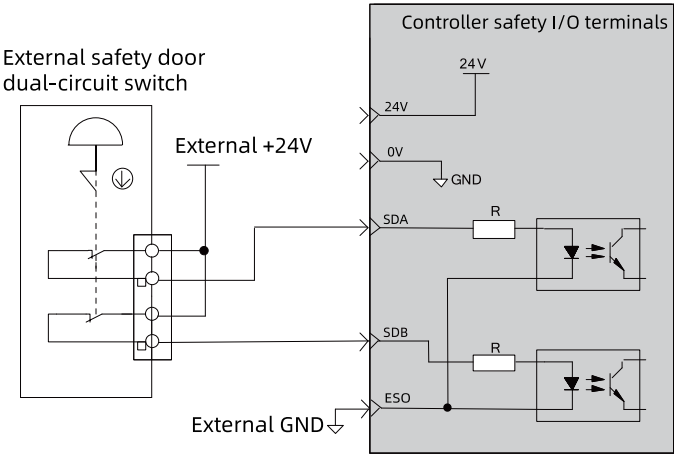
- The safety door function utilizes a common DI detection method with a dual circuit structure.
- The safety door is a normally closed contact connection, with a dual circuit structure. The disconnection of any circuit will trigger the safety stop function.

The controller system turns on the safety door function by default. Therefore, note the wiring as follows:

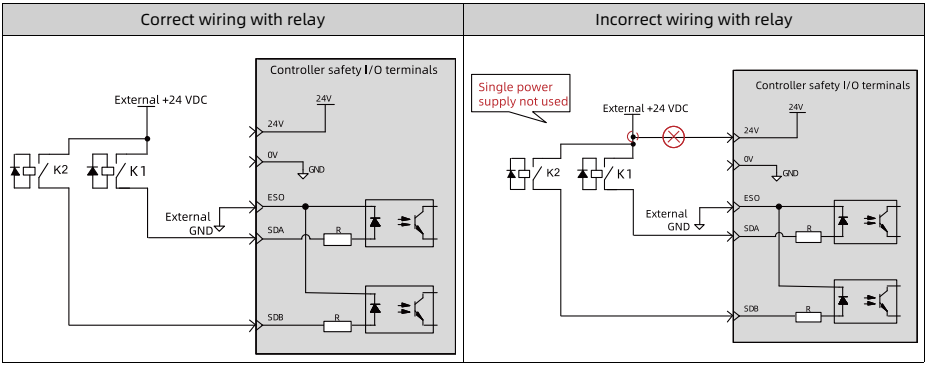
Connect the safety door circuit to the designated I/Os for SAFETY DOOR 1 (SDA) and SAFETY DOOR 2 (SDB). The safety door function is active only when both I/O inputs are valid. Otherwise, the system will alarm.

By default, the safety door and start confirmation circuits are powered by internal power supply. If you need to use the safety door function, it is recommended to supply power to the safety door trigger device from an external +24 V power supply, and then connect the safety door signal to the corresponding interface terminal on the controller. The safety door wiring when using an external +24 V power supply is shown below.

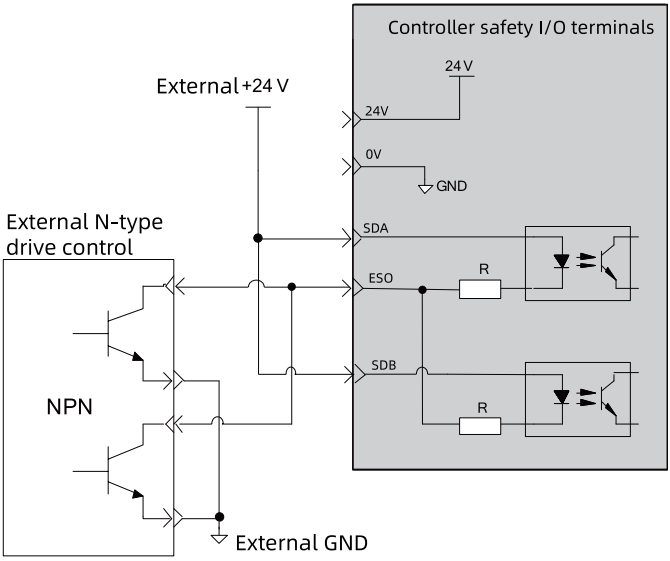
- When the external safety door control uses a dual-switch (recommended wiring with external 24 V power supply):



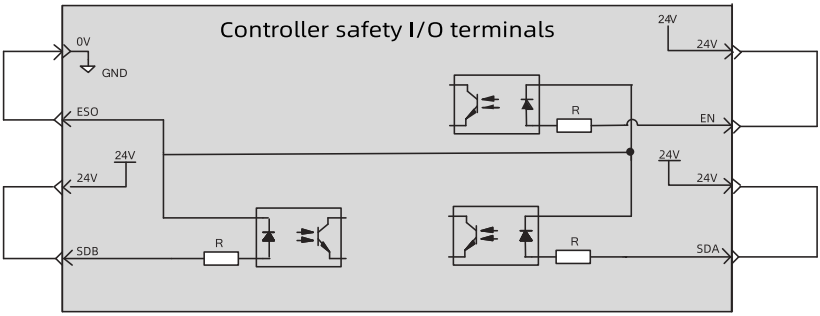
- When the external safety door control uses a relay output (recommended wiring with external 24 V power supply):



- When the external safety door control uses an NPN-type drive output (recommended wiring with external 24 V power supply):



- Wiring for shielding safety door function (factory default wiring):



CAUTION

If the safety door function (protective stop function) is left at factory default wiring, it will not be enabled. If the robot has no safety door function (customer), companies and individuals that establish safety-related systems must conduct a risk assessment of the system according to relevant safety standards to ensure that the system meets the required safety integrity level. In addition, companies and individuals that establish safety-related systems must take full responsibility for system installation and commissioning.

Start confirmation function wiring

The start confirmation function is used for checking and confirming the operation of the robot before starting and running.

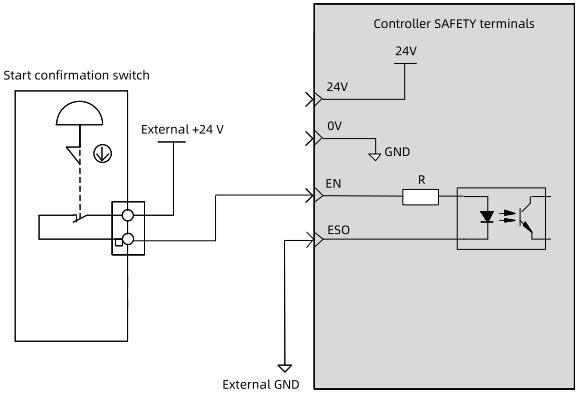
- The start confirmation function adopts the following working method:
  - Rising edge detection method. When the DI port detects a valid rising edge signal (with a pulse width greater than 500 μs) from 0 to 1, the start confirmation function is enabled and active. For example, the external control device uses a self-resetting type contact switch for control.
  - If the DI port detects that there is always an ON input level, that is, this function is blocked. For example, the external control device uses a normally closed contact switch for control, and the input is always in a valid state.

The controller system turns on the start confirmation function by default. Therefore, note the wiring as follows:

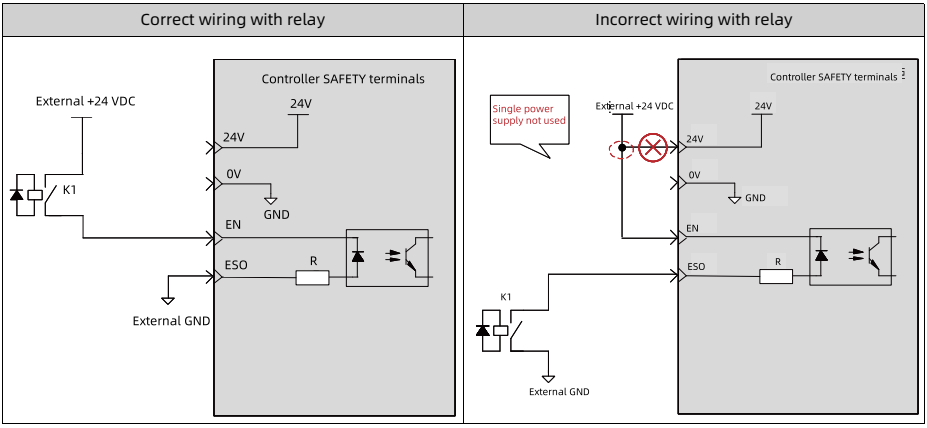
When the start confirmation function is active, the I/O detection circuit requires a rising edge input of 0 to 1 before each operation of the system. Otherwise, after the start button is pressed, the system will prompt "Please confirm the startup before automatic operation". Therefore, it is recommended to use a self-resetting switch in the start confirmation control circuit.

By default, the start confirmation circuit are powered by internal power supply. If you need to connect an external control device to remotely operate the start confirmation function, it is recommended to use an external +24 V power supply. The start confirmation function wiring when using an external +24 V power supply is shown below.

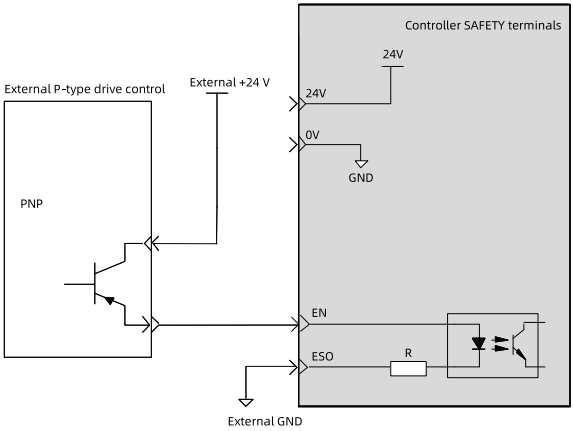
- When the external start confirmation control uses a switch (recommended wiring with external 24 V power supply):



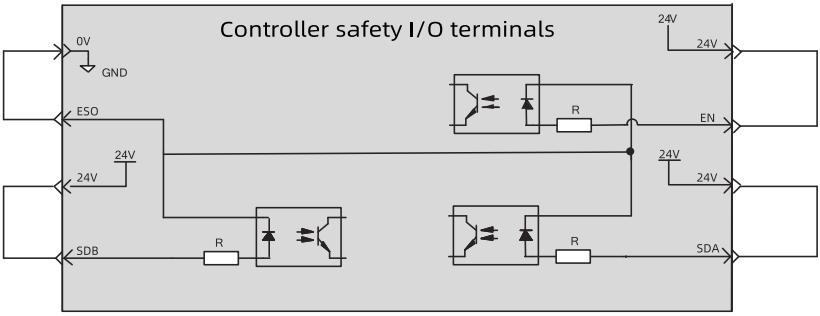
- When the external start confirmation control uses a relay output (recommended wiring with external 24 V power supply):



- When the external start confirmation control uses an NPN-type drive output (recommended wiring with external 24 V power supply):



- Wiring for shielding the start confirmation function (factory default wiring):



CAUTION

If the start confirmation function is left at factory default wiring, it will not be enabled, and the robot will have no start confirmation function. Companies and individuals establishing safety-related systems must conduct a risk assessment according to relevant safety standards to ensure that the system meets the safety requirements. In addition, companies and individuals that establish safety-related systems must take full responsibility for system installation and commissioning.

8.2.8 Ethernet Interface

This interface is used for vision system, with a rate of 100 Mbps. The specifications are described below.

No.	Definition	Description
1	TX+	Data transmission +
2	TX-	Data transmission -
3	RX+	Data reception +
4	-	-
5	-	-
6	RX-	Data reception -
7	-	-
8	-	-
Enclosure	PE	Shield

8.2.9 EtherCAT-M Interface

Note

The EtherCAT-M interface is a reserved interface and is not currently supported.

The EtherCAT(M) interface is an EtherCAT master communication interface for connecting external expansion axes, with a rage of 100 Mbps.

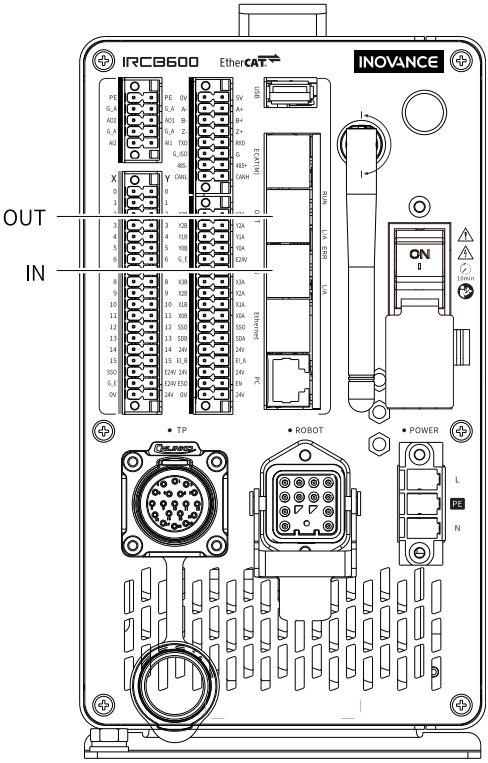
Item	Specification
Communication protocol	EtherCAT protocol
Service supported	CoE (PDO, SDO)
Synchronization mode	DC - Distributed clock

Item	Specification
Physical layer	100Base-TX
Baud rate	100 Mbps (100Base-TX)
Duplex mode	Full duplex
Topology	Linear
Transmission medium	Shielded cables of Cat 5e or higher
Transmission distance	Less than 100 m between two nodes (with proper environment and cables)
EtherCAT frame length	44 bytes to 1498 bytes
Process data	Maximum 1486 bytes per Ethernet frame

8.2.10EtherCAT Slave Interface

When the controller serves as an EtherCAT slave, the EtherCAT slave communication interfaces are used, and provide a communication rate of 100 Mbps.

When used as an intermediate node in a daisy-chain connection, EtherCAT-IN serves as the slave input and EtherCAT-OUT as the slave output. When used as the end node, only the EtherCAT-IN interface needs to be connected.



Item	Specification
Communication protocol	EtherCAT protocol
Service supported	CoE (PDO/SDO)
Synchronization mode	DC - Distributed clock
Physical layer	100Base-TX
Baud rate	100 Mbps (100Base-TX)
Duplex mode	Full duplex
Topology	Linear
Transmission medium	Shielded cables of Cat 5e or higher
Transmission distance	Less than 100 m between two nodes (with proper environment and cables)
Synchronous jitter	< 1 μs

8.2.11PC Interface

The PC interface serves as a PC-based teach pendant interface and is used to connect to the PC version of InoRobotTP. It provides a communication rate of 100 Mbps, and one interface is provided.

8.2.12USB Interface

The standard USB2.0 interface enables the connection and communication between the controller and external USB devices, for system upgrades, program loading, and more.

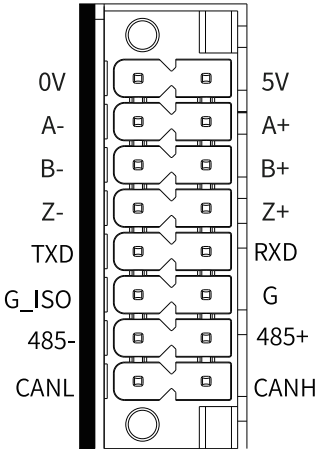
Note

The USB drive must be in FAT32, EXT2, or EXT3 format to be successfully loaded.

8.2.13 ABZ & RS232 & RS485 & CAN Interface

Note

The RS232 and CAN interfaces are reserved and are not open for external use.



Pin		Definition
0V	5V	The terminal is used to provide 4.5 VDC to 5.5 VDC power supply to an external unit with the maximum output current of 0.35 A.
A-	A+	Differential input, phase A
B-	B+	Differential input, phase B

Pin		Definition
Z-	Z+	Index: single capture
TXD	RXD	RS232 signal (reserved)
G		RS232 reference ground
G_ISO		RS485/CAN signal reference ground
485-	485+	RS485 bus signal
CANL	CANH	CAN bus signal

ABZ hardware specifications

Input channels	
Item	Specification
Number of input channels	1
Input connection method	Crimping wiring terminal
Input type	Differential/single-ended input; 4x frequency multiplication counting mode
Operating voltage range (DC)	3.3 V to 5 V
Maximum input switching frequency	500 kHz
Maximum input impedance (R)	> 300R
Input signal	A/B/Z channel input
Isolation mode	Optocoupler isolation

RS232 & RS485 & CAN hardware specifications

Compatible with one RS232 internal debug interface (100 kbps), one RS485 interface (up to 1 Mbps), and one CAN communication interface (1 Mbps).

Table 8-4 Serial port hardware specifications

Item	Specification		
Interface	RS232	RS485	CAN (reserved)
Number of channels supported	1x	1x	1x
Hardware interface	Pluggable terminal block - socket - screw termination - right angle - 3.5 mm pitch		
Isolation mode	Non-isolated	Isolated	Isolated
Short-circuit protection	Supported		
24 V misconnection protection	Supported		
Baud rates supported	1 Mbps	1200, 9600, 19200, 38400, 57600, 115200, 187500 bps	5 kbps to 1 Mbps

Item	Specification		
Termination resistor	No	No, external termination resistor required by customer as needed	Yes
Number of slaves supported	-	Up to 32 slaves	127
Communication distance	-	See the RS485 data rate and distance relationship table.	See the CAN data rate and distance relationship table.

The RS485 data rate and distance relationship table is as follows:

Bit rate (kbps)	Distance (m)	Wire gauge
1000	40	AWG26
5	10000	AWG26

The CAN data rate and distance relationship table is as follows:

Bit rate (kbps)	Distance (m)	Wire gauge
1000	40	AWG26
5	10000	AWG26

Note

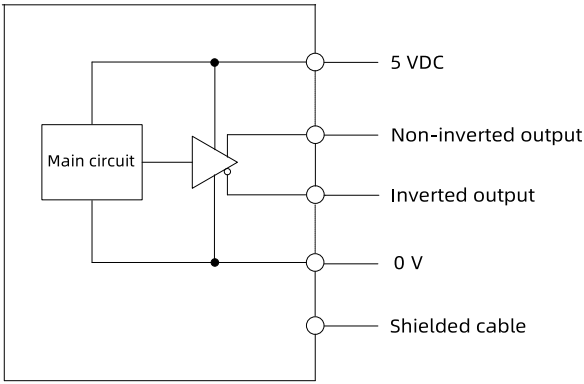
There are currently no clear functional requirements for CANopen in collaborative robots, and the software does not support it.

8.2.13.1 ABZ Wiring Method

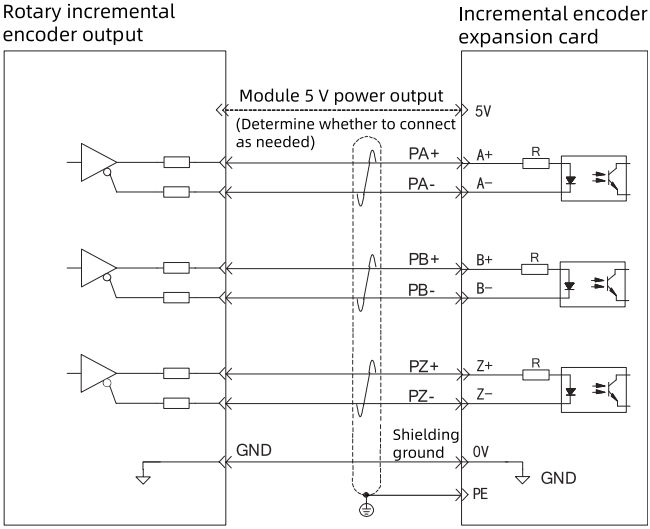
Wiring diagram

- Do not bundle the cable together with power cables (with high voltage, large current) that produce strong interference signals. Separate it from other cables and avoid cabling in parallel.
- Use recommended cables. It is recommended to use shielded twisted pair cables to enhance anti-interference capacity.
- Only encoder input signals with voltage levels of 0 V to 5 V are supported.

1. Differential input (recommended)
   An encoder example is shown below:

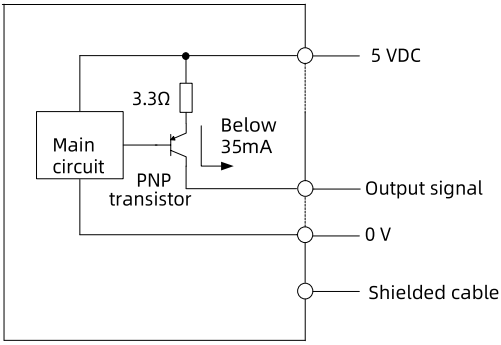


Wiring method:

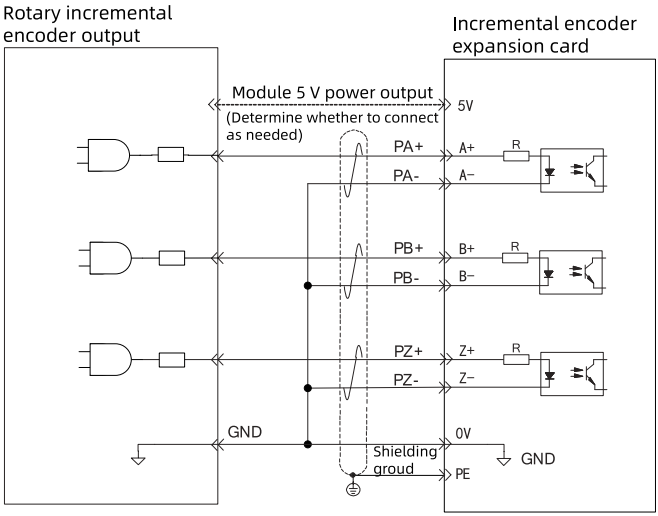


2. Single-ended PNP-type 5 V input

An encoder example is shown below:

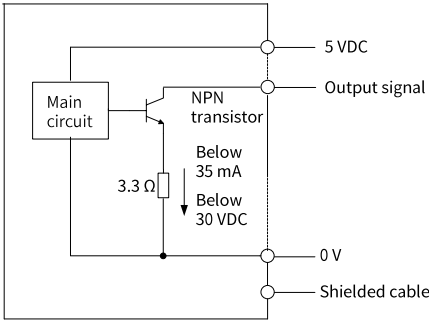


Wiring method:

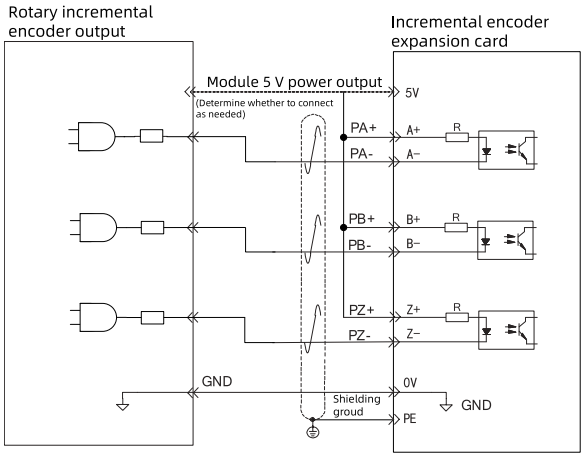


3. Single-ended NPN-type 5 V input

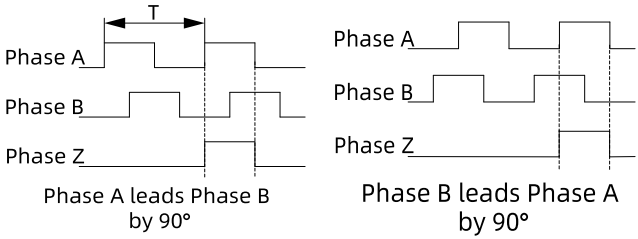
An encoder example is shown below:



Wiring method:



Single-ended input waveform:



8.2.13.2 RS485 Wiring Method

RS485 topology

It is recommended to use shielded twisted pair cables for the RS485 bus connection. The specific requirements are as follows:

- Termination resistor: Use shielded twisted pair cables for the RS485+ and RS485- connection, and connect a 120 Ω termination resistor at both ends of the bus to prevent signal reflection.

Note

The RS485 interface inside the controller does not have a pre-installed 120 Ω termination resistor.

- Reference ground connection: Connect the reference grounds of the RS485 signals of all nodes together.
- Number of nodes: Up to 128 nodes can be connected.
- Branch distance: The branch distance for each node should be less than 3 m.

The RS485 bus connection topology is shown in the figure below:

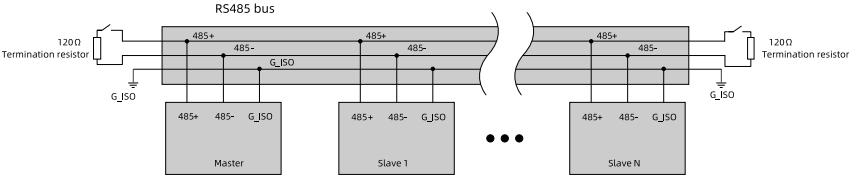


Figure 8-10 RS485 topology

Multi-node topology

In case of a large number of nodes, connect the RS485 bus using the daisy chain mode. If branch line connections are required, the branch length from the bus to the node should be as short as possible; it is recommended not to exceed 3 m. Star connections must be strictly prohibited.

The following figures show the common bus structures.

- Daisy chain connection

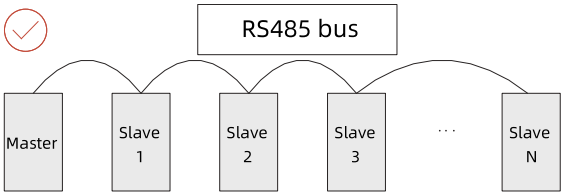


Figure 8-11 Daisy chain connection

- Branch line connection

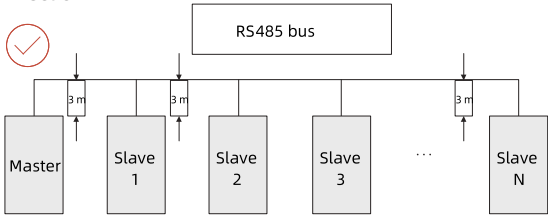


Figure 8-12 Branch connection

Note

Branch lines should not exceed 3 m.

- Star connection (prohibited)

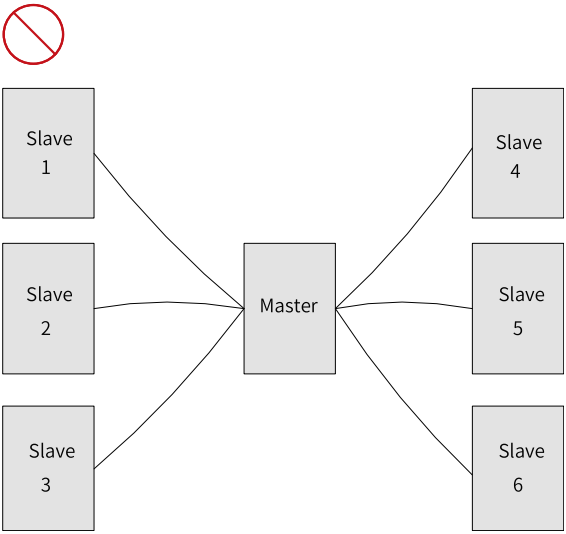
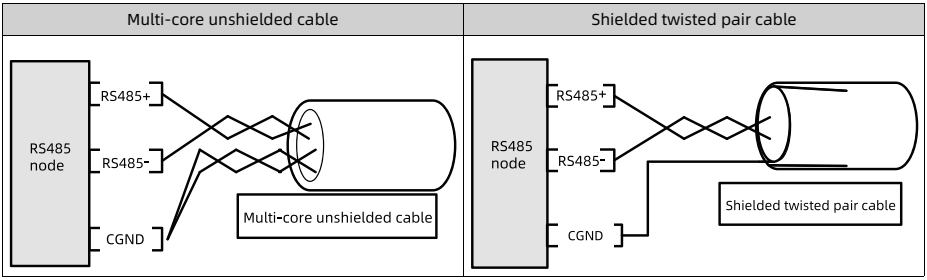


Figure 8-13 Star connection

Multi-node wiring

- Terminal wiring for nodes with CGND

  Ensure that the RS485 bus contains three cables and the terminals are connected correctly. For use of shielded cables, connect the shield to the CGND terminal. Do not connect the shield to any other part (including enclosure on site and the grounding terminal of the device) except the CGND terminal. Due to cable attenuation, use AGW26 or thicker cables if the connection length is longer than 3 m. Twisted pair cables are always recommended for connecting RS485+ and RS485-.

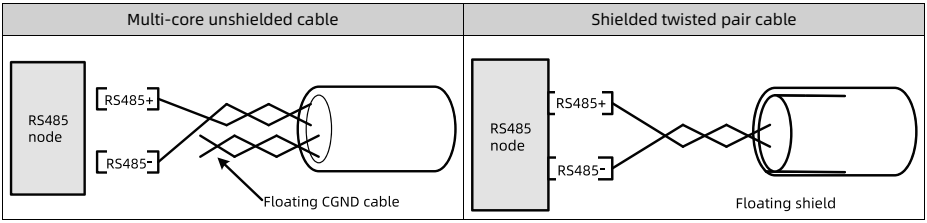


Recommended cable 1: Use multi-conductor twisted pair cables, with one twisted pair connected to RS485+ and RS485-, and others twisted together to connect CGND.

Recommended cable 2: Use shielded twisted pair cables, with the twisted pair connected to RS485+ and RS485-, and the shield connected to CGND.

In applications where shielded cables are used, the shield must be connected to CGND only, and never to the site ground.

- Terminal wiring for nodes without CGND
  For nodes without CGND, do not connect CGND cable or the shield to the PE terminal of nodes directly. Handle this issue by following the three methods.



  - Method 1: Check whether another port on this node shares a common reference ground with the RS485 circuit. If yes, connect the CGND cable (the shield) of the bus directly to the pin.
  - Method 2: Find the reference ground of the RS485 circuit on the node board and connect the drain wire to CGND or the shield.
  - Method 3: If the reference ground of the RS485 circuit cannot be found, keep the CGND cable or the shield unconnected and use an extra grounding cable to connect this node to the PE terminal of other nodes.

8.2.14Recommended Communication Cable

Cat 5e shielded twisted pair (STP) cables are recommended for the communication cables (EtherCAT-M, EtherNet, EtherCAT-IN, EtherCAT-OUT). In harsh EMC environments, highly flexible shielded Cat 6 cables are recommended.

Note

IR-Link uses a standard Ethernet cable.

The supported S6 series cable models are described in the figure below:

S6 - L - T 04 - 3.0
① ② ③ ④ ⑤

① **S6 Series**	③ **Cable type** T: communication cable	⑤ **Cable length** 0.2: 0.2 m 0.3: 0.3 m ... 5.0: 5 m 10.0: 10 m
② **Cable**	④ **Communication cable connection type** 04: EtherCAT multi-device communication cable	

The cable ordering information is shown in the following table.

Material code	Cable Model	Length (m)
15040261	S6-L-T04-0.3	0.3
15040262	S6-L-T04-3.0	3
15041960	S6-L-T04-0.2	0.2
15041961	S6-L-T04-0.5	0.5
15041962	S6-L-T04-1.0	1
15041963	S6-L-T04-2.0	2
15041964	S6-L-T04-5.0	5
15041965	S6-L-T04-10.0	10
15300377	Highly flexible Cat 6 shielded cable (recommended for harsh EMC environments)	5
15300378	Highly flexible Cat 6 shielded cable (recommended for harsh EMC environments)	3

See the following table for specifications of Cat5 shielded twisted pair cables.

Item	Description
UL Certification	Compliance with UL
CAT.5E cable	CAT.5E cable
Double shield	Braided shield (coverage: 85%) Aluminum foil shield (coverage: 100%)
Environmental worthiness	Operating ambient temperature: -30℃ to +60℃ Resistant to industrial oil, corrosive acid and alkali

9 Common Issues

9.1 Robot Startup and Shutdown

Once the controller starts successfully, you can connect the teach pendant to the controller and control the startup or shutdown of the manipulator.

Starting the manipulator

1. Confirm that the zero position is correct. (Note: An incorrect zero position may damage cables and other components in the manipulator.)
2. Click the "Robot not powered on" button. In the confirmation dialog, click "Confirm" to power on the manipulator. The button on the teach pendant then changes to "Robot powering on", and the indicator at the end of the manipulator changes to a blue running light.

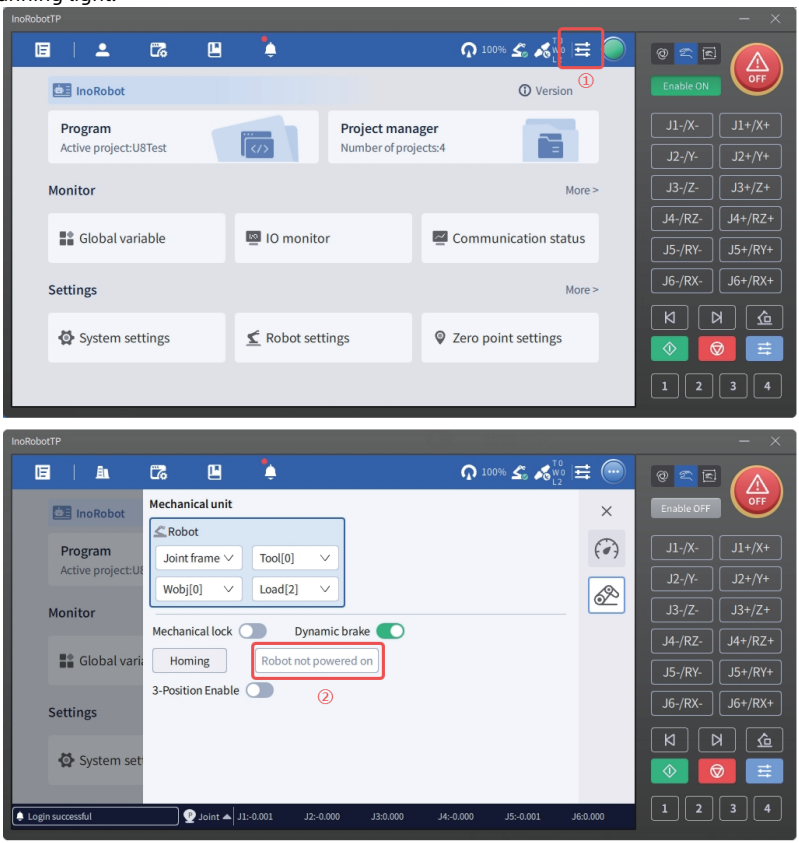


Figure 9-1 Robot not powered on

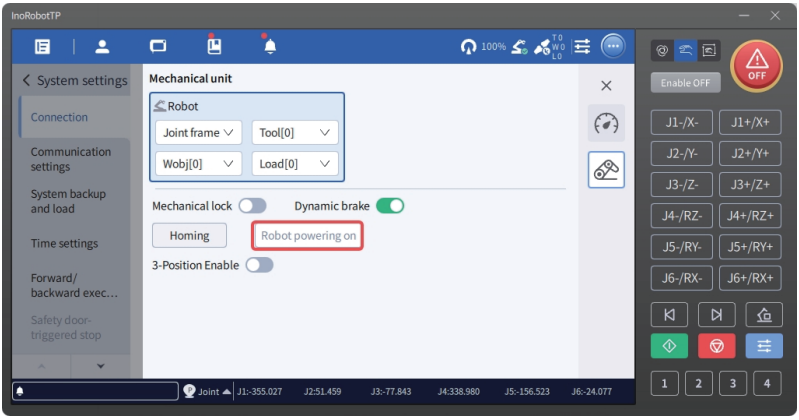


Figure 9-2 Robot powering on

3. When the button on the teach pendant changes to the "Robot powered on" state and the indicator at the end of the manipulator is steady on, it indicates that the manipulator has started successfully.

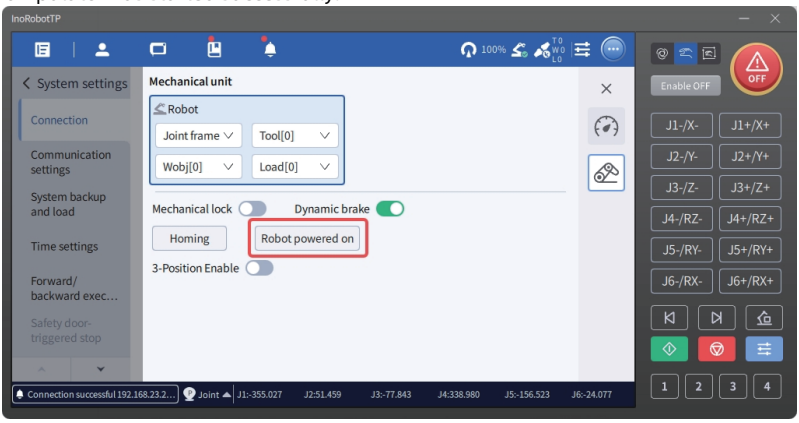


Figure 9-3 Robot powered on

Shutting down the manipulator

1. Click the "Robot powered on" button. In the confirmation dialog, click "Confirm" to shut down the manipulator. The button on the teach pendant then changes to "Robot powering off", and the indicator at the end of the manipulator turns off.

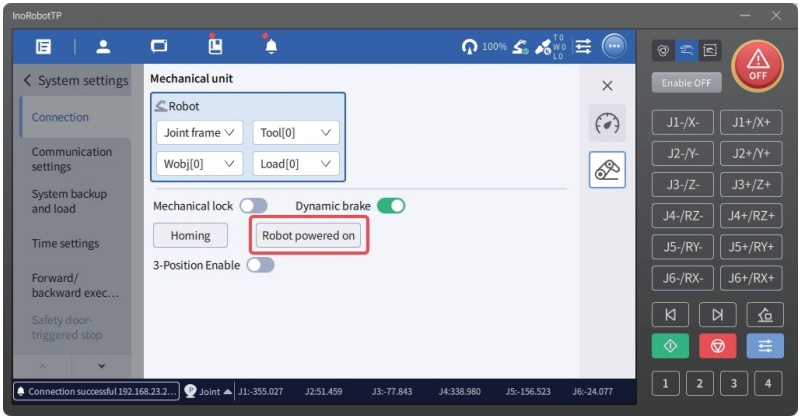


Figure 9-4 Robot powered on

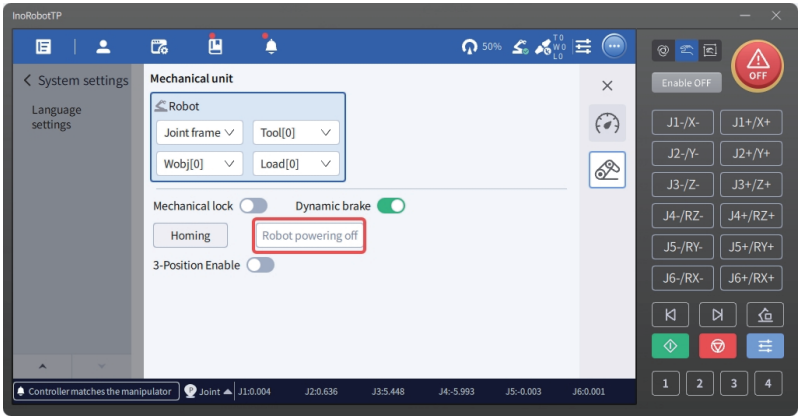


Figure 9-5 Robot powering off

2. When the button on the teach pendant changes to the "Robot not powered on" state and the indicator at the end of the manipulator turns off, this indicates that the manipulator has been shut down successfully.

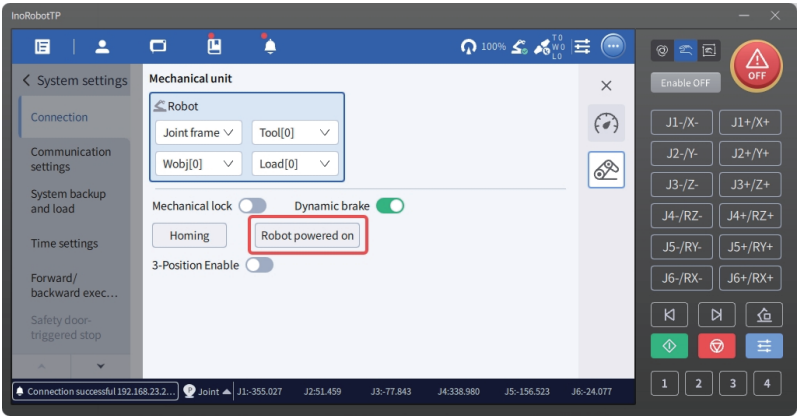


Figure 9-6 Robot not powered on

CAUTION

- Before starting or shutting down the manipulator, start the controller first.
- The manipulator can be shut down only after it is in a non-automatic, non-program-running, non-mechanically-locked, and non-enabled state.

9.2 Common Controller Faults and Solutions

No.	Fault	Solution
1	Controller power indicator not lit when powered on	1. Check that the power supply is connected correctly. Connect the L/N/PE cables according to the markings. 2. Check that the micro circuit breaker switch is toggled ON.
2	Wi-Fi connection failed	1. Check that the Wi-Fi antenna is unfolded. Unfold the antenna as recommended. 2. Check that the correct controller Wi-Fi name is selected on the tablet teach pendant. The default controller Wi-Fi name is the controller SN.

No.	Fault	Solution
3	Communication with PC through Ethernet port failed	1. Observe the two indicators on the Ethernet port. The hardware communication is normal only when the indicators are on or flashing. 2. The Ethernet signal line in the aviation connector is mutually exclusive with the PC Ethernet port. To use the PC Ethernet port, you need to remove the aviation connector of the teach pendant. 3. Check that the IP addresses are set correctly.
4	DO invalid	1. Check that E24V/G_E is connected to a 24 V power supply and is powered by a single power supply. 2. Check that the total output current of a single DO does not exceed 0.4 A when the I/O terminals are powered by an external 24 V power supply; check that the total continuous output current of the 16 DOs does not exceed 0.8 A when the I/O terminals are powered by the power supply inside the controller. 3. Check that the wiring is correct when driving relay or optocoupler load.
5	DI invalid	1. Check that it is powered by a single power supply. 2. Check that the connected common terminal matches the input terminal, with SSO and X0-X15 as a group. 3. Check that the input voltage value at the X* is valid. When SSO is connected to 24V and X* is connected to 0V, the input signal is active; when SSO is connected to 0V and X* is connected to 24V, the input signal is active.
6	Emergency stop alarm	Check that the SAFETY terminal wiring is correct. For details, see *" Emergency Stop/Safety Door/Start Confirmation" on page 140*.

10 Inspection and Maintenance

10.1 Maintenance Precautions

Before maintenance, read this guide, and other related guides carefully to fully understand the methods of safe maintenance.

Only authorized personnel who have taken safety training should be allowed to maintain the robot system.

Safety training is the program for industrial robot operators that follows the laws and regulations of each nation. The personnel who have taken safety training acquire knowledge of industrial robots (operations, teaching, etc.), knowledge of inspections, and knowledge of related rules/regulations.

10.2 Manipulator Maintenance Guide

In order to ensure the robot operates more safely and efficiently, regular inspections and maintenance are required. Based on the parts to be inspected and maintained, it can be categorized into daily inspection, weekly inspection, monthly inspection, biannual inspection, and annual inspection.

The following table lists the necessary maintenance items at each stage. You can designate qualified personnel to carry out various inspection and maintenance operations.



If the robot has been idle for a long time, it is recommended to warm it up at low speed (10% speed) for 30 minutes before resuming operation. Failure to warm up may result in poor lubrication, abnormal noise, and other issues.

Daily inspection and maintenance

Inspection item	Inspection point
Visual inspection	• Check that there is no grease leakage at the gaps between joint modules. • Check that the manipulator has no external defects, and remove any attached dust. • Check that the external cables on the manipulator and any additional cables have no wear.
Operating status check	Check that each joint moves without abnormal noise or vibration.

Inspection item	Inspection point
Check that the screws are not loose.	• Check that the end effector screws are not loose. • Check that the base mounting screws are not loose.
Check that the connectors are not loose.	• Check that the base heavy-duty aviation connector is not loose. • Check that the I/O aviation connector and EtherCAT aviation connector on the end flange are not loose.

Weekly inspection and maintenance

Inspection item	Inspection point
Check that the screws are not loose.	Check that the screws connecting the joint modules are not loose.
Brake inspection	Check that the brake of each joint module operates normally.

Monthly inspection and maintenance

Inspection item	Inspection point
End button inspection	Check that the end buttons can be pressed normally and function properly.
Joint module cable inspection	Check that the internal cables of each joint module are properly connected and have no wear.

Biannual inspection and maintenance

Inspection item	Inspection point
External cable inspection	Check that the trailing cable and power cable between the manipulator and the controller have no breakage, outer sheath corrosion, or other damage.

Annual inspection and maintenance

Inspection item	Inspection point
Reducer screw inspection	Check that the connecting screws of the reducer are not loose.
Repeatability inspection	Use a gauge to measure the repeatability and confirm that it does not exceed the specification.

10.3 Controller Maintenance Guide

Daily inspection

The ambient temperature, humidity, dust, and vibration will age the equipment and thereby reduces its service life. Therefore, it is necessary to carry out routine and regular maintenance. More frequent inspections are required if the drive is used in environments subject to the following conditions:

- High ambient temperature
- Frequent start/stop
- AC power supply or load fluctuation
- Strong vibration or impact
- Dust and hydrochloric acid

Check the following items daily to ensure a proper operation of the device. It is recommended to make a copy of this checklist and sign the "Checked" column after each inspection.

Inspection item	Content	Solution	Checked
Installation environment	Check that the controller and cables are normal.	Check that the mounting bracket has no vibration. Check that the terminals are not loose or corroded.	□
Input Voltage	Input power supply voltage	Check that the input voltage is within the permissible range. Check that no large load is being started around the equipment.	□
No.	Controller connection terminals	Check that terminals such as input, output, and safety I/O are properly seated and the locking latches are locked.	□

Regular inspection

Regularly inspect the areas that are difficult to check during operation. Always keep the controller clean. Effectively remove dust, especially metal dust, from the product surface to prevent it from entering the product.

Inspection item	Content	Solution	1-Month inspection
Cable	Check whether the heavy-load cable and connections are discolored. Check whether the insulation is aged or cracked.	Replace the cracked cable. Replace the damaged terminals.	□
Air duct	Check whether the air filter and heatsink are clogged. Check whether the fan is damaged.	Clean the air vent. Replace the fan.	□

During inspection and maintenance, it is recommended to lock the padlock in place to prevent accidental activation of the controller switch.

The recommended padlock dimensions are shown in the figure below:

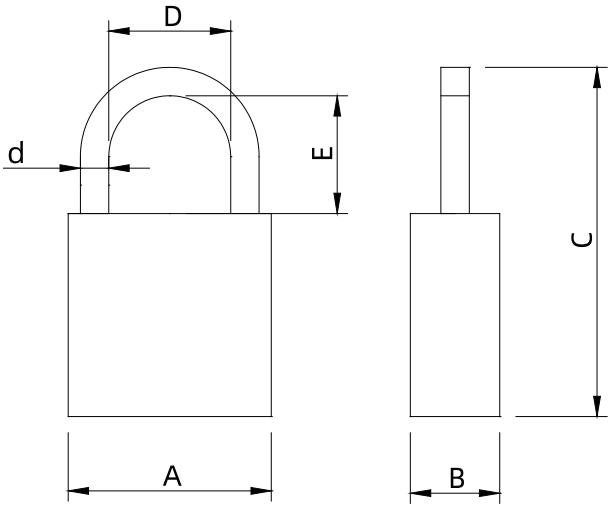


Table 10–1 Padlock dimensions (in mm)

A	B	C	D	E	d
25 to 30	10 to 15	40 to 45	13 to 18	15 to 20	3.5 to 5

10.4 Zero Point Calibration

10.4.1Overview

The zero point is the reference point for the operation of the robot. If any robot joint module is replaced, the robot cannot position properly because a gap exists between the zero point stored in each motor and its corresponding zero point stored in the controller. Therefore, after the parts are replaced, zero point calibration is recommended.

Note

After the calibration, the absolute accuracy of the robot may deviate from the default absolute accuracy at delivery.



- Install a safety fence for the system to prevent people from entering the motion area of the system. Failure to comply may result in serious safety issues.
- Before operation, check that there is no person inside the safety fence. Do not enter the motion area during system running. Failure to comply may result in serious safety issues.
- Operating the robot system in teaching mode can ensure the safety of the operator to a certain extent, although the motion is limited (low speed and low power). However, severe safety issues may also occur when the robot moves unexpectedly.

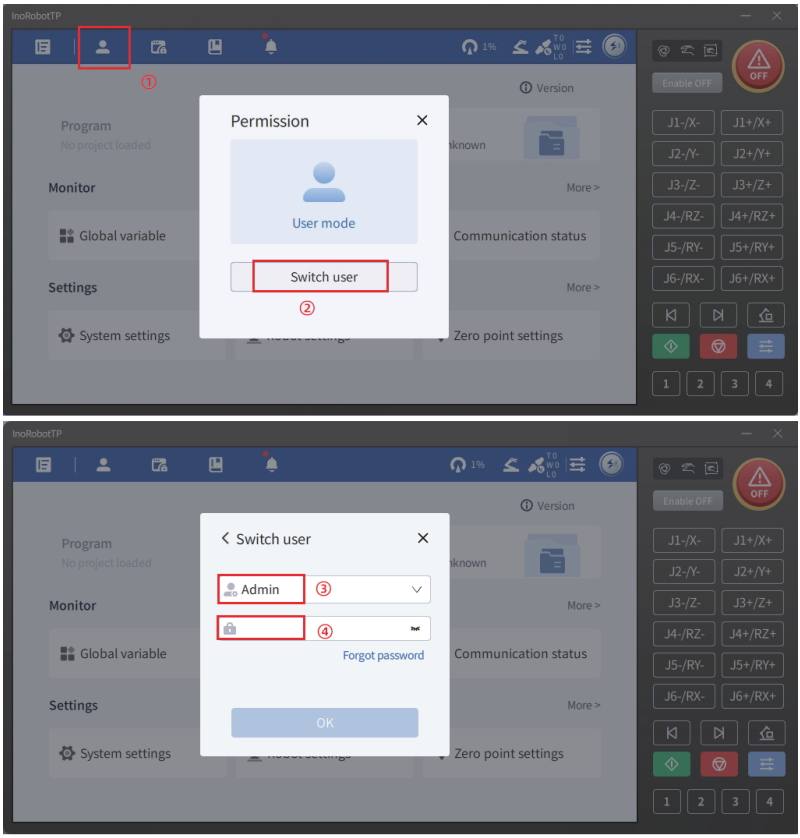
10.4.2Zero Point Calibration of Each Joint

Both the PC-based teach pendant software (InoRobotTP) and the hand-held teach pendant provide an operation interface for zero point calibration. The following describes the zero point calibration operations on the InoRobotTP software. The operations on the hand-held teach pendant are similar.

1. Log in to the user account.
   a. Click the "User" shortcut key on the main interface of the InoRobotTP software or the hand-held teach pendant to open the "User mode" setting interface.
   b. Select the "Admin" mode, enter the password in the password input box,.and click the "OK" button to log in.

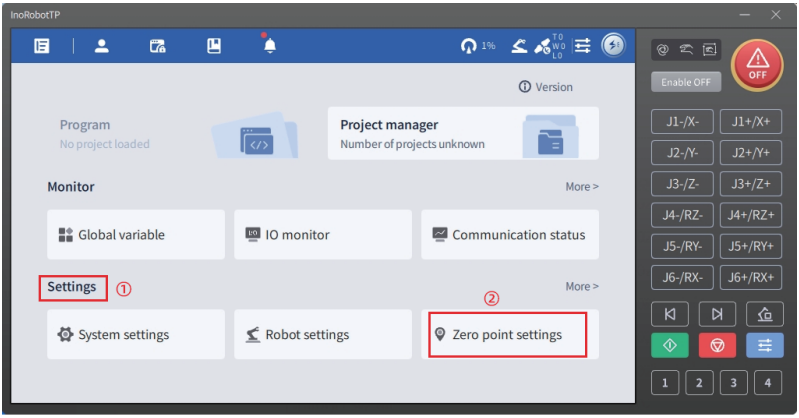
Note

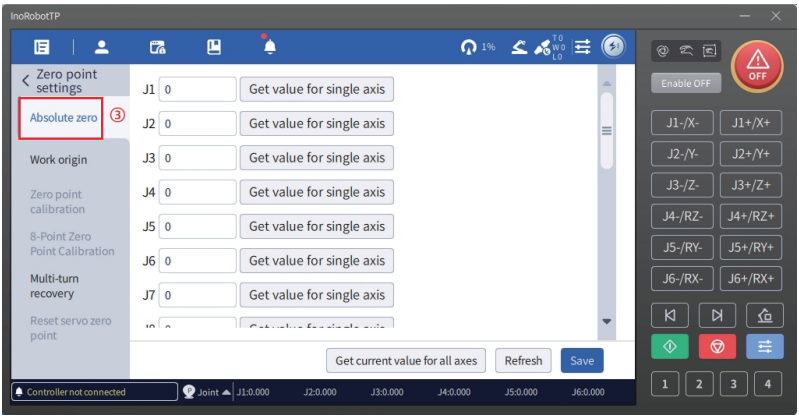
The initial default password for Admin mode is 000000.



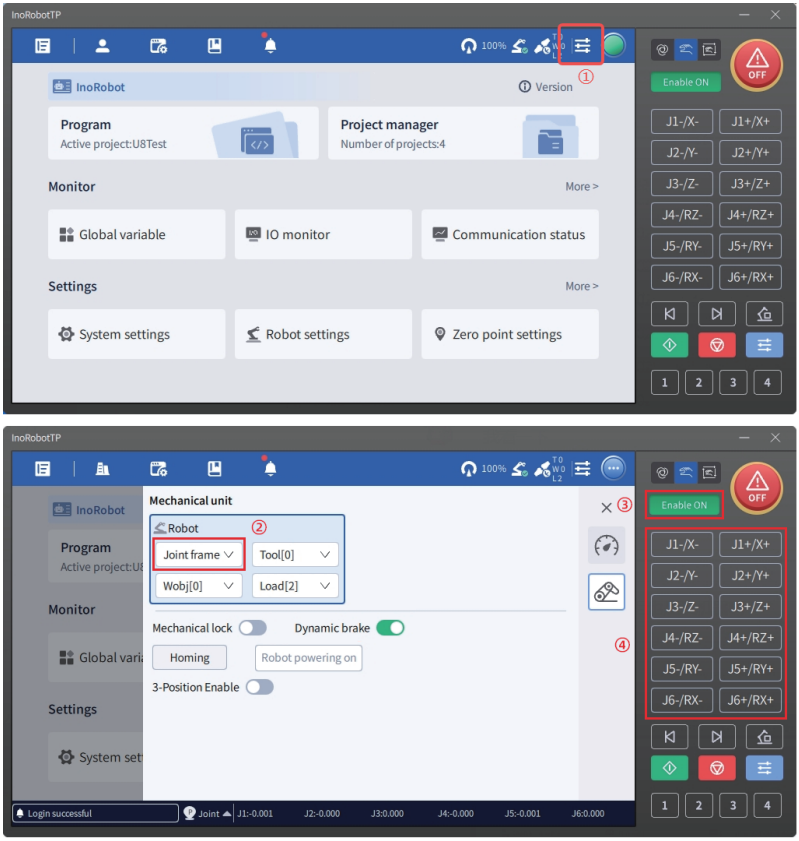
2. Go to the absolute zero setting interface.

   Choose "Settings" > "Zero point settings" > "Absolute zero" on the main interface of the InoRobotTP software or the hand-held teach pendant.





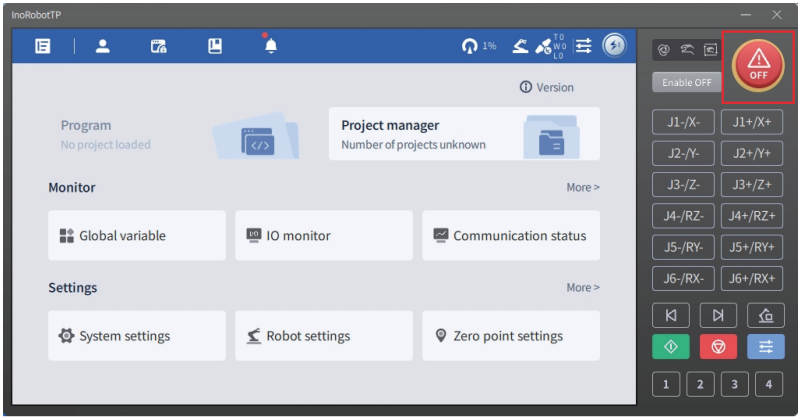
3. Move each joint of the robot to the position near the zero point.
   a. Move the robot close to the zero point by using the joystick on the hand-held teach pendant or by the operation interface of the InoRobotTP software. For details, see the "IR-TP200 Series Industrial Robot Teach Pendant User Guide".
   b. For the zero point position of each joint, see *"10.4.3 Joint Calibration" on page 176*. Calibrate the zero point positions using the calibration tool.



4. Switch to the emergency stop state.

   a. Click the virtual emergency stop button on the InoRobotTP software or press the red emergency stop button on the hand-held teach pendant.

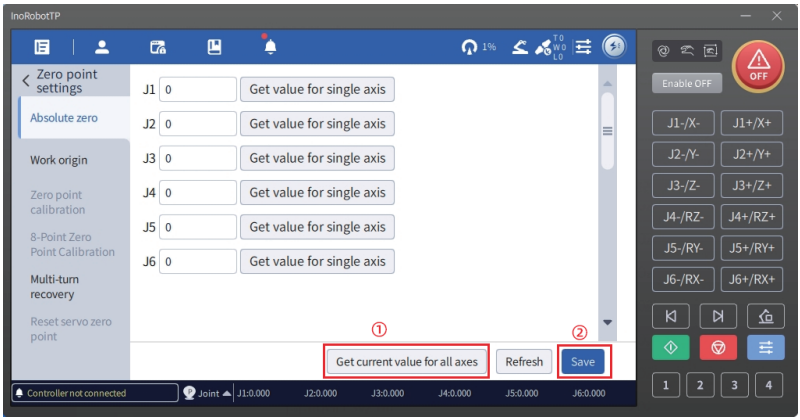
   b. The status indicator on the upper right corner of the InoRobotTP software (or the display of the hand-held teach pendant) shows the emergency stop state (in red).



5. Obtain and save the zero point information.

   a. When the robot is at the zero point position, click the "Get current values for all axes" button to obtain the encoder pulse counts.

   b. Click the "Save" button to complete the zero point calibration.



10.4.3Joint Calibration

Materials	Code	Note
Calibration tool	32024422	The calibration tool is used to calibrate the axes of the robot manually.
	32024423	

The physical view of the calibration tool is shown in the figure below.



Figure 10-1 Calibration tool for J1 to J5



Figure 10-2 Calibration tool for J6

- Calibration of J1 to J6
  Move the robot at the lowest speed by using the teach pendant. Adjust the positions of J1 to J6 until the calibration tool just fits into the reference slot, as shown below.



Figure 10-3 J1 to J5

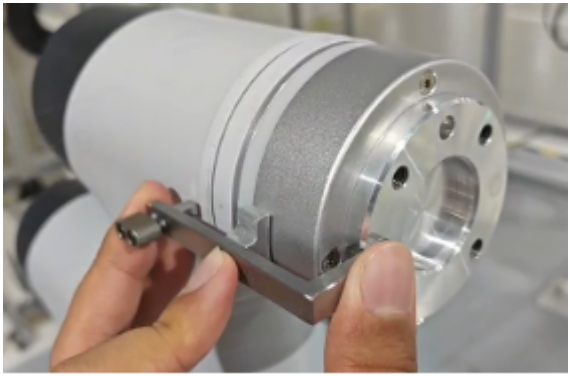
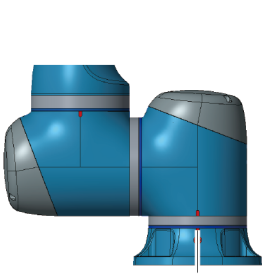
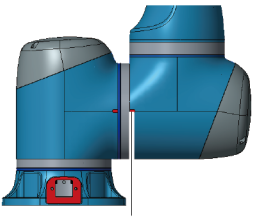


Figure 10-4 J6

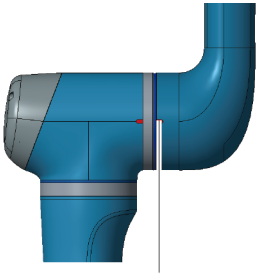
- Zero Point Calibration of Each Joint
  The effect of zero point calibration of each joint is shown in the figures below.



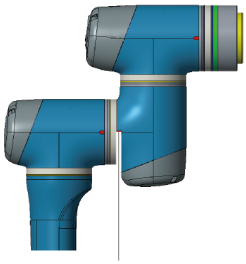
Zero calibration of J1



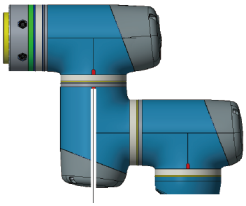
Zero calibration of J2



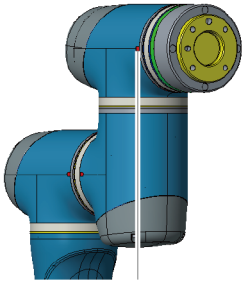
Zero calibration of J3



Zero calibration of J4



Zero calibration of J5



Zero calibration of J6

10.5 Options

Options	Description	Specification	Code
I/O connection cable	For the end I/O aviation connector of the collaborative robot	8-pin, 0.5 m	15051397
EtherCAT connection cable	For the end EtherCAT aviation connector of the collaborative robot	6-pin, 0.5 m	15051400
Hand-held teach pendant	For wired teaching of the robot	IR-TP200	01640048

11 Service and Support

Should you encounter a safety accident during the use or operation of the product, or face challenges in operating and maintaining the equipment, which remain unresolved after the relevant documentation is consulted, we provide multiple channels to ensure prompt resolution:

- Channel #1: Contact service@inovance.com.
- Channel #2: Visit https://www.inovance.com/global to access document downloads, after-sales support, spare parts ordering, repair applications, and authenticity verification services.
- Channel #3: Download My Inovance app (https://zshc-eu.inovance.com/download-pc/) where you can access products info and documentation, and query product parameters.

We are committed to providing you with quick and professional technical support, and we look forward to your satisfaction and trust.

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