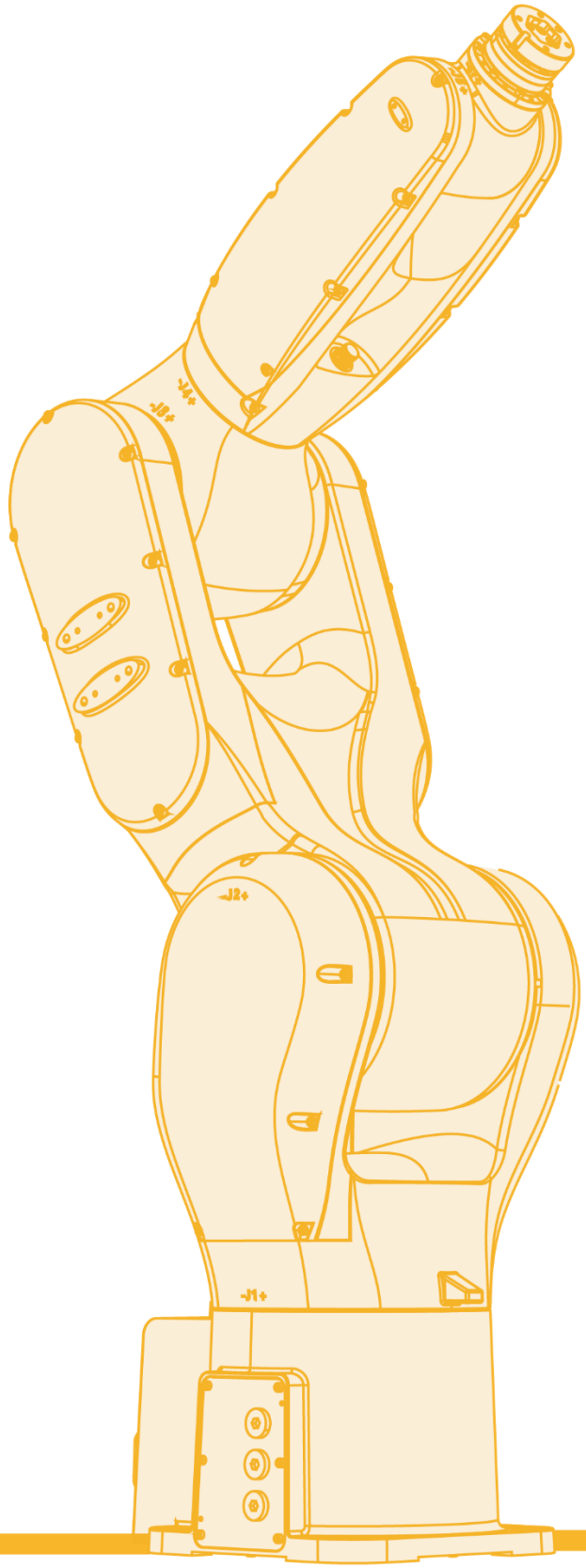
PEITIAN ROBOTICS

AIR15-950 Operation Manual

V1.0.0



Foreword

About this manual

This manual is for technicians to install and use the AIR15-950 industrial robot quickly, correctly, and safely, to be familiar with the relevant precautions, and to perform regular routine maintenance work on the manipulator.

Prerequisites

Before operating the robot, be sure to read the relevant safety instructions and operation instructions of the product carefully. Users must understand the safety knowledge and basic operation knowledge before using the robot.

Please read the following documents when necessary:

- "inCube20 Control Cabinet Manual"
- "AIR-TP teach pendant operation manual"
- "ARL Programming Manual"

Target groups

- Operators
- Product technicians
- Technical service personnel
- Robot teachers

Meaning of common signs

The signs and their meanings in this manual are detailed in Table 1.

Table 1 Signs used in this manual

Sign	Meaning
 Danger	Failure to follow the instructions may result in an accident causing the severe or fatal injury or the great losses of property.
 Warning	Failure to follow the instructions may result in an accident causing the severe or fatal injury or the great losses of property.
 Caution	Prompt for the environmental conditions and important things or shortcuts you shall pay attention to

Sign	Meaning
 Prompt	Prompt for additional literature and instructions for additional information or more detailed operating instructions

Manual description

The contents of this manual are subject to supplementation and modification. Please visit "Download Center" on the website regularly to obtain the latest version of this manual in a timely manner.

Website URL: http://robot.peitian.com/

Revision history

The revision history contains the instructions for each document update. The latest version of the document contains updates to all previous versions of the document.

Table 2 Signs used in this manual

Version	Publication date	Modification description
V1.0.0	2023.02.07	1st official release

Manual Number and Version

The manual-related information is shown in Table 3.

Table 3 Document-related information

Document name	AIR15-950 Operation Manual
Document number	UM-P05310000054-001
Document version	V1.0.0

Declaration of applicable with product standards

The requirements for industrial robot system design are detailed in Table 4.

Table 4 Declaration of applicable safety standards

Standard	Description	Version
2006/42/EC	Machinery directive: Machinery directive 2006/42/EC (new version) issued by European Parliament and Council on May 17, 2006 to modify 95/16/EC	2006
2014/30/EU	Electromagnetic compatibility directive:	2014

Standard	Description	Version
	2014/30/EU directive issued by European Parliament and Council on February 26, 2014 to balance the electromagnetic compatibility regulations of member states	
2014/68/EU	Pressure facility directive: Electromagnetic compatibility directive: 2014/68/EU directive issued by European Parliament and Council on May 15, 2014 to balance the pressure facility regulations of member states (It is only suitable for the robot with hydraulic balance weight)	2014
ISO 13850	Safety of machinery: Emergency stop function - Principles for design	2015
ISO 13849-1	Safety of machinery: Safety-related parts of control systems - Part 1: General principles for design	2015
ISO 12100	Safety of machinery: General principles for design - Risk assessment and risk reduction	2010
ISO 10218-1	Robots and robotic devices - Safety requirements for industrial robots : Part 1: Robots (Prompt: Information is consistent with ANSI/RIAR.15.06-2012, Part 1)	2011
61000-6-2	Electromagnetic compatibility (EMC): Part 6-2: Generic standards - Immunity for industrial environments	2005
61000-6-4 + A1	Electromagnetic compatibility (EMC): Part 6-4: Generic standards - Emission standard for industrial environments	2011
60204-1 + A1	Safety of machinery: Electrical equipment of machines - Part 1: General requirements	2009
IEC 60529	IP rating provided by enclosures (IP Code): This standard applies to the IP rating for the electrical equipment with enclosures and the rated voltage exceeding 72.5kv.	2001

General safety description

Thank you for purchasing our manipulator. This description is required for the safe use of the manipulator. before using the operator, please read the manual carefully and use the manipulator correctly on the premise of understanding it.

For the detailed functions of the manipulator, please fully understand its specifications through the relevant instructions.

Safety considerations

In general, the manipulator cannot be operated by a single operation, and only install the end effector, and the frame functions as the peripheral equipment and the system to perform the operation.

When considering its security, the manipulator should not be considered independently, but should be considered in the system environment.

When using the manipulator, be sure to take corresponding measures to the safety fence.

Warning, caution and prompts

This specification includes matters needing attention to ensure the personal safety of operators and prevent damage to operators. According to their safety importance, they are described as "warning" and "caution" in this paper, and the supplementary instructions are described as "prompts".

Before using the operator, the user must read these "warnings "," cautions" and "prompts ".

 Warning	In the case of an incorrect operation, it is possible to cause death or serious injury to the operator or other operator.
 Caution	If the operation is wrong, it may cause the operator or other operator to slightly injure or damage the equipment.

General considerations

 Warning	■ When connecting or disconnecting related peripheral devices (such as safety fences, etc.) and various signals of the manipulator, be sure to confirm that the manipulator is in a stopped state to avoid incorrect connections. ■ Do not use the operator in the situation shown below. Otherwise, it will not only have a negative impact on operators and peripherals, but also cause casualties. ● Used in flammable environments.

- Used in explosive environments.
- Used in environments where there is a lot of radiation.
- Used in water or in high humidity environments.
- Used for the purpose of transporting people or animals.
- Use as a foot (e.g., on or depending on the operator)

■ Operators who use the operator should wear the safety appliances shown below before carrying out their work.

- Work clothes suitable for the job content
- Safety shoes
- Safety helmet


Prompt

Personnel who carry out programming and maintenance operations must receive appropriate training through the relevant training of the company.

Considerations during installation


Warning

■ When handling and installing the machines, they must be carried out correctly according to the method shown in our manual. If the operation is carried out in the wrong way, it is possible that the operator will be killed or injured due to the overturning of the operator.

■ When using the operator for the first time after installation, be sure to do so at a low speed, and then gradually accelerate the speed and confirm that there are any anomalies.

Matters needing attention in operation


Warning

■ When using the operator, be sure to make sure there are no personnel in the safety fence before carrying out the operation. At the same time, check to see if there is a potential danger, and when it is confirmed that there is a potential danger, be sure to eliminate the danger before carrying out the operation.

■ When using the instruction device, because there may be errors in the operation of wearing gloves, it is important to take off the gloves before carrying out the work.


Prompt

Information such as programs and system variables can be stored in storage media such as memory cards. In order to prevent data loss caused by unexpected accidents, it is recommended that users back up data regularly.

Considerations in programming


Warning

■ When programming, try to do it outside the safety fence, the following matters shall be taken into account when the safety fence needs to be carried out as a last resort:

- Check the safety fence carefully and make sure it is not dangerous before entering the fence.

- The emergency stop button can be pressed at any time.
- The manipulator shall be operated at low speed
- The operation should be carried out after confirming the state of the whole system, so as to avoid the operator falling into a dangerous situation due to the remote control instructions or actions for the peripheral equipment.

- Operators using the machine should wear the following safety equipment before starting the operation:
  - Workwear suitable for job tasks
  - Safety shoes
  - Safety helmet
- When programming, try to do it outside the safety fence. When you need to do it inside the safety fence due to unavoidable circumstances, you should pay attention to the following matters:
  - Check the situation inside the safety fence carefully and make sure there is no danger before entering the fence.
  - You can press the emergency stop button at any time.
  - The manipulator should be run at low speed.
  - Work should be carried out after confirming the status of the entire system to avoid putting workers in danger due to remote control instructions or movements of peripheral equipment.


Caution

After the program is finished, it is important to perform the test operation in accordance with the specified procedure. At this time, the operator must operate outside the safety fence.


Prompt

For operators who are programmed, it is important to receive appropriate training through the company.

Attention should be paid to maintenance work


Warning

- When switching on the power supply, part of the maintenance operation is in danger of electric shock, as far as possible, the maintenance operation should be carried out in the state of power off; professional maintenance personnel should be designated according to the need to carry out maintenance operation; other personnel should be avoided to turn on the power supply when maintaining the operation; even if the power supply must be turned on before the operation can be carried out, the emergency stop button should be pressed and then the operation should be carried out.
- Please consult our company when you need to replace the parts.
- The replacement of parts by the client may result in unexpected accidents, which may cause the operator to be damaged and the operator is injured.
- When entering the security fence, check the whole system carefully and make sure it is not dangerous. If there is a dangerous situation and have to enter the fence, you must grasp the state of the system and be very careful.
- If you need to replace the parts, be sure to use our specified parts. If you use a part other than the specified part, it may cause damage to the operator.

- When removing the motor and brake, the crane hoisting and other measures should be taken to remove the motor and brake, so as to avoid the falling of the manipulator arm.
- When carrying out maintenance operations, when it is necessary to move the operator as a last resort, the following matters should be taken into account:
  - It is important to ensure that the escape channel is smooth and that the operation should be carried out again under the operation of the whole system in order to avoid blockage of the retreat by the operator and peripherals.
  - Always pay attention to the danger around you and be prepared so that you can press the emergency stop button at any time when you need it.
- The auxiliary equipment such as the crane shall be used when the moving motor and the speed reducer and the like have certain weight parts, so as to avoid the excessive work load for the operators. At the same time, it is necessary to avoid the wrong operation, otherwise, the operation and death of the operation may be caused.
- Be careful not to fall because of the lubricating oil that falls on the ground, wipe the lubricating oil that falls on the ground as soon as possible, and eliminate the possible danger.
- Do not place any part of the body on any part of the manipulator during the operation, and it is prohibited to climb on the manipulator, so as to avoid unnecessary personal injury or adverse effect on the manipulator .
- The following parts will be hot and need attention. When you have to touch the equipment when you have to touch it in the event of heat, you should prepare protective appliances such as heat-resistant gloves:
  - Servo motor
  - reducer
  - Adjacent to motor / reducer
  - Inside the control cabinet
- The parts (such as screws, etc.) removed during the replacement of the parts should be correctly loaded back to their original parts, and if the parts are found to be insufficient or surplus, they should be reconfirmed and installed correctly.
- During the maintenance of the pneumatic system and hydraulic system, it is important to release the internal pressure to zero and operate again.
- After replacing the parts, be sure to carry on the test operation according to the prescribed method. At this point, the operator must operate outside the safety fence.
- After the maintenance operation, the grease, debris and water sprinkled on the ground around the operator and inside the safety fence should be thoroughly cleaned.
- When replacing parts, dust and other foreign bodies should be prevented from entering the manipulator.
- Operators who carry out maintenance and repair operations must receive the training of the company and pass the relevant assessment.
- When carrying out maintenance operations, appropriate lighting appliances should be equipped, but care should be taken not to make the lighting appliances a source of new danger.

- Be sure to refer to this specification for regular maintenance, if not regular maintenance, will affect the service life of the operator, and may lead to accidents.

Safety protection measures before use

Before operating the manipulator and peripheral equipment and the manipulator system composed of them, the safety precautions of the operators and the system must be fully studied. Figure 1 is a diagram of the safe work of industrial robots.

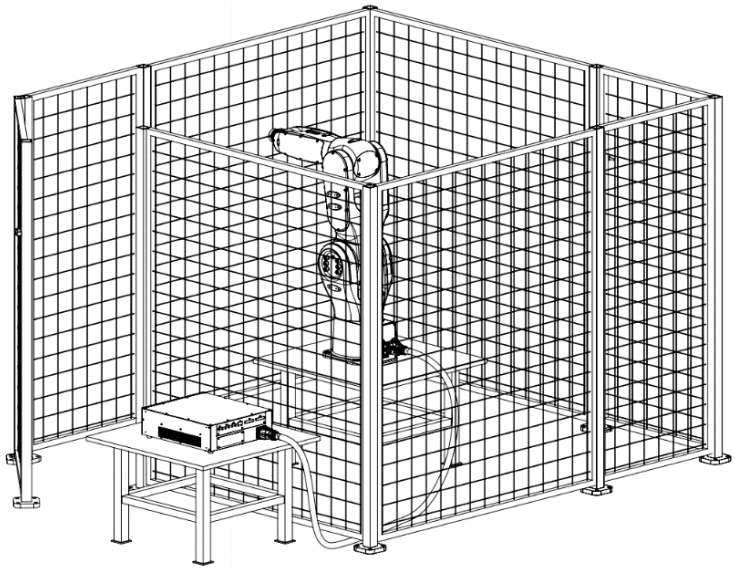


Figure 1 Diagram of safe work of industrial robots

Definition of operating personnel

Manipulator operation personnel consist of operator, teacher and maintenance engineer who shall satisfy the following conditions:

Operator

- Switch on/off the power supply of manipulator.
- Start the manipulator program via the operating panel.
- have no right to operate within the safety barrier

Teacher

- Execute the functions of operator.
- Perform the manipulator teaching, etc. outside the safety barrier.

Maintenance Engineer

- Execute the functions of teacher.
- Perform the maintenance (repair, adjustment, replacement, etc.) of manipulator.

Safety of operation personnel

Operator, teacher and maintenance engineer shall carefully perform the operation, programming and maintenance of manipulator, and shall at least wear the following items:

- Work clothes suitable for task
- Safety shoe
- Helmet

When the auto system is used, be sure to protect the operation personnel. The measures shall be taken to prevent the operation personnel from entering the range of manipulator.

The general precautions are listed below. Please take the appropriate measures to ensure the safety of operation personnel:

- The operation personnel running the manipulator system shall receive the training from the company and pass the relevant assessment.
- While the equipment is running, even if the manipulator seems to have stopped, the manipulator is possibly waiting for the start signal and is about to act. The manipulator shall be regarded as operating at this state. To ensure the safety of operation personnel, it is necessary to confirm that the manipulator is in the operating state via the audible and visual alarms such as the warning lamp
- Be sure to set the safety barrier and safety door around the system so that the operation personnel cannot enter the safety barrier without opening the safety door. The interlock switch, safety pin, etc. shall be set on the safety door so that when the operator opens the safety door, the manipulator will stop.
- Peripheral equipment shall be electrically grounded.
- The peripheral equipment shall be set outside the range of manipulator if possible.
- The range of manipulator shall be clearly marked with the lines on the floor to make the operator understand the range of manipulator including the mechanical arm and other tools.
- A proximity switch or photoelectric switch shall be installed on the floor so that when the operation personnel are about to enter the range of manipulator, the audible and visual alarms such as the buzzer are issued to stop the manipulator, thereby ensuring the safety of operation personnel.
- A lock shall be set to make sure that the manipulator power cannot be turned on except by the operation personnel responsible for the operation.
- Always disconnect the manipulator power when performing the individual commissioning of peripheral equipment.

Safety of operators

Operators are not authorized to perform jobs within the safety barrier:

- Disconnect the power supply of manipulator control cabinet or press the emergency stop button when the manipulator is not operated.

- Operate the manipulator system outside the safety barrier.
- The guard fence and safety door shall be provided to prevent the unrelated personnel from entering the range of manipulator or to prevent operators from entering a hazardous location.
- Emergency stop button shall be set within the reach of operators.


Prompt

Manipulator controller is designed to be connected to an external emergency stop button. With this connection, the manipulator will stop when the external emergency stop button is pressed.

Safety of teachers

In some cases, it is necessary to enter the scope of operation of the operator when carrying out the operation of the manipulator, especially at this time, the safety should be paid attention to:

- If you do not need to enter the operation maneuvering range, be sure to operate outside the operating maneuvering range.
- Before proceeding with the teaching, verify that the manipulator or peripheral equipment is in a safe state.
- If it is inevitable to enter the range of manipulator to conduct the teaching, first confirm the positions and states of safety devices (such as the emergency stop button, emergency automatic stop switching of teach pendant, etc.).
- Teachers shall pay special attention to make other people away from the range of manipulator
- Before starting the manipulator, first confirm that there is no people and no abnormality in the range of manipulator.
- After the teaching is over, be sure to perform the test run following the steps below:

  Step1. At low speed, execute at least one cycle intermittently to confirm no abnormality.

  Step2. At low speed, execute at least one cycle continuously to confirm no abnormality

  Step3. At intermediate speed, execute at least one cycle continuously to confirm no abnormality

  Step4. At operating speed, execute at least one cycle continuously to confirm no abnormality

  Step5. Execute the program in automatic operation mode.

- The teacher must evacuate outside the safety fence when the operator operates automatically.

Safety of repair engineer

To ensure the safety of repair engineer, full attention shall be paid to the following items:

- Never enter the range of manipulator while the manipulator is running.
- Perform the repair operation while the controller is powered off if possible. Main circuit breaker shall be locked to prevent other personnel from turning on the power.
- If it is Inevitable to enter the range of manipulator when it is powered on, you shall first press the emergency stop button of control cabinet or teach pendant. In addition, the operators shall hang the "Repairing" sign to remind other people not to operate the manipulator.
- Before performing a repair, verify that the manipulator or peripheral equipment is in a safe status.
- Do not perform the automatic operation when there is someone in the range of manipulator.
- When working near the walls and appliances, or when several operators are close to each other, be careful not to block the escape routes of other operators.
- When the manipulator is equipped with a tool, and there are movable devices such as conveyor belts in addition to the manipulator, pay attention to the operation of these devices.
- A person who is familiar with the manipulator system and is able to detect the danger shall be assigned next to the operating panel and operating box so that he can press the emergency stop button at any time.
- When replacing or reassembling the parts, be sure to prevent the foreign matters from sticking or entering.
- In case of the repair inside the controller, If the unit, printed circuit board, etc. may be contacted, be sure to disconnect the power supply of main circuit breaker of controller to prevent electric shock.
- Be sure to replace with the parts designated by us.
- When the manipulator system is restarted after the repair operation, it shall be confirmed in advance that there are no people in the range of manipulator, and the manipulator and peripheral equipment are in a normal status.

Safety of peripheral equipment

Precautions in terms of procedures:

- The detection devices such as the limit switch shall be used to detect the dangerous status, and the manipulator shall be stopped as needed according to the signals of detection device.
- In case of abnormalities of other manipulators or peripheral equipment, the measures shall be taken, such as stopping the manipulator, even if there is no abnormality in the manipulator.
- For the system of which the manipulator is operating synchronously with the peripheral equipment, special care shall be taken to avoid the interference with each other.

- The manipulator may be interlocked with peripheral equipment and the manipulator may be stopped if required so as to control the status of all devices in the system from the manipulator.

Mechanical precautions:

- Manipulator system shall be kept clean and the use environments shall be free of grease, water, dust, etc.
- Do not use the cutting fluids and cleaning agents of unknown nature.
- Limit switches and mechanical brakes shall be used to limit the operation of manipulator to avoid the collisions between the manipulator and peripheral equipment.
- User cables and hoses shall not be added to the manipulator.
- When installing the cable outside the manipulator, do not interfere with the movement of machine.
- For the models of which the cable is exposed, do not conduct the modification that will interfere with the exposed part of cable.
- When installing the external device on the manipulator, be sure not to interfere with other parts of manipulator.
- For the manipulator in action, the frequent power-off operation via the emergency stop button may lead to the fault of manipulator.

Mechanical safety of manipulator

Precautions for operation:

When the manipulator is operated in slow feed mode, the operators shall be highly vigilant regardless of the circumstances and quickly respond to various problems.

Precautions in terms of procedures:

If the ranges of multiple manipulators overlap, care shall be taken to avoid the interference between manipulators.

Be sure to specify an operation origin for the manipulator program and create a program that starts and ends at the origin, so that it is clear from the outside whether the manipulator operation has ended.

Mechanism precautions:

The working environments of manipulator shall be kept clean and free of grease, water, dust, etc.

Safety of end effector

When controlling various types of transmissions (pneumatic, hydraulic, and electrical), after issuing the control command, be sure to fully consider the time difference from the issuance to the actual action and conduct the control with certain room of extension and retraction.

A detection unit shall be set on the end effector to monitor the status of end effector and control the action of manipulator.

Contents

1 Overview and basic composition of manipulator

1.1 Overview of industrial robot

Industrial robot consists of the following parts is as shown in Figure 1-1:

- Manipulator
- Control cabinet
- Teach pendant
- Connecting [power supply] cable, etc.

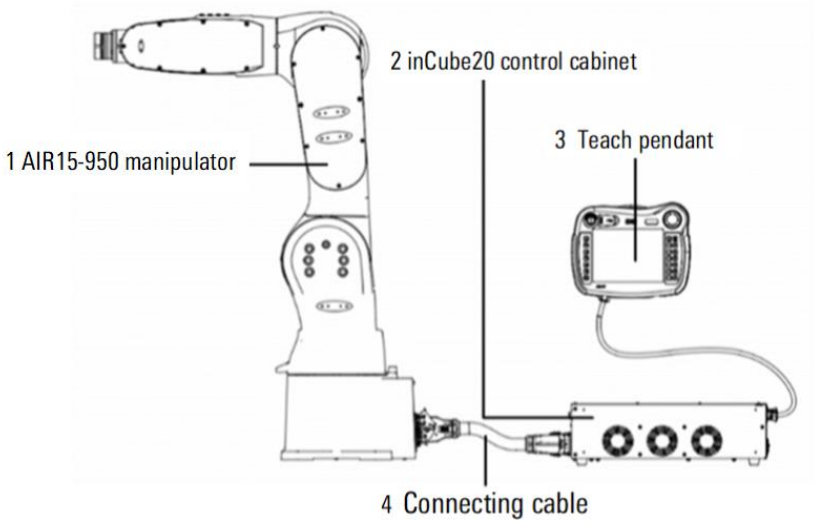


Figure 1-1 Composition of AIR15-950 robot system

1.2 Basic composition

Manipulator refers to the mechanism of robot system to grab or move the objects (tools or workpieces), also known as the robot body. This manipulator is the 6-DOF tandem industrial robot that consists of three swing axes and three rotating axes.

The robot manipulator and the names of its various parts are as shown in Figure 1-2.

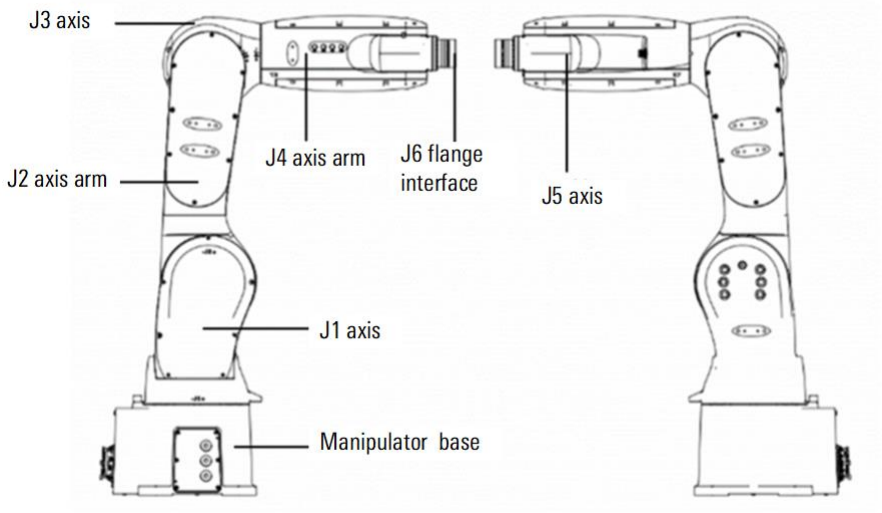


Figure 1-2 Robot body and its various parts

1.3 Basic specifications

The basic specifications of manipulator are as shown in Table 1-1:

Table 1-1 Basic specifications of robot

Model		AIR15-950	AIR15-950/3	AIR15-950/4
Number of axes		6	3	4
Coordinate form		6-DOF articulated robot	3-DOF articulated robot	4-DOF articulated robot
Number of control axes		6 axes (J1,J2,J3,J4,J5,J6)	3 axes (J2,J3,J5)	4 axes (J2,J3,J5,J6)
Range (Upper limit / lower limit)	J1*	-170°~170°	-	-
	J2	-100°~135°	-100° ~135°	-100° ~135°
	J3	-120°~156°	-120° ~156°	-120° ~156°
	J4	-200°~200°	-	-
	J5	-135°~135°	-135° ~135°	-135° ~135°
	J6	-360°~360°	-	-360° ~360°
Max speed	J1	310° /s	-	-
	J2	320° /s	320° /s	320° /s
	J3	350° /s	350° /s	350° /s
	J4	490° /s	-	-
	J5	565° /s	565° /s	565° /s
	J6	815° /s	-	815° /s
Repeated positioning accuracy		± 0.035mm	± 0.025mm	± 0.025mm
Robot weight		83.5kg	71kg	73kg

Model		AIR15-950	AIR15-950/3	AIR15-950/4
Installation method		Ground installation, wall installation and inverted installation		
Drive mode		Electrical servo drive with AC servo motor		
Transport capacity	Wrist + elbow	15kg		
Noise		70dB		
IP rating		Default IP65, optional IP67/ISO 5* Caution For ISO 5 version, please contact sales.		
Mounting conditions		■ Ambient temperature: 0°C~45°C ■ Humidity: not more than 95% at constant temperature without condensation ■ Allowable altitude: not more than 1,000m above sea level ■ No corrosive, flammable or explosive gases		

Caution " * " If the mechanical limit of J1 axle is removed, the range may reach -180° to 180°.

1.4 Product naming rules

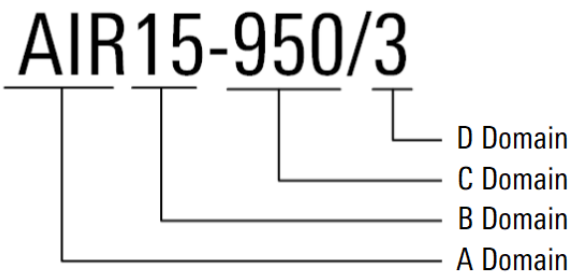


Figure 1-3 Diagram of product naming rules

Table 1-2 Description of product naming rules

Domain	Meaning	Domain value	Explanation
Domain A	Product range	AIR	It means that this product belongs to the product series of Peitian AIR
Domain B	Wrist load	15	Indicates that the wrist load of the robot does not exceed 15kg
Domain C	Arm extension	950	Indicates the arm extension of the robot is 950mm
Domain D	Number of special axes	3	Indicates that the number of control axes is 3

1.5 Environmental requirements for operation

See Table 1-3 for the service environment requirements.

Table 1-3 Operating environment requirements

Parameter	Explanation	
Temperature	Minimum temperature	0℃
	Maximum temperature	45℃
	 Caution	When the ambient temperature is lower than 10℃, it is recommended to heat up the engine for a few minutes before use to avoid robot alarm or performance degradation caused by the change of grease viscosity
Humidity	The installation environment of the manipulator shall not exceed the humidity level not higher than 95% specified in the document "IEC 60721-3-3-2002 classification of environmental conditions"	
Altitude	The altitude of the normal working environment of the manipulator shall not exceed 1000m. Within the altitude range of 1000m-4000m, the manipulator shall be derated for use	
Vibration strength	The robot operator shall be used in an environment without vibration as far as possible. The limit frequency of environmental vibration is 22Hz and the amplitude shall not exceed 0.15mm	
Special environmental requirements	It is forbidden to use this machine in flammable, explosive and corrosive environment	

2 The label name and meaning

2.1 Safety sign of manipulator

A manipulator safety label shall be pasted on the back of the upper arm of the manipulator. As shown in Figure 2-1.

Figure 2-1 "No Approaching" sign of manipulator

It is so easy or may cause unnecessary personal injury and even death if you do not comply with this regulation!

2.2 Manipulator nameplate

The nameplate of the manipulator can be seen on the base of the manipulator. The nameplate contains the corresponding model, version number, weight, serial number, production date and other information. As shown in Figure 2-2.

Figure 2-2 Robot nameplate

2.3 Direction sign of each axis

"+" or "-" sign is provided at the rotating or swinging joints of axes 1~6 of manipulator as shown in Figure 2-3 to indicate the moving direction of each axis. "J1" in sign represents the axis 1 (other axes are represented by the corresponding numbers), "+" indicates the positive direction, and "-" indicates the negative direction.

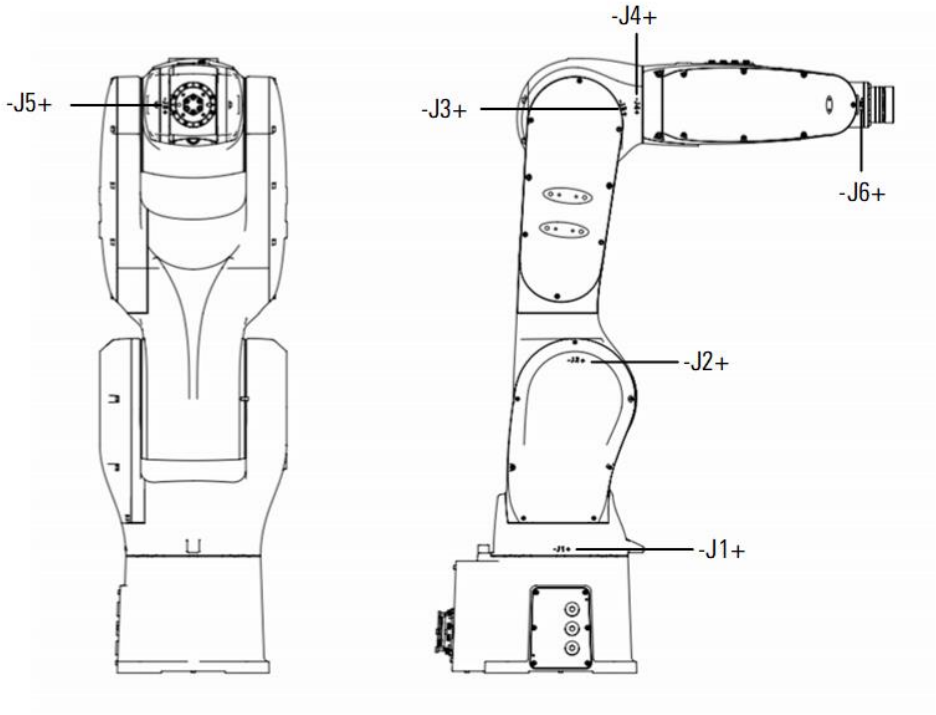


Figure 2-3 Direction sign of each axis on manipulator

3 Preparation before installation

3.1 Check item

Following requirements shall be strictly adhered to before installation:

- Ensure that the installers pass the relevant training of company and perform the installation according to the international and local laws and regulations.
- After the unpacking, make sure that the product is not bumped or damaged
- Make sure that the carrier bracket, swinging ring screws, etc. are installed to the manipulator as required.
- Make sure the installation environments are as required by Chapter1.4.
- Make sure that the installation site can withstand the pressure or pull from the manipulator and its load.

3.2 Installation tool and required connectors

The following tools may be required to install the manipulator (more tools may be required, depending on the installation method).

- A set of Internal hexagonal wrench;
- Adjustable wrench;
- Torque wrenches of different specifications, etc.

The following connectors may be required to install the manipulator (more connectors may be required, depending on the installation method).

- Several M12 screws with appropriate length and strength grade 12.9 or other hexagonal head cap screws;
- A number of chemical bolts of appropriate length and strength grade not less than 4.8;
- Several spring pads of Φ12 or other specifications;
- Several round pins (Φ 8mm). Please see Chapter4.2 in this manual for details.

4 Installation of manipulator

4.1 Technical specifications

When installing the manipulator, the strength of the foundation installation surface shall be fully considered. In addition, the inclination of the installation ground of the manipulator shall be less than 5°.

The size of the manipulator base is shown in Figure 4-1. Among them, M16 threaded hole can be used as a through hole for installing M12 screw, M5 threaded hole can be used for connecting equipment grounding cable, and can be used if high-precision positioning is required Φ8H8 pin hole is used as locating hole.

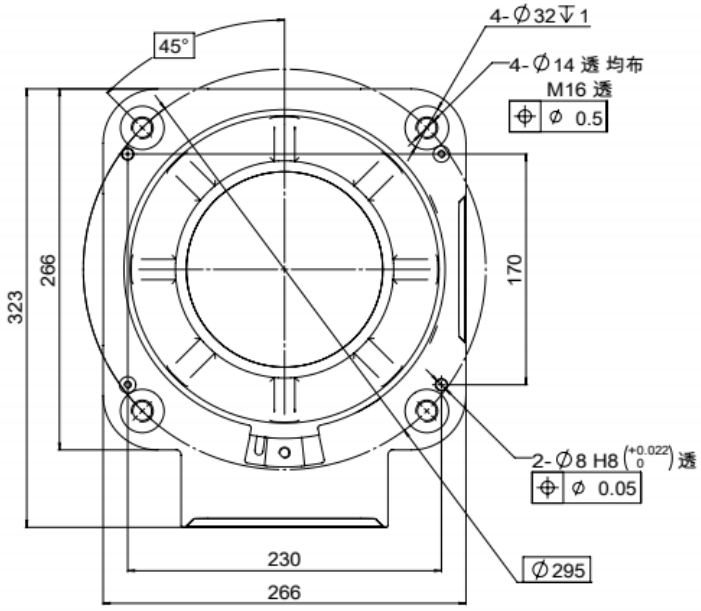


Figure 4-1 Manipulator base interface size

4.2 Fixed mode

The AIR15-950 manipulator provides two fixing methods: ground fixing and bracket fixing.

Prompt

- Specific fixing mode depends on the usage environments.
- Strength of chemical bolt is subject to the strength of concrete. Therefore, the safety shall be fully considered according to the design guidelines of manufacturer before the construction.

The names and specifications of parts required to fix the manipulator are as shown in Table 4-1.

Table 4-1 Parts required for fixing the manipulator

Part Name	Remarks	Ground fixing	Bracket fixing
Fixing screw	Four M12x40 (Grade 12.9)	○	○
Chemical bolt	Four M20 (not less than Grade 4.8)	○	
Fixing plate of robot	20mm thick, 1 piece	○	

Part Name	Remarks	Ground fixing	Bracket fixing
Mounting bracket	20mm thick		○

Prompt

- There shall be no insulating materials between the fixing plate and mounting bracket of robot and the manipulator and concrete.
- Mark "○" means that the part is in need.
- Bracket shall be firmly installed on the ground with the strength not less than the fixing strength between the fixing plate of robot and the ground for the ground fixing (mode 1).

Ground fixing

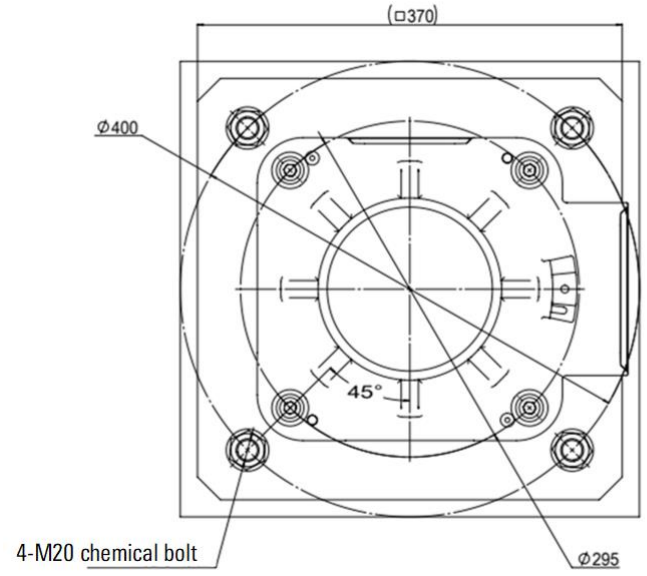
Fixing steps:

Step1. According to the recommended size shown in Figure 4-2, M20 chemical bolts (strength grade not less than 4.8) shall be arranged on the concrete foundation. Please strictly follow the instructions for the use of the selected chemical bolts;

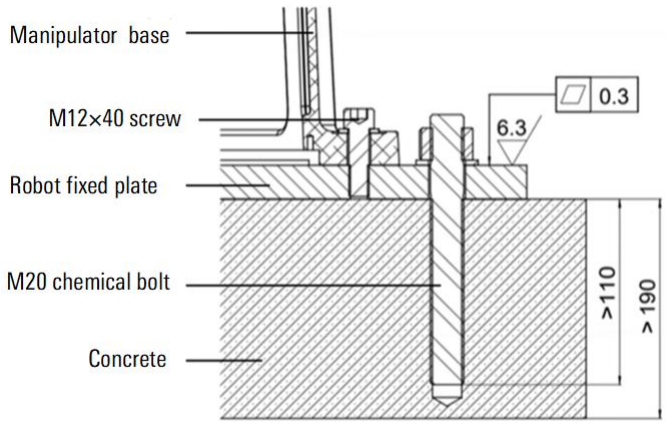
Step2. Put the robot fixed plate close to the installation plane, and then fix it with four M20 hexagon nuts (strength grade not less than 4.8) and M20 flat washers after it is placed firmly;

Step3. In the handling posture, transfer the manipulator to the upper part of the robot fixed plate, adjust the direction of the manipulator to align the M16 threaded hole position of the base with the M12 threaded hole position of the robot fixed plate;

Step4. Check whether the base is closely connected with the fixed plate without shaking. Fix the base of the manipulator on the fixed plate with four M12x40 screws (strength grade 12.9).



(a) Layout size



(b) Sectional drawing

Figure 4-2 Diagram of ground fixation

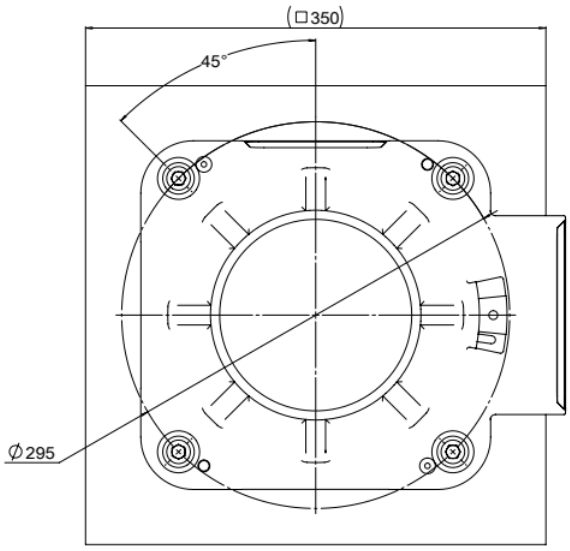
Prompt	Fixing plate surface shall meet certain roughness and flatness requirements as detailed in Figure 4-2.

Bracket fixing

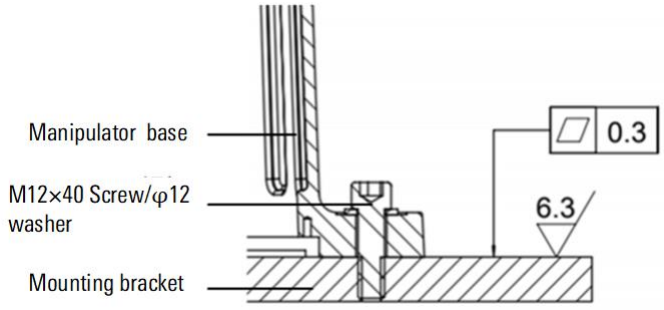
Fixing steps:

Step1. In the handling posture, transfer the manipulator to the upper part of the mounting bracket, adjust the direction of the manipulator to align the M16 threaded hole position of the base with the M12 threaded hole position of the mounting bracket;

Step2. Check whether the base is closely fitted to the surface of the mounting bracket without shaking, and use four M12x40 screws (strength grade 12.9) and φ12 washer, fix the manipulator base on the bracket.



(a) Layout size



(b) Sectional drawing

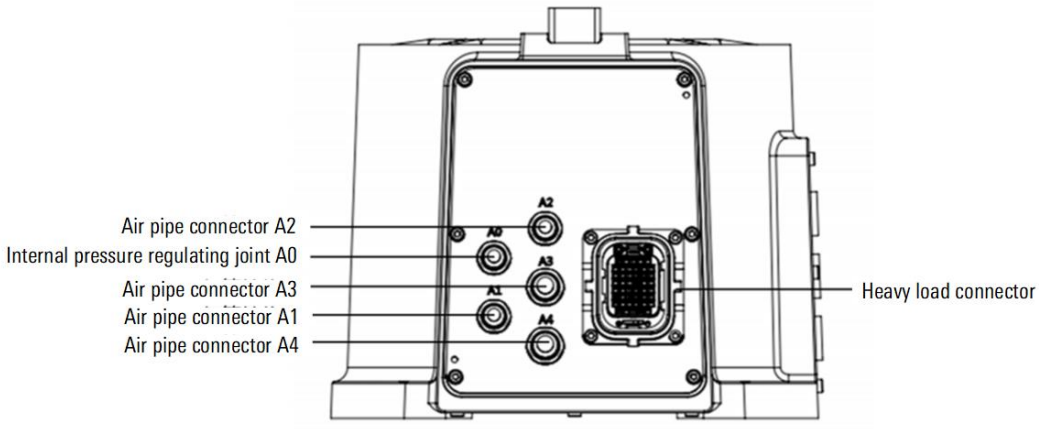
Figure 4-3 Bracket fixing diagram

Prompt	Mounting surface of bracket shall meet certain flatness requirements as shown in Figure 4-3.
Warning	■ Fixing screw M12 of manipulator shall not be shorter than 35mm, and the insufficient length will cause the poor fixing and other accidents. ■ When installing the manipulator ceiling, the length of fixing screws for manipulator shall be increased to 40mm and the thickness of mounting plate shall be not less than 25mm.

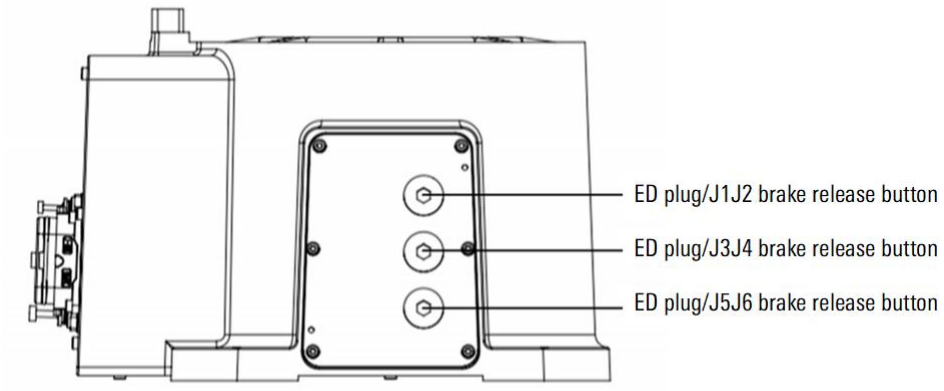
5 Electrical connection of the manipulator

5.1 Manipulator electrical interface type

The base of the AIR15-950 manipulator has heavy-duty connector, gas pipe connector and manual brake release button. As shown in Figure 5-1(a), the right side has a heavy-duty connector, and the left side has three ϕ6 and two ϕ8 quick gas pipe connectors, where A0, A1 and A2 are ϕ6 air pipe connectors, A3 and A4 are ϕ8 air pipe connectors. The air pipe connector can be directly inserted into the air pipe after pulling out the blind plug; As shown in Figure 5-1 (b), there are three manual brake release buttons inside the ED plug.



(a) Rear view



(b)Left view

Figure 5-1 Electrical interface of manipulator base

> **Caution**
>
> When the internal pressure regulating joint A0 is used to adjust the internal pressure of the manipulator, the internal and external pressure difference shall not exceed 0.02MPa, and the internal pressure shall not be less than the external pressure, otherwise the sealing parts may be damaged.

Operating steps for manual brake release:

Step1. To prevent the axis from falling due to gravity when the brake is released, the manipulator needs to be fixed;

Step2. Use a wrench to remove the ED plug on the base to see the brake release button inside the base;

Step3. Connect the manipulator with the control cabinet, and connect the control cabinet with the power supply. See Chapter 6.2 of this manual for specific operation;

Step4. Press and hold the brake release button to release the brakes on the six axes of the manipulator.

Caution

After performing the manual brake release operation, reinstall the ED plug on the base of the manipulator to prevent dust or liquid from entering the inside of the manipulator.

There are aviation sockets (forearm IO interface) on the forearm of the AIR15-950 manipulator and the air circuit directly connected with the base air pipe connector. The specific location is shown in Figure 5-2. The straight-through gas path is blocked by the plug. If it is necessary to use it, unscrew the plug and connect the appropriate air pipe connector.

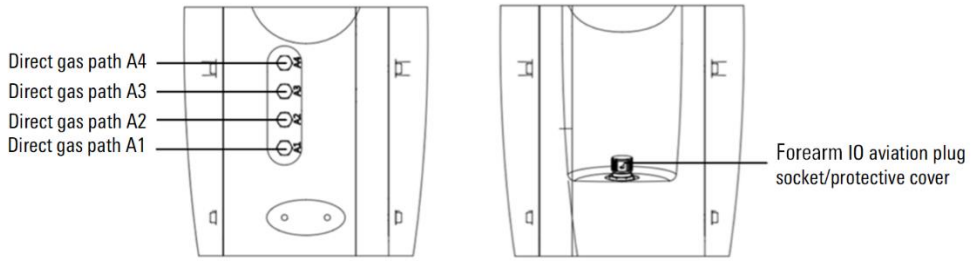


Figure 5-2 Interface of manipulator forearm

Caution

- The forearm IO interface (HRS/LF10WBRB-12P) of the AIR15-950 manipulator is equipped with a waterproof and dustproof cover. When the interface is not used, please do not unscrew the cover to prevent dust or liquid from entering the inside of the manipulator.
- If you need to use the forearm IO interface, please select the corresponding optional HRS/LF10WBPD-12S aviation plug. For specific installation and use methods, please refer to the detailed description of the corresponding model on the official website: www.hirose.com.

5.2 Definition of manipulator's heavy load and aviation insertion interface

The heavy-load interface of the manipulator is shown in Figure 5-3, and the definition of heavy-load interface is shown in Table 5-1, Table 5-2 and Table 5-3:

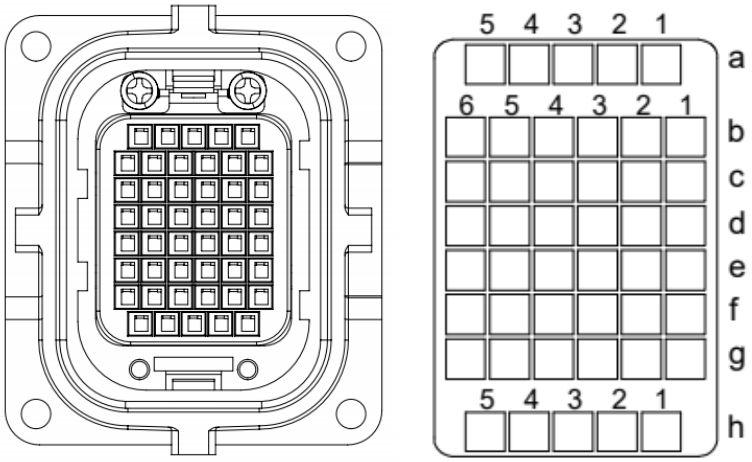


Figure 5-3 Manipulator heavy load interface

Table 5-1 Definition of manipulator heavy load interface (power line part)

Signal name	Axis number	Pin number	Signal name	Axis number	Pin number
U1	1 axis	1f	U4	4 axis	5f
V1	1 axis	1g	V4	4 axis	5g
W1	1 axis	1h	W4	4 axis	5h
PE	1 axis	1d	PE	4 axis	4d
U2	2 axis	4f	U5	5 axis	3f
V2	2 axis	4g	V5	5 axis	3g
W2	2 axis	4h	W5	5 axis	3h
PE	2 axis	4d	PE	5 axis	1d
U3	3 axis	2f	U6	6 axis	5e
V3	3 axis	2g	V6	6 axis	6f
W3	3 axis	2h	W6	6 axis	6g
PE	3 axis	1d	PE	6 axis	4d

Table 5-2 Manipulator heavy-load interface definition (encoder line part)

Signal name	Axis number	Pin number	Signal name	Axis number	Pin number
J1_PS+	1 axis	1a	J4_PS+	4 axis	4a
J1_PS-	1 axis	1b	J4_PS-	4 axis	4b
J2_PS+	2 axis	2a	J5_PS+	5 axis	5a
J2_PS-	2 axis	2b	J5_PS-	5 axis	5b
J3_PS+	3 axis	3a	J6_PS+	6 axis	6b
J3_PS-	3 axis	3b	J6_PS-	6 axis	6c
Coder 0V	1-6 axis	1c	Coder 24V	1-6 axis	2c

Table 5-3 Manipulator heavy-load interface definition (ENP part)

Signal name	Axis number	Pin number
24V_BR+	1-6 axis	3e
24V_BR+2_0	1-6 axis	2e
GND_24VBR	1-6 axis	1e
E_NAME_BOARD_RS485_A	-	4c
E_NAME_BOARD_RS485_B	-	3c

Prompt

When the robot is connected to the control cabinet, either end of the heavy load cable can be connected to the manipulator or the control cabinet.

The IO interfaces of the forearm of the AIR15-950 manipulator are shown in Figure 5-4, and the relevant description of each interface is shown in Table 5-4.

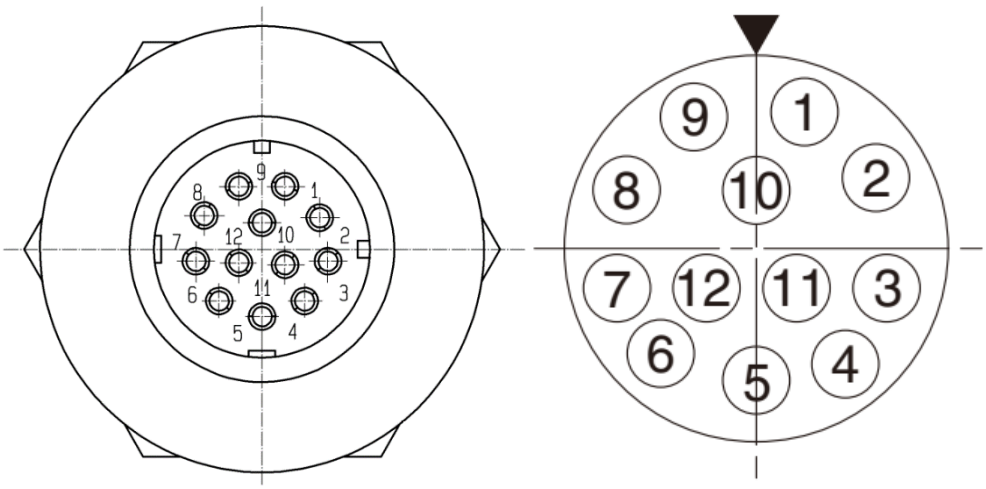


Figure 5-4 Manipulator forearm IO interface

Table 5-4 Manipulator forearm IO interface definition

Signal name	Connector number
24V	8
GND	9
DO0	6
DO1	7
DO2	10
DO3	11
DO4	12
DI0	1

Signal name	Connector number
DI1	2
DI2	3
DI3	4
DI4	5

6 Adaptation and connection of the manipulator and accessories

6.1 Examples of accessory types

The accessory equipment of the manipulator mainly includes mechanical grab (Figure 6-1), hydraulic pressure sucker (Figure 6-2), welding gun welder (Figure 6-3), infrared identification equipment, visual identification equipment, cutting machine, other special equipment, etc. The connection between the external auxiliary equipment of the manipulator and the manipulator is similar to the connection between the load and the manipulator. It can be directly or indirectly connected to the manipulator through the flange. See Chapter7.7 of this manual for details.

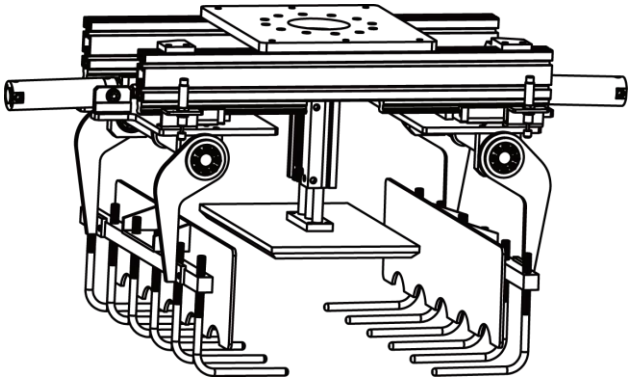


Figure 6-1 Industrial robot grab

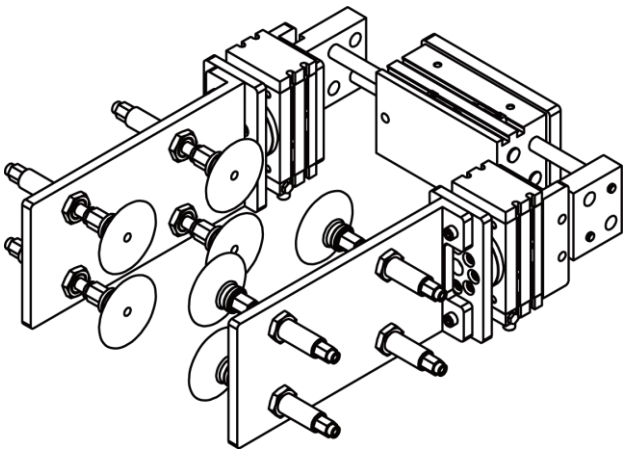


Figure 6-2 Suction cups for industrial robots

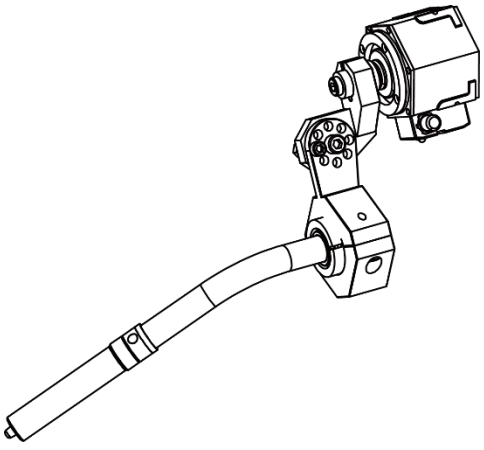


Figure 6-3 Arc welding gun for industrial robot

6.2 Connection between manipulator and control cabinet

The manipulator is connected to the control cabinet through a cable (i.e., heavy-load wire). The control cabinet and its interface are shown in Figure 6-4 below. The definition of heavy-load wire connector is described in Chapter 5.1 of this manual. The heavy-load wire does not distinguish between the manipulator end and the control cabinet end (see Figure 6-5). For more detailed information, please refer to the corresponding manual of the electrical part.

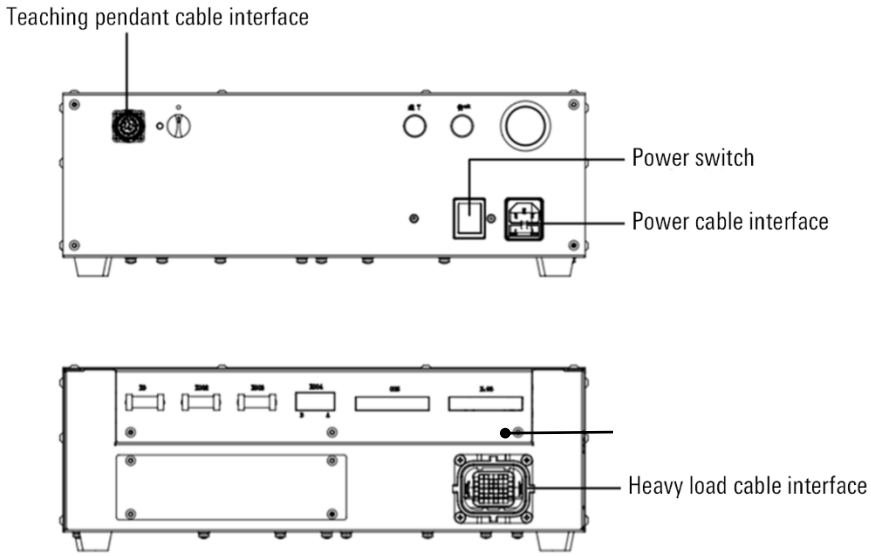


Figure 6-4 Diagram of control cabinet

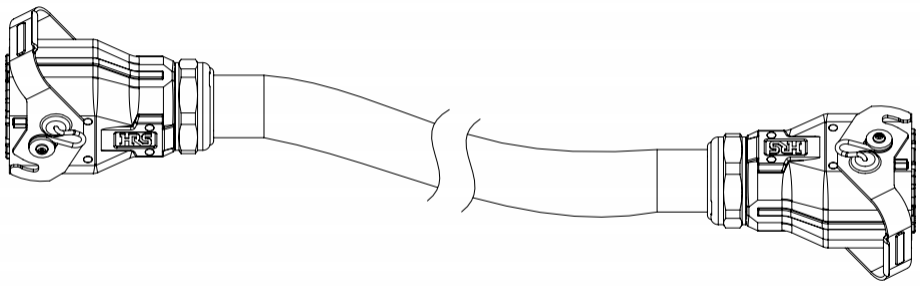


Figure 6-5 Diagram of heavy load line

Fixing steps:

Step1. Connect the manipulator, insert the plug at one end of the heavy-load line into the connection port of the manipulator's heavy-load line (see Figure 6-6), and fasten the lock;

Step2. Connect the control cabinet, insert the plug at one end of the heavy load line into the connection port of the heavy load line of the control cabinet (see Figure 6-7), and fasten the lock.

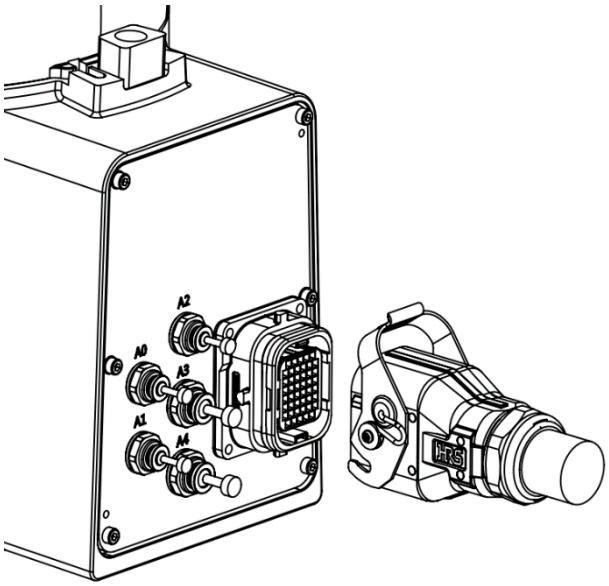


Figure 6-6 Manipulator side heavy load line connection interface

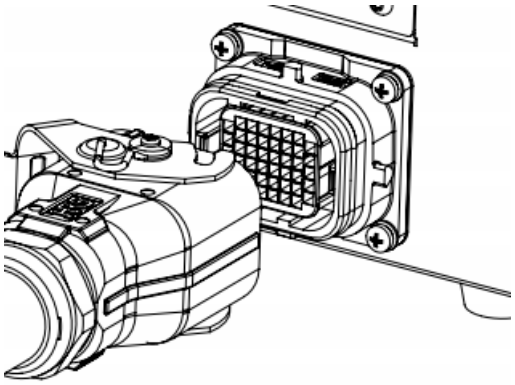


Figure 6-7 Control cabinet side heavy load line connection interface

7 Performance parameters of the manipulator

7.1 Basic specification

See Chapter1.3 Basic Specifications of this manual for the basic specifications of manipulator.

7.2 Movement direction of each axis

For the 6-DOF industrial robot manipulator, its motion direction is defined as shown in Figure 7-1.

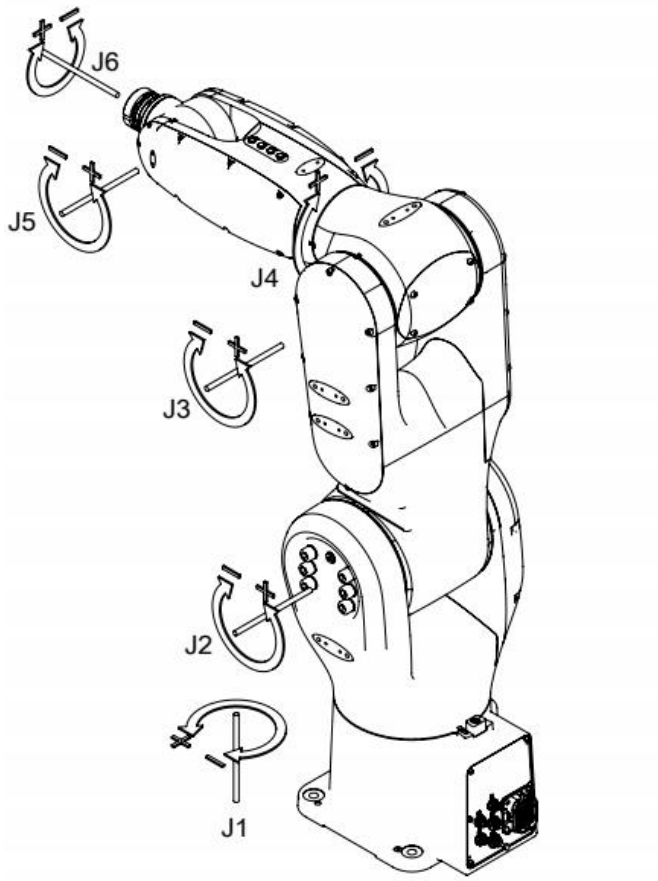


Figure 7-1 Movement direction of each axis of the manipulator

7.3 Dimension and working range of each axis

The motion range of each axis of the manipulator is shown in Table 7-1 as follows.

Table 7-1 Motion range of each axis of the manipulator

Axis number	Range of motion (°)
J1*	-170~+170
J2	-100~+135

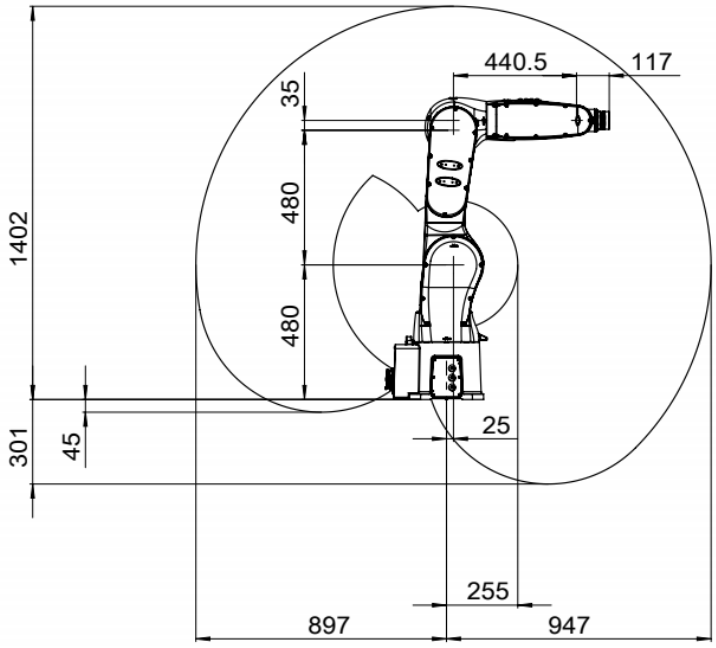
Axis number	Range of motion (°)
J3	-120~+156
J4	-200~+200
J5	-135~+135
J6	-360~+360

Prompt

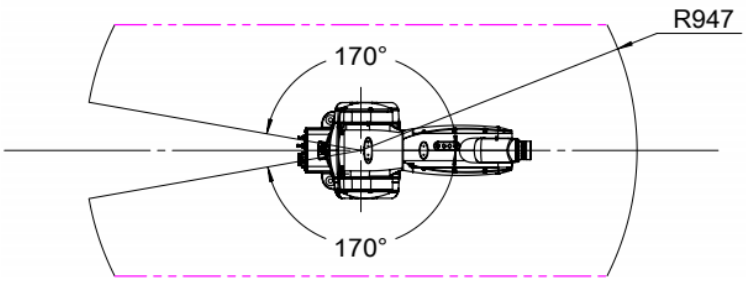
"*": If the mechanical limit of J1 axis is removed, the movement range can reach - 180 °~180 °.

The operating range diagram of the manipulator is shown in Figure 7-2.

When installing peripheral equipment, attention should be paid to avoid interference with the main body and the range of motion of the robot, unit: mm.



(a) Lateral view



(b) Vertical view

Figure 7-2 Operating range of the manipulator

7.4 Mechanical limit

Zero point and movable range are respectively set on each axis. As long as the origin position is not lost due to servo system abnormality and system error, the robot is controlled to move within the movable range. In addition, in order to further ensure safety, mechanical brakes are provided on 1 axis to limit the movable range.

Figure 7-3 shows the position of mechanical brake.

Do not modify the mechanical brake, otherwise the robot may not stop normally.

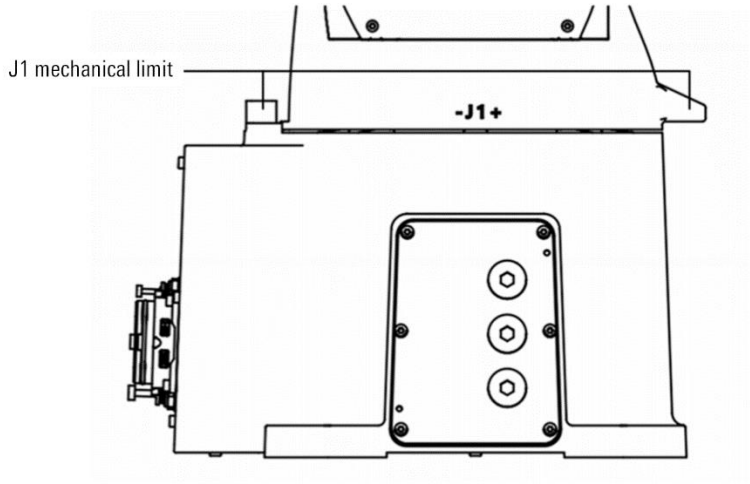


Figure 7-3 Mechanical brake on the manipulator

7.5 Speed of each axis

The maximum angular speed of each axis of the manipulator is shown in Table 7-2.

Table 7-2 Maximum angular speed of each axis of the manipulator

Axis number	Maximum angular velocity(°/s)
J1	310
J2	320
J3	350
J4	490
J5	565
J6	815

7.6 Output flange size

The Table 7-3 and Figure 7-4 show output flange specification and connection size. Tightening torque of screws is shown in Appendix B.

Table 7-3 Specification of output mechanical interface of manipulator

Parameter	Value
Locating circle diameter	31.5mm or 63mm
Diameter of graduation circle of threaded hole	50mm
Screw grade	12.9 grade
Screw diameter	M6
Screw quantity	4
Locating pin	6mm
Screw standard	GB/T 70.1-2000

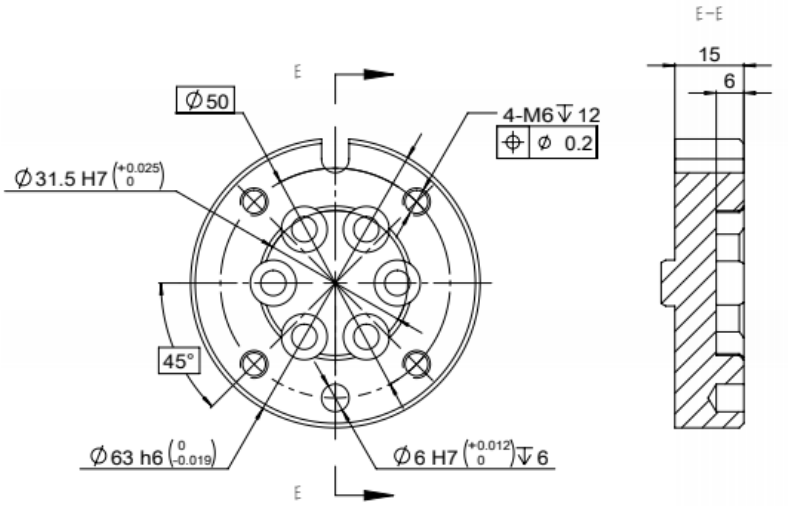


Figure 7-4 The flange dimension diagram of wrist

Warning

When installing the fixture, the depth of the threaded hole and pin hole shall be fully considered for the screws and locating pins used. It is forbidden to install the length beyond the depth of the threaded hole (12mm) and the depth of the pin hole (6mm), otherwise the wrist of the manipulator will be damaged.

7.7 Load and installation method

Calculation method of inertia moment

Inertia moment refers to the difficulty of rotation of the load (clamp end + workpiece) when the robot joint starts to rotate (inertia). The moment of inertia increases with the weight of the load and eccentricity. Since this will also increase the load on the joints, please ensure that the inertia moment is within the allowable range.

The moment M (N · m) and inertia moment I (kgm^2) can be obtained when the load (clamp end + workpiece) volume is small by the following formula.

$$M(N \cdot m) = m(kg) \times L(m) \times g(m/s^2)$$

$$I(kgm^2) = m(kg) \times L^2(m)$$

Where, M is the load weight (kg), L is the load eccentricity (m), and g is the gravitational acceleration (m/s^2).

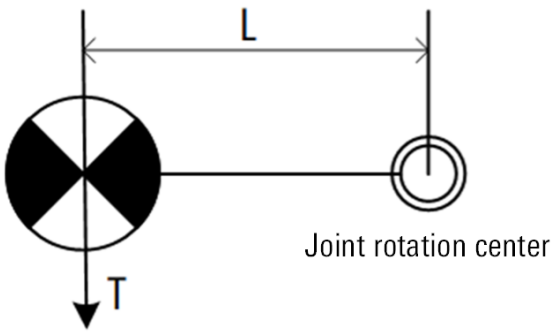


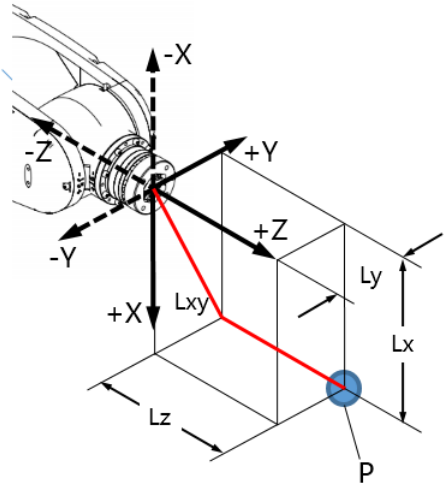
Figure 7-5 Diagram of load eccentricity

Wrist load installation of manipulator

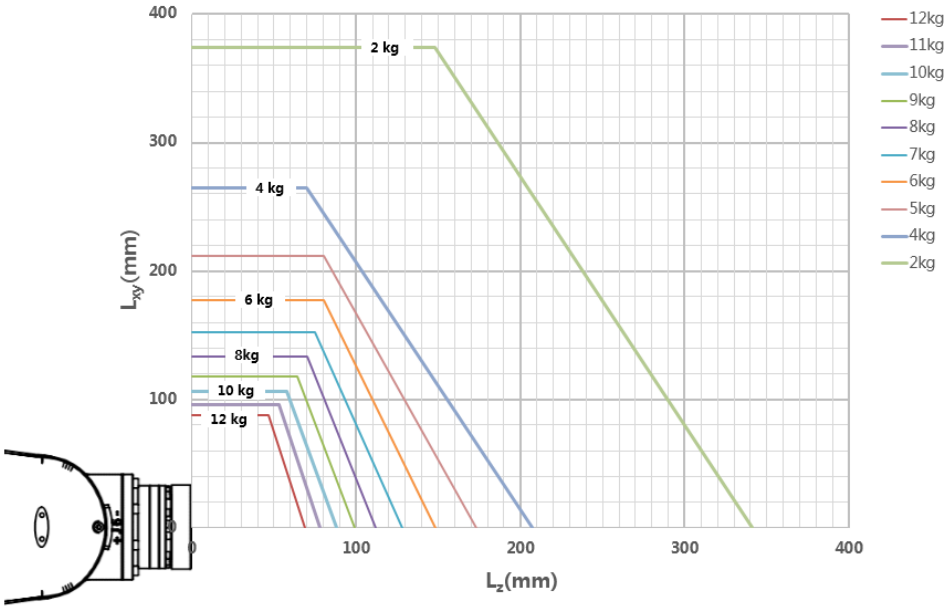
The load line diagram of the manipulator wrist is shown in Figure 7-6. If the manipulator meets the requirement of wrist downward and the deviation between the centerline and the vertical line is within ± 10°, the load centroid range can be determined according to Figure 7-7.

The load line diagram of the manipulator wrist is shown in Figure 7-6.

- For a load with a mass not exceeding 15kg, its centroid positions Lxy and Lz shall be within the range of the corresponding wireframe shown in Figure 7-6(b); Figure 7-6(a) defines the meaning of Lxy and Lz. Lxy represents the distance between the projected position of the load centroid on the flange plane and the origin, and Lz represents the distance between the projected position of the load centroid on the flange axis and the origin.
- The allowable wrist torque of Axis 4 is less than 27.2 N · m, Axis 5 is less than 21.9 N · m, and Axis 6 is less than 10.4 N · m.
- The allowable load moment of inertia of Axis 4 is less than 1.2kg · m ², the allowable load moment of inertia of Axis 5 is less than 0.5kg · m², the allowable load moment of inertia of Axis 6 is less than 0.3kg · m².



(a) Diagram of position relationship between end flange and load centroid



(b) Diagram of allowable range of load centroid position

Figure 7-6 Diagram of the position of the load centroid at the wrist of the manipulator

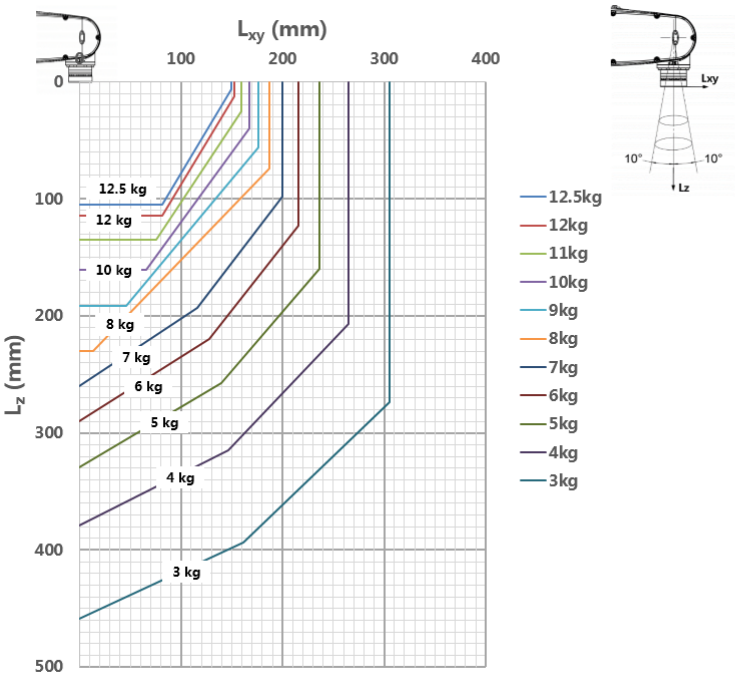


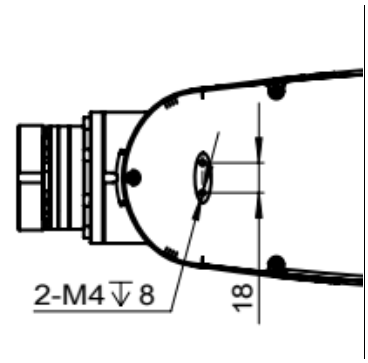
Figure 7-7 Diagram of load centroid position when the wrist of the manipulator is downward

Installation position of other parts of the manipulator

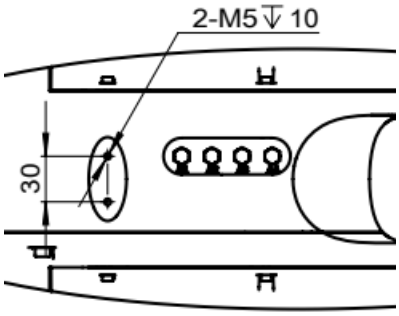
In order to facilitate cable fixation on the manipulator, other parts are reserved for the manipulator as follows:

- Fixed position of manipulator forearm

See Figure 7-8 for the specification and size of the installation hole of the manipulator forearm.



(a) Mounting holes on both sides



(b) Top mounting hole

Figure 7-8 Dimension drawing of manipulator forearm interface

- Fixed position of manipulator elbow

The specifications and dimensions of the mounting hole on the elbow of the manipulator are shown in Figure 7-9.

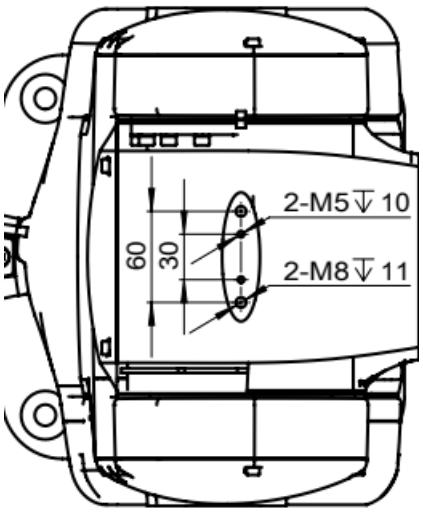


Figure 7-9 Dimension drawing of elbow interface of manipulator

- Fixed position of manipulator upper arm

The specifications and dimensions of the mounting hole of the manipulator upper arm are shown in Figure 7-10.

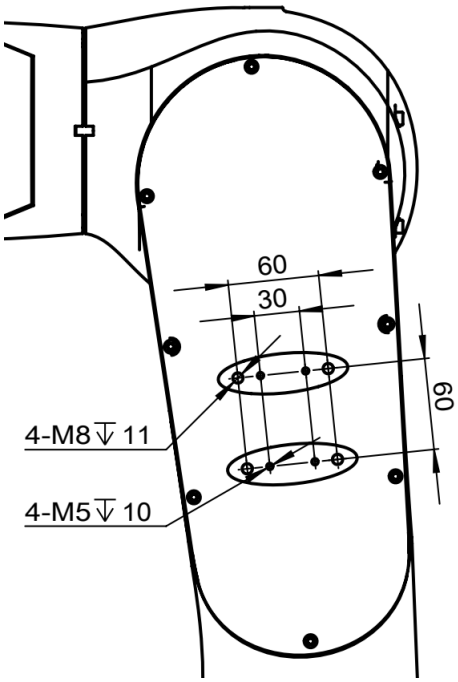


Figure 7-10 Diagram of upper arm interface

- Fixed position of manipulator shoulder

The specifications and dimensions of the mounting hole on the shoulder of the manipulator are shown in Figure 7-11.

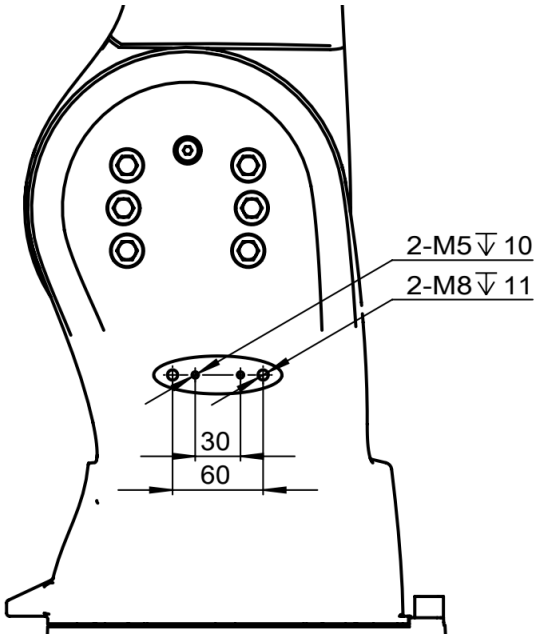


Figure 7-11 Diagram of shoulder interface

The above parts are designed for cable fixation. If it is necessary to install external equipment, it is necessary to ensure that:

- Forearm load + wrist load<15kg.
- Shoulder load + upper arm load + elbow load<15kg.

- Because it may adversely affect the safety and function of the manipulator, it is absolutely not allowed to add machining holes and screw holes to the main body of the manipulator.

- When installing the equipment, the screw used should fully consider the depth of the threaded hole, and the installation length should not exceed the depth of the threaded hole, otherwise the internal components or cables of the manipulator will be damaged.
- When installing the equipment, it is necessary to fully consider the installation reliability. It is recommended to install the equipment with 12.9 grade screws according to the specified torque, and apply thread sealant at the thread, otherwise it may become loose or even broken during long-term operation, causing accidents
- When installing cables or external equipment on the manipulator, pay attention to avoid interference between the cables or external equipment and the manipulator, otherwise it may cause unexpected serious faults and consequences.

8 Calibration of the axes of the manipulator

8.1 General

This section describes the case where the manipulator needs to be calibrated and the zero-point calibration method under different requirements.

8.2 When calibration is required

The manipulator needs to be recalibrated when the following situations occur:

- Repair such as motor replacement or belt pulley removal.
- Replace the encoder battery.
- The encoder wire of the motor is loose or reinstalled.
- The manipulator has a strong collision.
- Replace the control cabinet or control system (e.g.: industrial personal computer).

8.3 Calibration position of each axis

The position of each axis of the manipulator is shown in Figure 8-1 below, in which, except for the J3 axis, it is 90 °, and the other axes are 0 °.

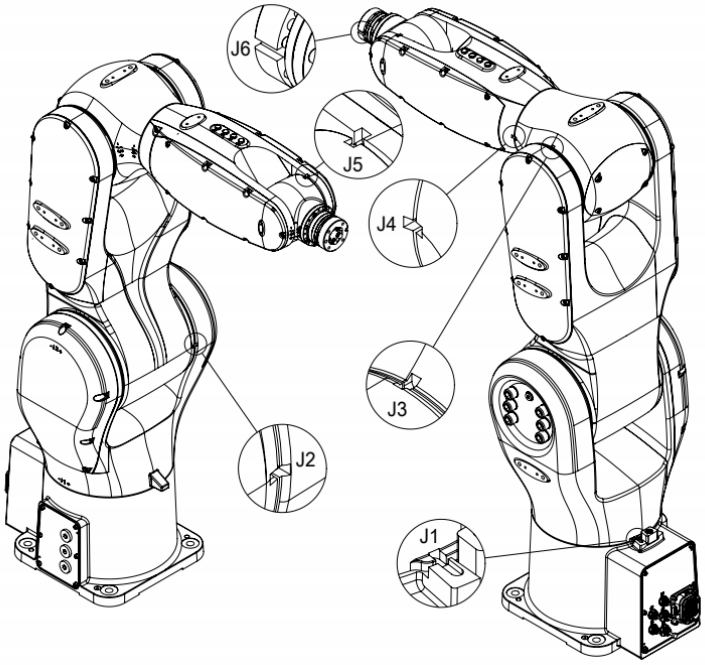


Figure 8-1 Zero point diagram of each axis

Caution

- The robot calibration must always be performed at the same temperature conditions to avoid errors due to thermal expansion and contraction.
- The industrial robot calibration must be calibrated in sequence from the J1 axis to the J6 axis.

Calibration required for high repetitive positioning accuracy

During the operation of the manipulator, only when it is required to have higher repeat positioning accuracy, the positioning accuracy of the path shall not be required. According to the zero point calibration position shown in Figure 8-1, the naked eye shall be used to make the zero point position of each shaft to be aligned, as shown in Figure 8-2.

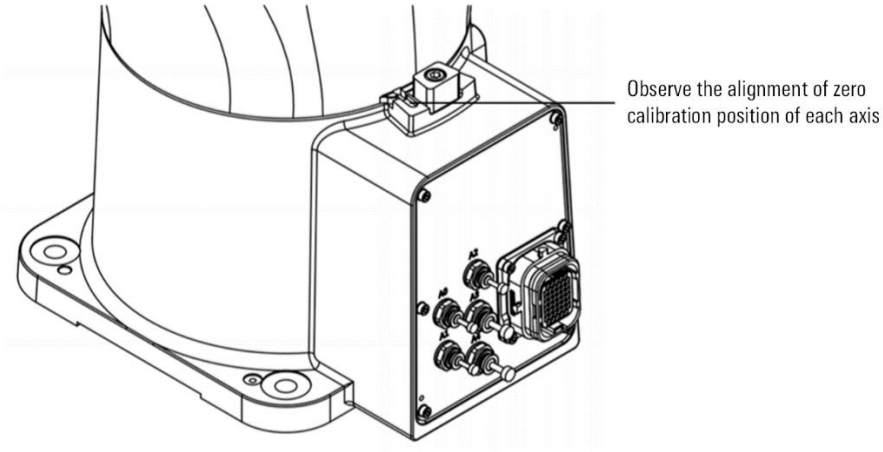


Figure 8-2 Calibration method of naked eye observation zero

Warning	In the calibration process of the manipulator, the speed should be reduced as much as possible, and the operator should not enter the working range of the robot. After each time the robot stops moving, the alignment of the zero scale on the axis position should be observed.

Calibration for rough requirements for path positioning accuracy

When the path positioning accuracy is roughly required, the calibration block is used, as shown in Figure 8-3.

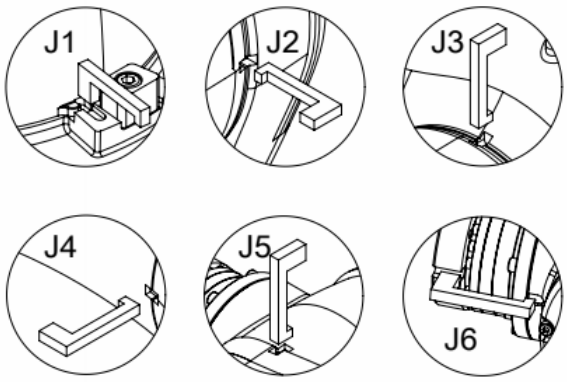


Figure 8-3 Calibration method of zero calibration block

Warning	In the calibration process of the manipulator, the speed should be reduced as much as possible, and the operator should not enter the working range of the robot. After each time the robot stops moving, the alignment of the zero scale on the axis position should be observed.
Caution	When the calibration block is used for calibration of the manipulator, the basic alignment of the calibration slot shall be observed with the naked eye, the operating speed of the manipulator is reduced to the manual lowest gear, and after the position of the fine adjustment shaft, the calibration block is used for calibration, and the calibration block can be inserted into the two calibration grooves at the same time after multiple fine adjustment, as shown in Figure 8-3.

Calibration under the requirement of high path positioning accuracy

When the manipulator is required to have high path positioning accuracy, it is necessary to calibrate and compensate the angle and length of each axis accurately, and to contact the company to use special equipment for calibration.

9 Transport and handing

Caution

Manipulator shall be equipped with the matching handling bracket. The incorrect handling method may cause the damage to manipulator. Manipulator posture during handling is subject to the description in Chapter9.1. Handing Dimensions of this manual Precautions for manipulator during handing as shown in Figure 9-1.

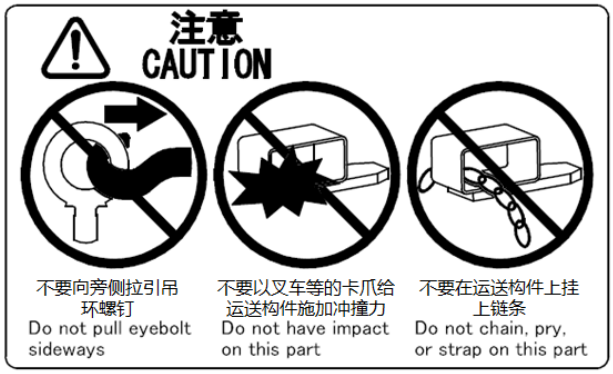


Figure 9-1 Precautions for manipulator during handing

9.1 Handing posture

One to six axis posture of the manipulator during handling shall be posed as shown in Figure 9-2 and Table 9-1.

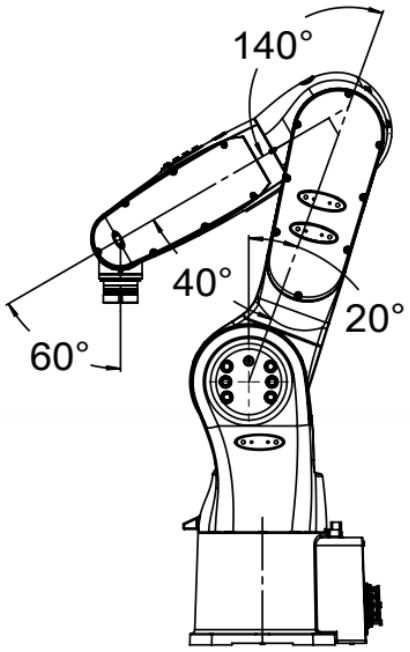


Figure 9-2 Handling posture of manipulator

Table 9-1 Angle value of each axis during robot handling

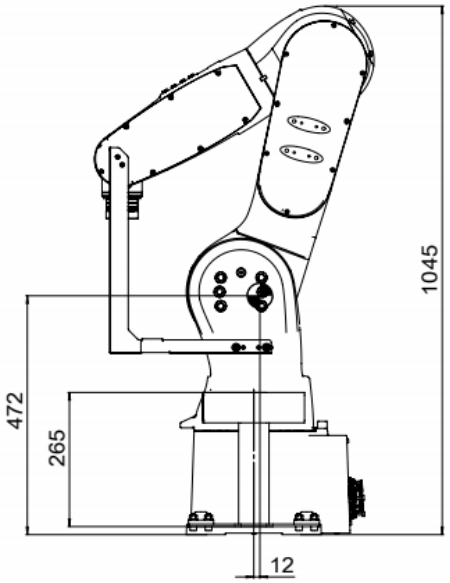
A1	A2	A3	A4	A5	A6
0	-20°	140°	0	60°	0

Warning

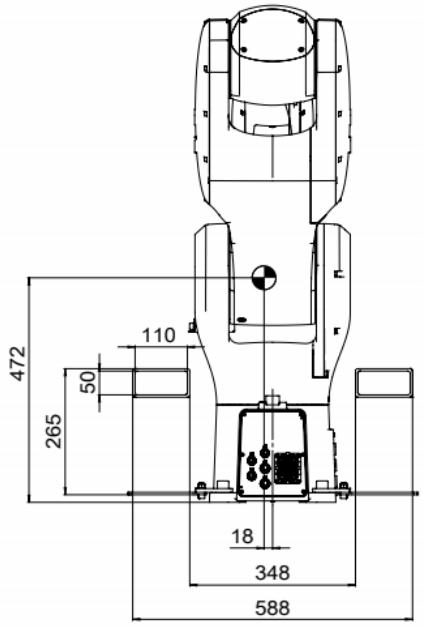
- The manipulator must be handled in strict accordance with the posture in Table 9-1, otherwise it may tip over.
- When the manipulator is transported for a long distance or with strong vibration, it is necessary to install the handling and fixing bracket shown in Figure 9-3 to prevent mechanical damage caused by excessive transportation vibration. The handling and fixing bracket are provided in the factory packaging, please keep it properly for the second transportation.

9.2 Handing dimensions

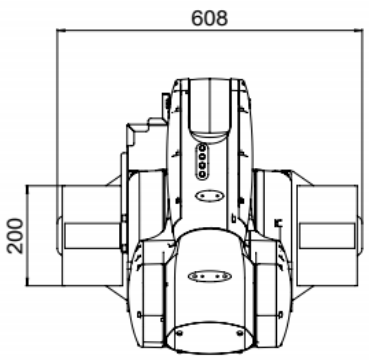
Three views of manipulator during the handling process are as shown in Figure 9-3 (it shall be noted that the actual dimensions may be slightly larger than those in the figure).



(a) Right view



(b) Rear view



(c) Vertical view

Figure 9-3 Manipulator size during handling

> Warning
>
> The actual size may be slightly larger than the size in Figure 9-3, please note.

9.3 Handing with forklift

Handling with forklift is as shown in Figure 9-4. Forklift shall meet the requirement for the weight of manipulator (About 84kg). The total weight of manipulator and handling device is about 100kg.

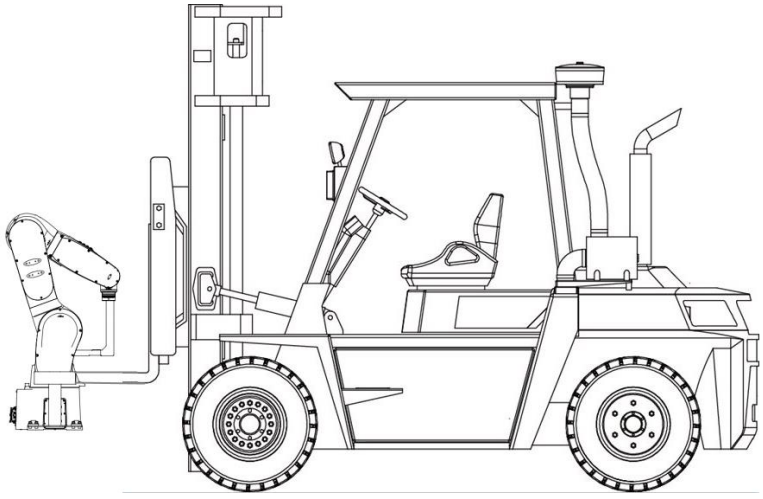


Figure 9-4 Diagram of handling with forklift

> Caution
>
> Manipulator shall be equipped with the matching handling bracket. The incorrect handling method may cause the damage to manipulator. Manipulator posture during handling is subject to the description in Chapter9.1.

9.4 Handing with swinging ring

Handling with swinging ring is as shown in Figure 9-5, Lifting device shall meet the requirement for the weight of manipulator (About 84kg). The total weight of manipulator and handling device is about 86kg.

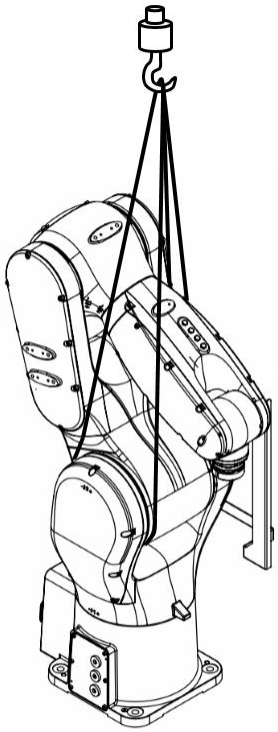


Figure 9-5 Diagram of manipulator handling with swinging ring

Caution

- When manipulator is handled with swinging ring, insert a soft object between the sling and manipulator to avoid the scratching on the manipulator body by sling.
- Manipulator may turn over when transported with swinging ring. During the handling, please take special care to keep the manipulator steady.
- Do not pull the swinging ring to the side to avoid the damage to the manipulator and the unpredictable failure.

10 General principles of maintenance

This manual is a description of preventive maintenance of the manipulator. For the maintenance of a complete set of industrial robot systems, it should also include:

- Control cabinet maintenance-see "Control cabinet maintenance manual".
- End-effector maintenance-see related manual.


Warning

- No maintenance can be performed until the Safety guidelines and safety precautions are read, and maintenance can only be done by properly trained technicians.
- The primary objective of preventive maintenance is to ensure the maximum use of the operating system. Every plan, and well-implemented periodic maintenance, should help to achieve this goal. If regular maintenance cannot achieve the goal of shortening the downtime of the device, it is unnecessary to maintain and cause waste.
- Robot systems are designed to work under rather demanding conditions and require minimal maintenance. Nevertheless, daily inspection and regular maintenance must be carried out according to a given interval cycle.
- The time interval in the maintenance table is the recommended value, and the time interval actually required by the maintenance operator can be changed due to the actual working environment of the manipulator.
- When carrying out daily maintenance or maintenance, many precautions must be kept in mind so as not to introduce additional errors or dangers into the system.
- For well-functioning equipment, do not carry out more maintenance than required on a regular basis.
- All surfaces should be wiped clean before starting the maintenance process.
- In order to avoid unnecessary pollution caused by the impurities such as dust, the outside shall be cleaned before opening the control cabinet door and the outer cover of the manipulator.

11 Maintenance items

11.1 Daily maintenance

When running the manipulator every day, the following items should be checked. As shown in Table 11-1.

Table 11-1 Daily maintenance of manipulator

Ordinal	Inspection item	Main points of inspection
1	Vibration, sound, motor heating	Check if there is abnormal vibration, abnormal noise and abnormally high temperature of each shaft
2	presence or absence of positioning accuracy change	Check if there is a deviation from the last start up position and if there is a deviation from the stop position
3	Action confirmation of peripherals	Confirm that the operation of the manipulator and the peripherals are consistent with the instructions

11.2 First maintenance

The manipulator shall run for the first time 320 hours or 1 month (whichever is shorter), and the following items shall be inspected and maintained. As shown in Table 11-2.

Table 11-2 Manipulator first maintenance project

Ordinal	Inspection item	Main points of inspection
1	Whether the cable and cable sheath of the manipulator are damaged differently and whether the motor connector is loose	Observe the cable activity part of the manipulator, check whether the cable is damaged, whether the cable is bent or distorted locally, check whether the cable sheath is damaged or not, and check whether the motor connector is loose (Note 1)
2	Fasten external main bolts	Torque wrench to tighten the end-effector mounting bolts and the external main bolts (Note 2)
3	All parts of the cleaning manipulator	Clean and maintain the parts of the manipulator, and check whether the parts are damaged (Note 3).
4	Whether the terminal actuator cable is damaged or not	Inspect the cable for damage, and the cable sheath is damaged
5	Whether the synchronous belt is worn or not	Check if the synchronous belt is worn, elongated, and broken (note 4)
6	Check if that the stop rubber block at the J1 axis is damaged	Check whether the limit rubber block is loose, collision damage, aging and so on.

Note 1:

Maintenance site

- Internal cable and cable sheath inside the manipulator base (with the electrical mounting plate removed).
- Big arm of manipulator and internal cable and cable sheath of J1 axle body.
- Connecting cable of manipulator, grounding terminal, user cable joint

Confirmation

- Check the cable sheath for crack and wear, and if so, replace it.
- Check if the lubricating grease on the surface of internal cable of J1 axle body and the internal cable of big arm is disappeared, and if the lubricating grease is about to disappear, add it properly.
- Check the line for wear and replace it if it is exposed.
- Grounding terminal: Check if it is loose.

Note 2:

Tightening Part

- Tighten the mounting bolts of end effector and fixing bolts of manipulator, etc.
- The external connecting screws of manipulator, especially the connecting screws of shaft and the reducer or gearbox.
- For the tightening torque, please refer to the values suggested in the appendix of this manual.

Note 3:

About Cleaning

- The parts that need to be cleaned, the dust on the plane, and the accumulation of splashes shall be cleaned regularly.
- Special care shall be taken to clean the place between the rotating parts of wrist J5 axle to remove debris in time.
- Check if oil is leaking from the reducer or gearbox.
- If the oil is still seen one day after the oil is wiped off, the oil leakage is possible.

Note 4:

About the Maintenance of Synchronous Belt

- After disassembling the manipulator cover plate, check whether the synchronous belt is worn or damaged. For the details, see Chapter12.4 in this manual.
- Check the inside of synchronous belt teeth for white hair, the belt side for wear, belt teeth for crush, the belt body for breakage and elongation (pre-tightening force is decreasing), etc.

11.3 Regular maintenance

960 hours (3 months) regular maintenance

For every 960 hours or 3 months of operation of the manipulator (whichever is the shorter time), the following items need to be inspected and repaired. As shown in Table 11-3.

Table 11-3 Manipulator 960 hours (3 months) maintenance project

Ordinal	Inspection item	Main points of inspection
1	Control cabinet vent cleaning	If there is a lot of dust stuck to the vent of the control cabinet, please remove it
2	Cleaning of operators	Wipe away dirt, remove accumulated spatter, dust, dust, chips, etc.

1920 hours (6 months) regular maintenance

The manipulator shall run for 1920 hours or 6 months (whichever is shorter), and the following items shall be inspected and repaired. As shown in Table 11-4.

Table 11-4 Manipulator 1920 hours (6 months) maintenance project

Ordinal	Inspection item	Main points of inspection
1	Whether the cable and cable sheath of the manipulator are damaged	See Chapter11.2
2	Whether the synchronous belt is worn or not	Check the synchronous belt for wear, elongation and fracture

3840 hours (1 year) regular maintenance

For every 3840 hours or 1 year (whichever is the shorter time), the manipulator needs to carry out the inspection and maintenance of the following items. As shown in Table 11-5.

Table 11-5 Manipulator 3840 hours (1 year) maintenance project

Ordinal	Inspection item	Main points of inspection
1	Whether the cable and cable sheath of the manipulator are damaged	See Chapter11.2
2	Fasten external main bolts	See Chapter11.2
3	All parts of the cleaning manipulator	See Chapter11.2
4	Whether the terminal actuator cable is damaged or not	See Chapter11.2
5	Replacement of synchronous belt	See Chapter11.2
6	Whether the J1 axis limit rubber block is damaged or not	See Chapter11.2

7860 hours (2 years) regular maintenance

The manipulator shall be operated for 2 years or 7860 hours (whichever is short), and the following items shall be inspected and repaired. As shown in Table 11-6.

Table 11-6 Manipulator 7860 hours (2 years) maintenance project

Ordinal	Inspection item	Main points of inspection
1	Replacement of battery	See Chapter12.3

11520 hours (3 years) regular maintenance

The manipulator shall be operated for 3 years or 11520 hours (whichever is less), and the following items shall be inspected and repaired. As shown in Table 11-7.

Table 11-7 Manipulator 11520 hours (3 years) maintenance project

Ordinal	Inspection item	Main points of inspection
1	Replacement of synchronous belt	See Chapter11.2

15360 hours (4 years) periodic maintenance

The manipulator shall be operated for 4 years or 15360 hours (whichever is short), and the following items shall be inspected and repaired. As shown in Table 11-8.

Table 11-8 Manipulator machine 15360-hour (4-year) maintenance project

Ordinal	Inspection item	Main points of inspection
1	Replacement of internal cable of manipulator	To replace the manipulator cable, please consult with us

19200 hours (5 years) regular maintenance

For every 5 years or 19200 hours (whichever is the shorter time), the manipulator needs to be overhauled and many parts need to be replaced. Please contact us. As shown in Table 11-9.

Table 11-9 Manipulator 19200 hours (5 years) maintenance project

Ordinal	Inspection item	Main points of inspection
1	Overhaul of manipulator	Please consult our company

12 Project maintenance process

12.1 Cleaning of manipulator

To ensure the long-term operation of robot, the manipulator shall be cleaned every 960h or 3 months (whichever comes first) according to the following process:

Step1. Adjust the robot to the calibration state.

Step2. To prevent the hazards, turn off the power, hydraulic, and pneumatic sources connected to the robot.

Step3. Clean the manipulator with the vacuum cleaner or wipe it with a cloth.

Step4. After all safety conditions are met, conduct the follow-up work of manipulator.

- Do not apply the water jet on the manipulator, especially the joints and seals.
- Do not clean the manipulator with compressed air.
- Do not remove any protector of manipulator.
- Do not clean the manipulator with solvent.

12.2 Check and repair of cable

In order to ensure that the robot can operate for a long time, the operator cable should be checked every 1920 hours or 6 months (whichever is shorter).

Check and repair the internal cables of the base

Maintenance steps:

Step1. Remove the base cover plate, as shown in Figure 12-1, and observe the cable inside the base.

Step2. Check whether the cable and fixing plate are worn or damaged.

Step3. Check the internal cables for wear or damage.

Step4. In case of cracks, wear or damage, contact our company for replacement.

Step5. Install the cable into the base as it is.

Step6. Install the base cover plate, and pay attention to putting the sealing gasket back as it is.

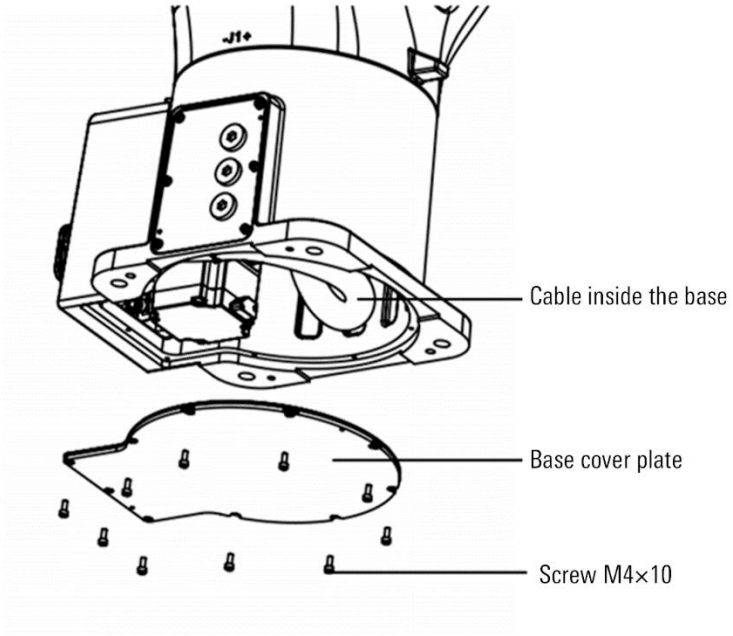


Figure 12-1 Cable maintenance inside the base

Check and repair the shoulder internal cable

Maintenance steps:

Step1. Remove the cover plate of J1 axis manipulator, as shown in Figure 12-2;

Step2. Check whether the cable and bracket are connected reliably.

Step3. Check whether there is wear or damage at the fixing position of the cable and bracket.

Step4. In case of cracks, wear or damage, contact our company for replacement.

Step5. Check whether the grease on the surface of the internal cable disappears.

Step6. If the grease on the cable surface disappears, it should be replenished in time.

Step7. Install the cover plate of J1 axis manipulator, and note that the sealing washer should be put back as it is.

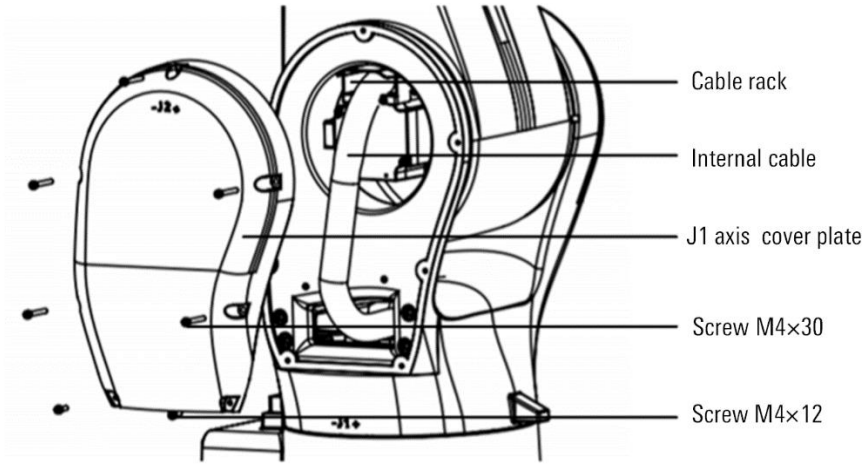


Figure 12-2 Check and repair the shoulder internal cable

Check and repair the upper arm internal cable

Maintenance steps:

Step1. Remove the cover plate, as shown in Figure 12-3.

Step2. Check whether the cable and bracket are connected reliably.

Step3. Check whether there is wear or damage at the fixed part of the cable and cable bracket.

Step4. In case of cracks, wear or damage, contact our company for replacement.

Step5. Check whether the grease on the surface of the internal cable disappears.

Step6. If the grease on the cable surface disappears, it should be replenished in time.

Step7. Install the cover plate, and pay attention to putting the sealing gasket back as it is.

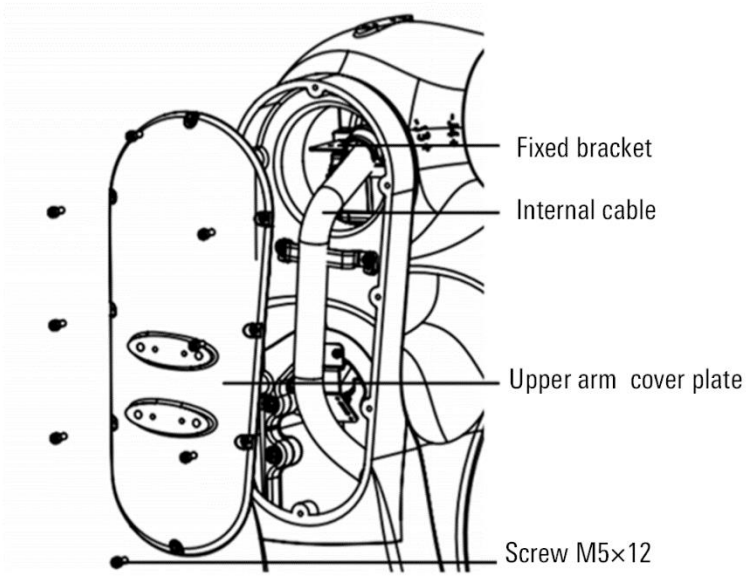


Figure 12-3 Check and repair the upper arm internal cable

Please entrust the service department of the company to replace the internal cables of the manipulator. The use of unqualified cables may cause the robot to fail to work properly.

12.3 Battery replacement

The position data of each axis of the manipulator shall be stored by the encoder battery. The battery shall be replaced in time every 7860 hours or 2 years (whichever is shorter). Or if the driver prompts A2 alarm, the battery should be replaced in time.

Maintenance steps:

Step1. Adjust the robot to the calibration state.

Step2. To prevent the hazards, turn off the power, hydraulic, and pneumatic sources connected to the robot.

Step3. Remove the side cover plate of the base of the manipulator. Pay attention to the connecting cables inside to prevent damage caused by pulling.

Step4. Remove the fixing sheet metal of the battery box from the right cover plate to see the battery, as shown in Figure 12-4.

Step5. Remove the old battery from the box and put the new battery into the box. Be sure to keep the positive and negative polarities of battery same as the old one.

Step6. Install the battery box fixing sheet metal back into the base side cover plate.

Step7. Replace the cover plate at the base side, and pay attention to the sealing gasket should be put back as it is.

Step8. After ensuring that all safety conditions are met, calibrate and test the manipulator.

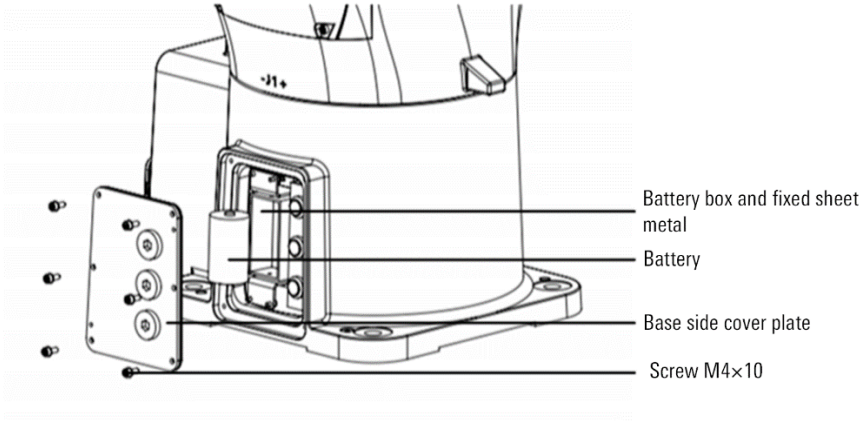


Figure 12-4 Diagram of replacing battery

12.4 Replace grease

Manipulator J2, J3 axis reducer, every 11520 hours or 3 years (whichever is shorter), need to replace the internal grease.

Grease type and grease quantity, please refer to Table 12-1.

Table 12-1 Grease model and quantity of manipulator

Manipulator model	Replace the grease part	Amount of grease	Grease type
AIR15-950	J2 axis reducer	246g	VIGOGREASE RE0
	J3 axis reducer	96g	

When replacing the grease, please refer to Table 12-2 for the posture of the manipulator.

Table 12-2 Grease changing posture of manipulator

Replace the grease part	J1	J2	J3	J4	J5	J6
J2 axis reducer	0°	0°	90°	any	any	any
J3 axis reducer	0°	0°	90°	any	any	any

Warning

- Reducer oil temperature may be higher than 90°, to be replaced after cooling.
- Wear gloves to prevent allergic reactions.
- Open the drain carefully and slowly to prevent oil spatter.

J2 axis reducer replacement grease process

The replacement process is as follows:

Step1. Run the manipulator as shown in Table 12-2.

Step2. To prevent danger, turn off the power, hydraulic and pneumatic sources connected to the robot.

Step3. Place the sump tank for collecting waste oil near the grease outlet.

Step4. Remove the grease outlet M10x1 plug, as shown in Figure 12-5.

Step5. Install grease drain tubing to ensure waste oil flows into the sump tank.

Step6. Remove the grease injection port M10x1 plug, install the grease injection nozzle, and use manual grease injection gun to inject grease until the new grease is discharged from the outlet.

Step7. Release the grease pressure inside the reducer as shown in Table 12-3.

Step8. The amount of oil discharged by weighing shall be equal to the amount of oil injected. If the discharge amount is less than the injection amount, the excess amount is discharged by gas at the fat injection port. If the discharge volume is greater than the injection volume, inject the missing amount from the grease outlet.

Step9. Remove the grease injector, install the M10x1 plug on the grease outlet and grease injector, and apply the sealing tape/sealant.

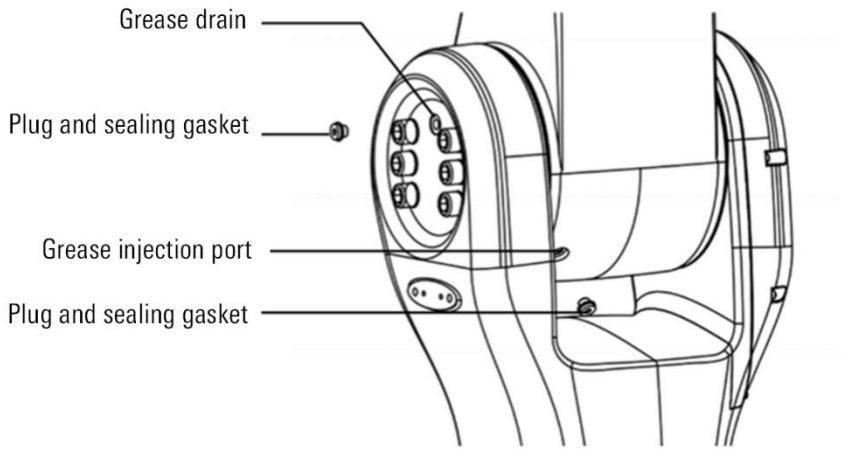


Figure 12-5 Replace J2 axis reducer grease

Caution

When injecting fat from the fat injection port into the inner part of the manipulator, the fat injection speed by hand pump is less than 8g/s and the fat injection pressure is less than 0.3mpa. In order to ensure the smooth elimination of the old oil inside the reducer, after a period of oil injection, take a rest for a while, such as the oil outlet no old oil discharge to continue the oil injection. When the oil filling speed is too fast, the instantaneous pressure inside the reducer becomes higher, and the grease may cause damage to the motor oil seal and the grease enters the motor.

J3 axis reducer replacement grease process

The replacement process is as follows:

Step1. Run the manipulator as shown in Table 12-2.

Step2. To prevent danger, turn off the power, hydraulic and pneumatic sources connected to the robot.

Step3. Remove the upper arm cover plate and elbow cover plate.

Step4. Place the sump tank for collecting waste oil near the grease outlet.

Step5. Remove the grease outlet M10x1 plug, as shown in Figure 12-6.

Step6. Install grease drain tubing to ensure waste oil flows into the sump tank.

Step7. Remove the grease injection port M10x1 plug, install the grease injection nozzle, and use manual grease injection gun to inject grease until the new grease is discharged from the outlet.

Step8. Release the grease pressure inside the reducer as shown in Table 12-3.

Step9. The amount of oil discharged by weighing shall be equal to the amount of oil injected. If the discharge amount is less than the injection amount, the excess amount is discharged by gas at the fat injection port. If the discharge volume is greater than the injection volume, inject the missing amount from the grease outlet

Step10. Remove the grease injection nozzle from the grease injection port, and install M10x1 plug and sealing washer at the grease drain port and grease injection port.

Step11. Install the upper arm cover plate and elbow cover plate, and note that the sealing gasket at the cover plate should be put back as it is.

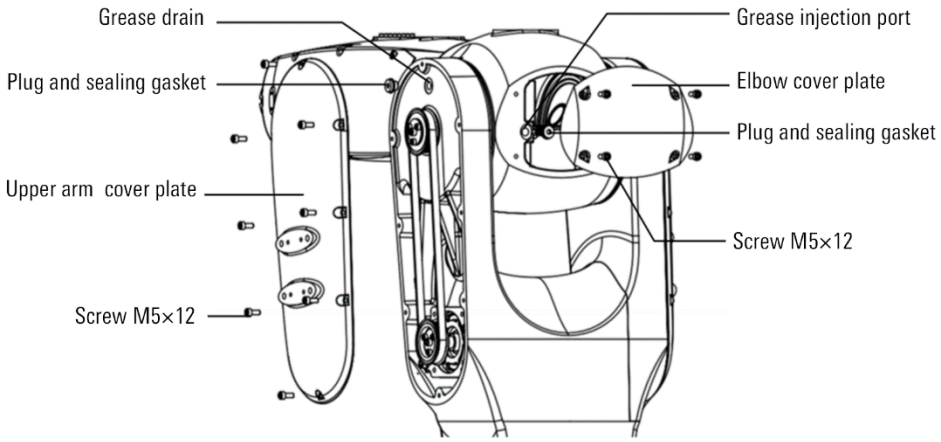


Figure 12-6 Replace J3 axis reducer grease

Caution

When injecting fat from the fat injection port into the inner part of the operation machine, the fat injection speed by hand pump is less than 8g/s and the fat injection pressure is less than 0.3mpa. In order to ensure the smooth elimination of the old oil inside the reducer, after a period of oil injection, take a rest for a while, such as the oil outlet no old oil discharge to continue the oil injection. When the oil filling speed is too fast, the instantaneous pressure inside the reducer becomes higher, and the grease may cause damage to the motor oil seal and the grease enters the motor.

Release grease pressure inside reducer

When releasing the inner grease pressure of the reducer, please install the recovery device at the outlet of the exhaust grease to avoid the splash of the grease and the pollution of the environment.

Table 12-3 Release internal pressure of reducer and gearbox

Replace the grease part	Action point	Action time	Premise
J2 axis reducer	>90°	Ten minutes	Sealing head or oil nozzle shall be installed at the grease injection port, and sealing screws shall not be installed at the grease injection port
J3 axis reducer	>90°	Ten minutes	

Improper fat-feeding operations may cause a sharp increase in the pressure in the reducer or gearbox, damaging internal parts such as the sealing ring, resulting in oil leakage or poor operation. The following precautions must be observed:

- Be sure to remove the sealing screw on the grease outlet before fatting.
- Use a hand pump to slowly feed the fat.
- Be sure to use the specified grease.
- After the grease supply, install the sealing screw after releasing the internal pressure as shown in Table 12-3.
- Thoroughly remove grease from floor and manipulator to avoid slipping.

12.5 Replacement of synchronous belt

The synchronous belt of J1, J3, J4, J5 and J6 axes needs to be replaced every 3840 hours or 1 year of operation of the manipulator (whichever is shorter).

For the model of synchronous belt, please see Table 12-4.

Table 12-4 Synchronous belt model for manipulator

Manipulator Model	Position	Model
AIR15-950	J1 axis inside the base	Gates, 410-5GT-9
	J3 axis inside the upper arm	Gates, 630-3GT-9
	J4 axis inside elbow	Gates, 273-3GT-6
	J5 axis inside forearm	Gates, 525-3GT-6
	J6 axis inside forearm	Gates, 390-3GT-6

At the replacement of synchronous belt, the manipulator shall be posed as shown in Table 12-5.

Table 12-5 Posture of manipulator at the replacement of synchronous belt

J1	J2	J3	J4	J5	J6
Arbitrarily	0°	90°	0°	90°	Arbitrarily

Replacement process for synchronous belt of J5 axes

Replacement as follows:

Step1. Operate the manipulator to the attitude shown in Table 12-5.

Step2. Cut off the power supply of the control device.

Step3. Remove the manipulator forearm cover plate and seven M4 screws, as shown in Figure 12-7.

Step4. Remove three M5 screws from the motor base, as shown in Figure 12-8.

Step5. Move the motor pulley assembly, remove the old synchronous belt and install the new synchronous belt.

Step6. Install the motor base screw M5 initially.

Step7. Adjust the synchronous belt to the proper tension (as shown in Figure 12-9); The synchronous belt frequency is 96Hz -100Hz, which can also be measured by pressure method, with pressure G=1.7 N and deformation f=3.2 mm.

Step8. Install the motor base screw M5 with the specified torque.

Step9. Install the right cover plate of the manipulator forearm and apply sealant at the joint.

Step10. Calibrate the J5 axis of the manipulator.

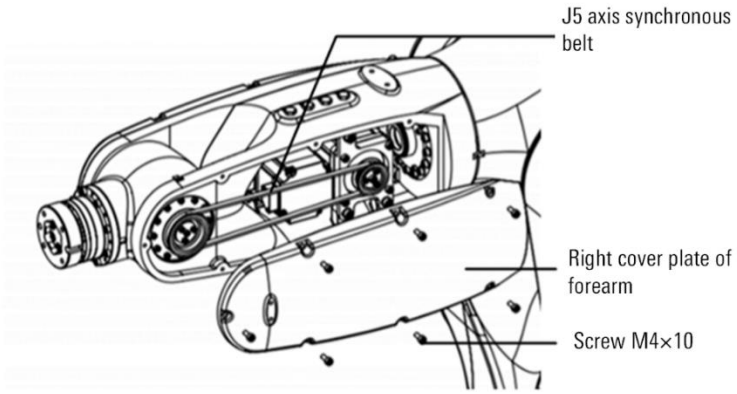


Figure 12-7 Remove the right cover plate of the forearm

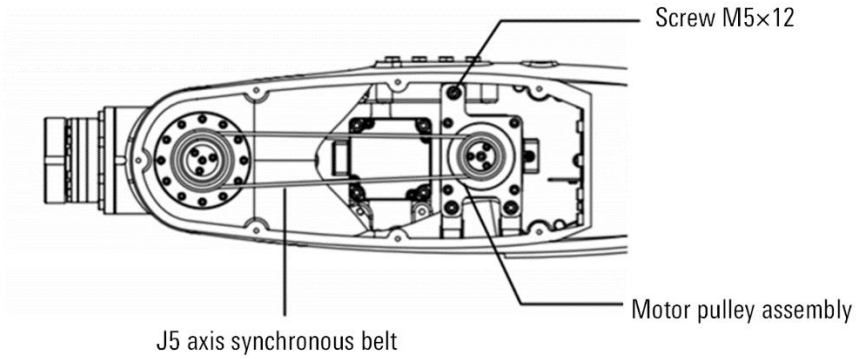


Figure 12-8 Remove the J5 axis timing belt

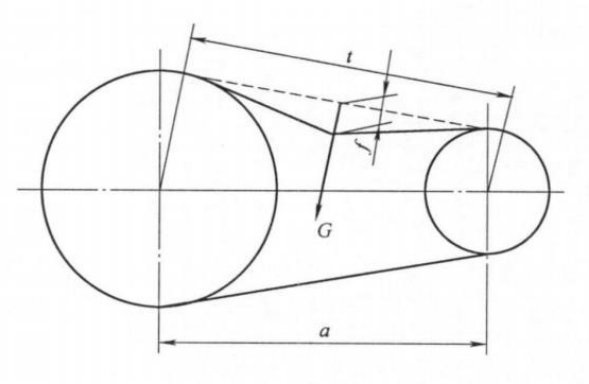


Figure 12-9 Installation deflection of synchronous belt

Replacement process for synchronous belt of J6 axes

Replacement as follows:

Step1. Operate the manipulator to the attitude shown in Table 12-5.

Step2. Cut off the power supply of the control device.

Step3. Remove the manipulator forearm cover plate and seven M4 screws, as shown in Figure 12-10.

Step4. Remove three M5 screws from the motor base, as shown in Figure 12-11.

Step5. Move the motor pulley assembly, remove the old synchronous belt and install the new synchronous belt.

Step6. Install the motor base screw M5 initially.

Step7. Adjust the timing belt to the proper tension (as shown in Figure 12-9); The synchronous belt frequency is 101Hz -106Hz, which can also be measured by pressure method, with pressure G=0.9 N and deformation f=2.2 mm.

Step8. Install the motor base screw M5 with the specified torque.

Step9. Install the left cover plate of the manipulator forearm and apply sealant at the joint.

Step10. Calibrate the J6 axis of the manipulator.

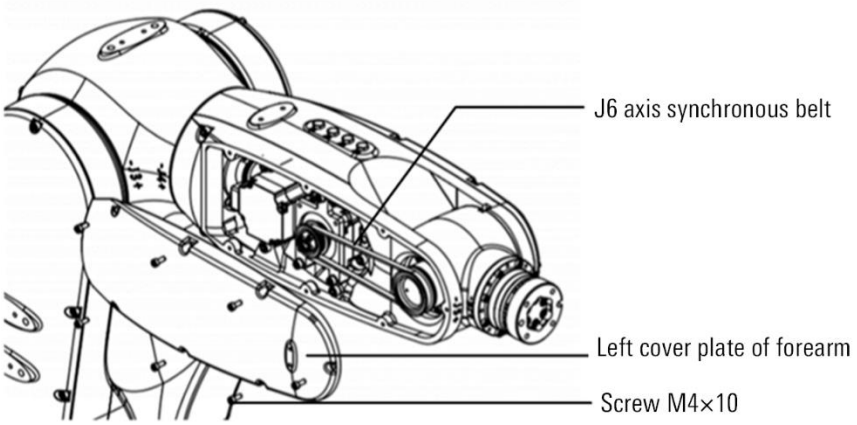


Figure 12-10 Remove the left cover plate of the upper arm

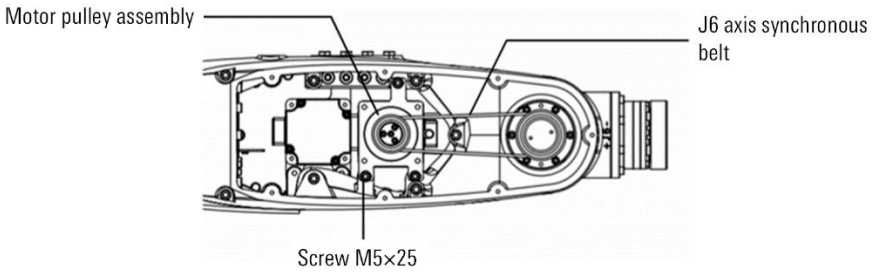


Figure 12-11 Remove the J6 axis synchronous belt

Caution

After replacing the synchronous belt, calibrate the J5 axis of the manipulator. Refer to Chapter8 of this manual for details.

13 Common faults and treatment

The fault of manipulator may be caused by a number of different reasons. It is often difficult to thoroughly find out the cause. If the wrong handling method is used, the fault may be further deteriorated. Therefore, it is very important to analyze the fault situation and find out the real cause.

Vibration or abnormal noise

The possible fault and causes of manipulator are as shown in Table 13-1. If you are unsure of the cause or do not know how to proceed, please contact us.

Table 13-1 Possible faults and causes of manipulator

Fault	Classification	Possible Causes	Treatment
Vibration Abnormal noise	■ When the manipulator operates, its base floats from the workshop pedestal ■ There is a gap between the base and workshop pedestal ■ The screws connecting the base and workshop pedestal are loose	Fixation of Base: ■ The manipulator base is not firmly fixed on the workshop pedestal ■ The base floats from the workshop pedestal and generates the vibration when the manipulator acts due to the screw looseness, insufficient flatness of base and the foreign objects.	■ When the screw is loose, tighten it with the torque wrench according to the proper torque ■ Trim the base flatness in accordance with the tolerance ■ Check if the foreign matters are trapped, and if so, remove them ■ Please consult with us
	Workshop pedestal vibrates when the manipulator acts	Workshop Pedestal: ■ Pedestal is not completely fixed on the foundation. Therefore, the workshop pedestal vibrates when the manipulator acts. ■ The insufficient rigidity of workshop pedestal, and the reaction force and torque generated by the manipulator cause the deformation and vibration.	■ Completely fix the workshop pedestal according to the corresponding method ■ Workshop pedestal shall be processed to improve its rigidity ■ For the workshop pedestal with machining difficulty, the vibration may be mitigated through the modification of moving program ■ Please consult with us
Vibration Abnormal noise	■ Vibration at a specific posture during the action ■ No vibration at the slow action ■ Obvious vibration during acceleration and deceleration ■ Simultaneous vibration of multiple axes	■ Load of manipulator exceeds the allowable value ■ Action procedures are too strict on the manipulator ■ Improper acceleration	■ Confirm whether the manipulator load exceeds the allowable value, and reduce the load or change the action procedures ■ Mitigate the specific vibrations by reducing speed, reducing acceleration and changing the action procedures

Fault	Classification	Possible Causes	Treatment
	■ Collision or long-term overload operation of manipulator ■ No replacement of lubricating grease for a long time	■ Mechanical transmission system is subjected to excessive external force due to collision or overload, causing the damage to the gear surface or rolling surface of the gear, bearing, reducer or the peeling due to fatigue ■ The gear surfaces or rolling surfaces of gear, bearing and reducer are damaged due to the foreign matters trapped in the gear, bearing or reducer. ■ The gear surfaces or rolling surfaces of gear, bearing and reducer peel off due to fatigue because of no replacement of lubricating grease for long term ■ The above reasons may cause the periodic vibration or abnormal noise	■ Make the manipulator operate uniaxially to confirm the Joint that produces the vibration and noise ■ If you need to replace the gear, bearing and reducer, please contact us. ■ Do not use the manipulator at overloaded status ■ If you need to replace the lubricating grease, please contact us. ■ Please consult with us
Vibration Abnormal noise	Causes may not be determined mechanically	■ Fault of the circuit inside the controller, failure of command to transmit to the motor, or the motor information not correctly transmitted to the controller ■ Fault of pulse encoder and the position of motor not correctly transmitted to the controller ■ Failure of motor body to perform its original functions ■ Breakage of internal motor cable of manipulator causes the command not to be correctly transmitted to the motor and control system ■ Voltage reduction and no guarantee for the specified voltage ■ Incorrect control parameters are input	■ For the fault of controller, see the controller manual ■ Replace the motor of vibrating Joint to confirm whether it vibrates ■ Check the cables of the manipulator body, between the manipulator body and control cabinet, and inside the controller for damage, and if so, replace the cable. ■ Check whether the cable joint is in good contact. In case of the poor contact or looseness, re-tighten or take appropriate measures to ensure the good contact. ■ Check whether the action control parameters are correct, and if not, re-enter the correct parameters. ■ Please consult with us

Fault	Classification	Possible Causes	Treatment
	The mechanical action near the manipulator is closely related to the vibration of robot.	■ Mechanical electrical noise from the manipulator ■ If the grounding wire is not connected properly, the electrical noise will mix into the grounding wire, causing the vibration of manipulator due to the interference with command ■ Poor connection of grounding wire will lead to the unstable grounding, causing the vibration of manipulator due to electrical noise interference.	■ Connect the grounding wire properly to avoid the electrical noise mixed into the manipulator ■ Please consult with us
Vibration Abnormal noise	■ Abnormal noise after the replacement of lubricating grease ■ Abnormal noise occurs during the operation of robot after a long-term shutdown ■ Abnormal noise at low speed	Abnormal noise from the manipulator at low speed immediately after the replacement or at the restart after the long-term shutdown.	Observe the operation of manipulator for 1-2 days. Usually, the abnormal noise will disappear.

Shake of manipulator

Table 13-2 shows the causes and treatment measures of the shaking of the manipulator. If you cannot determine the cause or how to deal with it, please contact our company.

Table 13-2 Causes and treatment measures of manipulator shaking

Fault	Classification	Possible Causes	Treatment
Shake of manipulator	■ After power-off, some parts of manipulator may be shaken manually. ■ There is a gap between the connecting surfaces of manipulator	■ Manipulator bolts are loose ■ Connecting bolts on the manipulator are loose due to the overload, collision, etc., thus resulting in the shake	For each Joint, check if the bolts at the following parts are loose. If so, tighten it with a torque wrench according to a suitable torque. ■ Fixing bolts of motor ■ Fixing bolts of reducer shell ■ Fixing bolts of output shaft of reducer ■ Fixing bolts of pedestal ■ Fixing bolts between arms ■ Fixing bolts of shell ■ Fixing bolts of end effector

Fault	Classification	Possible Causes	Treatment
	Turn off the power of manipulator, and confirm that the screws are tightened, and shake the entire head of manipulator manually	Large backlash is resulted from the wear or damage of internal gears of manipulator due to the overload, collision, etc.	If you need to replace the internal gear, please consult with us

Motor overheating

The causes and treatment measures of motor overheating are shown in Table 13-3. If you cannot determine the cause or how to deal with it, please contact our company.

Table 13-3 Causes and treatment measures of motor overheating

Fault	Classification	Possible Causes	Treatment
Motor overheating	■ Ambient temperature rises for installation of manipulator, and the overheating of motor ■ Motor overheats after the cover plate is mounted on the motor ■ Motor overheats after the action procedures of manipulator and load conditions are changed	Ambient temperature: ■ Ambient temperature rises or the deterioration of heat dissipation of motor after the cover plate is installed ■ Load Action: ■ Current value of motor exceeds its rated value due to the load and operating procedures	■ Decrease of ambient temperature may prevent the motor from overheating ■ Improvement of ventilation conditions around the motor, i.e. the heat dissipation of motor, may effectively prevent the motor from overheating. ■ A radiation shielding plate if there is a heat source around the motor may prevent the motor from overheating. ■ Slowing down the action procedures and reducing the load may decrease the average current value of motor, thus preventing the motor from overheating. ■ Please consult with us
	Motor overheats after the action control parameters of manipulator are changed	Control Parameter: ■ Improper input parameters will cause the incorrect acceleration and deceleration of robot, so that the average current value of increases.	■ Enter the appropriate parameters according to the relevant instructions. ■ Please consult with us
	Motor overheats due to the causes other than above ones	Mechanical Fault of Manipulator: ■ Mechanical system fault of manipulator causes the overload of motor ■ Motor fault: ■ Brake fault causes the motor to always operate when the brake is	■ Please rectify the mechanical fault by reference to the instructions of vibration, abnormal noise and looseness. ■ Please confirm whether the brake is released when the motor is powered on.

Fault	Classification	Possible Causes	Treatment
		applied, which causes the motor to withstand excessive load ■ Failure of motor body to perform its functions causes the excessive current to flow through the motor	■ After the motor is replaced, the overheating of motor disappears. It is confirmed that the condition is abnormal. ■ Please consult with us

Leakage of lubricating grease

The causes and treatment measures of grease leakage are shown in Table 13-4. If you cannot determine the cause or how to deal with it, please contact our company.

Table 13-4 Causes of grease leakage and treatment measures

Fault	Classification	Possible Causes	Treatment
Leakage of lubricating grease	Lubricating grease leaks out from the mechanical part	Poor Sealing: ■ Crack of casting due to the excessive external force caused by the collision ■ Damage of O-ring during the disassembly and reassembly ■ Scratch of oil seal due to the dust intrusion ■ Poor sealing between the cover plate and casting	■ In case of casting crack, etc., the sealant may be used to block the lubricating grease as an emergency measure, but in view of the further extension of crack, the part shall be replaced as soon as possible. ■ Please consult with us

Falling of manipulator axis

Table 13-5 shows the reasons and treatment measures for the falling of the manipulator axis. If you cannot determine the cause or how to deal with it, please contact our company.

Table 13-5 Causes and treatment measures of manipulator axis falling

Fault	Classification	Possible Causes	Treatment
Falling of manipulator Joint	■ The brake is completely ineffective and the Joint falls quickly ■ After the brake is contracted, the shaft falls slowly	■ The damage of brake drive relay causes the brake to always be powered on and not to work. ■ Wear and damage of brake body affect the braking effect. ■ The lubricating oil and grease inside the motor cause the brake to slip.	■ Check if the brake drive relay is damaged, and if so, replace the relay ■ In case of the wear of brake, the damage of brake body and the lubricating grease inside the motor, replace the motor. ■ Please consult with us

Position offset

The causes and treatment measures of position deviation are shown in Table 13-6. If you cannot determine the cause or how to deal with it, please contact our company.

Table 13-6 Causes of position deviation and treatment measures

Fault	Classification	Possible Causes	Treatment
Position offset	■ Manipulator deviates from the teaching position ■ The repeated positioning accuracy of manipulator is greater than the allowed value	Mechanical Fault: ■ The unstable repeated positioning accuracy may be caused by the mechanical system abnormality, screw looseness, etc. ■ The repeated positioning accuracy keeps stable after the deviation; the joint surface of pedestal surface, Joint casting and reducer may slide due to the excessive load such as the collision. ■ Abnormality of motor encoder	■ In case of the unstable repeated positioning accuracy, please rectify the mechanical fault by reference to the instructions for the vibration, abnormal noise and shaking. ■ If the repeated positioning accuracy keeps stable, please modify the teaching program. If the collision does not occur again, the deviation may be avoided. ■ In case of the abnormality of motor encoder, replace the motor or encoder. ■ Please consult with us
	Position only deviates from the specific peripheral equipment	Deviation of Peripheral Equipment ■ The external equipment under the external force leads to the deviation relative to the manipulator	■ Please relocate the peripheral equipment ■ Please modify the teaching program ■ Please consult with us

Fault	Classification	Possible Causes	Treatment
	Deviation occurs after the modification of parameters	■ Parameters: ■ The modification of calibration data causes the loss of manipulator origin	■ Re-enter the previous correct calibration data ■ In case of uncertain calibration data, please recalibrate the manipulator ■ Please consult with us

14 Conditions of storage

14.1 Environmental conditions for long-term storage of manipulator

Table 14-1 Environmental conditions for long-term storage of manipulator

Parameter	Value
Min. ambient temperature	-25℃
Max. ambient temperature	55℃
Max. ambient temperature (storage time less than 24h)	70℃
Max. ambient humidity	Less than 95% at constant temperature, no condensation
Max. vibration condition	Frequency: 22Hz, amplitude: 0.15mm

14.2 Precautions for storage of manipulator

In addition to Chapter1.4 Environmental Requirements for Operation of this manual, the following shall be paid with attention for the long-term storage of manipulator:

- Before the long-term storage of manipulator, it shall be posed for handling and placed on the horizontal surface. For details, see Chapter4 Transport and Handing of this manual
- When the manipulator is not in use for a long time, cut off all powers, unplug the heavy-duty connector on the body, and cover the heavy-duty connector.
- The exterior protection such as the paper or wooden packing box shall be provided to protect the manipulator body from the long-term exposure of sunlight, water, oil, corrosive liquids, etc.
- The manipulator surface shall be cleaned regularly for dust and pollutant with the specific cleaning cycle depending on the storage environment of manipulator.
- When the storage period is over and the manipulator is put into the operation again, the manipulator shall be checked in accordance with Chapter3.1 Check item of this manual

Appendix A Periodic maintenance schedule of manipulator

Note: ○ indicates that maintenance is required.

Schedule A Periodic maintenance schedule of the manipulator

Item	Maintenance cycle	First Maintenance 320h	3 months 960h	6 months 1,920h	9 months 2,880h	1 year 3,840h	15 months 4,800h	18 months 5,760h	21 months 6,720h	2 years 7,680h	27 months 8,640h	30 months 9,600h	33 months 10,560h	3 years 11,520h	39 months 12,480h	42 months 13,440h	45 months 14,400h	4 years 15,360h	51 months 16,320h	54 months 17,280h	57 months 18,240h	5 years 19,200h
Cleaning of manipulator	0.5h	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Cleaning of control cabinet vent	0.1h	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Check the timing belt for wear	0.5h	○		○	○	○		○		○		○		○		○		○		○		○
Check the manipulator cable for damage	3h	○		○	○	○		○		○		○		○		○		○		○		○
Check the manipulator cable sheath for damage	2h	○		○	○	○		○		○		○		○		○		○		○		○
Check the connecting cable of teach	0.2h	○			○	○				○				○				○				○

Item	Maintenance cycle	First Maintenance 320h	3 months 960h	6 months 1,920 h	9 months 2,880 h	1 year 3,840 h	15 months 4,800 h	18 months 5,760 h	21 months 6,720 h	2 years 7,680 h	27 months 8,640 h	30 months 9,600 h	33 months 10,560 h	3 years 11,520 h	39 months 12,480 h	42 months 13,440 h	45 months 14,400 h	4 years 15,360h	51 months 16,320 h	54 months 17,280 h	57 months 18,240 h	5 years 19,200 h
pendant, control cabinet and manipulator for damage																						
Check the connectors of motor, etc. for looseness	0.2h	○			○	○				○				○				○				○
Tighten the end effector screws	0.2h	○			○	○				○				○				○				○
Tighten the external main screws	1h	○			○	○				○				○				○				○
Check the end effector cable for damage	0.2h	○			○	○				○				○				○				○
Check the limit rubber block for damage	0.1h	○			○	○				○				○				○				○
Replacement of Synchronous	1h					○				○				○				○				○

Item	Maintenance cycle	First Maintenance 320h	3 months 960h	6 months 1,920 h	9 months 2,880 h	1 year 3,840 h	15 months 4,800 h	18 months 5,760 h	21 months 6,720 h	2 years 7,680 h	27 months 8,640 h	30 months 9,600 h	33 months 10,560 h	3 years 11,520 h	39 months 12,480 h	42 months 13,440 h	45 months 14,400 h	4 years 15,360h	51 months 16,320 h	54 months 17,280 h	57 months 18,240 h	5 years 19,200 h
Belt																						
Battery Replacement	0.5h									○								○				
Replace the internal cables of manipulator	8h																	○				
Manipulator overhaul																						○

Appendix B Table of screw strength and tightening torque (Nm)

Schedule B1 Carbon steel screw strength and screw tightening torque table (Nm)

Performance level / Thread specification	8.8 level	10.9 level	12.9 level
M2.5	0.68	0.93	1.1
M3	1.2	1.6	2.0
M4	2.8	3.7	4.4
M5	5.6	7.5	9
M6	9.5	12.5	15
M8	23	31	36
M10	45	60	70
M12	78	104	125
M14	113	165	195
M16	195	250	305
M20	370	500	600

Schedule B2 Stainless steel screw strength and screw tightening torque table (Nm)

Thread specification	Stainless steel A4-80	Stainless steel A2-70 and A4-70	Stainless steel A2-50
M3	1.0	0.8	0.4
M4	2.4	1.9	0.9
M5	4.8	3.8	1.9
M6	8.0	6.4	3.1
M8	19.5	15.5	7.5
M10	38.5	30.5	15.0
M12	66.0	52.0	25.5
M14	106.0	84.0	41.0
M16	165.0	130.0	64.0
M20	320.0	253.0	125.0
M24	557.0	441.0	217.0
M30	1107.0	876.0	-

- All screws must be tightened with proper torque.
- Except for the torque specified in the text, the corresponding tightening torque shall be selected according to the screw performance level.
- Remove foreign matters in screws and threaded holes.
- Torque for lightly lubricated screws.
- Screws shall be tightened evenly and symmetrically.
- According to the installation requirements of the reducer and other moving parts, apply thread adhesive to the engagement part of some screws.

PEITIAN ROBOTICS

WeChat Official Account

Official Website

Sevice Hotline : 400-990-0909
Official Website : http://robot.peitian.com

UM-P05310000054-001 / V1.0.0 / 2023.09.22