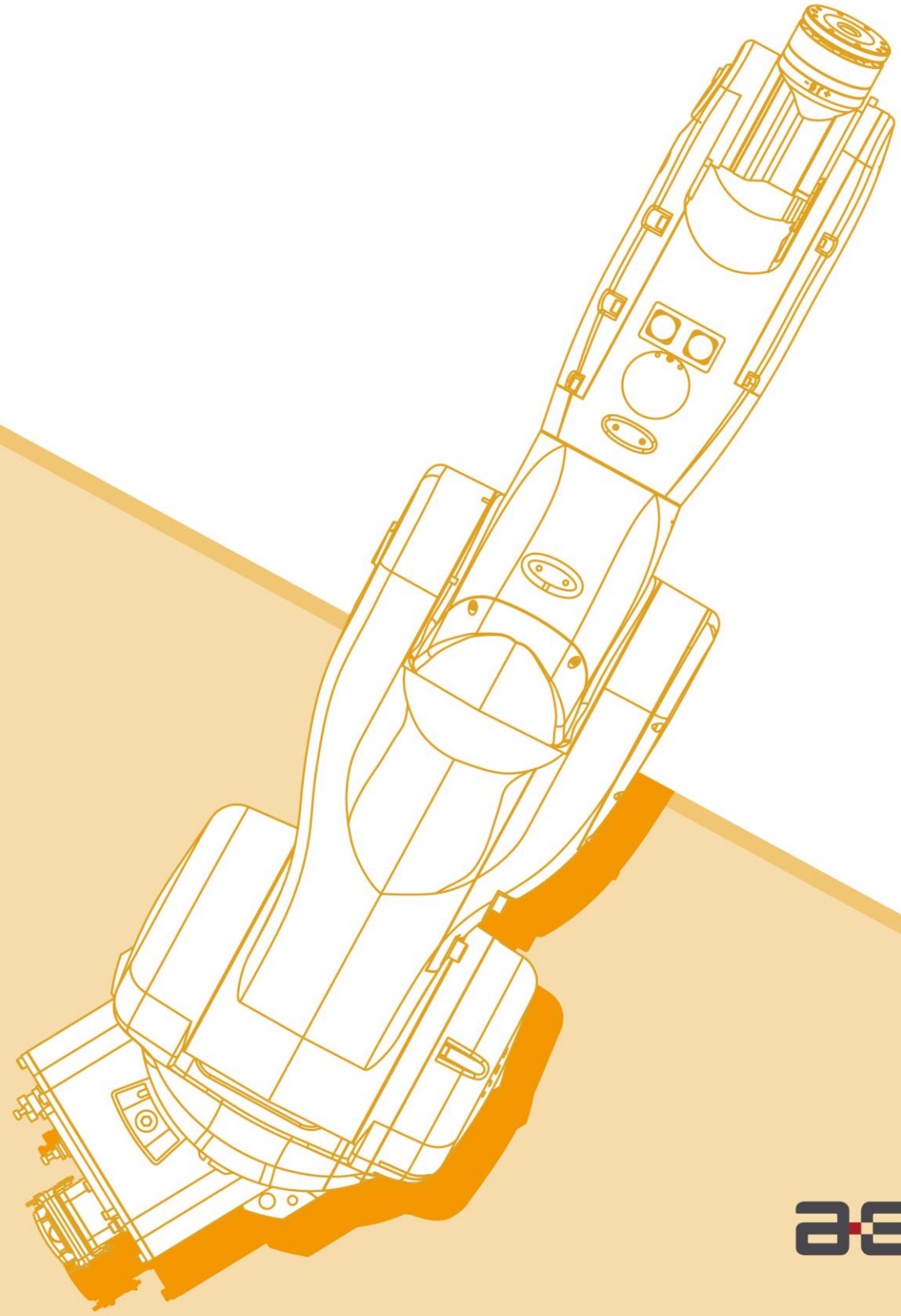
AIR8-710B Operation Manual

V1.0.2



PEITIAN ROBOTICS

Foreword

About this manual

This manual is for technicians to install, use, and use the AIR8-710B 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	2021.12.04	First official release
V1.0.1	2022.03.11	Second official release Added "Heat engine related instructions"
V1.0.2	2023.03.22	The third official release Add "Grounding instructions"

Manual Number and Version

The manual-related information is shown in Table 3.

Table 3 Document-related information

Document name	"AIR8-710B Operation Manual"
Document number	UM-P05310000054-001
Document version	V1.0.2

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: 2014/30/EU directive issued by European Parliament and Council on February 26, 2014 to balance the electromagnetic compatibility regulations of member states	2014
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.


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 schematic diagram of the safe work of industrial robots.

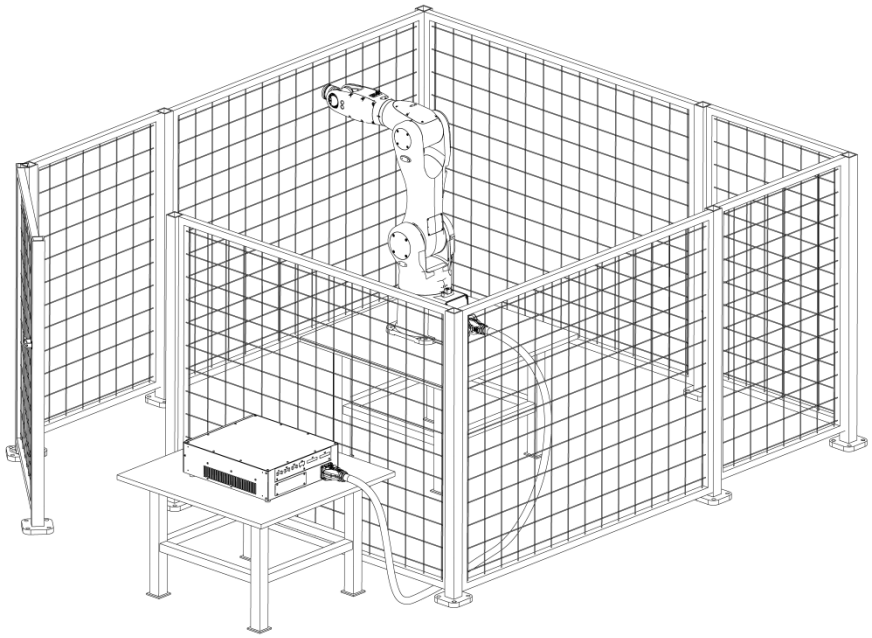


Figure 1 Schematic diagram of safe work of industrial robots

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 operator, 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 is 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.

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1 AIR8-710B robot overview and basic composition

1.1 Overview of industrial robot

Industrial robot consists of the following parts:

- Manipulator
- Control cabinet
- Teach pendant
- Connecting (power supply) cable, etc.

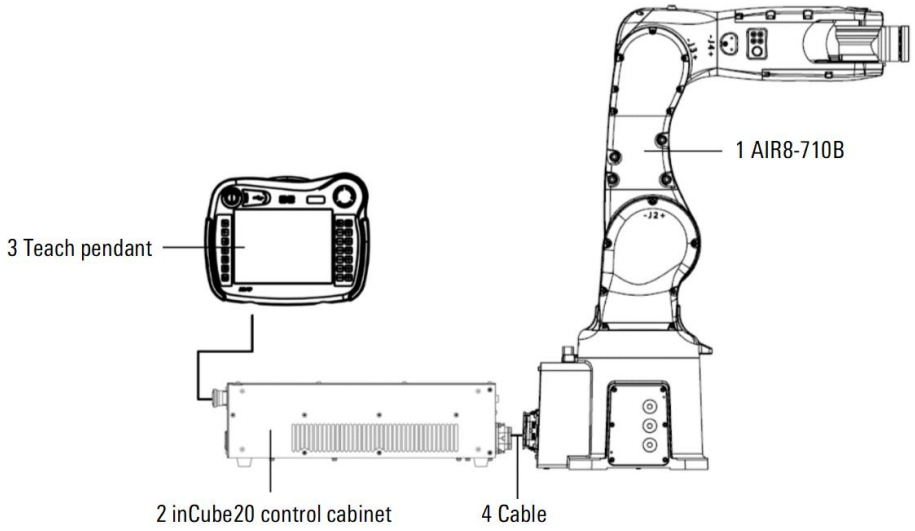


Figure 1-1 Composition of robot system

Figure 1-1 shows an example of industrial robot system in which:

1. Manipulator
2. Control cabinet (inCube20)
3. Teach pendant
4. Connecting (power supply) cable

1.2 Basic structure

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.

AIR8-710B robot manipulator and the names of its various parts are as shown in Figure 1-2.

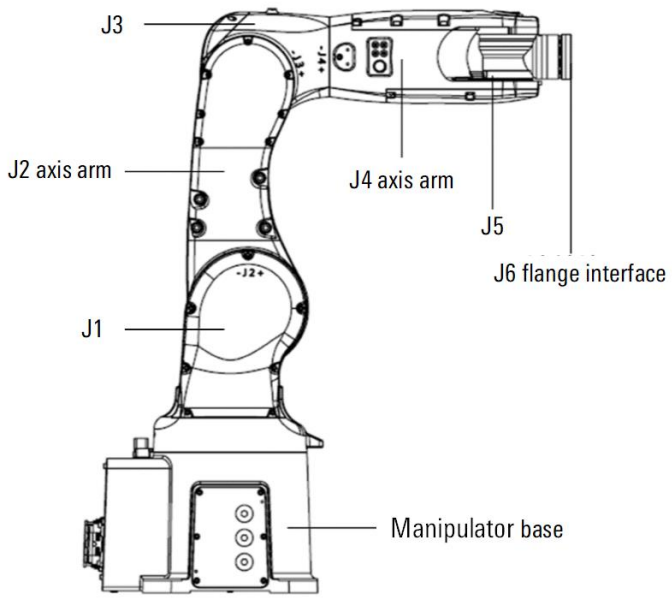


Figure 1-2 AIR8-710B robot body and its various parts

1.3 Basic specifications

The basic specifications of AIR8-710B robot manipulator are as shown in Table 1-1.

Table 1-1 Basic Specifications of AIR8-710B

Basic specifications		Illustrate
Coordinate form		6-DOF articulated robot
Number of control axes		6 axes (J1, J2, J3, J4, J5 and J6)
Mounting mode		Ground mounting, wall mounting* and upside-down mounting*
Range (upper limit/ lower limit)	J1**	-170° ~170°
	J2	-100° ~135°
	J3	-120° ~156°
	J4	-200° ~200°
	J5	-135° ~135°
	J6	-360° ~360°
Max. speed	J1	380° /s
	J2	350° /s
	J3	480° /s
	J4	490° /s
	J5	565° /s
	J6	815° /s
Transport capacity	Wrist + elbow	8kg
Drive mode		Electrical servo drive with AC servo motor

Basic specifications	Illustrate
Repeated positioning accuracy	±0.02mm
Robot weight	50kg
Noise	70dB
IP rating	IP67
Mounting conditions	■ Ambient temperature :0~45°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

Prompt

■ **"*"** The mounting mode is wall mounting and upside-down mounting, please consult our company for the operation range and speed limit.

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

1.4 Environmental requirements for manipulator

The range of ambient temperature for AIR8-710B manipulator is as shown in Table 1-2.

Table 1-2 Operating environment requirements

Parameter	Illustrate	
Temperature	Lowest temperature	0℃
	Maximum temperature	45℃
Humidity	The operating environment requirements of the manipulator do not exceed the humidity level not higher than 95% as specified in the document "IEC 60721-3-3-2002 Classification of environmental conditions"	
Altitude	The altitude of the normal operating environment of the manipulator should not exceed 1000 meters. In the height range of 1000 meters to 4000 meters, the manipulator should be used at a reduced rated power.	
Shock resistance	The robot manipulator should be used in an environment without vibration as much as possible. The environmental vibration limit frequency is 22Hz, and the amplitude does not exceed 0.15mm.	
Special environmental requirements	The manipulator is prohibited to use in flammable, explosive and corrosive environment	

1.5 Product naming rules

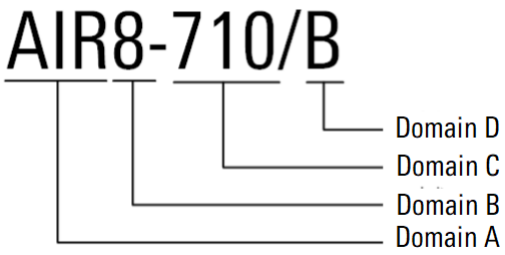


Figure 1-3 Product naming rules diagram

Table 1-3Product naming rules description

Domain	Meaning	Domain value	Explanation
Domain A	Product series	AIR	Indicates that this product belongs to the PeiTian AIR product series.
Domain B	Wrist Load	8	Indicates that the robot wrist load does not exceed 8kg.
Domain C	Wingspan	710	Indicates that the robot arm has a reach of 710mm.
Domain D	Generation	B	Indicates the second generation.

2 The label name and meaning of AIR8-710B

2.1 Safety sign of manipulator

An operator safety label shall be pasted on the back of the upper arm of the operator, as shown in Figure 2-1.

Figure 2-1 Safety sign of manipulator

Danger

If you do not follow this rule, it is extremely easy or may cause unnecessary personal injury or even casualties!

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 Manipulator nameplate

2.3 Manipulator handling gesture label

The posture label of the handling manipulator is shown in Figure 2-3.

搬运姿态
Transportation Posture

J1	J2	J3	J4	J5	J6
0°	- 24°	156°	0°	48°	0°

在松卸基座固定螺钉前，
机器人必须处于搬运姿态。

The robot must be in the "Transportation Posture" before the screw bolts of the base are loosed.

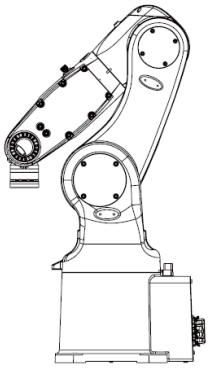


Figure 2-3 Robot handling gesture label

2.4 Direction sign of each joint

"+" or "-" sign is provided at the rotating or swinging joints of axes 1~6 of manipulator as shown in Figure 2-4 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.

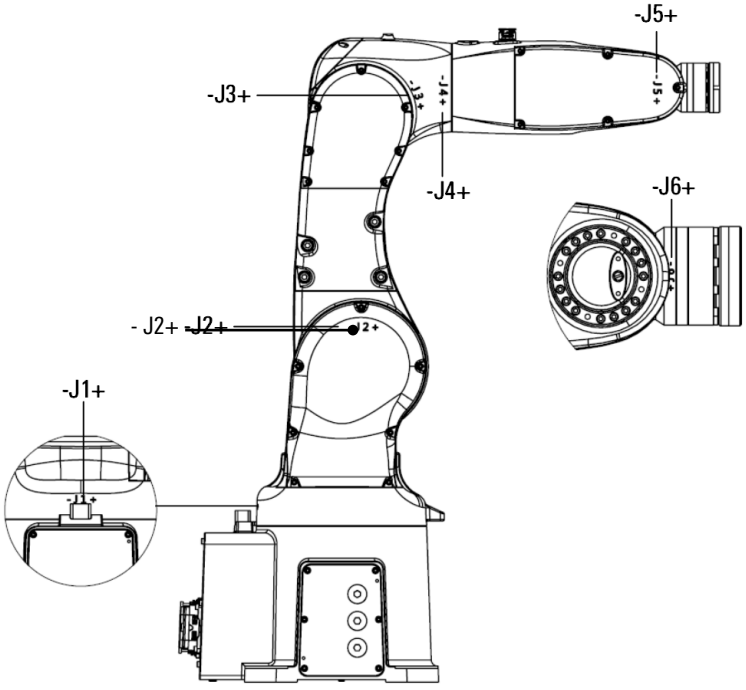


Figure 2-4 Direction sign of each axis on manipulator

3 AIR8-710B transport and handing

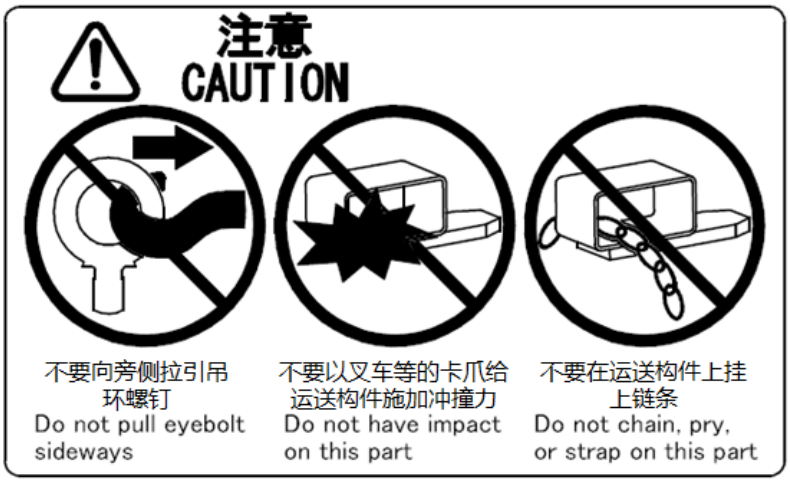


Figure 3-1 Precautions for manipulator during handing

Caution

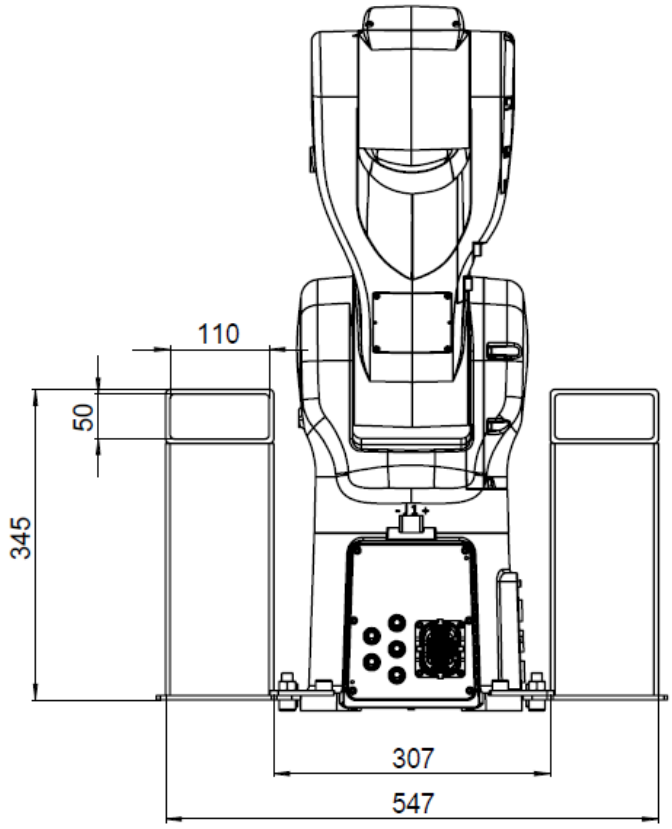
Manipulator shall be equipped with the matching handling bracket. The incorrect handling method may cause the damage to manipulator. Manipulator posture during handling is subject to the description in *Chapter 3.1* of this manual Precautions for manipulator during handing as shown in Figure 3-1.

During handing, the following points should be noted:

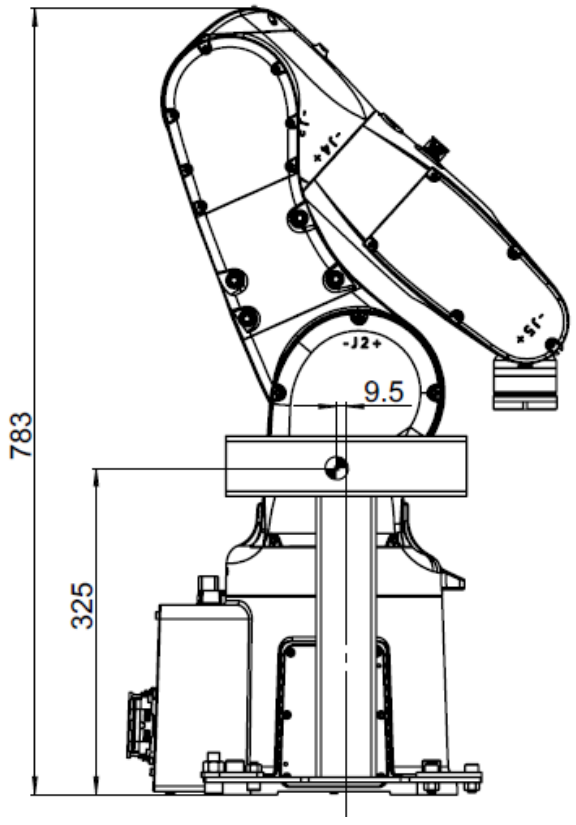
- Do not pull eyebolt sideways.
- Do not use forklift and other grippers to apply impact force to the delivery support.
- Do not put chains on delivery support.

3.1 Handing dimensions

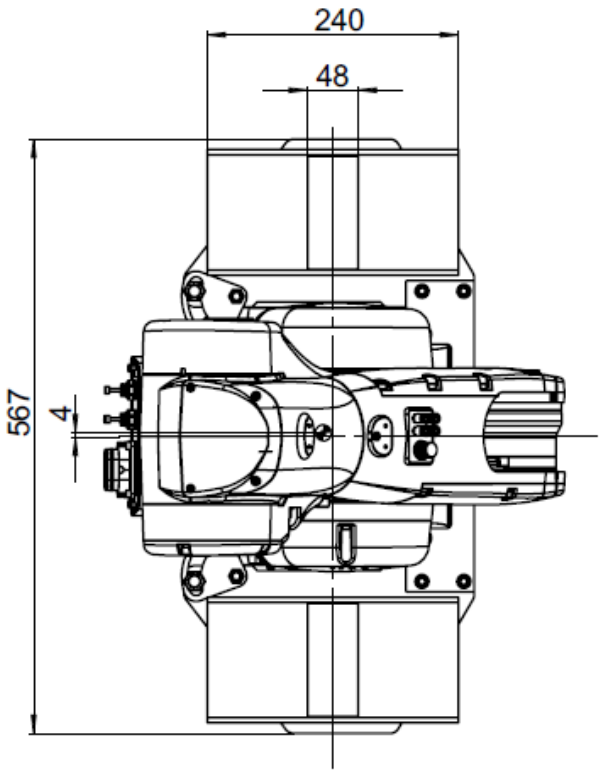
Three views of manipulator during the handling process are as shown in Figure 3-2 (it shall be noted that the actual dimensions may be slightly larger than those in the Figure):



(a)



(b)



(c)

Figure 3-2 Dimensions of AIR8-710B manipulator during the handling process

3.2 Handing posture

The position and posture of the AIR8-710B manipulator during transportation are shown in Figure 3-3.

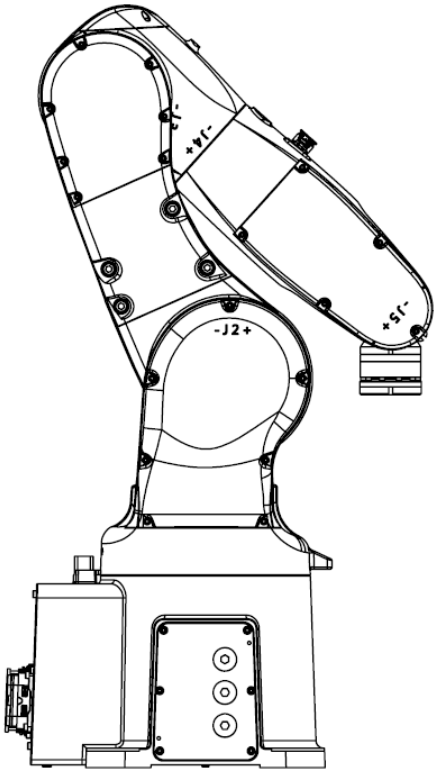


Figure 3-3 Handling posture of AIR8-710B manipulator

Angle values of axes for AIR8-710B manipulator during handling are as shown in Table 3-1.

Table 3-1 Angle values of axes for robot during handling

A1	A2	A3	A4	A5	A6
0°	-24°	156°	0°	48°	0°

Warning

Manipulator shall be handled in strict accordance with the posture in the Table, otherwise it may fall due to unstable center of gravity.

3.3 Handing with forklift

Handling with forklift is as shown in Figure 3-4. Forklift shall meet the requirement for the weight of manipulator. The total weight of manipulator and handling device is about 65.4kg.

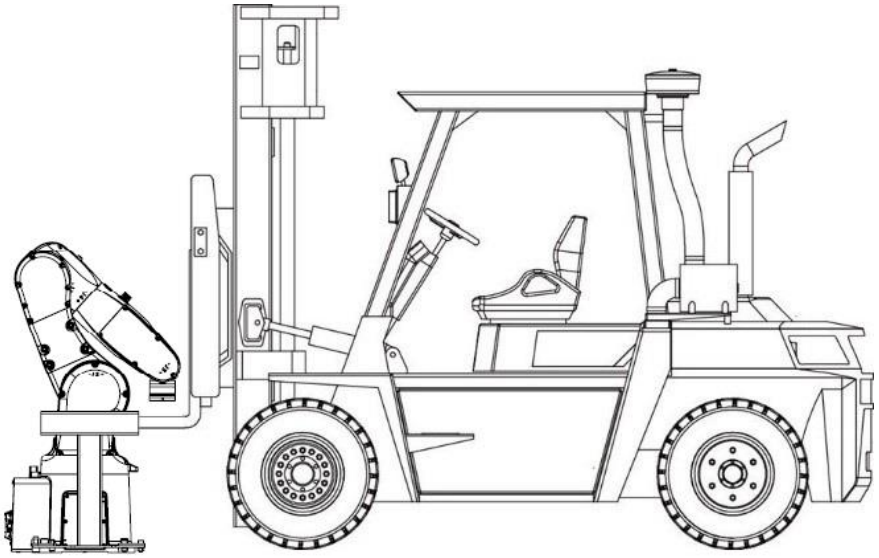


Figure 3-4 AIR8-710B handling with forklift

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 *Chapter 3.1* of this manual.

3.4 Handing with swinging ring

Handling with swinging ring is as shown in Figure 3-5 lifting device shall meet the requirement for the weight of manipulator. The total weight of manipulator and handling device is about 50kg.

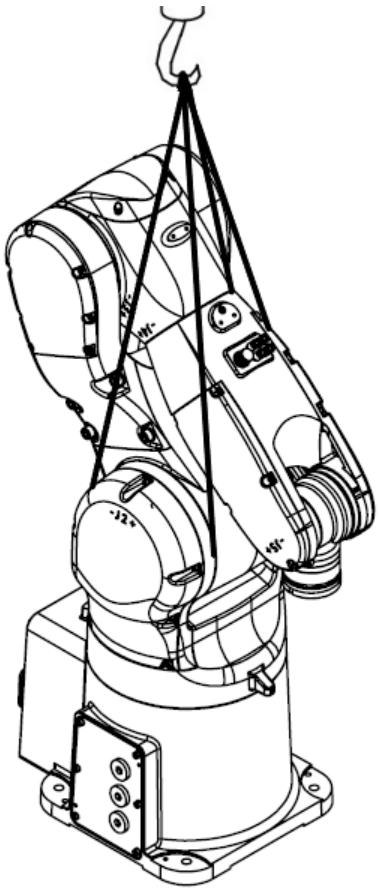


Figure 3-5 AIR8-710B manipulator handling with swinging ring

Caution

- When manipulator is handled with swinging ring, insert a soft object between the sling and manipulator to avoid the scratching on the manipulator 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.

4 AIR8-710B preparation before installation

4.1 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 *Chapter 1.4.*
- Make sure that the installation site can withstand the pressure or pull from the manipulator and its load.

4.2 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 M10 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 Φ10 or other specifications.
- Several round pins (Φ6mm). Please see Chapter 6.2 in this manual for details.

5 Installation of AIR8-710B manipulator

5.1 Technical specifications

It should be given to the strength of foundation installation surface for the installation of manipulator. The installation ground inclination shall be less than 5° for manipulator.

Dimensions of AIR8-710B manipulator base are as shown in Figure 5-1:

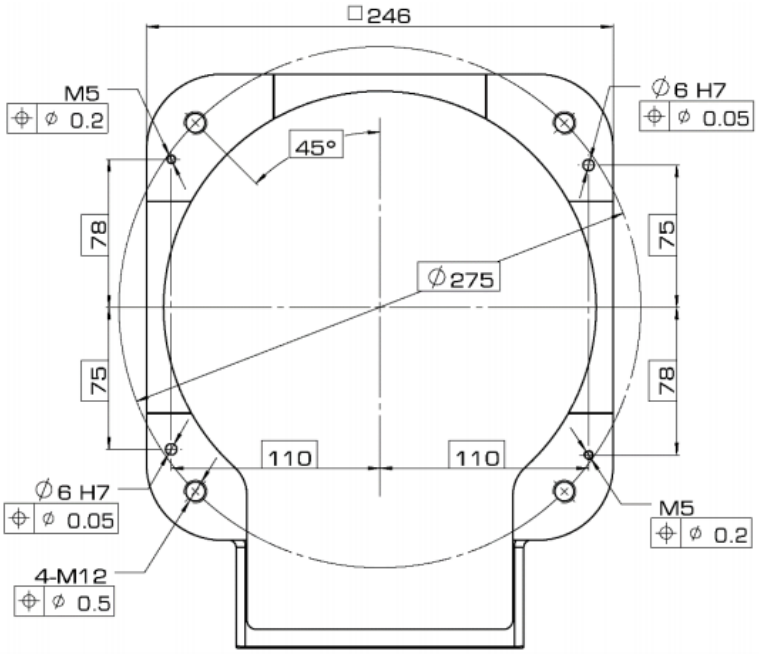


Figure 5-1 Dimensions of AIR8-710B manipulator base interface

5.2 Fixed mode

Two ways of fixing are suitable for AIR8-710B manipulator:

- Ground fixing (mode 1)
- Bracket fixing (mode 2)

Prompt

- Specific fixing mode depends on the usage environments.
- Strength of chemical bolt is subject to the strength of concrete. 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 5-1:

Table 5-1 Parts for Fixing Manipulator

Part Name	Remarks	Ground fixing	Bracket fixing
Fixing screw	Four M10x35 (Grade 12.9)	○	○
Chemical bolt	Four M20 (not less than Grade 4.8)	○	
Fixing plate of robot	Thickness 20mm, 1 piece	○	
Mounting bracket	Thickness 20mm		○

Prompt

- Mark "○" means that the part is in need.
- There shall be no insulating materials between the fixing plate and mounting bracket of robot and the manipulator and concrete.
- 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

Ground fixing process is as follows:

Step1. According to the recommended size shown in Figure 5-2, arrange M20 chemical bolts (with a strength grade not lower than 4.8) on the concrete foundation. Please strictly follow the installation instructions of the selected chemical bolts.

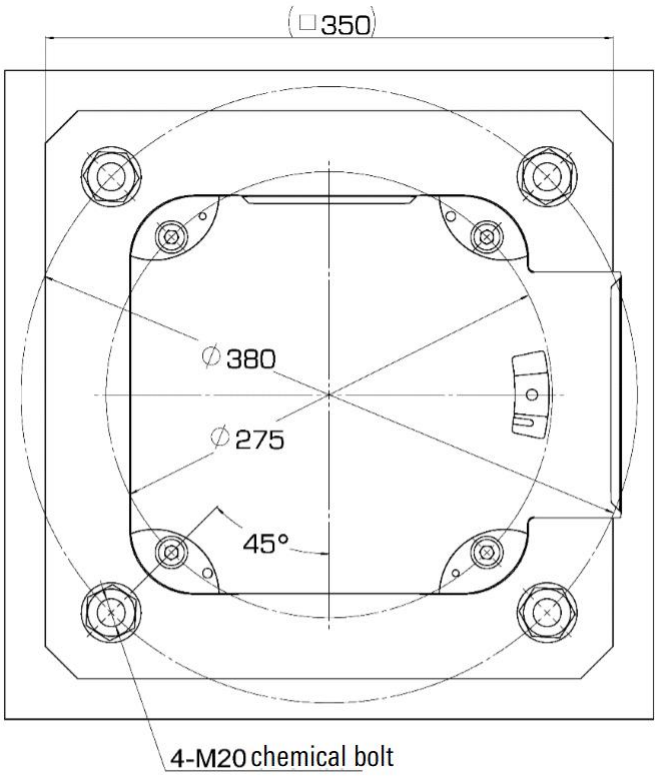
Step2. Fix the robot mounting plate tightly against the installation surface, place it securely, and secure it with four M20 hex nuts (with a strength grade of not less than 4.8) and M20 flat washers.

Step3. In the handling posture, transfer the manipulator above the robot's fixed plate, adjust the direction of the manipulator, align the base M12 threaded hole with the robot's fixed plate M10 threaded hole.

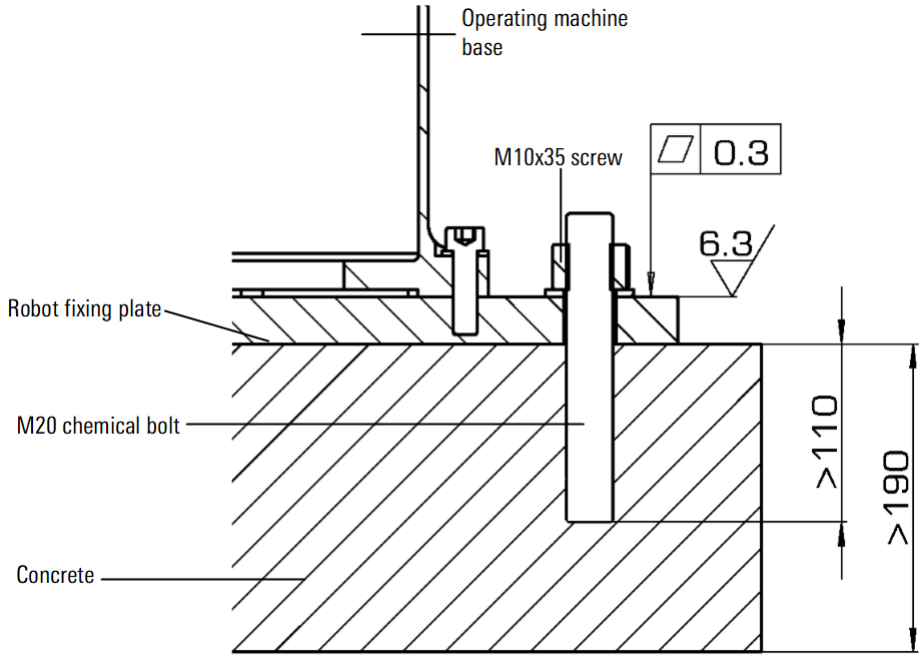
Step4. Check whether the base is tightly fitted to the mounting plate without any shaking. Use four M10x35 screws (grade 12.9) to securely install the base of the manipulator onto the mounting plate.

Prompt

Fixing plate surface shall meet certain roughness and flatness requirements as detailed in Figure 5-2.



(a)



(b)

Figure 5-2 Ground fixed mode

Bracket fixing

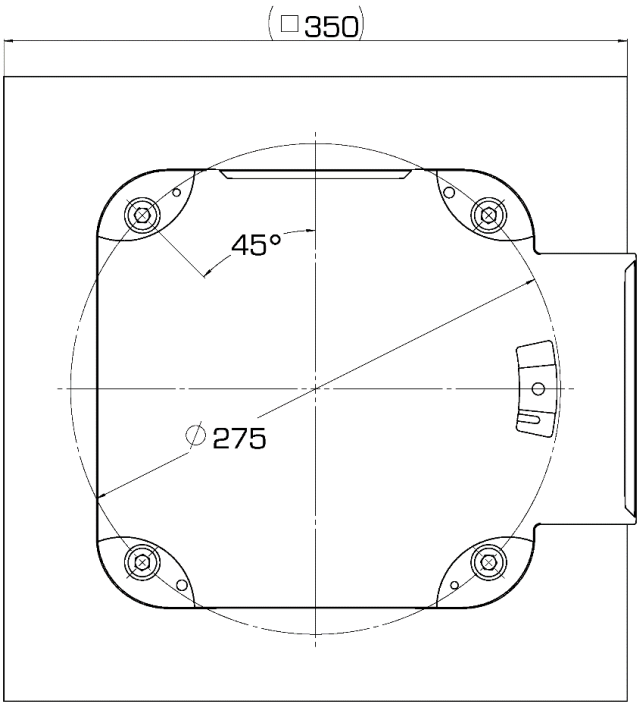
Bracket fixing process is as follows:

Step1. In the handling posture, transfer the manipulator above the installation bracket, adjust the direction of the manipulator, align the base M12 threaded hole with the installation bracket M10 threaded hole;

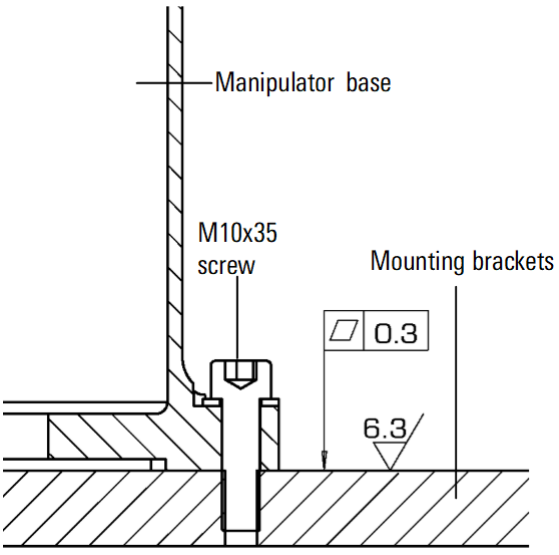
Step2. Check whether the base is tightly fitted to the mounting bracket without any shaking. Use four M10x35 screws (grade 12.9) to securely install the base onto the bracket.

Prompt

Mounting surface of bracket shall meet certain flatness requirements as shown in Figure 5-3.



(a)



(b)

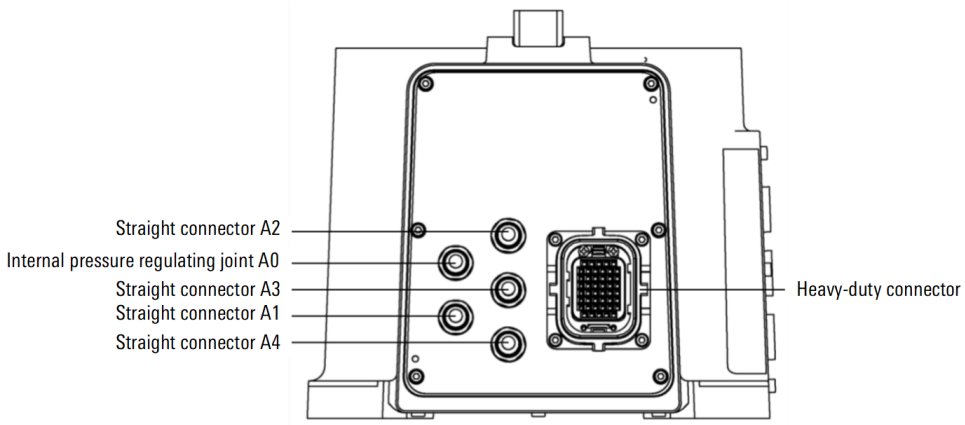
Figure 5-3 Bracket fixing mode

- Fixing screw M10 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.

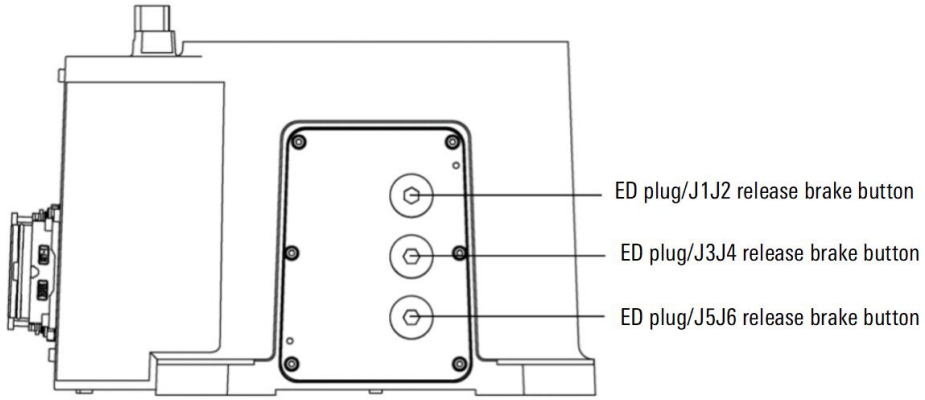
6 Electrical connection of AIR8-710B manipulator

6.1 Electrical interface type of manipulator

The AIR8-710B manipulator base is equipped with heavy-duty connectors, air pipe joints, and a manual release brake button. As shown in Figure 6-1 (a), the heavy-duty connector is on the right side, and there are five ϕ6 quick air pipe joints on the left side. After removing the blind plug, ϕ6 air pipes can be directly inserted. As shown in Figure 6-1 (b), there are three manual release brake buttons inside the ED plug.



(a) Rear view



(b) Left view

Figure 6-1 AIR8-710B manipulator main body base interface

When using the internal pressure regulating joint A0 to adjust the pressure inside the manipulator, it should be ensured that the pressure difference between the inside and outside does not exceed 0.02MPa. At the same time, the internal pressure should not be lower than the external pressure, otherwise it may damage the sealing components.

There is an aviation socket (forearm IO interface) on the manipulator arm of AIR8-710B, and there is an air passage directly connected to the base air pipe joint, as shown in Figure 6-2. The straight-through air passage is sealed with an M5 plug. If you need to use it, you can unscrew the plug and connect a suitable M5 air pipe joint to use.

Steps to operate the 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, and you will be able to see the loose brake button inside the base.

Step3. Connect the manipulator to the control cabinet and connect the control cabinet to the power supply. For specific instructions, refer to Chapter7.2.2 of this manual.

Step4. Press and hold the brake button to release the brakes of the 6 axes of the machine.

Warning

After performing manual loosening of the brake, please reinstall the ED plug onto the manipulator base to prevent dust or liquid from entering the interior of the manipulator.

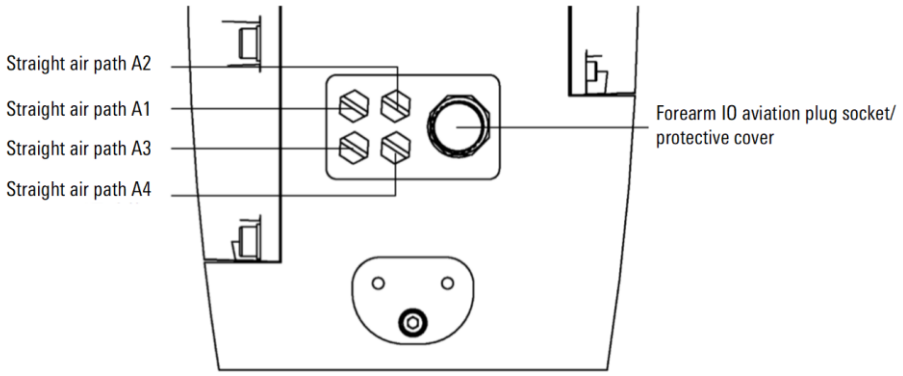


Figure 6-2 Interface on the forearm of AIR8-710B manipulator

Warning

- The forearm IO interface (HRS/LF10WBRB-12P) of the AIR8-710B manipulator is equipped with a waterproof and dustproof cover. Please do not unscrew the cover when the interface is not in use to prevent dust or liquid from entering the internal of the manipulator.
- If you need to use the forearm IO interface, please select the HRS/LF10WBPD-12S aviation plug that comes standard from the factory. For specific installation and usage methods, please refer to the detailed instructions for the corresponding model on the official Hirose website www.hirose.com. Alternatively, you can also choose the L-shaped connector LF10WBLP-12SA with a bent tube.

6.2 Definitions of heavy-duty and aviation plug interfaces of manipulator

Heavy-duty interface of AIR8-710B manipulator (power line) is defined as shown in Table 6-1:

Table 6-1 Definition of heavy-duty interface of manipulator (power line)

Signal name	Axis number	Pin number	Signal name	Axis number	Pin number
U1	Axis 1	1f	U4	Axis 4	5f
V1	Axis 1	1g	V4	Axis 4	5g
W1	Axis 1	1h	W4	Axis 4	5h
PE	Axis 1	1d	PE	Axis 4	4d
U2	Axis 2	4f	U5	Axis 5	3f
V2	Axis 2	4g	V5	Axis 5	3g
W2	Axis 2	4h	W5	Axis 5	3h

Signal name	Axis number	Pin number	Signal name	Axis number	Pin number
PE	Axis 2	4d	PE	Axis 5	1d
U3	Axis 3	2f	U6	Axis 6	5e
V3	Axis 3	2g	V6	Axis 6	6f
W3	Axis 3	2h	W6	Axis 6	6g
PE	Axis 3	1d	PE	Axis 6	4d

Heavy-duty interface of AIR8-710B manipulator (encoder line) is defined as shown in Table 6-2:

Table 6-2 Definition of heavy-duty interface of manipulator (encoder line)

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

The heavy-duty interface definition of AIR8-710B manipulator (electromagnetic valve and forearm IO section) is shown in Table 6-3

Table 6-3 Manipulator heavy-duty interface definition (brake and forearm IO part)

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

Heavy-duty interface of AIR8-710B manipulator is as shown in Figure 6-3:

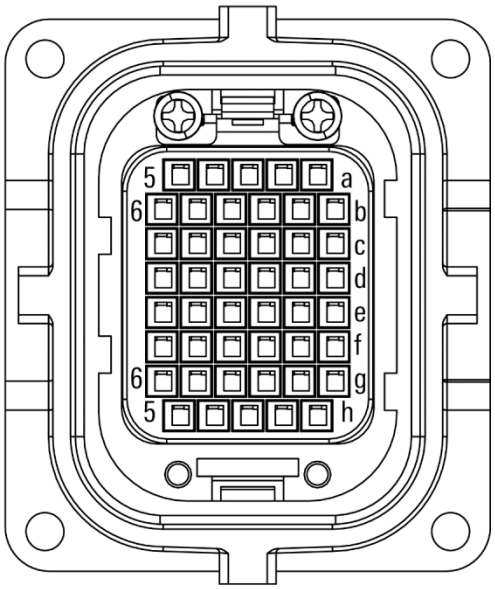


Figure 6-3 AIR8-710B manipulator heavy-duty interface

Prompt

When the robot is connected to the control cabinet, either end of the heavy-duty cable can be plugged into the robot or the control cabinet for heavy-duty.

The IO interface of the AIR8-710B manipulator forearm is shown in Figure 6-4, and the relevant descriptions of each interface can be found in Table 6-4. The IO interface of the manipulator forearm only supports PNP type sensors.

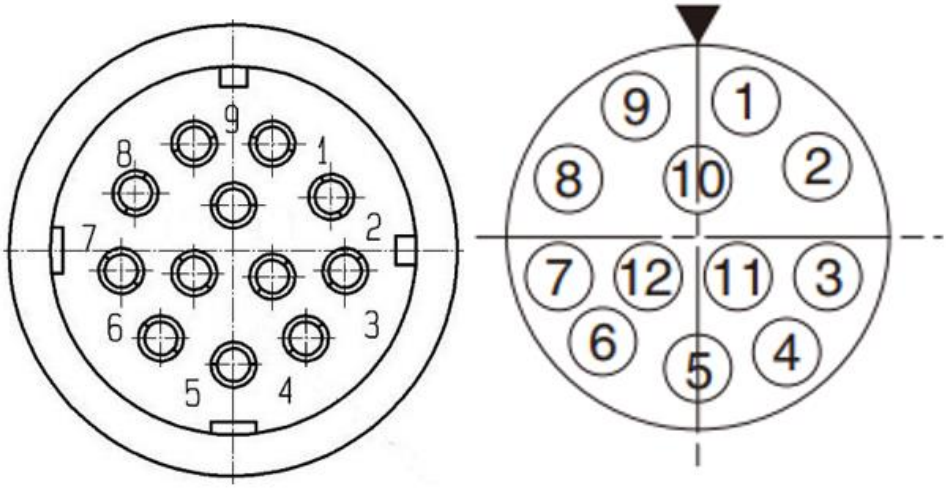


Figure 6-4 AIR8-710B forearm IO interface for manipulator

Table 6-4 Definition of forearm IO interface

Signal name	Connector number
24V	8
GND	9
DO0	6
DO1	7

Signal name	Connector number
DI0	1
DI1	2
DI2	3
DI3	4
DI4	5

6.3 Grounding instructions

The manipulator requires a reliable grounding, and the purpose of grounding includes but is not limited to the following:

- Avoid the situation where the outer shell of the manipulator becomes charged due to insulation failure of the wires, in order to protect the operators from electric shock.
- Provide a common reference zero potential to the circuit, so that there is no potential difference between the grounds of each circuit, ensuring the stable operation of the system.
- Prevent interference from external electromagnetic fields on sensitive electrical equipment inside.
- Reduce the lightning-induced current that may damage the equipment and prevent damage to internal electronic devices.

The grounding point/connection point is on the base of the manipulator in Figure 6-5. The user needs to ground one end of the wire and fix the other end to the base using an appropriate terminal and M5 bolt. The contact surface between the terminal and the base should be cleaned thoroughly to ensure conductivity.

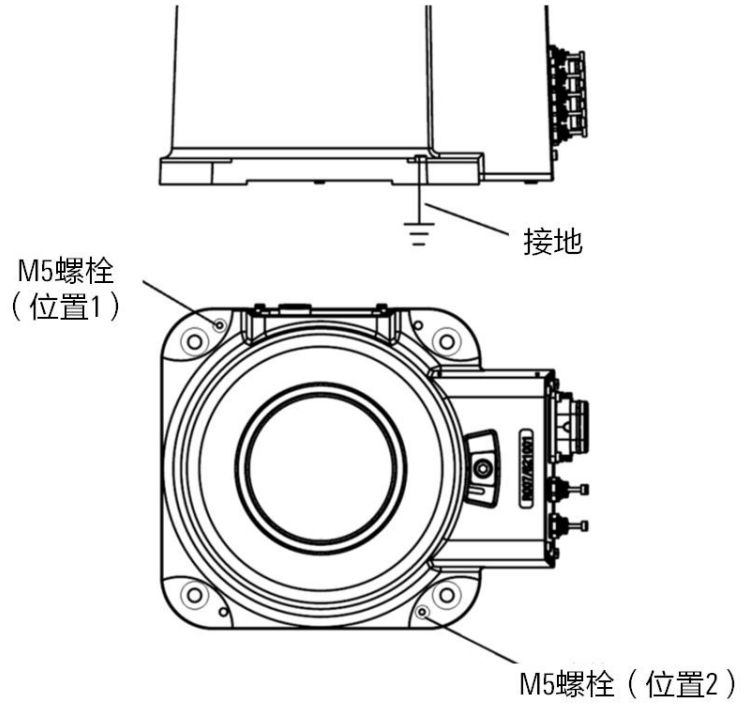


Figure 6-5 Grounding method of AIR8-710B

7 Adaptation and connection of AIR8-710B manipulator and accessories

7.1 Examples of accessory types

The accessory equipment of the manipulator mainly includes mechanical grab (Figure 7-1), hydraulic pressure sucker (Figure 7-2), welding gun welder (Figure 7-3), infrared identification equipment, visual identification equipment, cutting machine and other special equipment, etc.

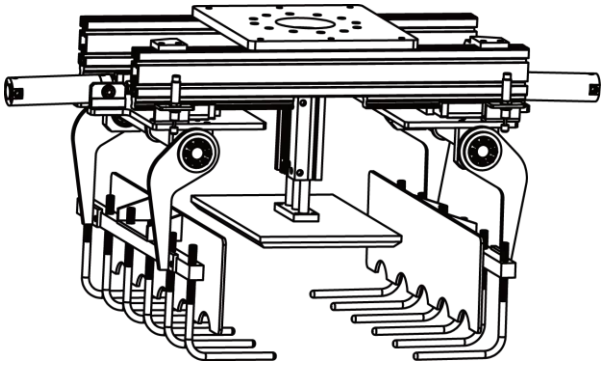


Figure 7-1 Industrial robot grab

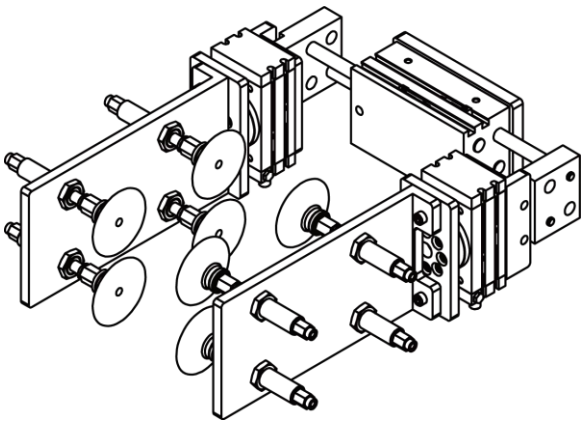


Figure 7-2 Suction cups for industrial robots

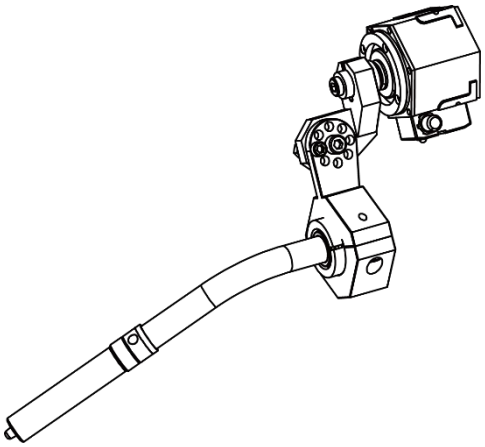


Figure 7-3 Arc welding gun for industrial robot

7.2 Connection mode

7.2.1 Connection between manipulator and accessories

The connection and load between the external auxiliary equipment and the manipulator are similar to those of the manipulator, and can be directly or indirectly connected to the manipulator through the flange, which is detailed in *Chapter 8.6* of this manual.

7.2.2 Connection between manipulator and control cabinet

As described in *Chapter 6.2* of this manual, the heavy-duty connector on the manipulator is connected to the control cabinet through three cables. The definition of heavy-duty connector on the control cabinet of AIR8-710B manipulator is shown in Figure 7-4 below. For more details, please refer to the corresponding manual of the electrical part.

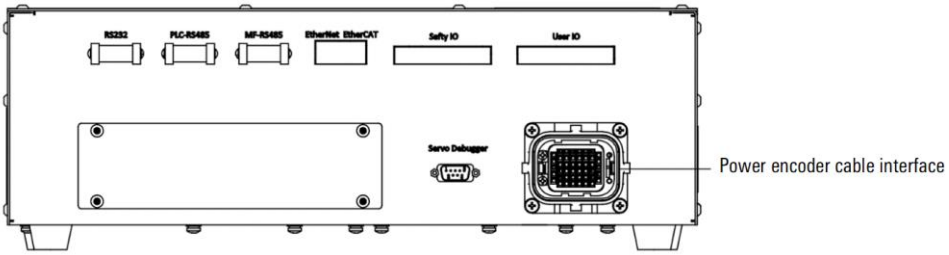


Figure 7-4 The definition of inCube10 cabinet cable connector

8 Performance parameters of AIR8-710B manipulator

8.1 Basic specification

See *Chapter 1.3* of this manual for the basic specifications of AIR8-710B manipulator.

8.2 Dimension and working range of each joint

The motion range of each axis of AIR8-710B manipulator is shown in Table 8-1.

Table 8-1 Motion range of each axis of AIR8-710B manipulator

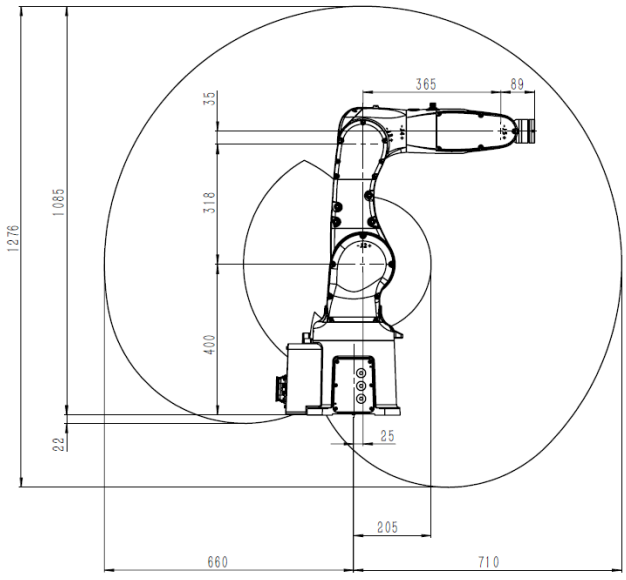
Axis number	Range of motion (°)
J1*	-170 ~ +170
J2	-100 ~ +135
J3	-120 ~ +156
J4	-200 ~ +200
J5	-135 ~ +135
J6	-360 ~ +360

Prompt

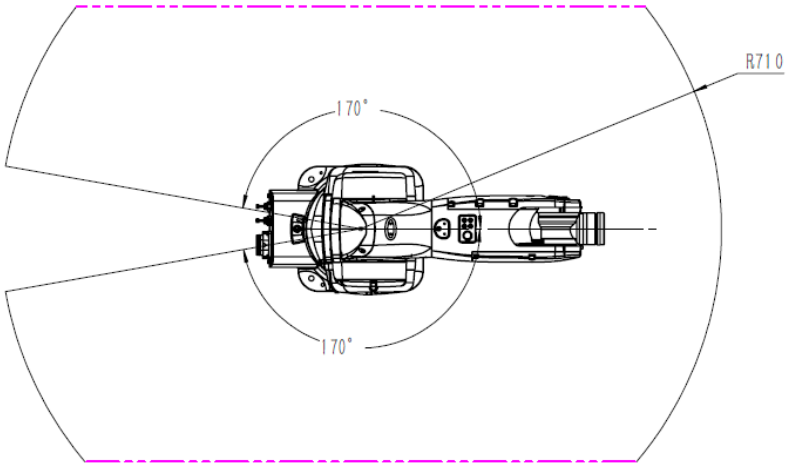
"*": If the mechanical limit of J1 axis is removed, the motion range can reach -180° ~ 180°.

See Figure 8-1 for the motion range of the manipulator.

During the installation of peripheral equipment, attention shall be paid to avoid interference with the main part and motion range of the robot. Unit: mm.



(a)



(b)

Figure 8-1 Working range of AIR8-710B manipulator

8.3 Mechanical limit

On each axis, there are zero points and movable ranges. As long as the origin position is not lost due to servo system abnormalities or system errors, the robot is controlled to move within the movable range. In addition, to further ensure safety, a optional mechanical brake is provided on axis 1 to limit the movable range. The mechanical body of axis 4 has a sliding limit device as its mechanical limit.

Figure 8-2 shows the position of mechanical brake.

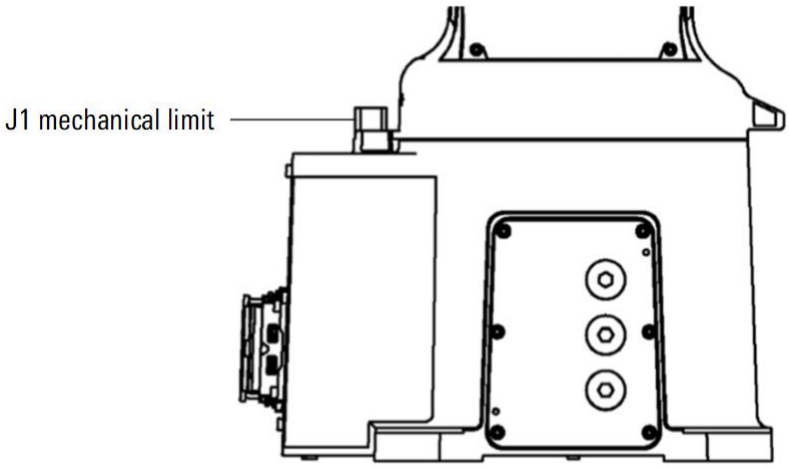


Figure 8-2 Mechanical brake on AIR8-710B manipulator

Warning

Please do not modify the mechanical brake system, as it may cause the robot to fail to stop properly.

8.4 Speed of each axis

The maximum angular speed of each axis of the manipulator is shown in Table 8-2.

Table 8-2 Maximum angular speed of each axis of the manipulator

Axis number	Maximum angular velocity (°/s)
J1	380
J2	350
J3	480
J4	490
J5	565
J6	815

8.5 Output flange size

Figure 8-3 show output flange connection size of AIR8-710B.

The Table 8-3 show output flange specification of AIR8-710B. Tightening torque of screws is shown in *Appendix B*.

Table 8-3 The output mechanical interface specifications of AIR8-710B

Specification	Description
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

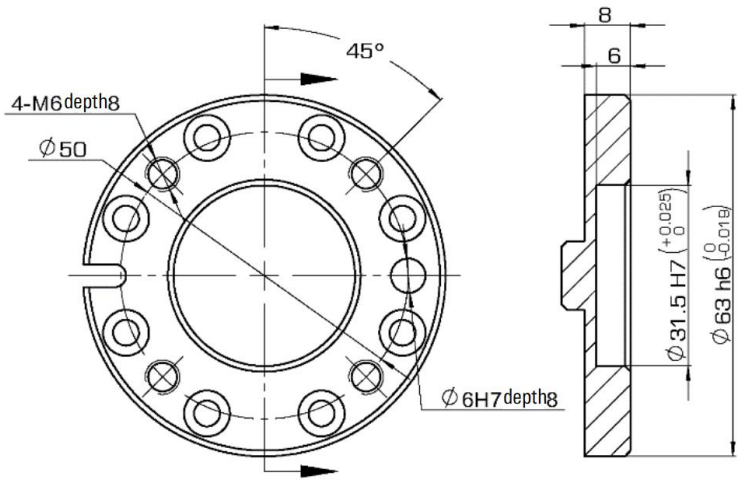


Figure 8-3 The flange dimension diagram of wrist of AIR8-710B manipulator

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 (8mm) and the depth of the pin hole (8mm), otherwise the wrist of the operator will be damaged.

8.6 Load and installation method

8.6.1 Moment of inertia calculation method

The moment of inertia refers to how difficult it is for the load (end of fixture + workpiece) to rotate when the robot joint starts to rotate (the amount of inertia). The moment of inertia increases with load weight and eccentricity. Since this will also increase the load on the joints, make sure the moment of inertia is within the allowable value range.

Through the following formula, the moment M (N·m) and inertia moment I (kgm^2) can be obtained when the load (end of fixture + workpiece) is small.

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

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

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

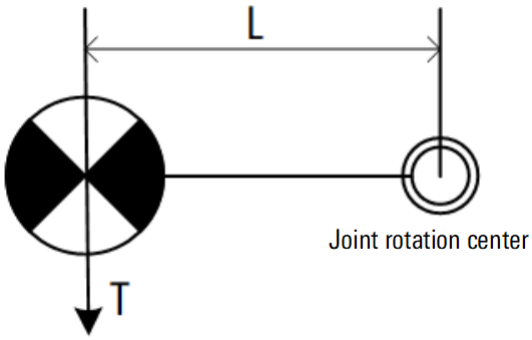
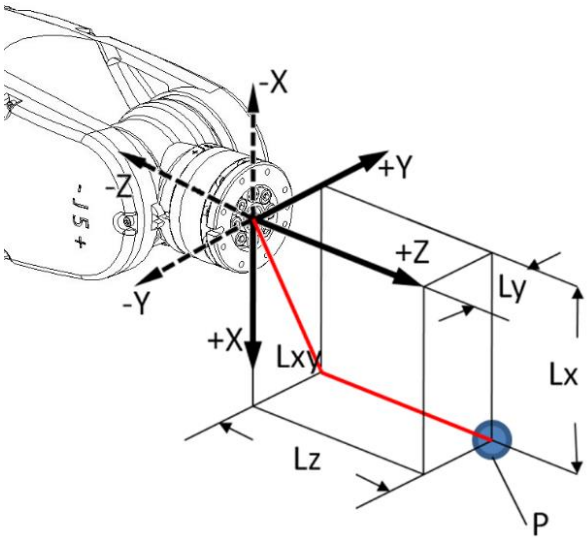


Figure 8-4 Load eccentricity diagram

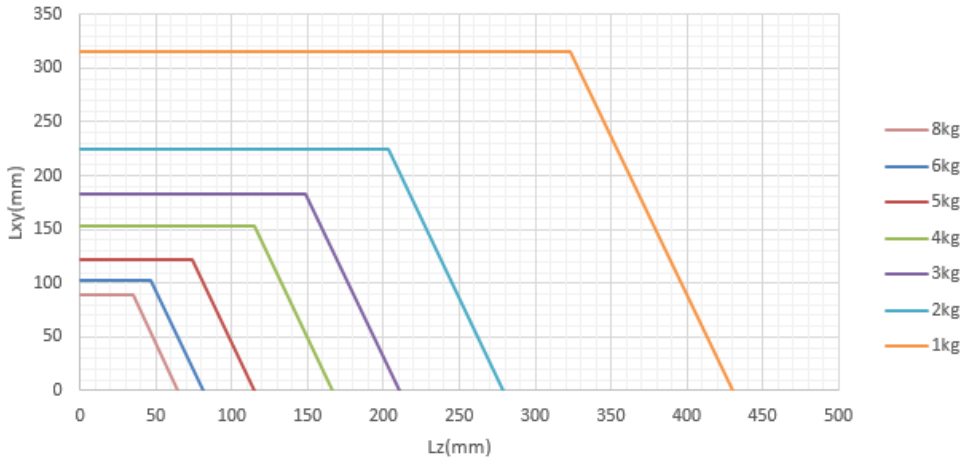
8.6.2 Wrist load installation of manipulator

The load line diagram of the AIR8-710B type manipulator wrist is shown in Figure 8-5.

- For loads with a mass not exceeding 1kg, 3kg, 5kg, 7kg, 8kg, the centroid positions Lxy and Lz should be within the range of the corresponding wireframe shown in Figure 8-5 (b); Figure 8-5 (a) is defined To understand 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 12Nm, that of axis 5 is less than 12Nm, and that of axis 6 is less than 6Nm.
- The allowable load moment of inertia of 4-axis is less than $0.3kgm^2$, that of 5-axis is less than $0.3kgm^2$, and that of 6-axis is less than $0.1kgm^2$.



(a)



(b)

Figure 8-5 Location of wrist load center of AIR8-710B manipulator

8.6.3 Installation of elbow equipment of J3 of manipulator

The specifications and dimensions of the equipment mounting holes of the J3 axis elbow of the AIR8-710B type manipulator are shown in Figure 8-6.

- AIR8-710B type manipulator can install external equipment with a weight not exceeding 8kg at the elbow and wrist.
- The position of the center of mass of the elbow load must be within the 50mm×50mm area shown in Figure 8-6.
- The height of the center of mass is less than 60mm from the installation surface.

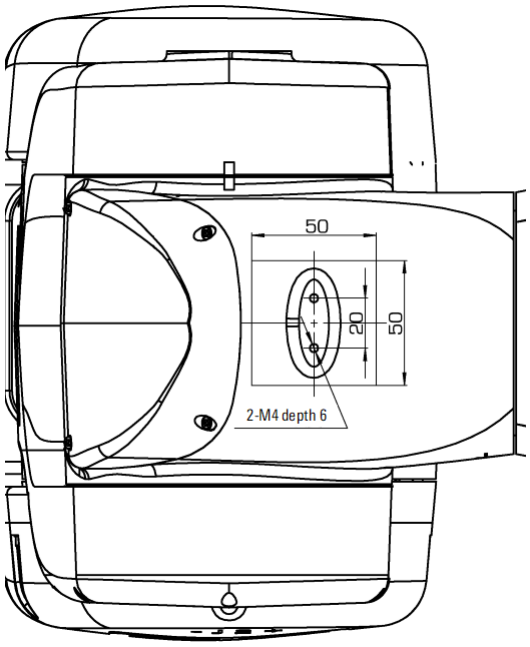


Figure 8-6 AIR8-710B type manipulator elbow load interface size diagram

When installing the equipment, the reliability of installation shall be fully considered. It is recommended to use 12.9 grade screws to install according to the specified torque, and apply thread glue on the thread, otherwise the long-term operation may lead to looseness or even fracture, resulting in accidents.

Warning

- Since it may cause adverse effects on the safety and function of the manipulator, it is absolutely not allowed to add machining holes and screw holes to the manipulator.
- When installing the equipment, the screw used shall fully consider the depth of the threaded hole, and the installation length shall not exceed the depth of the threaded hole (6mm), otherwise the elbow of the manipulator will be damaged.
- The mass center of elbow load shall not exceed the above value, otherwise the manipulator may give an alarm, fail to work normally, or reduce the working life.
- When installing the equipment at the elbow of the manipulator, pay attention to avoid the interference with the manipulator and the cable, otherwise the main body cable is broken, resulting in unexpected serious faults and consequences.

8.6.4 Installation location of other parts of the manipulator

In order to facilitate the cable fixing on the manipulator, the AIR8-710B manipulator also reserves other parts, as follows:

Fixed position of manipulator forearm

The mounting hole specifications and dimensions of the manipulator forearm are shown in Figure 8-7.

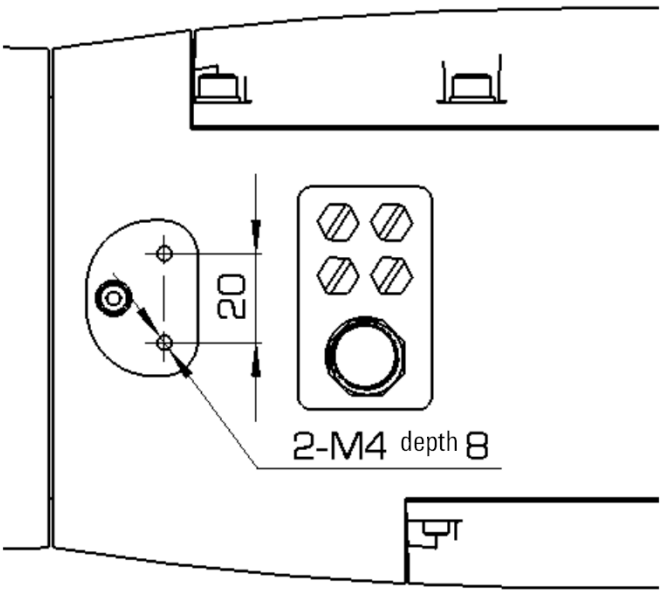


Figure 8-7 Dimension drawing of AIR8-710B type manipulator forearm interface

Fixed position of upper arm big arm and J1 axis

The mounting hole specifications and dimensions of the manipulator upper arm and J1 axis are shown in Figure 8-8 and Figure 8-9.

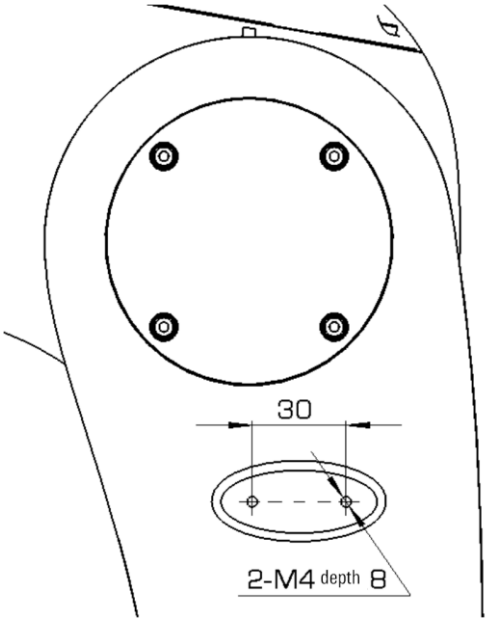


Figure 8-8 Dimension drawing of AIR8-710B upper arm interface

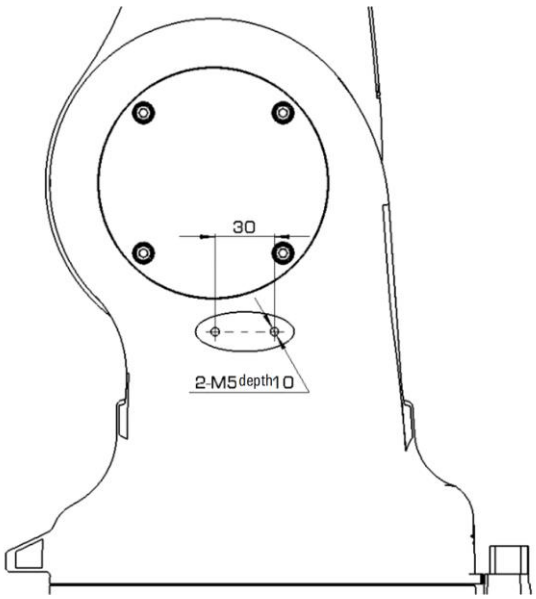


Figure 8-9 AIR8-710B J1 axis interface dimension drawing

Warning

- When installing the equipment, the screw used shall take full account of the depth of the threaded hole, and the installation length shall not exceed the depth of the threaded hole, otherwise the internal components or cables of the operator will be damaged.
- The above parts are designed for cable fixing. If equipment needs to be installed, ensure that the total load is less than 8kg.
- When installing the equipment, the reliability of installation shall be fully considered. It is recommended to use 12.9 grade screws to install according to the specified torque, and apply thread glue on the thread, otherwise the long-term operation may lead to looseness or even fracture, resulting in accidents.

9 Calibration of the axes of AIR8-710B manipulator

9.1 General

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

9.2 When calibration is required

The operator 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).

9.3 Calibration position of each joint

The position of each axis of the manipulator is shown in Figure 9-1 below, in which, except for the J3 axis, it is 90 °, and the other axes are 0 °.

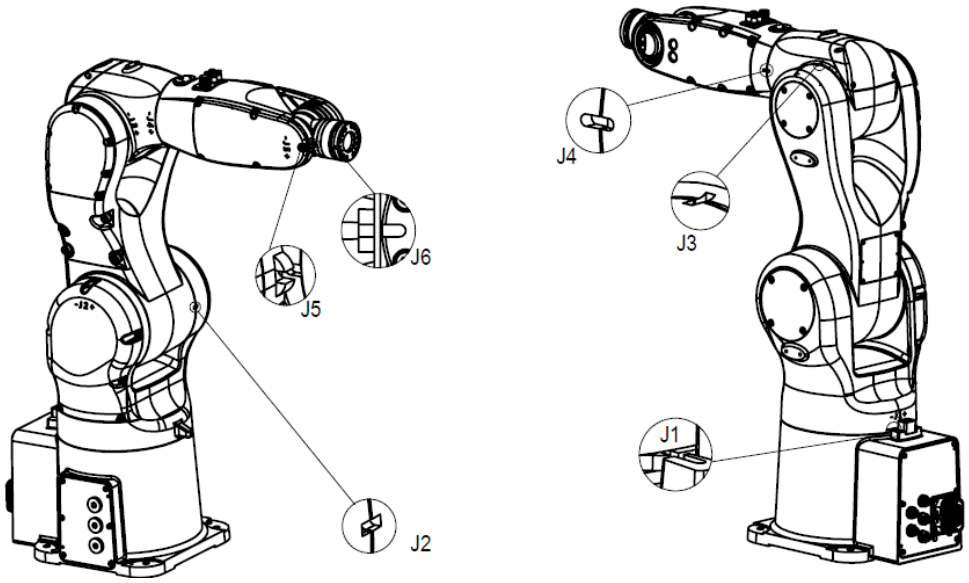


Figure 9-1 Zero point diagram of each axis of AIR8-710B manipulotor

Caution

- The robot calibration must always be performed at the same temperature conditions to avoid errors due to thermal expansion and contraction.
- The AIR8-710B industrial robot calibration must be calibrated in sequence from the joint J1 to J6.

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 9-1, the naked eye shall be used to make the zero point position of each shaft to be aligned, as shown in Figure 9-2.

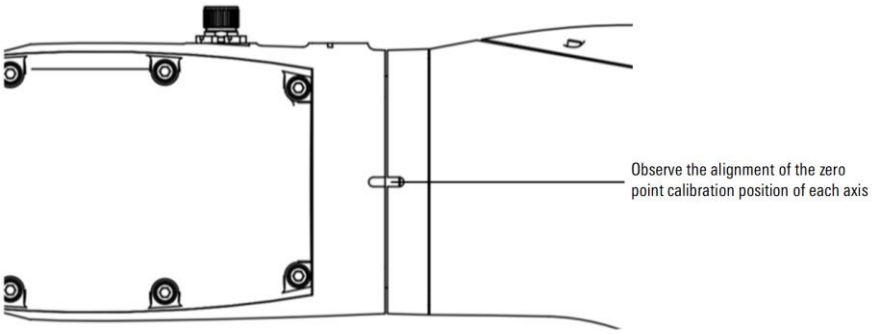


Figure 9-2 Calibration method of naked eye observation zero

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 9-3.

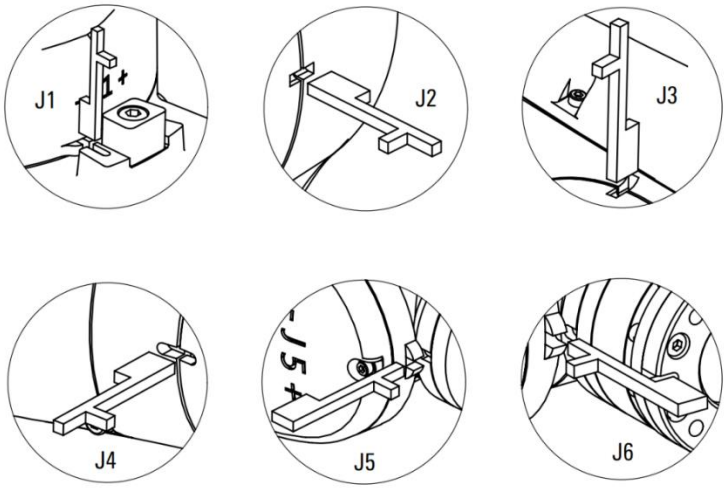


Figure 9-3 Calibration method of zero calibration block

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.

Warning	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 axis, 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 9-3.

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.

9.4 Calibrate the direction of motion of each joint

For a 6-degree-of-freedom industrial robot manipulator, its movement direction is defined as shown in Figure 9-4.

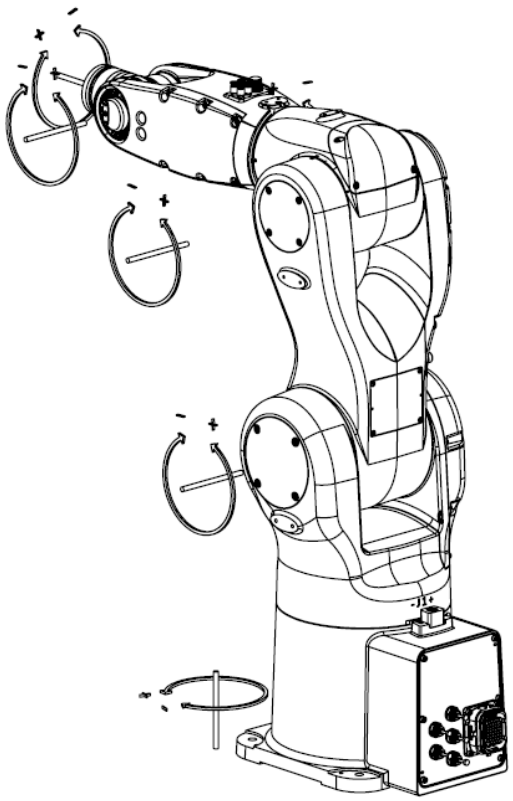


Figure 9-4 Direction of motion of each joint of the manipulator

10 General principles of maintenance

This manual is a description of preventive maintenance of AIR8-710B 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 operator 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 startup position and if there is a deviation from the stop position
3	Action confirmation of peripherals	Confirm that the operation of the operator 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 operator 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	Clean all parts of the 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	Check whether the limit rubber blocks at the J1, J2, J3 and J5 axes are damaged	Check whether the limit rubber block is loose, collision damage, aging and so on.
6	Whether the timing belt is worn	Check the timing belt for wear, elongation, and breakage (Note 4)

Note 1:

Check and repair points

- 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.
- Round connector: Turn it manually to see if it is loose.
- Square heavy load: Check if the control lever is off.
- 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

Regular maintenance for 960 h (3 months)

The following check and repair items shall be done for manipulator after the 960 h or 3 months (whichever comes first).

As shown in Table 11-3

Table 11-3 Maintenance Items for 960 h (3 months)

No.	Check Item	Essentials
1	Cleaning of control cabinet vent	Remove the dust accumulated at control cabinet vent
2	Cleaning of manipulator	Wipe off the dirt and remove the accumulated splash, dust, chip, etc.

Regular maintenance for 1,920 h (6 months)

The following check and repair items shall be done for manipulator after the 1,920 h or 6 months (whichever comes first). As shown in Table 11-4.

Table 11-4 Maintenance Items for 1,920 h (6 months)

No.	Check Item	Essentials
1	Check whether the manipulator cable and cable sheath are damaged	See the first maintenance in *Chapter 11.2.*
2	Is the synchronous belt worn?	Check the synchronous belt for wear, elongation and breakage

Regular maintenance for 3,840 h (1 year)

The following check and repair items shall be done for manipulator after the 3,840 h or 1 year (whichever comes first).

As shown in Table 11-5:

Table 11-5 Maintenance Items for 3,840 h (1 year)

No.	Check Item	Essentials
1	Check whether the manipulator cable and cable sheath are damaged	See the first maintenance in *Chapter 11.2.*
2	Fasten the main external bolts	See the first maintenance in *Chapter 11.2.*
3	Clean the parts of manipulator	See the first maintenance in *Chapter 11.2.*
4	Check whether the cables of end effector are damaged	See the first maintenance in *Chapter 11.2.*
5	Replacement of Synchronous Belt	See the first maintenance in *Chapter 11.2.*
6	Check whether the limit rubber block of J1 axle is damaged	See the first maintenance in *Chapter 11.2.*

Regular maintenance for 7,860 h (2 years)

The following check and repair items shall be done for manipulator after the 7,860 h or 2 years (whichever comes first).

As shown in Table 11-6:

Table 11-6 Maintenance Items for 7,860 h (2 years)

No.	Check Item	Essentials
1	Battery Replacement	See *the first maintenance in Chapter 12.3.*

Regular maintenance for 11,520 h (3 years)

The following check and repair items shall be done for manipulator after the 11,520 h or 3 years (whichever comes first).

As shown in Table 11-7:

Table 11-7 Maintenance Items for 11,520 h (3 years)

No.	Check Item	Essentials
1	Replacement of Synchronous Belt	See *the first maintenance in Chapter11.2.*

Regular maintenance for 15,360 h (4 years)

The following check and repair items shall be done for manipulator after the 15,360 h or 4 years (whichever comes first). As shown in Table 11-8:

Table 11-8 Maintenance Items for 15,360 h (4 years)

No.	Check Item	Essentials
1	Replace the internal cables of manipulator	Replace the manipulator cable, please consult with us

Regular maintenance for 19,200 h (5 year)

The manipulator shall be overhauled with many parts replaced for 5 years or 192,000 h (whichever comes first). Please contact us. As shown in Table 11-9:

Table 11-9 Maintenance Items for 19,200 h (5 years)

No.	Check Item	Essentials
1	Manipulator overhaul	Please consult with us

12 Project maintenance process

12.1 Cleaning of manipulator

To ensure the long-term operation of robot, the manipulator shall be cleaned every 960 h 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. Use a vacuum cleaner or wipe with a cloth to clean the manipulator. Pay special attention to cleaning the movable parts of the robot (joints, end flanges, hollow holes in the forearm, corrugated cable protection tubes, and the area around the welding gun and wire feeder tube).

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


Warning

- 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

To ensure the long-term operation of robot, the manipulator cable shall be checked every 1,920 h or 6 months (whichever comes first).

Cable repair process inside the base

The maintenance process is as follows:

Step1. Remove the cover plate, as shown in Figure 12-1, to observe the internal cables of the base.

Step2. Check if there is any wear or damage at the cable and fixed plate fixing point.

Step3. Check if there is any wear or damage to the internal cables.

Step4. If there are cracks, wear or damage, please contact our company for replacement in a timely manner.

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

Step6. Install the lower cover plate, making sure to put the sealing gasket back in its original position.

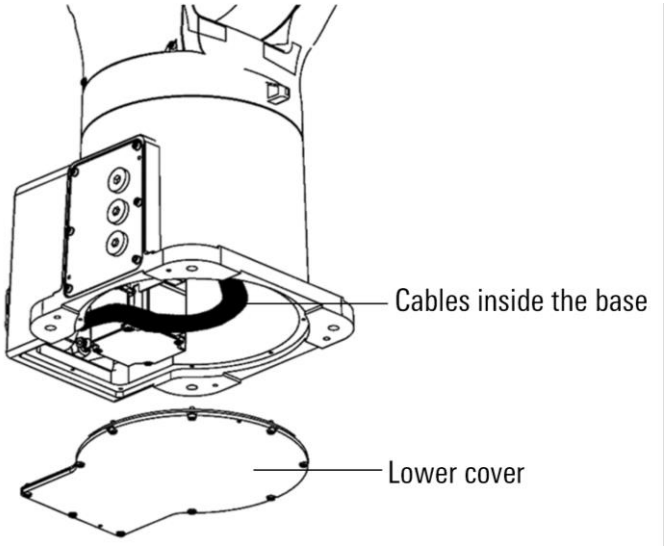


Figure 12-1 Overhaul of cables inside the base

J1 axis manipulator internal cable repair process

The maintenance process is as follows:

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

Step2. Pull out the cable and check whether the connection between the cable and the bracket is reliable.

Step3. Check the cable and bracket for wear or damage.

Step4. Check the internal cables for wear or damage.

Step5. If there is any crack, wear or damage, please contact our company in time for replacement.

Step6. Check whether the grease on the surface of the internal cable disappears.

Step7. If the grease on the cable surface disappears, it should be replenished in time.

Step8. Install the cable inside the J1 axis.

Step9. Install the cover of the J1 axis, and apply sealant to the joint surface of the cover and the J1 axis.

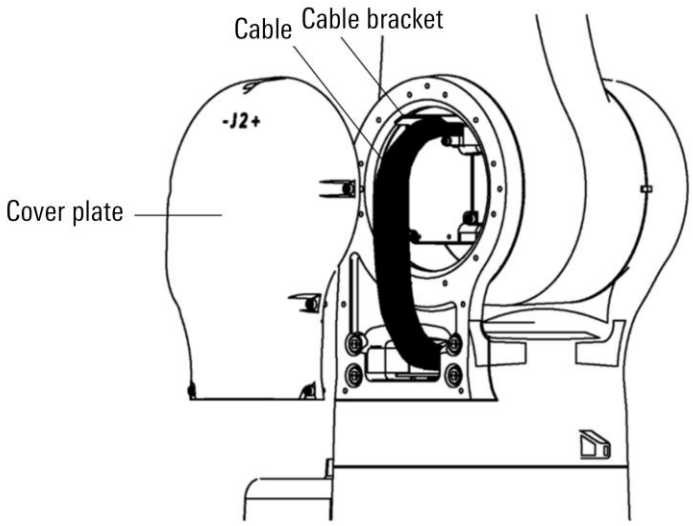


Figure 12-2 Overhaul of internal cable of J1 axis body

Overhaul process of inner upper arm cable

The maintenance process is as follows:

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

Step2. Check the cable and cable bracket for wear or damage.

Step3. Check the internal cables for wear or damage.

Step4. If there is any crack, wear or damage, please contact our company in time 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 apply sealant to the joint surface of the cover plate and the upper arm.

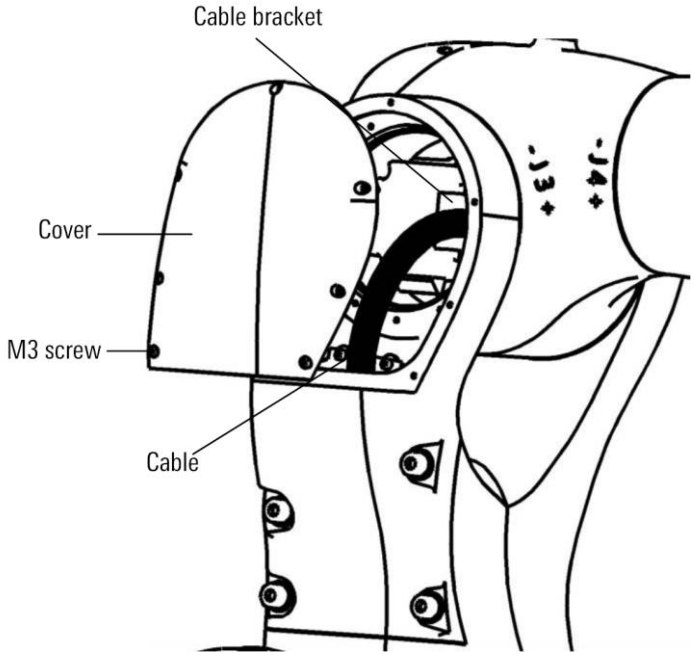


Figure 12-3 Overhaul of internal cable of upper arm


Warning

Please entrust the company's service department for the replacement of the internal cable 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 is saved by the encoder battery. The battery should be replaced in a timely manner when the machine has been running for 7860 hours or 2 years (whichever is shorter), or when the driver prompts A2 alarm.

The replacement process is as follows:

Step1. Adjust the robot to the calibration state.

Step2. To prevent danger, turn off the power, hydraulic source, and air source connected to the robot.

Step3. Disassemble the side cover of the operating base, paying attention to the connected cables inside to prevent damage from forcefully pulling or tugging.

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

Step5. Remove the old battery from the battery compartment and insert the new battery, making sure to align the positive and negative terminals with the old battery.

Step6. Fix the battery box fixing sheet metal back to the base side cover.

Step7. Install the base side cover back, making sure to put the sealing gasket back in its original position.

Step8. After ensuring that all safety conditions are met, proceed with the operation machine calibration and testing work.

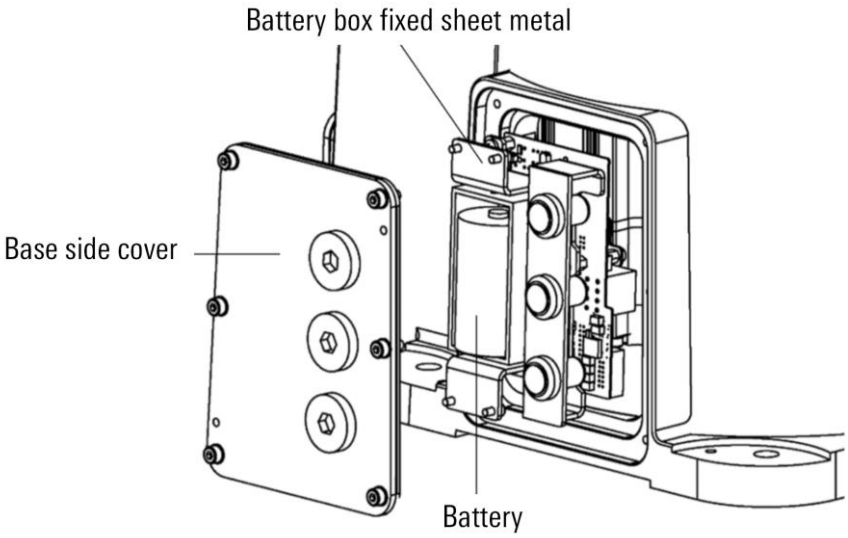


Figure 12-4 Battery replacement diagram

12.4 Replacing the timing belt

Every 3840 hours or 1 year of operation of the manipulator (whichever is shorter), the J1, J5 and J6 axis timing belts need to be replaced.

For the timing belt model, please refer to Table 12-1:

Table 12-1 Manipulator timing belt model

Manipulator model	Timing belt position	Timing belt model
AIR8-710B	Internal axis J1 of the base	Gates, 375-5GT-9
AIR8-710B	J5 axis inside the forearm	Gates, 360-3GT-6
AIR8-710B	J6 axis inside the forearm	Gates, 360-3GT-6

When replacing the timing belt, please refer to Table 12-2:

Table 12-2 Manipulator replacement timing belt posture

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

J5/J6 axis timing belt replacement process

The replacement process is as follows:

Step1. Run the manipulator to the attitude shown in Table 12-2.

Step2. Turn off the power of the control device.

Step3. Remove and operate the machine cover and five M3 screws, as shown in Figure 12-5.

Step4. Loosen the mounting screws of the motor assembly, as shown in Figure 12-6.

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

Step6. Initially tighten the motor base screw M4.

Step7. Adjust the position of the screw, adjust the timing belt to a suitable pretension and installation deflection (refer to Figure 12-7). The recommended pretension is 14.6N and the installation deflection is 2.6mm.

Step8. Install the motor base screw M4 with the specified torque.

Step9. Install the cover of the manipulator and apply sealant to the joint.

Step10. Carry out the calibration of the manipulator J5J6 axis.

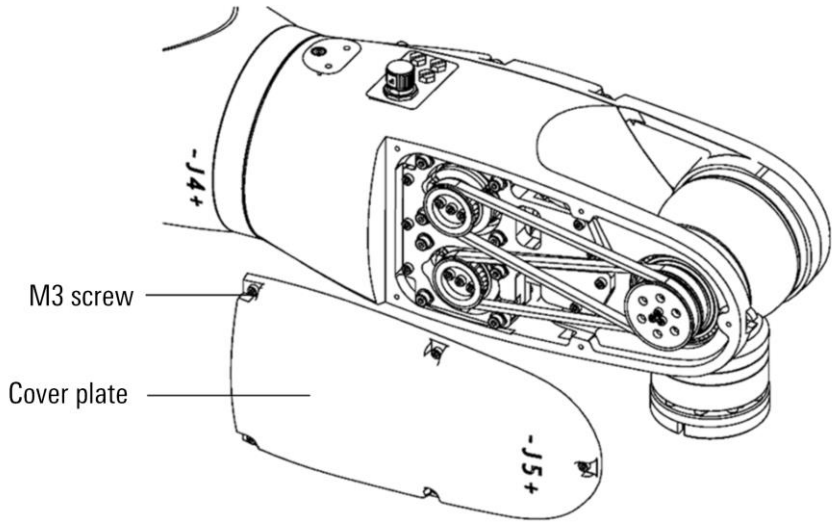


Figure 12-5 Remove cover

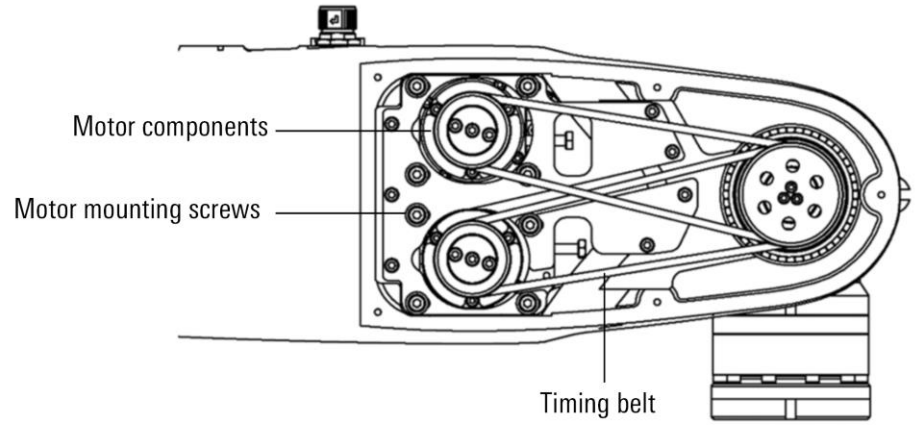


Figure 12-6 Remove the timing belt

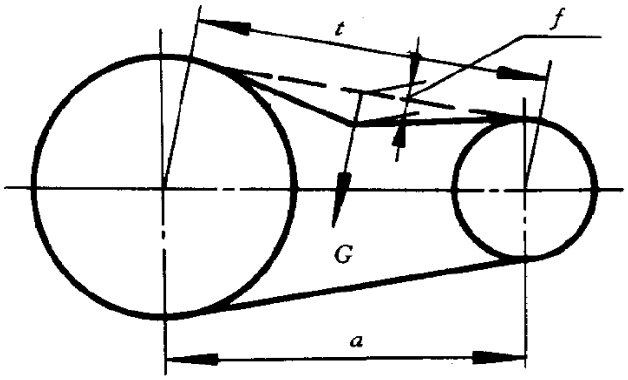


Figure 12-7 Timing belt installation deflection

Warning

After replacing the timing belt, the calibration of the J5J6 axis of the manipulator should be performed. For details, refer to *Chapter 9*.

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. The possible fault and causes of manipulator are as shown in Table 13-1-Table 13-7. 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: 1. The manipulator base is not firmly fixed on the workshop pedestal 2. 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.	1. When the screw is loose, tighten it with the torque wrench according to the proper torque 2. Trim the base flatness in accordance with the tolerance 3. Check if the foreign matters are trapped, and if so, remove them 4. Please consult with us
	Workshop pedestal vibrates when the manipulator acts	Workshop Pedestal: 1. Pedestal is not completely fixed on the foundation. Therefore, the workshop pedestal vibrates when the manipulator acts. 2. The insufficient rigidity of workshop pedestal, and the reaction force and torque generated by the manipulator cause the deformation and vibration.	1. Completely fix the workshop pedestal according to the corresponding method 2. Workshop pedestal shall be processed to improve its rigidity 3. For the workshop pedestal with machining difficulty, the vibration may be mitigated through the modification of moving program 4. Please consult with us

Table 13-2 Possible Faults and Causes of Manipulator

Fault	Classification	Possible Causes	Treatment
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	1. Load of manipulator exceeds the allowable value 2. Action procedures are too strict on the manipulator 3. Improper acceleration	1. Confirm whether the manipulator load exceeds the allowable value, and reduce the load or change the action procedures 2. Mitigate the specific vibrations by reducing speed, reducing acceleration and changing the action procedures
	■ Collision or long-term overload operation of manipulator ■ No replacement of lubricating grease for a long time	1. 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 2. 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. 3. 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 4. The above reasons may cause the periodic vibration or abnormal noise	1. Make the manipulator operate uniaxially to confirm the Joint that produces the vibration and noise 2. If you need to replace the gear, bearing and reducer, please contact us. 3. Do not use the manipulator at overloaded status 4. If you need to replace the lubricating grease, please contact us. 5. Please consult with us

Table 13-3 Possible Faults and Causes of Manipulator

Fault	Classification	Possible Causes	Treatment
Vibration Abnormal noise	Causes may not be determined mechanically	1. 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 2. Fault of pulse encoder and the position of motor not correctly transmitted to the controller 3. Failure of motor body to perform its original functions 4. Breakage of internal motor cable of manipulator causes the command not to be correctly transmitted to the motor and control system 5. Voltage drop and no guarantee for the specified voltage 6. Incorrect control parameters are input	1. For the fault of controller, see the controller manual 2. Replace the motor of vibrating Joint to confirm whether it vibrates 3. 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. 4. 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. 5. Check whether the action control parameters are correct, and if not, re-enter the correct parameters. 6. Please consult with us
	The mechanical action near the manipulator is closely related to the vibration of robot.	1. Mechanical electrical noise from the manipulator 2. 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 3. Poor connection of grounding wire will lead to the unstable grounding, causing the vibration of manipulator due to electrical noise interference.	1. Connect the grounding wire properly to avoid the electrical noise mixed into the manipulator 2. Please consult with us

Table 13-4 Possible Faults and Causes of Manipulator

Fault	Classification	Possible Causes	Treatment
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	1. Abnormal noise from the manipulator at low speed immediately after the replacement or at the restart after the long-term shutdown.	1.Observe the operation of manipulator for 1-2 days. Usually the abnormal noise will disappear.
Shake of manipulator	■ After power-off, some parts of manipulator may be shaken manually. ■ There is a gap between the connecting surfaces of manipulator	1. Manipulator bolts are loose 2. 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. 1. Fixing bolts of motor 2. Fixing bolts of reducer shell 3. Fixing bolts of output shaft of reducer 4. Fixing bolts of pedestal 5. Fixing bolts between arms 6. Fixing bolts of shell 7. Fixing bolts of end effector
	Turn off the power of manipulator, and confirm that the screws are tightened, and shake the entire head of manipulator manually	1. Large backlash is resulted from the wear or damage of internal gears of manipulator due to the overload, collision, etc.	1. If you need to replace the internal gear, please consult with us

Table 13-5 Possible Faults and Causes of Manipulator

Fault	Classification	Possible Causes	Treatment
Motor overheating	■ Ambient temperature rise 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 : 1. Ambient temperature rise or the deterioration of heat dissipation of motor after the cover plate is installed Load Action: 1. Current value of motor exceeds its rated value due to the load and operating procedures	1. Decrease of ambient temperature may prevent the motor from overheating 2. Improvement of ventilation conditions around the motor, i.e. the heat dissipation of motor, may effectively prevent the motor from overheating. 3. A radiation shielding plate if there is a heat source around the motor may prevent the motor from overheating. 4. Slowing down the action procedures and reducing the load may decrease the average current value of motor, thus preventing the motor from overheating. 5. Please consult with us
	Motor overheats after the action control parameters of manipulator are changed	Control Parameter: 1. Improper input parameters will cause the incorrect acceleration and deceleration of robot, so that the average current value of increases.	1. Enter the appropriate parameters according to the relevant instructions. 2. Please consult with us
	Motor overheats due to the causes other than above ones	Mechanical Fault of Manipulator: 1. Mechanical system fault of manipulator causes the overload of motor Motor fault: 1. Brake fault causes the motor to always operate when the brake is applied, which causes the motor to withstand excessive load 2. Failure of motor body to perform its functions causes the excessive current to flow through the motor	1. Please rectify the mechanical fault by reference to the instructions of vibration, abnormal noise and looseness. 2. Please confirm whether the brake is released when the motor is powered on. 3. After the motor is replaced, the overheating of motor disappears. It is confirmed that the this condition is abnormal. 4. Please consult with us

Table 13-6 Possible Faults and Causes of Manipulator

Fault	Classification	Possible Causes	Treatment
Leakage of lubricating grease	Lubricating grease leaks out from the mechanical part	Poor Sealing: 1. Crack of casting due to the excessive external force caused by the collision 2. Damage of O-ring during the disassembly and reassembly 3. Scratch of oil seal due to the dust intrusion 4. Poor sealing between the cover plate and casting	1. 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. 2. Please consult with us
Falling of manipulator Joint	■ The brake is completely ineffective and the Joint falls quickly ■ After the brake is contracted, the shaft falls slowly	1. The damage of brake drive relay causes the brake to always be powered on and not to work. 2. Wear and damage of brake body affect the braking effect. 3. The lubricating oil and grease inside the motor cause the brake to slip.	1. Check if the brake drive relay is damaged, and if so, replace the relay 2. In case of the wear of brake, the damage of brake body and the lubricating grease inside the motor, replace the motor. 3. Please consult with us

Table 13-7 Possible Faults and Causes of Manipulator

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: 1. The unstable repeated positioning accuracy may be caused by the mechanical system abnormality, screw looseness, etc. 2. 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. 3. Abnormality of motor encoder	1. 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. 2. If the repeated positioning accuracy keeps stable, please modify the teaching program. If the collision does not occur again, the deviation may be avoided. 3. In case of the abnormality of motor encoder, replace the motor or encoder. 4. Please consult with us

Fault	Classification	Possible Causes	Treatment
	Position only deviates from the specific peripheral equipment	Deviation of Peripheral Equipment 1. The external equipment under the external force leads to the deviation relative to the manipulator	1. Please relocate the peripheral equipment 2. Please modify the teaching program 3. Please consult with us
	Deviation occurs after the modification of parameters	Parameters: 1. The modification of calibration data causes the loss of manipulator origin	1. Re-enter the previous correct calibration data 2. In case of uncertain calibration data, please recalibrate the manipulator 3. 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 24 h)	70℃
Max. ambient humidity	Less than 95% at constant temperature without condensation
Max. vibration condition	Frequency 22 Hz, amplitude 0.15 mm

14.2 Precautions for storage of manipulator

In addition to *Chapter 1.4* 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 *Chapter 3* 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 *Chapter 4.1* of this manual.

Appendix A Periodic maintenance schedule of AIR8-710B manipulator

Appendix A Periodic Maintenance Schedule of AIR165-A 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
1	Cleaning of manipulator	0.5h	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
2	Cleaning of control cabinet vent	0.1h	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
3	Wether the synchronous belt worn	0.5h	○		○		○		○		○		○		○		○		○		○		○
4	Check the manipulator cable for damage	3h	○		○		○		○		○		○		○		○		○		○		○
5	Check the manipulator cable sheath for damage	2h	○		○		○		○		○		○		○		○		○		○		○
6	Check the connecting cable of teach pendant, control cabinet and manipulator for damage	0.2h	○				○				○				○				○				○

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
7	Check the connectors of motor, etc. for looseness	0.2h	○				○				○				○				○				○
8	Tighten the end effector screws	0.2h	○				○				○				○				○				○
9	Tighten the external main screws	1h	○				○				○				○				○				○
10	Check the end effector cable for damage	0.2h	○				○				○				○				○				○
11	Check the limit rubber block for damage	0.1h	○				○				○				○				○				○
12	Replacement of Synchronous Belt	1h					○				○				○				○				○
13	Battery Replacement	0.5h									○								○				
14	Replace the internal cables of manipulator	8h																	○				
15	Manipulator overhaul																						○

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
Note: ○ indicates that maintenance is required																						

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

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

Performance level / Thread specification	8.8 level	10.9 level	12.9 level
M2	0.35	0.48	0.56
M2.5	0.68	0.93	1.1
M3	1.2	1.6	2
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

Prompt

- 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.

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UM-P05310000054-001 / V1.0.2 / 2023.10.25
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