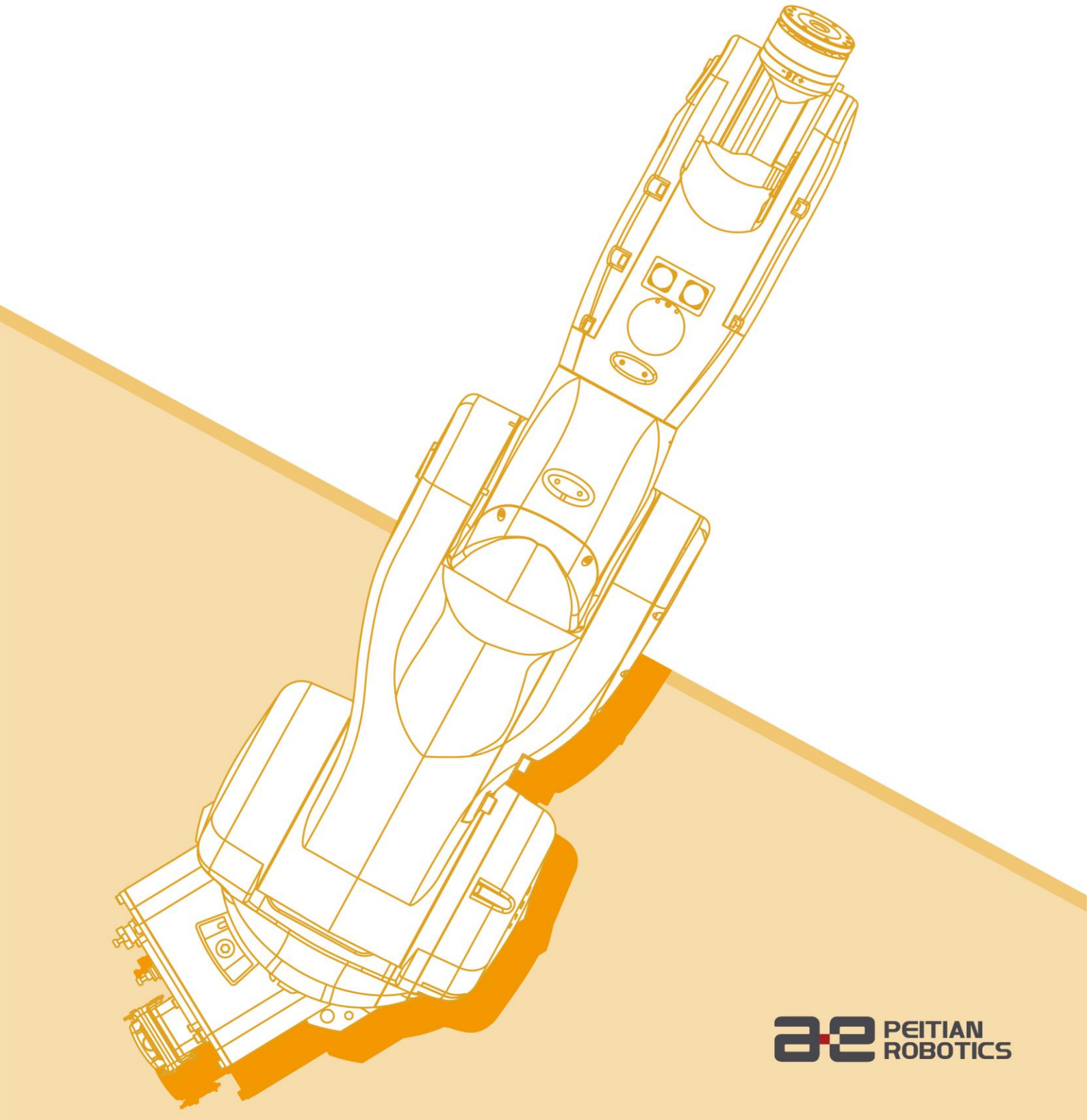
AIR8-710A Operation Manual

V2.4.1



PEITIAN ROBOTICS

Sign

Before using an industrial robot, be sure to read the manual carefully and use it correctly while understanding its content.

Nothing in this manual shall be reproduced or transmitted in any way.

All parameters and design may be changed at any time without notice.

There may be no liability for any errors that may occur in this manual.

We try to describe as many cases as possible in this manual.

However, for various reasons that do not have to be done and are not possible, we have not described it for a variety of reasons.

Therefore, for those situations that are not described in the manual, the "impossible" can be regarded as the case.

The products described in this specification are subject to the limitations of "the Foreign Trade Law of the People's Republic of China".

The export of the product from China to other countries must be subject to the export license of the Chinese Government.

In addition, when the product is re-exported to other countries, the Government's permission to re-export the product should be obtained.

To export or re-export such products, please contact us.

The identity used in this article

The marks and their meanings are shown in Table 1.

Table 1 Common identifiers in this article

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

General safety description

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

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

Safety considerations

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

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

When using the operating machine, it is important 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.

The State party points out a supplementary note other than warning and attention.

General considerations

When connecting or disconnecting relevant peripheral equipment(such as safety fence, etc.)and various signals of the operator, make sure that the operator is in the stop state to avoid wrong connection.

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 homework content
- Safety shoes
- Safety helmet

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

Considerations during installation

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

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.

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

When the safety fence is to be programmed, as much as possible 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 operating machine 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.


Warning

- 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.


Warning

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 operating machine, so as to avoid unnecessary personal injury or adverse effect on the operating machine.

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

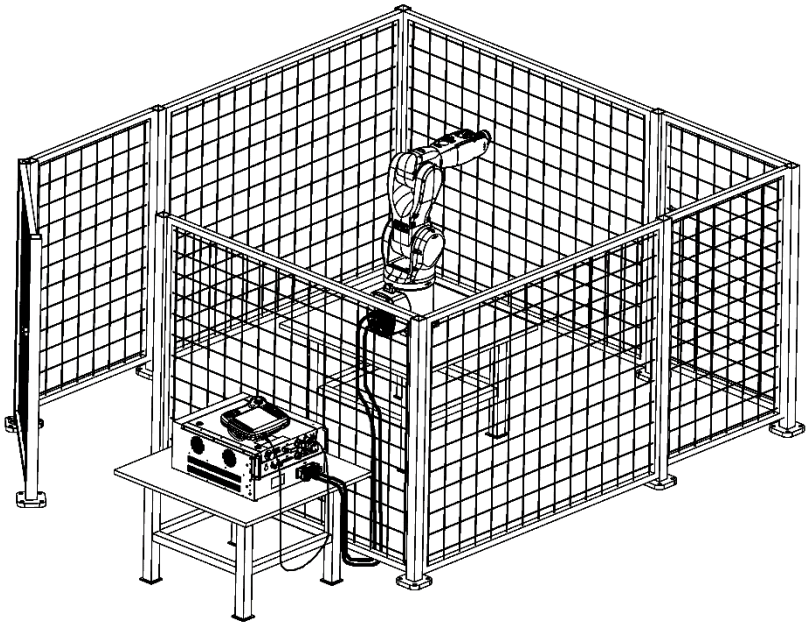


Figure1-1 The Figure of safe operation of industrial robot Schematic Diagram of Safety Operation of Industrial Robot

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 if possible 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 switch 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:

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

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

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

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

  5.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 if necessary 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.

Machinery safety of the manipulator

Attentions during the operation

Operators shall be on high alert and quickly respond to occurrence of all problems when operating the manipulator through slow feeding mode under any condition.

Attentions on relevant program

Mutual interference between manipulators shall be fully avoided during operational scope from multiple manipulators.

Set a specified work origin for manipulator program and create a program starting from work origin and ending at this one to see clearly whether operation of the manipulator is finished or not from the outer edge.

Attentions on mechanism

Keep operating environment of the manipulator clear and use it under environment without influence from grease, water and dust, etc..

Safety for end effector

Time difference before the command reaches the actual operation shall be fully considered and exercise the control with some extension and contraction after sending control command out when controlling all actuators (pneumatic, hydraulic and electric).

Set the detection unit on end effector to monitor status of end effector and control operation of the manipulator.

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1 Document description

1.1 Purpose and content of the manual

This manual is written to allow technicians to install, use the operating machine quickly, correctly, and safely, be familiar with the relevant precautions, and do regular routine maintenance work on the operating machine.

1.2 Manual number and version

The relevant information of the manual is shown in Table 1-1.

Table 1-1 Document related information

Manual name	*AIR8-710A Operation Manual*
Manual number	UM-P05100000007-001
Manual version	V2.4.1

1.3 Manual use objects

- Operator
- Teacher
- Maintenance Engineer

1.4 Relevant manual information

The contents of this manual may involve the following manuals, please refer to them as necessary:

- *AIR series industrial robot system failure and handling manual*
- *inCube10 Control Cabinet Manual*
- *AIR-TP teaching apparatus operator Manual*
- *ARL programming manual*
- *AIR series industrial robot system packing list*

1.5 Declaration of applicable with product standards

The requirements for industrial robot system design are detailed in Table 1-2.

Table 1-2 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

Standard	Description	Version
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

2 AIR8-710A robot overview and basic composition

2.1 Overview of industrial robot

Industrial robot consists of the following parts:

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

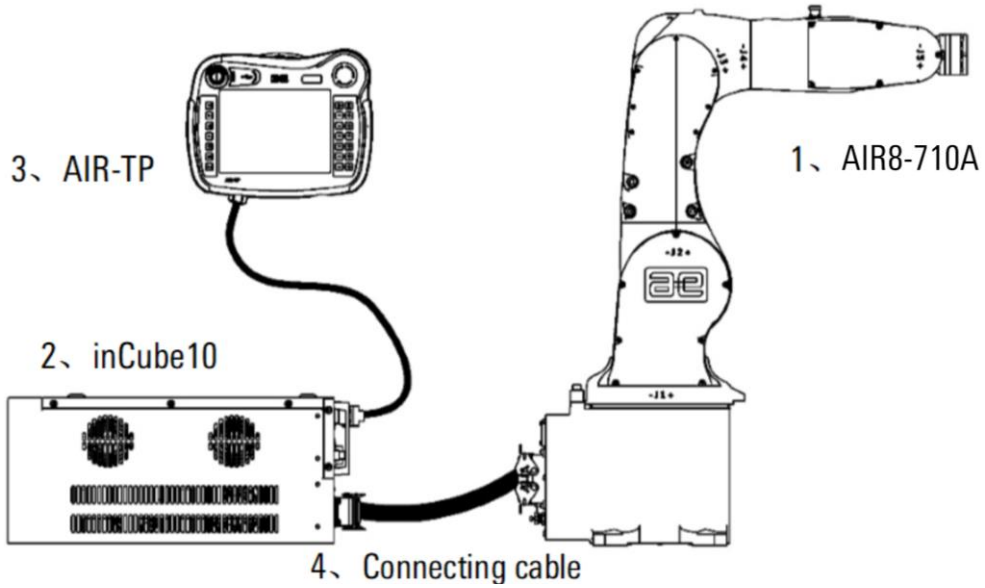


Figure 2-1 Composition of Robot System

Figure 2-1 shows an example of industrial robot system in which:

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

2.2 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.

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

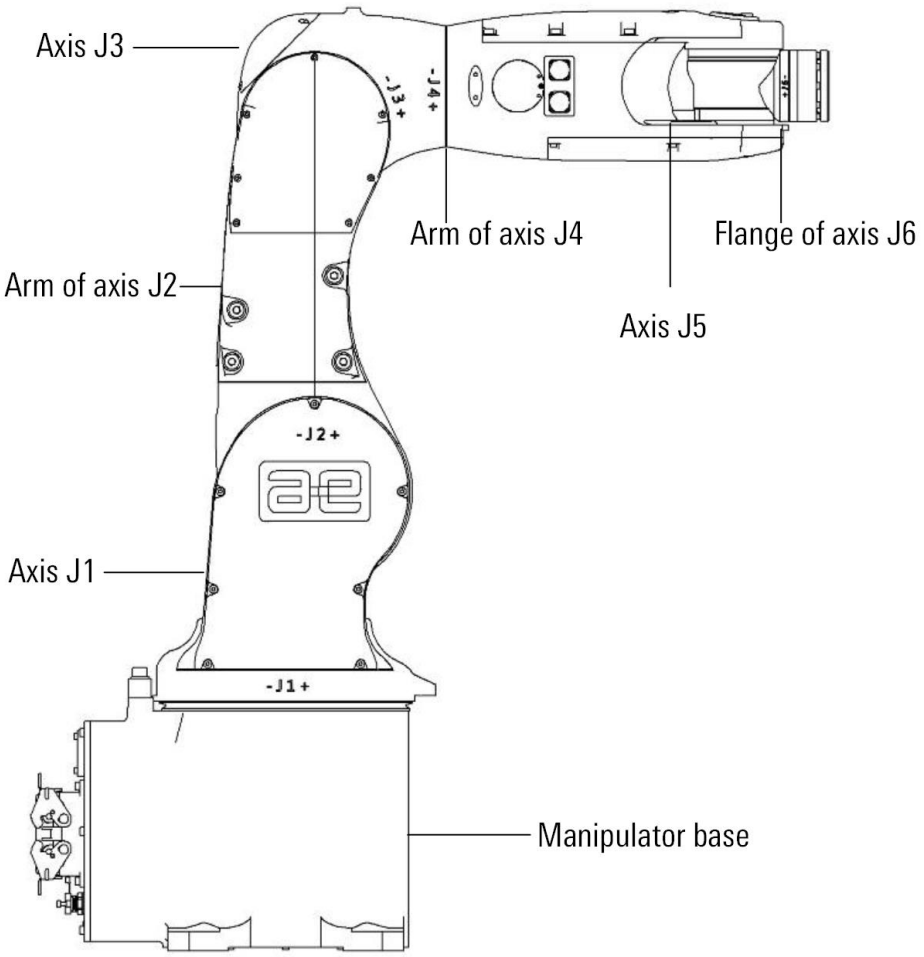


Figure 2-2 AIR8-710A robot body and its various parts

2.3 Basic specifications

The basic specifications of AIR8-710A robot manipulator are as shown in Table 2-1.

Table 2-1 Basic Specifications of AIR8-710A

-		AIR8-710A
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

-		AIR8-710A
	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
Repeated positioning accuracy		±0.02mm
Robot weight		43kg
Noise		70dB
IP rating		IP65
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°.

2.4 Environmental requirements for manipulator

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

Table 2-2 Operating environment requirements

Temperature	Lowest temperature	0℃
	Maximum temperature	45℃
Humidity	The operating environment requirements of the operating machine 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	

3 The label name and meaning of AIR8-710A

3.1 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 3-1.

Figure 3-1 Safety sign of manipulator

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

3.2 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 3-2.

Figure 3-2 Manipulator nameplate

3.3 Manipulator handling gesture label

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

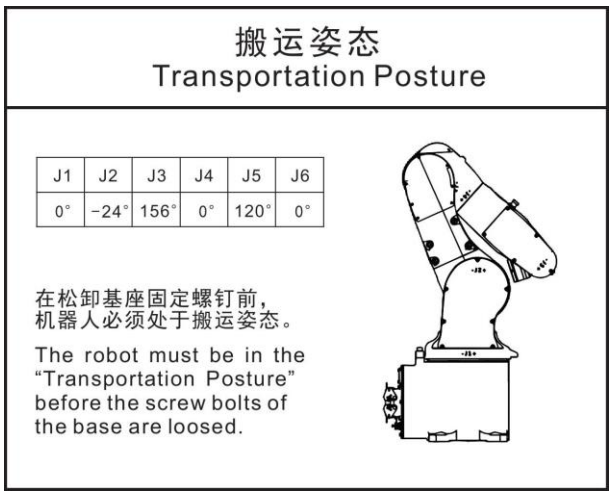


Figure 3-3 Robot handling gesture label

3.4 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 3-4 to indicate the moving direction of each axle. "J1" in sign represents the axle 1 (other axes are represented by the corresponding numbers), "+" indicates the positive direction, and "-" indicates the negative direction.

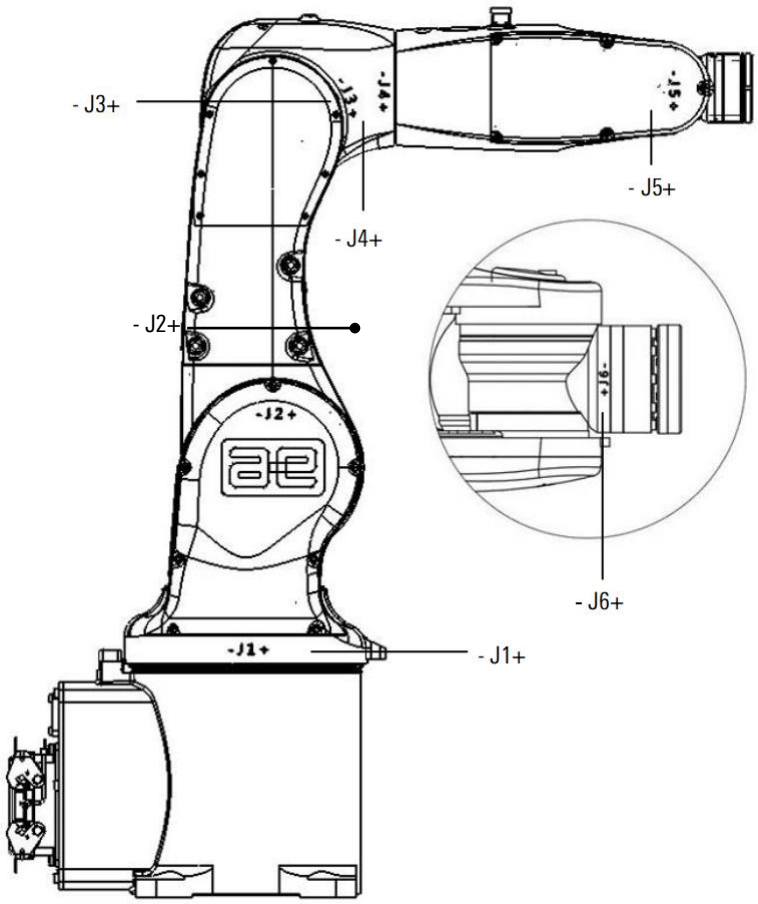


Figure 3-4 Direction sign of each axle on manipulato

4 AIR8-710A transport and handing

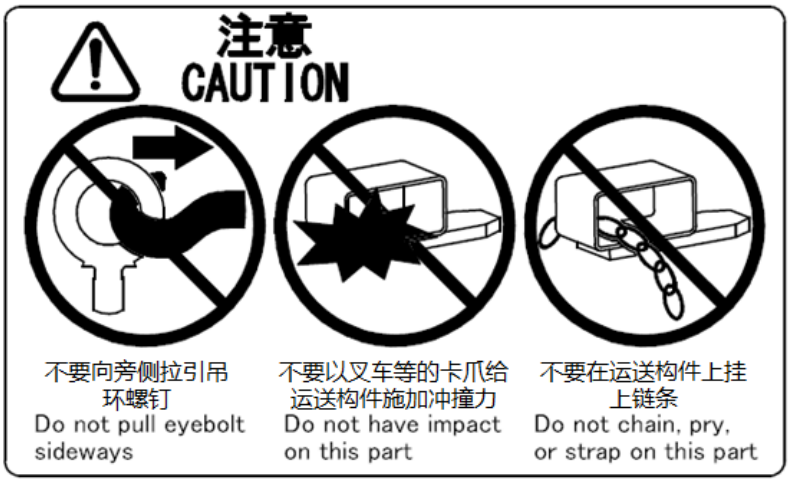


Figure 4-1 Precautions for manipulator during handing

Caution

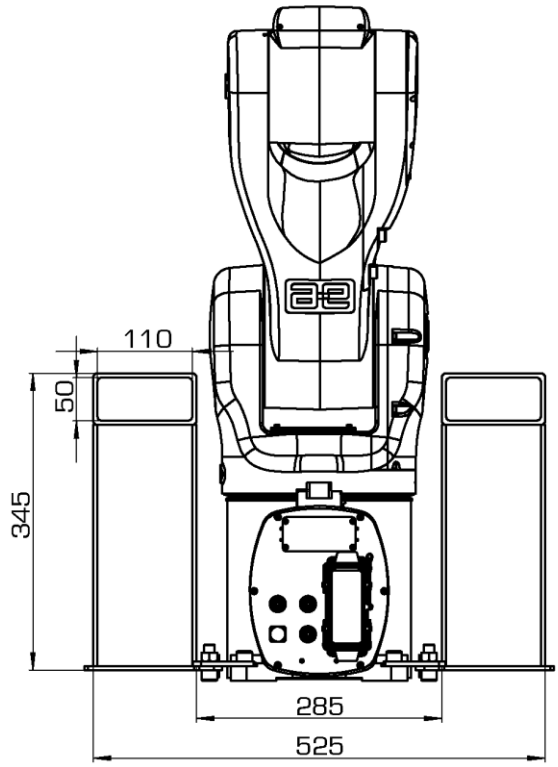
Manipulator shall be equipped with the matching handling bracket. The incorrect handling method may cause the damage to manipulator. Manipulator posture during handling is subject to the description in *Chapter 4.2* of this manual Precautions for manipulator during handing as shown in Figure 4-1.

During handing, the following points should be noted:

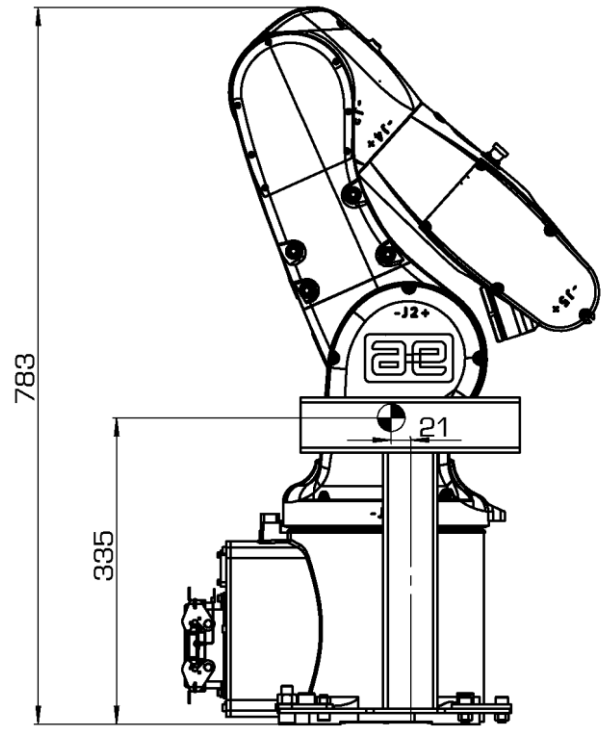
- Do not pull eyebolt sideways.
- Do not use forklift and other grippers to apply impact force to the delivery support.
- Do not put chains on delivery support.

4.2 Handing dimensions

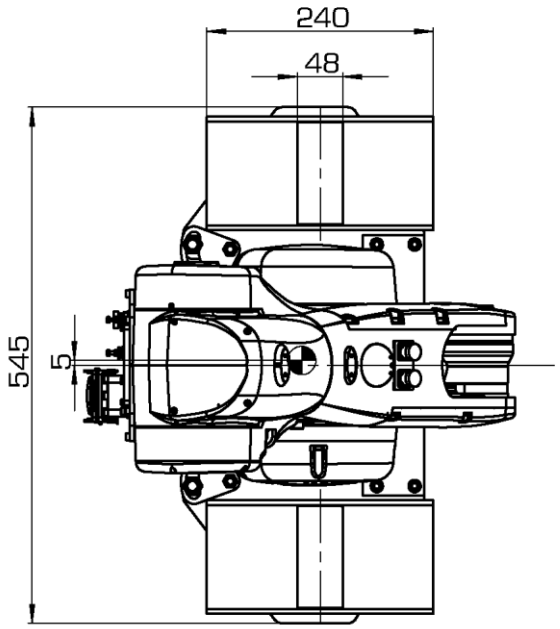
Three views of manipulator during the handling process are as shown in Figure 4-2 (it shall be noted that the actual dimensions may be slightly larger than those in the Figure):



(a)



(b)



(c)
Figure 4-2 Dimensions of AIR8-710A manipulator during the handling process

4.3 Handing posture

The position and posture of the AIR8-710A manipulator during transportation are shown in Figure 4-3.

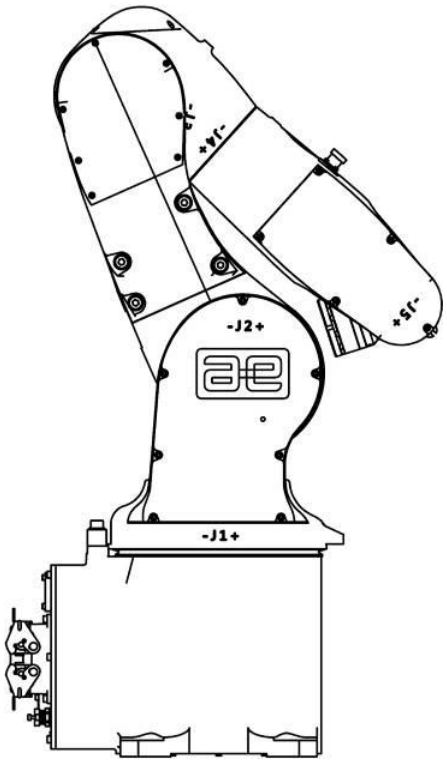


Figure 4-3 Handling Posture of AIR8-710A Manipulator

Angle values of axes for AIR8-710A manipulator during handling are as shown in Table 4-1.

Table 4-1 Angle Values of Axes for Robot during Handling

A1	A2	A3	A4	A5	A6
0°	-24°	156°	0°	120°	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.

4.4 Handing with forklift

Handling with forklift is as shown in Figure 4-4. Forklift shall meet the requirement for the weight of manipulator. The total weight of manipulator and handling device is about 60kg.

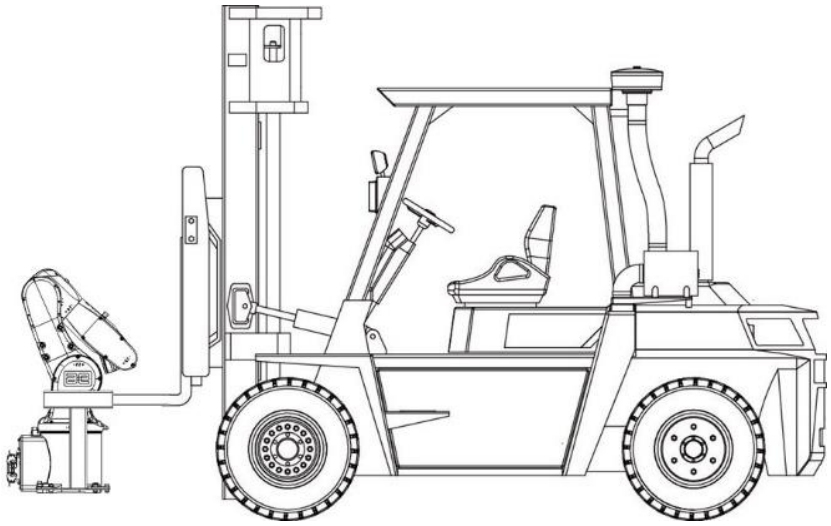


Figure 4-4 AIR8-710A Handling with Forklift

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 4.2* of this manual.

4.5 Handing with swinging ring

Handling with swinging ring is as shown in Figure 4-5 lifting device shall meet the requirement for the weight of manipulator. The total weight of manipulator and handling device is about 45kg.

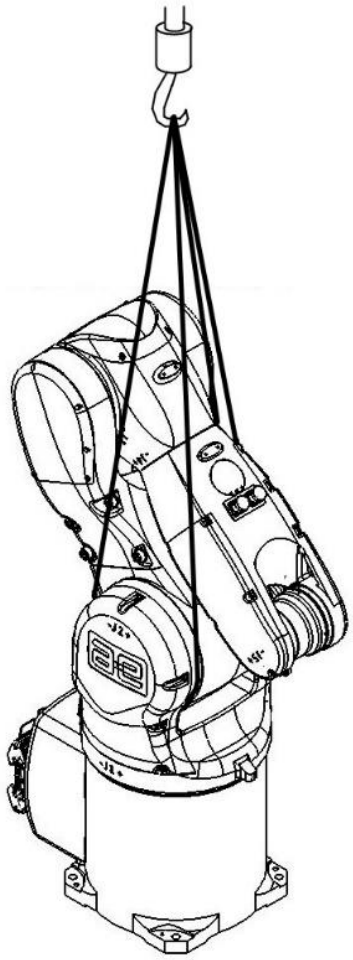


Figure 4-5 AIR8-710A Manipulator Handling with Swinging Ring

Caution

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

Caution

Manipulator may turn over when transported with swinging ring. During the handling, please take special care to keep the manipulator steady.

Caution

Do not pull the swinging ring to the side to avoid the damage to the manipulator and the unpredictable failure.

5 AIR8-710A preparation before installation

5.1 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 2.4.*
- Make sure that the installation site can withstand the pressure or pull from the manipulator and its load.

5.2 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.

6 Installation of AIR8-710A manipulator

6.1 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 AIR8-710A manipulator base are as shown in Figure 6-1:

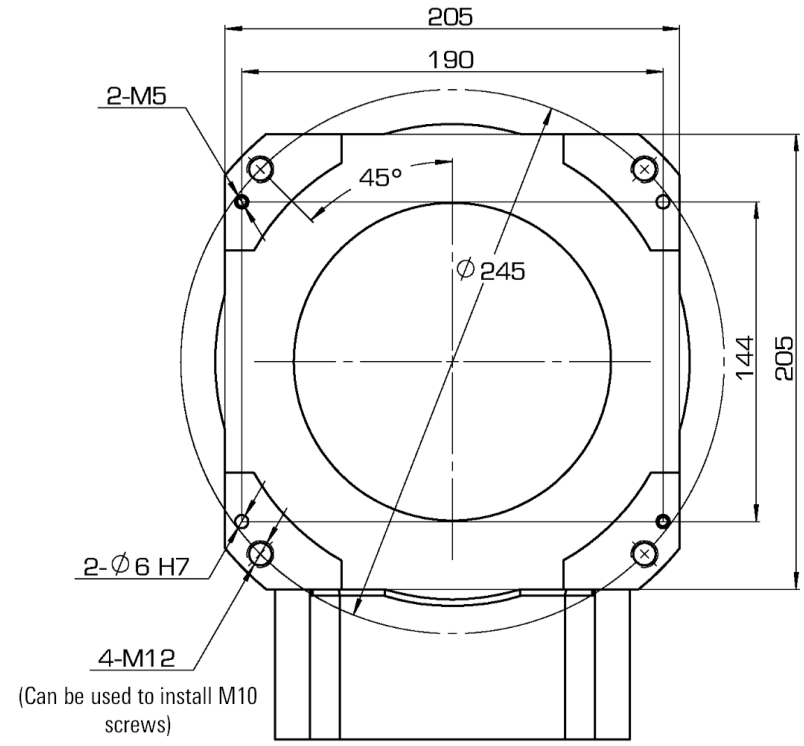


Figure 6-1 Dimensions of AIR8-710A Manipulator Base Interface

6.2 Fixed mode

Two ways of fixing are suitable for AIR8-710A 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 6-1:

Table 6-1 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	○	

Part Name	Remarks	Ground fixing	Bracket fixing
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

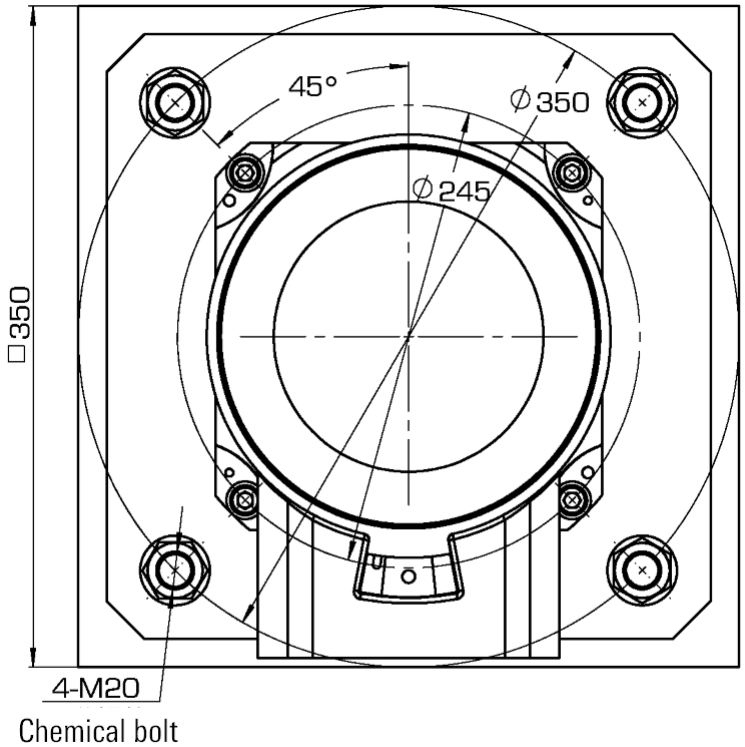
Ground fixing process is as follows:

Step1. Hold the fixing plate of robot close to the mounting surface and secure it with four M20 chemical bolts (strength not less than Grade 4.8).

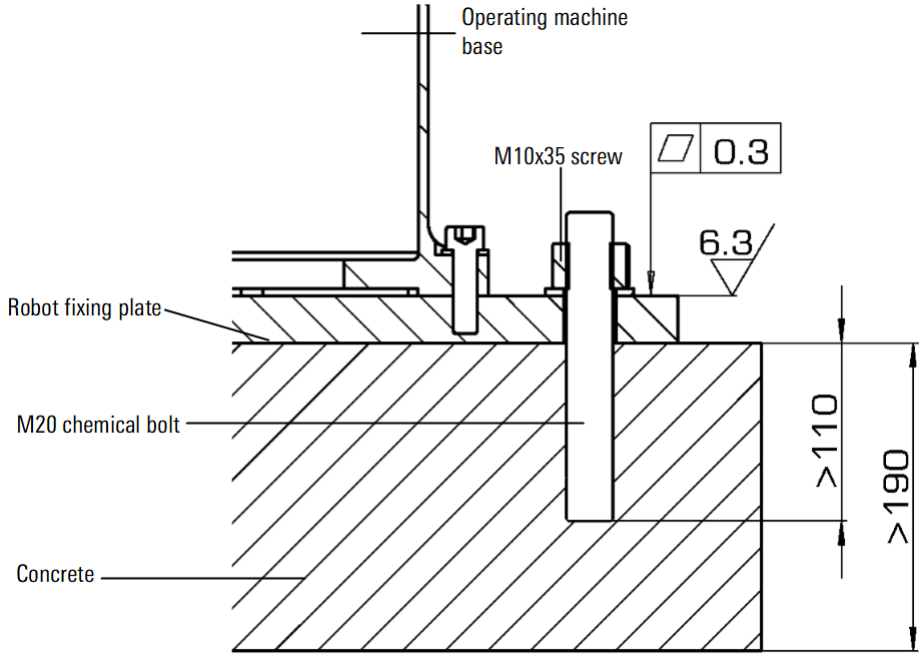
Step2. Install the manipulator base on the fixing plate with four M10x35bolts (Grade 12.9).

Prompt

Fixing plate surface shall meet certain roughness and flatness requirements as detailed in Figure 6-2.



(a)



(b)
Figure 6-2 Ground fixed mode

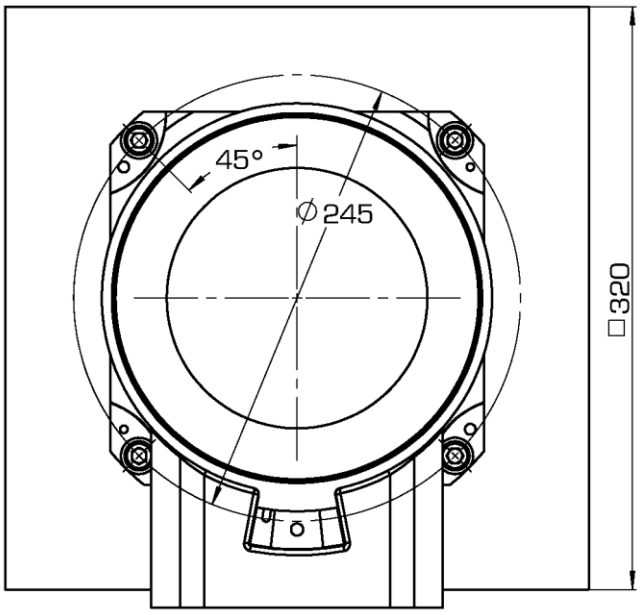
Bracket fixing

Bracket fixing process is as follows:

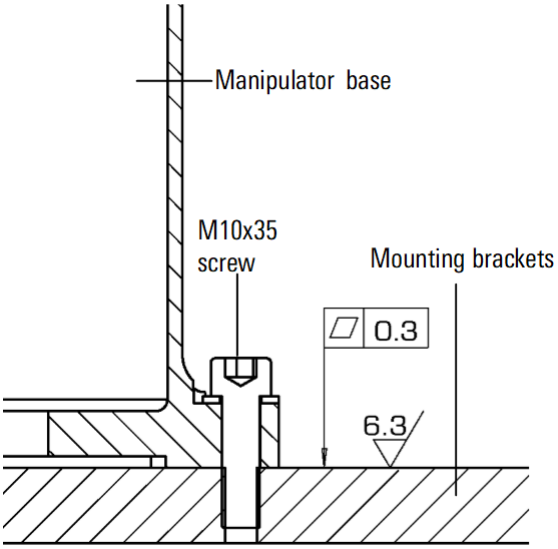
Install the manipulator base on the bracket with four M10x35 bolts (Grade 12.9).

Prompt

Mounting surface of bracket shall meet certain flatness requirements as shown in Figure 6-3.



(a)



(b)
Figure 6-3 Bracket fixing mode

Warning

- 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.

7 Electrical connection of AIR8-710A manipulator

7.1 Electrical interface type of manipulator

There are aviation plugs, heavy-duty connector, and quick-plug connectors on the base of the AIR8-710A operating machine, as shown in Figure 7-1. The right side is the heavy-duty connector interface, and the left side is the Ethernet interface and three trachea connectors.

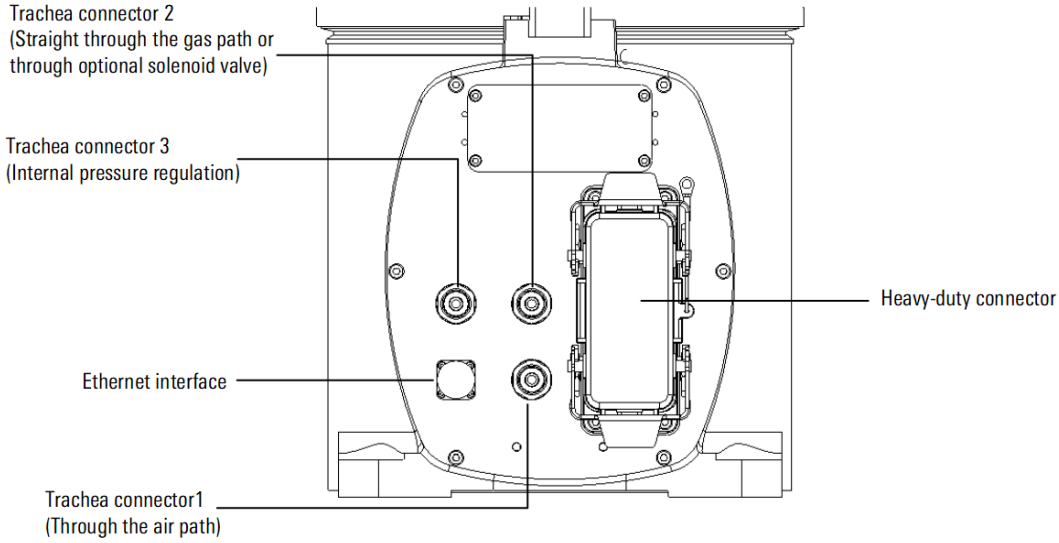
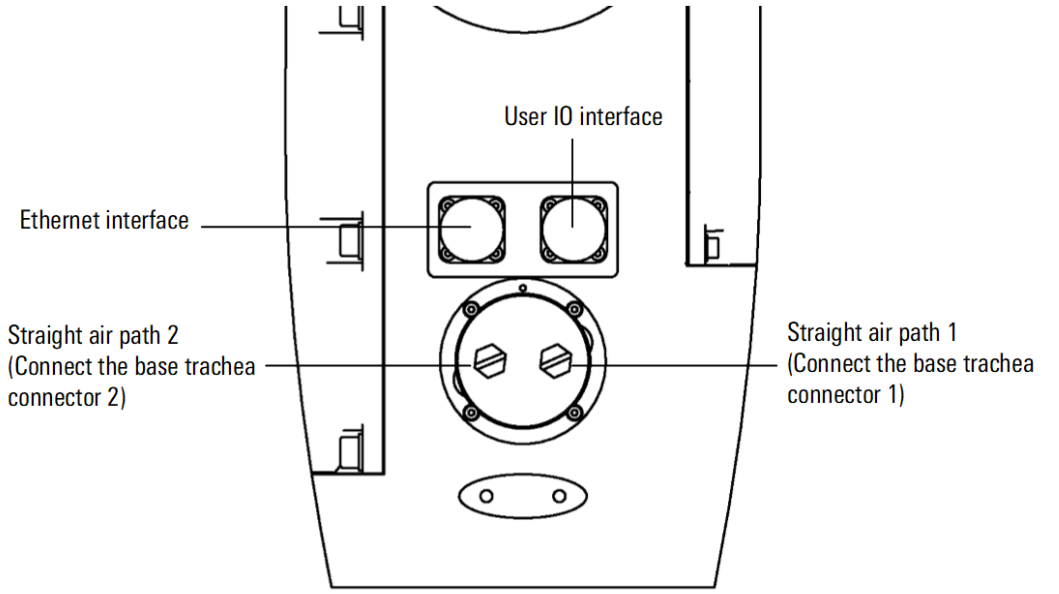
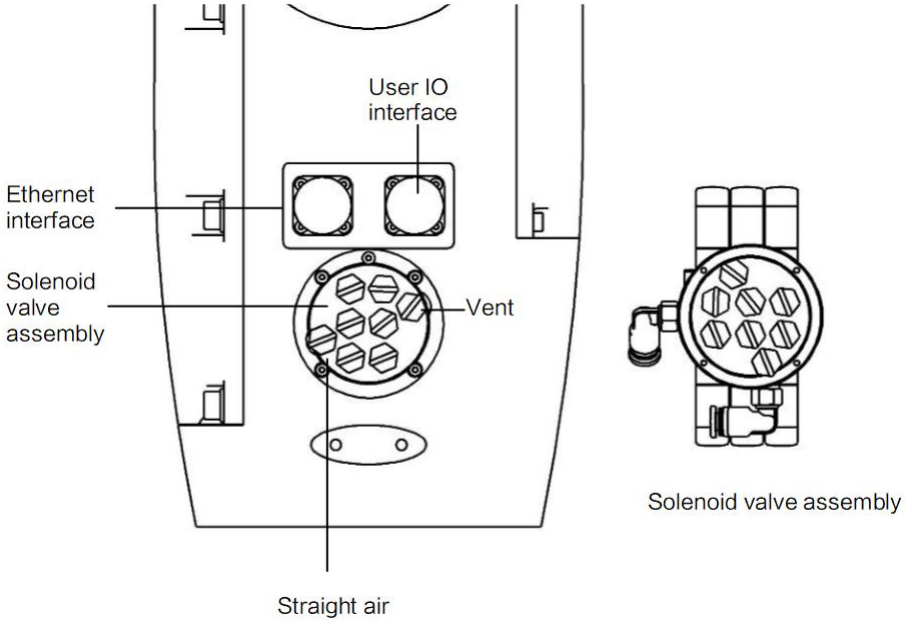


Figure 7-1 Heavy-duty connector on AIR8-710A manipulator

AIR8-710A type manipulator has aviation plug, straight air interface (standard configuration) or solenoid valve (optional) on the forearm, as shown in Figure 7-2, from left to right, from top to bottom are Ethernet interface, User IO interface and 2 straight-through pneumatic interfaces (standard) or 3 solenoid valves (optional).



(a) Standard components



(b) Optional components
Figure 7-2 AIR8-710A type manipulator upper arm interface

Caution

- The AIR8-710A type manipulator base and the arm's Ethernet interface (Weipu/ST1214-S4), the arm's user IO interface (Weipu/ST1214-S9) are equipped with a protective cover, when the interface is not used, please Do not open the cover to prevent dust or liquid from intruding into the operating machine.
- If you need to use Ethernet interface and user IO interface, please use the corresponding aviation plug: Ethernet interface to connect ST1210-P4 aviation plug, user IO interface to connect ST1210-P9 aviation plug, specific installation and use method , Please refer to the relevant information on Weipu Technology's official website www.weipukeji.com.
- The position of the solenoid valve cover on the arm of the AIR8-710A manipulator is shown in Figure 7-3. Before using the direct air path or the solenoid valve, the solenoid valve cover should be opened, as shown in Figure 7-4. Remove the M2 screw first, then Use the M3 screw to screw into the two top screw holes to lift the solenoid valve cover.

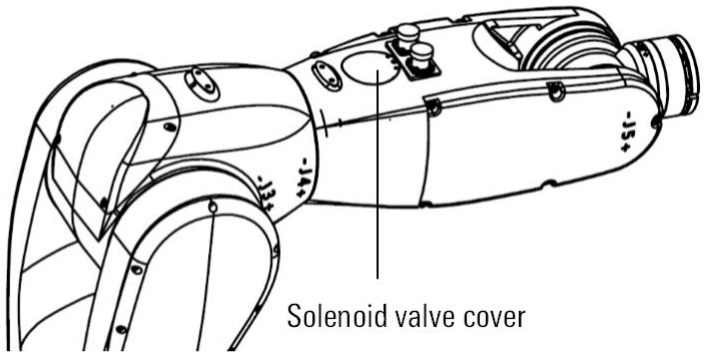


Figure 7-3The position of the solenoid valve cover on the arm of AIR8-710A manipulator

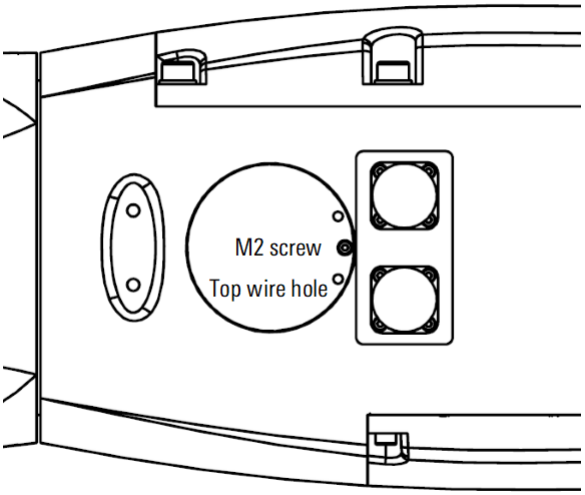


Figure 7-4 AIR8-710A type manipulator arm solenoid valve cover screw and jack hole

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

Heavy-duty interface of AIR8-710A manipulator (power line) is defined as shown in Table 7-1:

Table 7-1 Definition of Heavy-duty Interface of Manipulator (Power Line)

Signal Name	Axle Number	Pin Number	Signal Name	Axle Number	Pin Number
U1	Axle 1	10	U4	Axle 4	46
V1	Axle 1	11	V4	Axle 4	47
W1	Axle 1	12	W4	Axle 4	48
PE	Axle 1	8	PE	Axle 4	44
BK1+	Axle 1	21 common voltage	BK4+	Axle 4	45 common voltage
BK1-	Axle 1	9 common voltage	BK4-	Axle 4	33 common voltage
U2	Axle 2	22	U5	Axle 5	58
V2	Axle 2	23	V5	Axle 5	59
W2	Axle 2	24	W5	Axle 5	60
PE	Axle 2	20	PE	Axle 5	56
BK2+	Axle 2	21 common voltage	BK5+	Axle 5	69 common voltage
BK2-	Axle 2	9 common voltage	BK5-	Axle 5	57 common voltage
U3	Axle 3	34	U6	Axle 6	70
V3	Axle	35	V6	Axle 6	71
W3	Axle 3	36	W6	Axle 6	72
PE	Axle 3	32	PE	Axle 6	68
BK3+	Axle 3	45 common voltage	BK6+	Axle 6	69 common voltage
BK3-	Axle 3	33 common voltage	BK6-	Axle 6	57 common voltage

Heavy-duty interface of AIR8-710A manipulator (encoder line) is defined as shown in Table 7-2:

Table 7-2 Definition of Heavy-duty Interface of Manipulator (Encoder Line)-

Signal Name	Axle Number	Pin Number	Signal Name	Axle Number	Pin Number
1-5V	Axle 1	1	4-5V	Axle 4	37
1-0V	Axle 1	2	4-0V	Axle 4	38
1-PS+	Axle 1	3	4-PS+	Axle 4	39
1-PS-	Axle 1	4	4-PS-	Axle 4	40
2-5V	Axle 2	13	5-5V	Axle 5	49
2-0V	Axle 2	14	5-0V	Axle 5	50
2-PS+	Axle 2	15	5-PS+	Axle 5	51
2-PS-	Axle 2	16	5-PS-	Axle 5	52
3-5V	Axle 3	25	6-5V	Axle 6	61
3-0V	Axle 3	26	6-0V	Axle 6	62
3-PS+	Axle 3	27	6-PS+	Axle 6	63
3-PS-	Axle 3	28	6-PS-	Axle 6	64

Heavy-duty interface of AIR8-710A manipulator (solenoid valve and user IO) is defined as shown in Table 7-3:

Table 7-3 Definition of Heavy-duty Interface of Manipulator (solenoid valve and user IO)

Signal Name	Axle Number	Pin Number	Signal Name	Axle Number	Pin Number
1B	1-1B	41	DI1	1	5
1A	2-1A	42	DI2	2	6
2B	3-2B	53	DI3	3	7
2A	4-2A	54	DI4	4	17
3B	5-3B	65	DI5	5	18
3A	6-3A	66	DO1	6	29
0V	Cathode of solenoid valve	67	DO2	7	30
			24V	8	19
			GND	9	31

Heavy-duty interface of AIR8-710A manipulator is as shown in Figure 7-5:

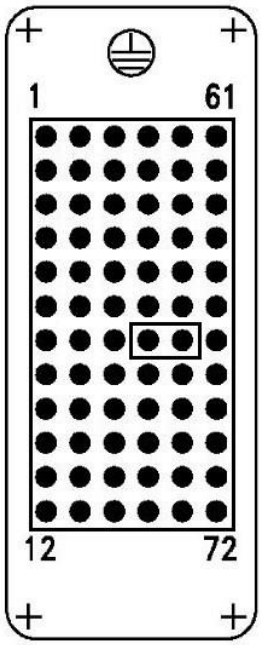


Figure 7-5 Heavy-duty Interface of AIR8-710A Manipulator

User IO interface of AIR8-710A manipulator is as shown in Figure 7-6:

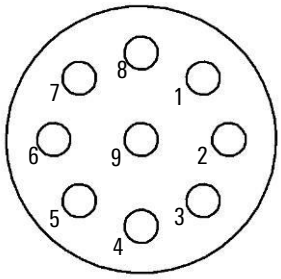


Figure 7-6 User IO Interface of AIR8-710A Manipulator

Ethernet interface reserved for AIR8-710A manipulator and its definition are as shown in Table 7-4 and Figure 7-7:

Table 7-4 Ethernet Interface Reserved for Manipulator Definition

Signal name	Interface number	Cable color
TX+	1	Blue
TX-	2	White
RX+	3	Yellow
RX-	4	White

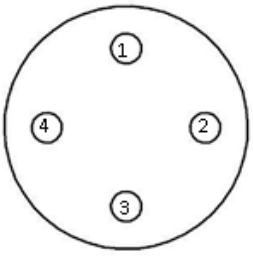


Figure 7-7 Ethernet Interface Reserved for Manipulator

Usage of solenoid valve on the small arm of AIR8-710A manipulator

- First check if the gas circuit is smooth before using the solenoid valve. Unscrew all the vent screw plugs of solenoid valve on the small arm and aerate the air pipe joint 2 on the base. If there are three vent holes (1A, 1B, 2A, 2B, 3A and 3B) of solenoid valve on the small arm are ventilated, it is proved that the solenoid valve is normal, and If not so, please contact us.
- Take two vent holes 1A and 1B of 1# solenoid valve as example to briefly explain the use of solenoid valve. For the locations of vent holes of solenoid valve, see Table 7-2. According to Table 7-5, interface DO17 of user IO interface controls the hole 1B. If the hole 1B of solenoid valve is ventilated, electrify DO17 to aerate the hole 1B of solenoid valve. At this point, disconnect DO17, the hole 1B of solenoid valve will keep being aerated until DO18 which controls the hole 1A is electrified. Hole 1B of solenoid valve will be closed, and the hole 1A will be ventilated.
- Example of teach pendant program for above operation process:

```
Setdo (17,true)

/ / Interface DO17 of user IO interface is powered on, and the hole 1B of solenoid valve is ventilated

Setdo (17,false)

// Interface DO17 is powered off, and the hole 1B of solenoid valve keeps being ventilated

Setdo (18,true)

// Interface DO18 is powered on, and the hole 1B of solenoid valve is closed, and hole 1A is ventilated
```


Prompt

DO initialization defaults to be false.

- Vent holes 2A and 2B of solenoid valve 2# and vent holes 3A and 3B of solenoid valve 3# are switched on and off according to the method in step 2 and corresponding interfaces of control cabinet in Table 7-5.

Table 7-5 Definition of Heavy-duty Interface of Manipulator (solenoid valve and user IO)

Number of Solenoid Valve	Pin Number for Heavy-duty Connector	Interface of Control Cabinet
1-1B	41	DO17
2-1A	42	DO18
3-2B	53	DO19
4-2A	54	DO20
5-3B	65	DO21
6-3A	66	DO22


Caution

- When the robot is connected, pay attention to the one-to-one correspondence between the heavy loads on the body and those on the control cabinet.
- To avoid the damage to solenoid valve, the gas into the solenoid valve shall be dry and clean, and shall be free of the chemicals, synthetic oil containing organic solvents, salt, corrosive gas, etc.; the gas shall pass through the air dryer and air filter with a filtration accuracy less than 5 μm before entering the solenoid valve.

8 Adaptation and connection of AIR8-710A manipulator and accessories

8.1 Examples of accessory types

The accessory equipment of the manipulator mainly includes mechanical grab (Figure 8-1), hydraulic pressure sucker (Figure 8-2), welding gun welder (Figure 8-3), infrared identification equipment, visual identification equipment, cutting machine and other special equipment, etc.

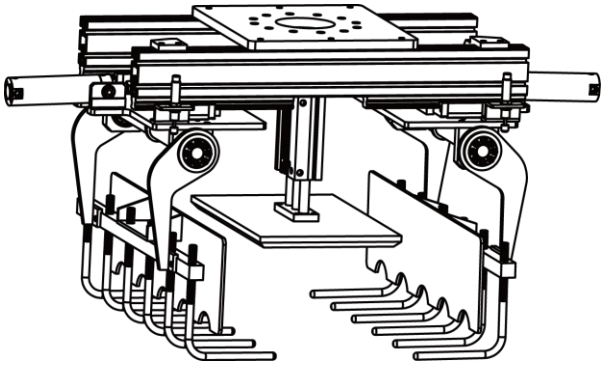


Figure 8-1 Industrial robot grab

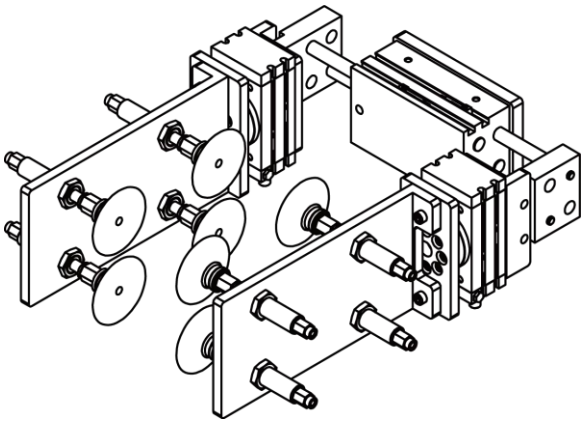


Figure 8-2 Suction cups for industrial robots

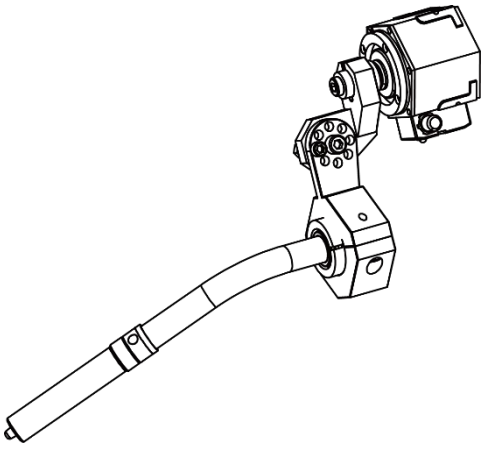


Figure 8-3 Arc welding gun for industrial robot

8.2 Connection mode

8.2.1 Connection between operator 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 operator through the flange, which is detailed in *Chapter 9.6* of this manual.

8.2.2 Connection between manipulator and control cabinet

As described in *Chapter 7.2* 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 AIR8-710A operator is shown in Figure 8-4 below. For more details, please refer to the corresponding manual of the electrical part.

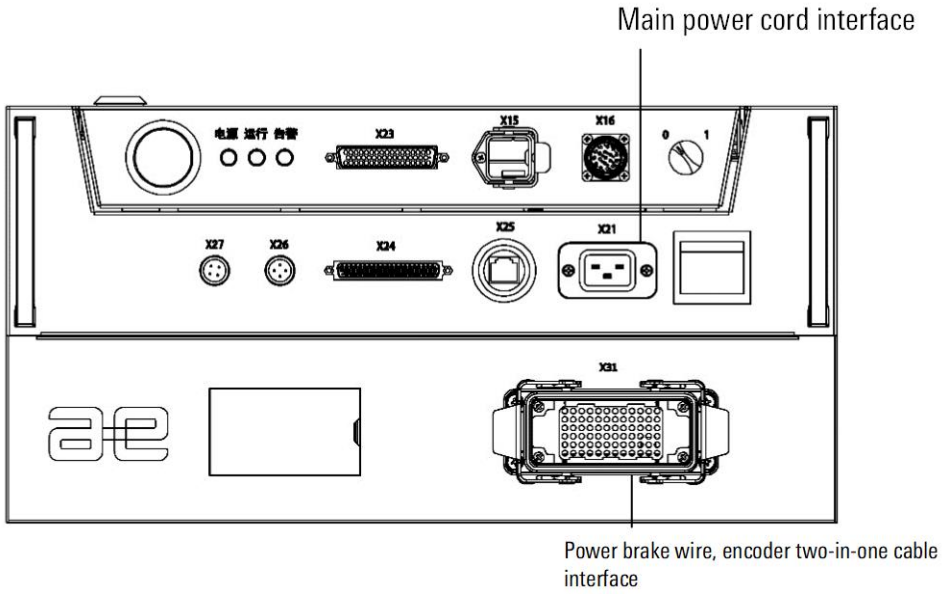


Figure 8-4 The definition of inCube10 cabinet cable connector

9 Performance parameters of AIR8-710A manipulator

9.1 Basic specification

See *Chapter 2.3* of this manual for the basic specifications of AIR8-710A manipulator.

9.2 Dimension and working range of each joint

The motion range of each axis of AIR8-710A manipulator is shown in Table 9-1.

Table 9-1 Motion range of each axis of AIR8-710A manipulator

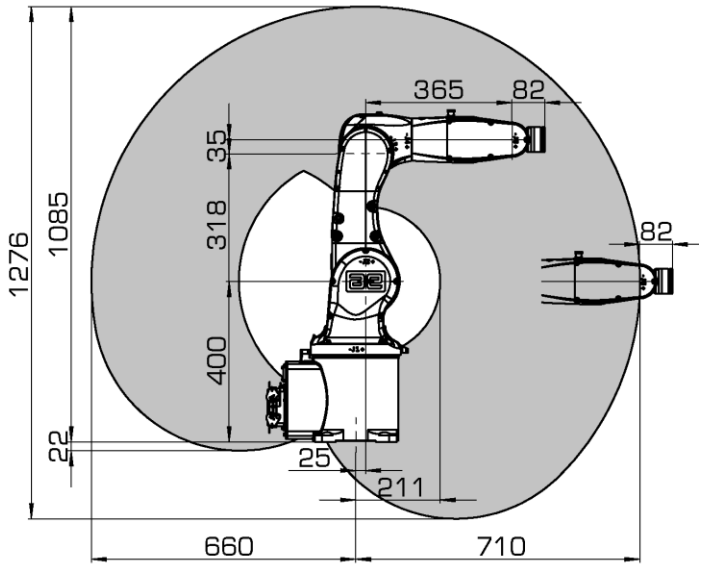
Axis number	Range of motion (°)
J1*	-170 ~ +170
J2	-100 ~ +135
J3	-120 ~ +156
J4	-200 ~ +200
J5	-135 ~ +135
J6	-360 ~ +360

Prompt

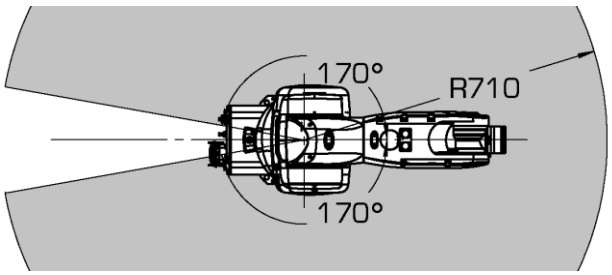
"*": If the mechanical limit of J1 axis is removed, the motion range can reach -180° ~ 180°.

See Figure 9-1 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 9-1 Working range of AIR8-710A manipulator

9.3 Mechanical limit

Zero point and movable range are respectively set on each axle. Robot is limited to the movable range except that the origin position is lost due to the servo system abnormality and system error. In addition, an optional mechanical brake is also available on some axle to limit the movable range in order to further ensure the safety.

Figure 9-2 shows the position of mechanical brake.

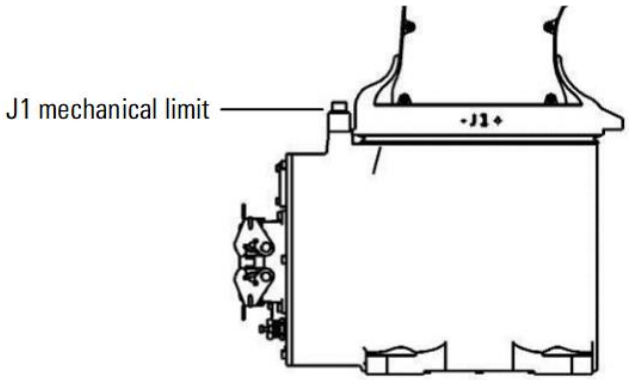


Figure 9-2 Mechanical brake on AIR8-710A manipulator

9.4 Speed of each joint

The maximum angular speed of each axis of the manipulator is shown in Table 9-2.

Table 9-2 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

9.5 Output flange size

Figure 9-3 show output flange connection size of AIR8-710A.

The Table 9-3 show output flange specification of AIR8-710A. Tightening torque of screws is shown in *Appendix B(Nm)*.

Table 9-3 The output mechanical interface specifications of AIR8-710A

Locating circle diameter	12mm or 62mm

Diameter of graduation circle of threaded hole	52mm
Screw grade	12.9 grade
Screw diameter	M4
Screw quantity	8
Locating pin	4mm
Screw standard	GB/T 70.1-2000

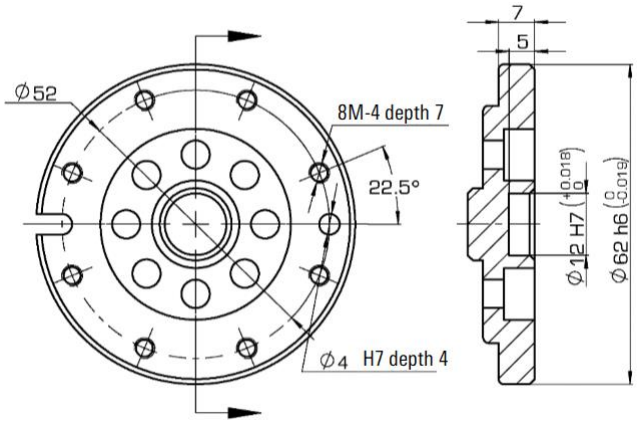


Figure 9-3 The flange dimension diagram of wrist of AIR8-710A manipulator

Warning

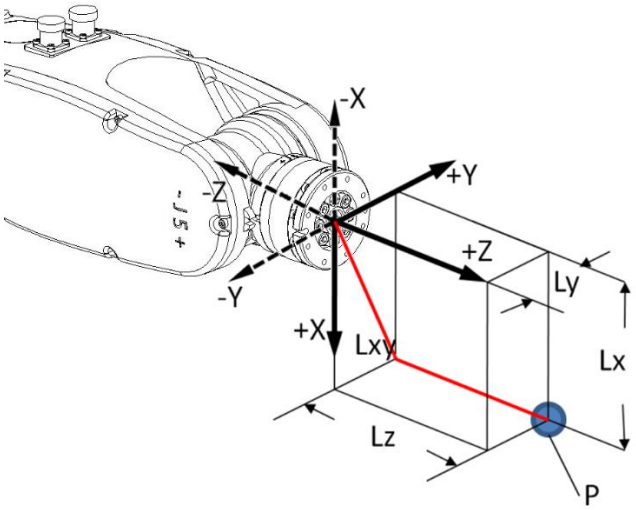
When installing the fixture, the depth of the threaded hole and pin hole shall be fully considered for the screws and locating pins used. It is forbidden to install the length beyond the depth of the threaded hole (7mm) and the depth of the pin hole (4mm), otherwise the wrist of the operator will be damaged.

9.6 Load and installation method

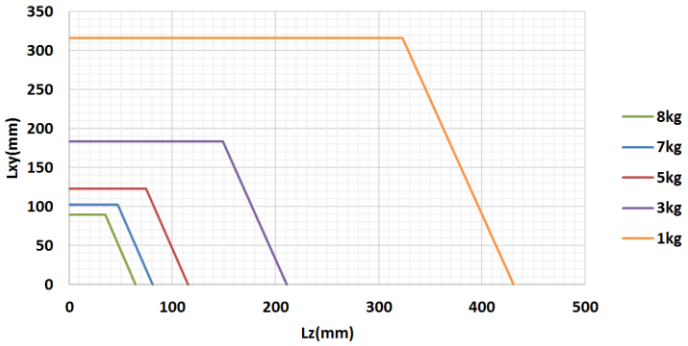
9.6.3 Wrist load installation of manipulator

The load line diagram of the AIR8-710A type manipulator wrist is shown in Figure 9-4.

- 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 9-4 (b); Figure 9-4 (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 0.3kgm², that of 5-axis is less than 0.3kgm², and that of 6-axis is less than 0.1kgm².



(a)



(b)

Figure 9-4 Location of wrist load center of AIR8-710A manipulator

9.6.4 Installation of elbow equipment of J3 of manipulator

The specifications and dimensions of the equipment mounting holes of the J3 axis elbow of the AIR8-710A type operating machine are shown in Figure 9-5.

- AIR8-710A 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 9-5.
- The height of the center of mass is less than 60mm from the installation surface.

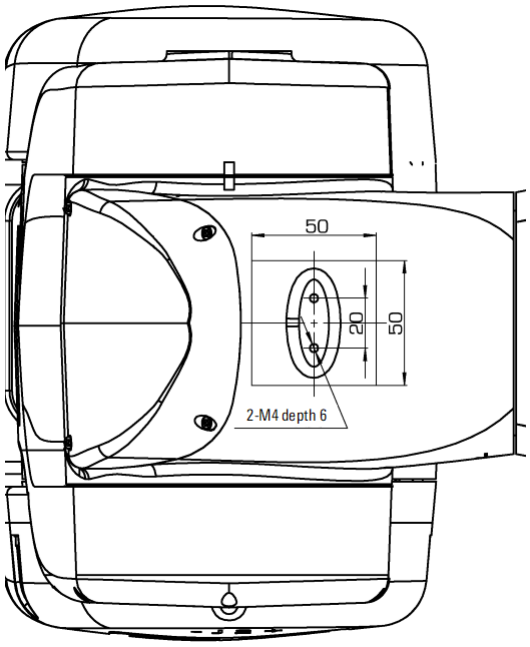


Figure 9-5 AIR8-710A type manipulator elbow load interface size diagram

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 body.
- 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.

9.6.5 Installation location of other parts of the manipulator

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

Fixed position of manipulator arm

The mounting hole specifications and dimensions of the manipulator arm are shown in Figure 9-6.

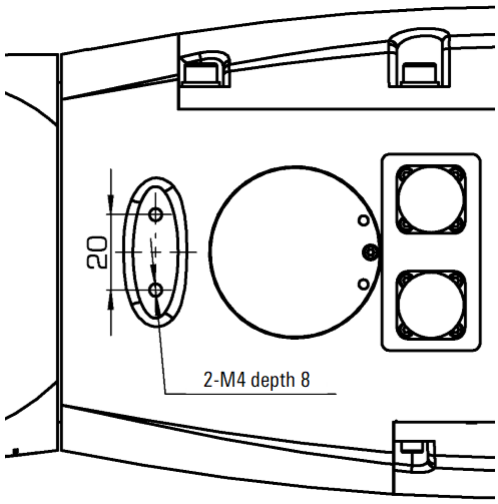


Figure 9-6 Dimension drawing of AIR8-710A type manipulator arm interface

Fixed position of manipulator big arm and J1 axis

The mounting hole specifications and dimensions of the manipulator big arm and J1 axis are shown in Figure 9-7 and Figure 9-8.

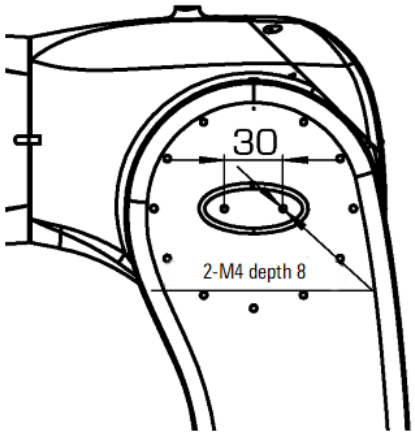


Figure 9-7 Dimension drawing of AIR8-710A big arm interface

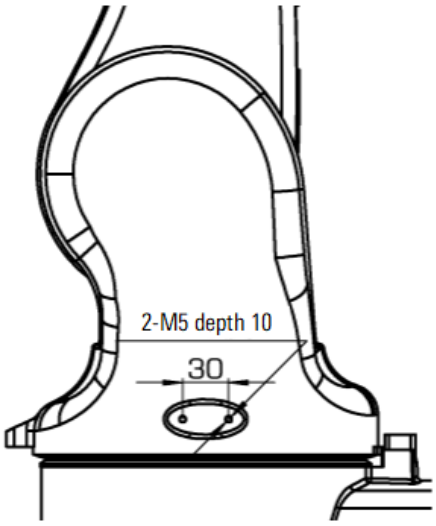


Figure 9-8 AIR8-710A J1 axis interface dimension drawing

- 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.

10 Calibration of the axes of AIR8-710A manipulator

10.1 General

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

10.2 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).

10.3 Calibration position of each joint

The position of each axis of the manipulator is shown in Figure 10-1 below, in which, except for the J3 axis, it is 90 °, and the other axes are 0 °.

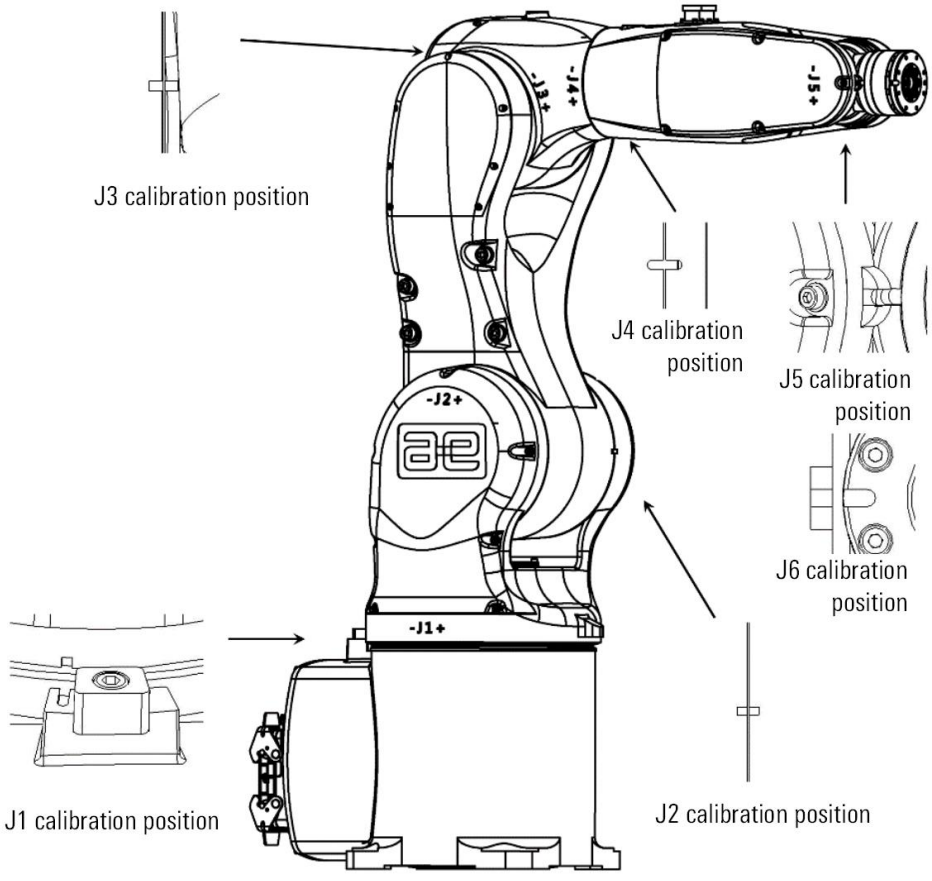


Figure 10-1 zero point diagram of each axis of AIR8-710A manipulotor

Caution

- The robot calibration must always be performed at the same temperature conditions to avoid errors due to thermal expansion and contraction.
- The AIR8-710A 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 10-1, the naked eye shall be used to make the zero point position of each shaft to be aligned, as shown in Figure 10-2.

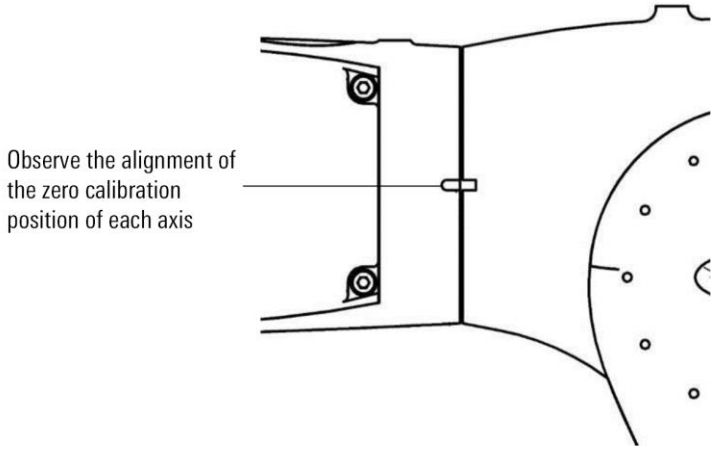


Figure 10-2 Calibration method of naked eye observation zero

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 10-3.

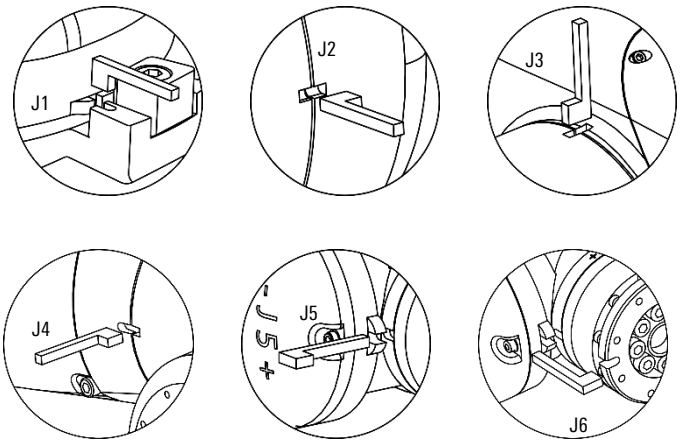


Figure 10-3 Calibration method of zero calibration block

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 shaft, the calibration block is used for calibration, and the calibration block can be inserted into the two calibration grooves at the same time after multiple fine adjustment, as shown in Figure 10-3.

Calibration under the requirement of high path positioning accuracy

When the operator 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.

10.4 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 10-4.

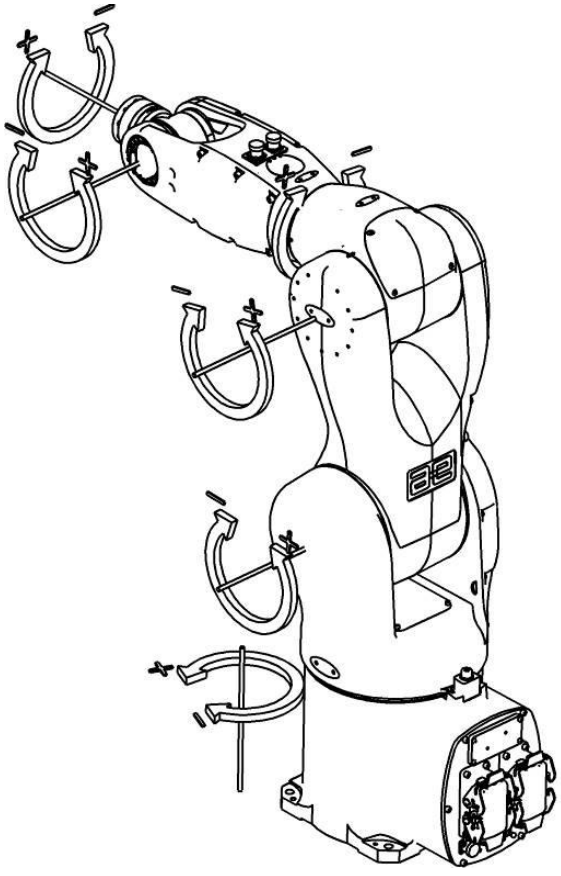


Figure 10-4 Direction of motion of each joint of the manipulator

11 General principles of maintenance

This manual is a description of preventive maintenance of AIR8-710A 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 operating machine

12 Maintenance items

12.1 Daily maintenance

When running the operator every day, the following items should be checked. As shown in Table 12-1 Daily Maintenance of Operation Machine:

Table 12-1 Daily Maintenance of Operation Machine

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

12.2 First maintenance

The operation machine 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 12-2:

Table 12-2 Operating Machine 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 *Chapter13.4* 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.

12.3 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 12-3

Table 12-3 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 12-4.

Table 12-4 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 12.2.*
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 12-5:

Table 12-5 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 12.2.*
2	Fasten the main external bolts	See the first maintenance in *Chapter 12.2.*
3	Clean the parts of manipulator	See the first maintenance in *Chapter 12.2.*
4	Check whether the cables of end effector are damaged	See the first maintenance in *Chapter 12.2.*
5	Replacement of Synchronous Belt	See the first maintenance in *Chapter 12.2.*
6	Check whether the limit rubber block of J1 axle is damaged	See the first maintenance in *Chapter 12.2.*

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 12-6:

Table 12-6 Maintenance Items for 7,860 h (2 years)

No.	Check Item	Essentials
1	Battery Replacement	See *the first maintenance in Chapter 13.3.*

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 12-7:

Table 12-7 Maintenance Items for 11,520 h (3 years)

No.	Check Item	Essentials
1	Replacement of Synchronous Belt	See *the first maintenance in Chapter12.2.*

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 12-8:

Table 12-8 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 12-9:

Table 12-9 Maintenance Items for 19,200 h (5 years)

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

13 Project maintenance process

13.1 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:

- Adjust the robot to the calibration state.
- To prevent the hazards, turn off the power, hydraulic, and pneumatic sources connected to the robot.
- Clean the manipulator with the vacuum cleaner or wipe it with a cloth.
- After all safety conditions are met, conduct the follow-up work of manipulator.

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

13.2 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:

- Remove the electrical installation plate, as shown in Figure 13-1, and pull out the cables inside the base.
- Check whether the cable fixing plate fixes the cable intact on the mounting plate.
- Check the cable and fixing plate for wear or damage.
- Check the internal cables for wear or damage.
- If there is any crack, wear or damage, please contact our company in time for replacement.
- Install the cable inside the base and keep it in a "U" shape.
- Install the electrical installation board, apply sealant to the joint surface of the electrical installation board and the base casting.

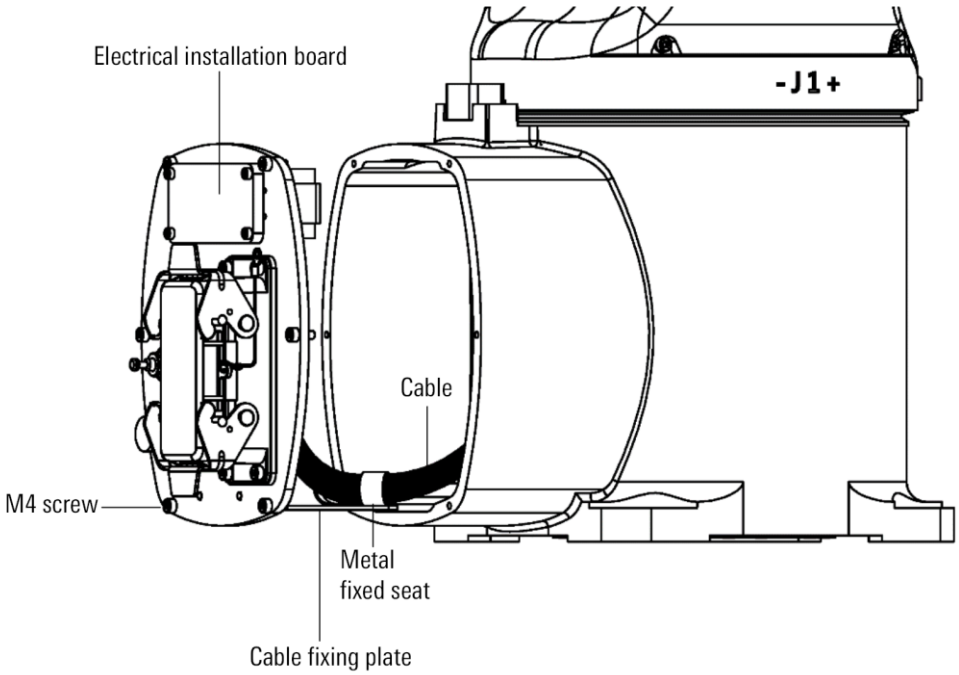


Figure 13-1 Overhaul of cables inside the base

J1 axis manipulator internal cable repair process

The maintenance process is as follows:

- Remove the cover of J1 axis body, as shown in Figure 13-2.
- Pull out the cable and check whether the connection between the cable and the bracket is reliable.
- Check the cable and bracket for wear or damage.
- Check the internal cables for wear or damage.
- If there is any crack, wear or damage, please contact our company in time for replacement.
- Check whether the grease on the surface of the internal cable disappears.
- If the grease on the cable surface disappears, it should be replenished in time.
- Install the cable inside the J1 shaft body.
- Install the cover of the J1 axis body, and apply sealant to the joint surface of the cover and the J1 axis body.

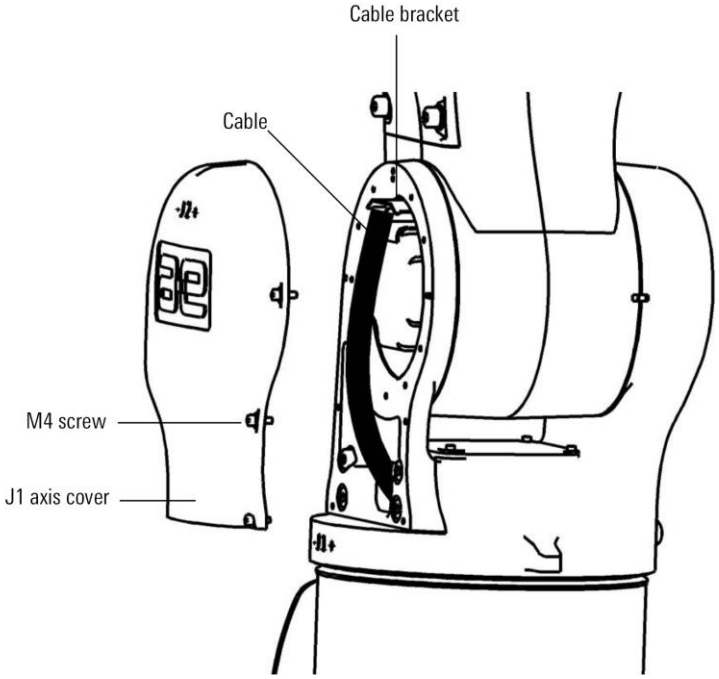


Figure 13-2 Overhaul of internal cable of J1 axis body

Overhaul process of inner arm cable

The maintenance process is as follows:

- Remove the cover, as shown in Figure 13-3.
- Check the cable and cable bracket for wear or damage.
- Check the internal cables for wear or damage.
- If there is any crack, wear or damage, please contact our company in time for replacement.
- Check whether the grease on the surface of the internal cable disappears.
- If the grease on the cable surface disappears, it should be replenished in time.
- Install the cover plate and apply sealant to the joint surface of the cover plate and the big arm.

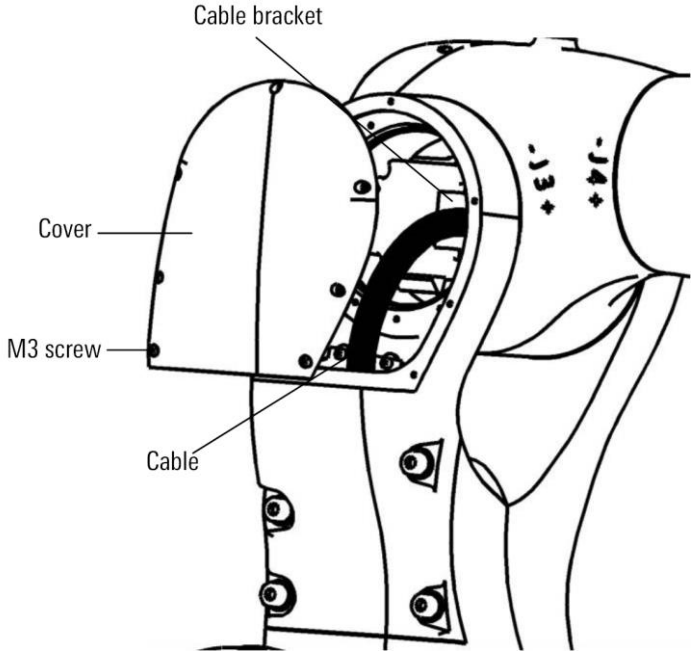


Figure 13-3 Overhaul of internal cable of big arm

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.

13.3 Battery replacement

The data on the positions of manipulator axes is saved with the encoder battery. The battery shall be replaced according to the following process every 7,860 h or 2 years (whichever comes first).

Replacement as follows:

- Adjust the robot to the calibration state.
- To prevent the hazards, turn off the power, hydraulic, and pneumatic sources connected to the robot.
- Remove the battery cover on the electrical mounting plate of manipulator, as shown in Figure 13-4.
- Remove the old battery from the box and put the new battery into the box. Be sure to keep the positive and negative polarities of battery same as the old one.
- When installing the battery cover, coat the joint surface between the electrical mounting plate and battery cover with the sealant.
- Make sure that all safety conditions are met, and then perform the calibration and testing of manipulator.

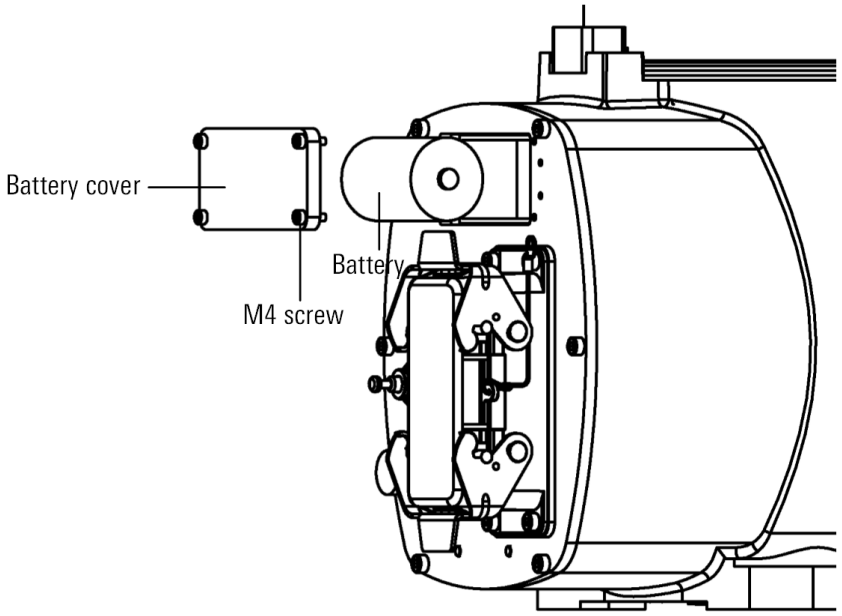


Figure 13-4 Schematic Diagram of Battery Replacement

13.4 Replacing the timing belt

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

For the timing belt model, please refer to Table 13-1:

Table 13-1 Manipulator timing belt model

Manipulator model	Timing belt position	Timing belt model
AIR8-710A	Internal J5 axis of small arm	Gates,360-3GT-6

Manipulator model	Timing belt position	Timing belt model
AIR8-710A	Internal J6 axis of small arm	Gates,360-3GT-6

When replacing the timing belt, please refer to Table 13-2:

Table 13-2 Operation machine 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:

- Run the manipulator to the attitude shown in Table 13-2.
- Turn off the power of the control device.
- Remove and operate the machine cover and five M3 screws, as shown in Figure 13-5.
- Loosen the mounting screws of the motor assembly, as shown in Figure 13-6.
- Move the motor pulley assembly, remove the old timing belt, and install the new timing belt.
- Initially tighten the motor base screw M4.
- Adjust the position of the screw, adjust the timing belt to a suitable pretension and installation deflection (refer to Figure 13-7). The recommended pretension is 14.6N and the installation deflection is 2.6mm.
- Install the motor base screw M4 with the specified torque.
- Install the cover of the operating machine and apply sealant to the joint.
- Carry out the calibration of the manipulator J5J6 axis.

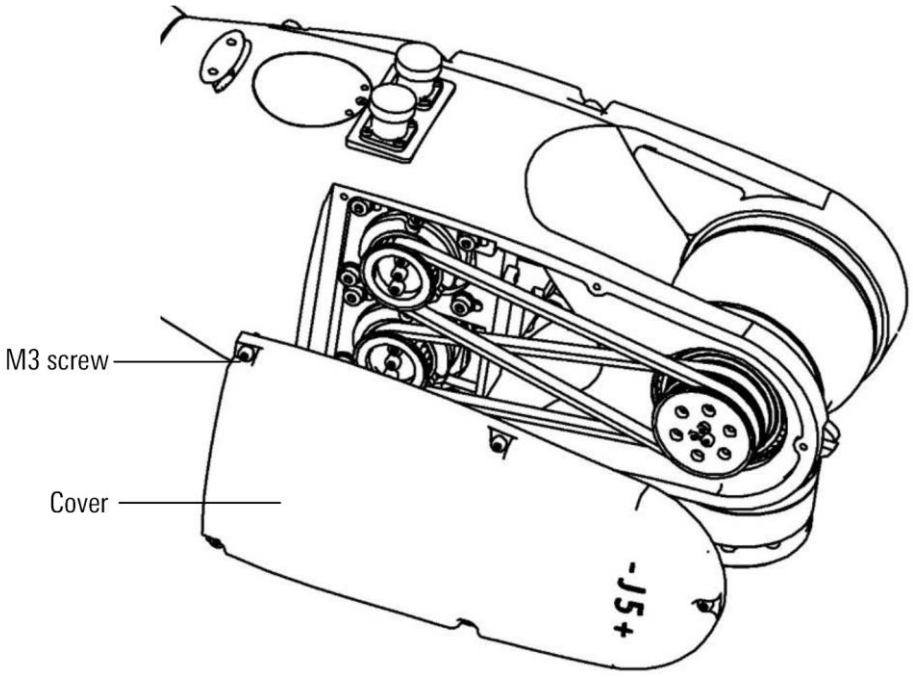


Figure 13-5 Remove cover

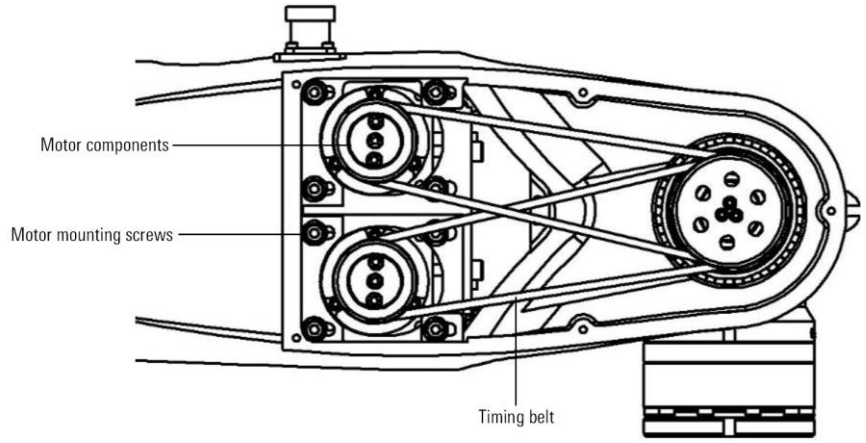


Figure 13-6 Remove the timing belt

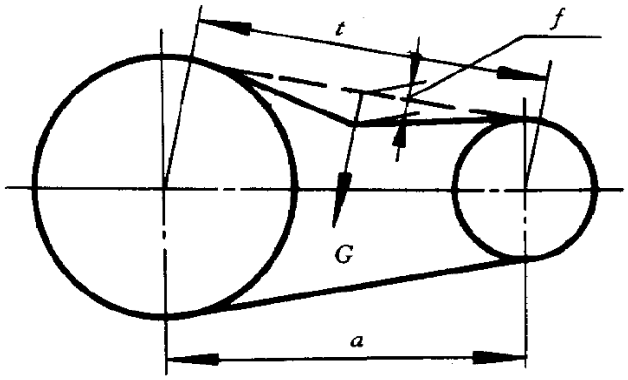


Figure 13-7 Timing belt installation deflection

Warning

After replacing the timing belt, the calibration of the J5J6 axis of the manipulator should be performed. For details, refer to *Chapter 10*.

14 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 14-1-Table 14-7. If you are unsure of the cause or do not know how to proceed, please contact us.

Table 14-1 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 14-2 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 14-3 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 14-4 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 14-5 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 14-6 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 14-7 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

15 Conditions of storage

15.1 Environmental conditions for long-term storage of manipulator

Table 15-1 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

15.2 Precautions for storage of manipulator

In addition to *Chapter 2.4* 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 4* 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 5.1* of this manual.

Appendix A Periodic maintenance schedule of AIR8-710A 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 year 7,680h	27 months 8,640h	30 months 9,600h	33 months 10,560h	3 year 11,520h	39 months 12,480h	42 months 13,440h	45 months 14,400h	4 year 15,360h	51 months 16,320h	54 months 17,280h	57 months 18,240h	5 year 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 year 7,680h	27 months 8,640h	30 months 9,600h	33 months 10,560h	3 year 11,520h	39 months 12,480h	42 months 13,440h	45 months 14,400h	4 year 15,360h	51 months 16,320h	54 months 17,280h	57 months 18,240h	5 year 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 year 7,680h	27 months 8,640h	30 months 9,600h	33 months 10,560h	3 year 11,520h	39 months 12,480h	42 months 13,440h	45 months 14,400h	4 year 15,360h	51 months 16,320h	54 months 17,280h	57 months 18,240h	5 year 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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