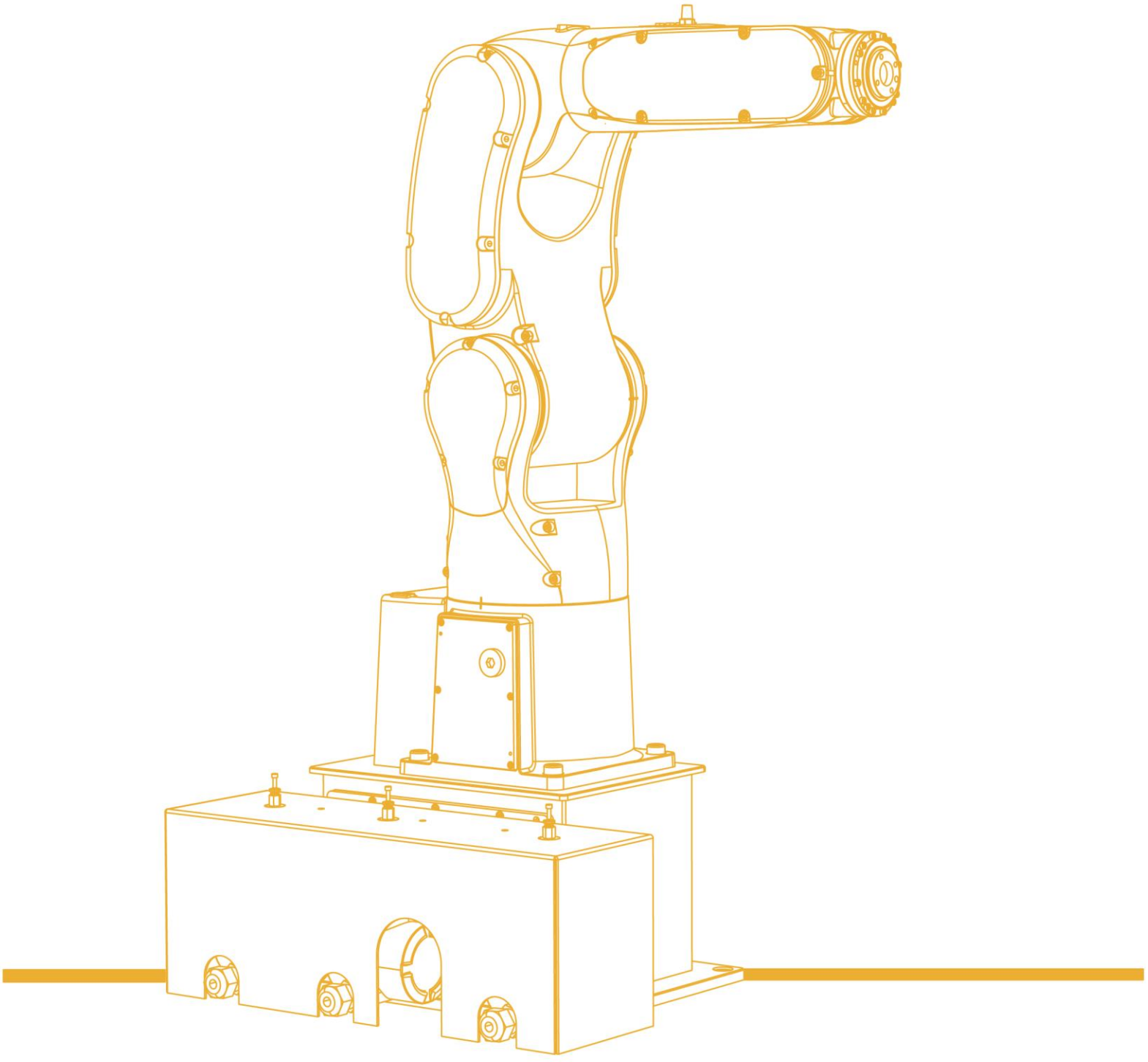
PEITIAN ROBOTICS

AIR3-560-XP Spraying Robot Operation Manual

V1.0.0



Foreword

About this manual

This manual is for technicians to install, use, and use the AIR3-560-XP industrial robot quickly, correctly, and safely, to be familiar with the relevant precautions, and to perform regular routine maintenance work on the manipulator.

Prerequisites

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

Please read the following documents when necessary:

- "inCube20 Control Cabinet Manual"
- "AIR-TP Teach Pendant Operation Manual"
- "ARL Programming Manual"

Target groups

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

Meaning of common signs

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

Table 1 Signs used in this manual

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

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

Manual description

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

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

Revision history

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

Table 2 Signs used in this manual

Version	Publication date	Modification description
V1.0.0	2023.08.29	First official release

Manual Number and Version

The manual-related information is shown in Table 3.

Table 3 Document-related information

Document name	"AIR3-560-XP Spraying Robot Operation Manual"
Document number	UM-P05310000119-001
Document version	V1.0.0

Declaration of applicable with product standards

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

Table 4 Declaration of applicable safety standards

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

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

Explosion-proof implementation standard

The explosion-proof requirements that the industrial robot system design complies with are detailed in Table 2.

Table 2 Execution standard

Standard	Description	Version
GB/T 3836.1	"Explosive Environment Part 1: General Requirements for Equipment"	2021
GB/T 3836.3	"Explosive atmospheres Part 3: Equipment protected by increased safety type "e""	2021
GB/T 3836.4	"Explosive atmospheres Part 4: Equipment protected by intrinsically safe type "i""	2021
GB/T 3836.5	"Explosive atmospheres Part 5: Equipment protected by positive pressure enclosure "p""	2021

General safety description

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

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

Safety considerations

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

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

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

WARNING, CAUTION AND PROMPTS.

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

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

 Warning	In the case of an incorrect operation, it is possible to cause death or serious injury to the operator or other operator.

 Caution	If the operation is wrong, it may cause the operator or other operator to slightly injure or damage the equipment.

 Prompt	Indicate additional instructions other than warnings and cautions.

General considerations

- When connecting or disconnecting related peripheral devices (such as safety fences, etc.) and various signals of the manipulator , be sure to confirm that the manipulator is in a stopped state to avoid incorrect connections.
- Do not use the operator in the situation shown below. Otherwise, it will not only have a negative impact on operators and peripherals, but also cause casualties.
  - Used in flammable environments.
  - Used in explosive environments.
  - Used in environments where there is a lot of radiation.
  - Used in water or in high humidity environments.
  - Used for the purpose of transporting people or animals.
  - Use as a foot (e.g., on or depending on the operator)
- Operators who use the operator should wear the safety appliances shown below before carrying out their work.
  - Work clothes suitable for the job content
  - Safety shoes
  - Safety helmet

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.


Prompt

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

Contents

1 Product specification

1.1 General functions and intended applications

Spray painting robot refers to a robot that can automatically spray paint or spray other coatings. It is widely used in automotive, instrument, electrical, enamel, and other manufacturing departments. All non-compliant use is illegal and prohibited. These non-compliant uses include:

- Use in environments where there is a danger of explosion.
- Use outside the allowed motion range.
- Transporting people or animals.
- Used as a climbing aid.


Caution

Changing the structure of the robot, such as drilling holes, can cause component damage. This is regarded as improper use and will result in loss of warranty and claim eligibility.

1.2 Environmental conditions and working and storage limitations

1.2.1 Environmental requirements

See Table 1-1 for the operating environment requirements of AIR3-560-XPmanipulator.

Table 1-1 Environmental requirements for AIR7-920B equipment manipulator

Parameter	Illustrate	
Temperature	Lowest temperature	-20℃
	Maximum temperature	40℃
Humidity	The operating environment requirements of the manipulator do not exceed the humidity level not higher than 95% as specified in the document "IEC 60721-3-3-2002 Classification of environmental conditions".	
Altitude	The altitude of the normal working environment for robots should not exceed 1000 meters.	
Power supply	The fluctuation of the working power supply voltage shall not exceed the rated voltage ±10%; the working frequency shall not exceed the rated frequency ±2%.	
Special environmental requirements	There are no flammable, corrosive gases or conductive dust in the surroundings.	

1.2.2 Precautions for storage

In addition to the content of Chapter 1.2.1 of this manual, the long-term storage of the manipulator should also pay attention to the following items:

- Before long-term storage of the manipulator, the posture should be in the transport posture, placed on a horizontal surface and fixed, see Chapter 3.2 of this manual for details.
- When the manipulator is not used for a long time, all power supply should be cut off.

- Use an outer protective cover such as paper or wooden packaging box to protect the manipulator from external light to avoid long-term exposure to the manipulator or exposure to water, oil, corrosive liquids, etc.
- The surface of the manipulator should be cleaned regularly, such as dust removal and decontamination. The specific cleaning cycle depends on the storage environment of the manipulator.

1.3 Basic specifications

The basic specifications of AIR3-560-XP robot are shown in Table 1-2.

Table 1-2 Basic specifications of AIR3-560-XP robot

Parameter		Illustrate
Coordinate form		Six-degree-of-freedom articulated robot
Number of control axes		6 axis(J1,J2,J3,J4,J5,J6)
Installation method		Ground installation, wall installation, upside-down installation
Action range (upper/lower limit)	J1*	-170° ~+170°
	J2	-110° ~+120°
	J3	-108° ~+152°
	J4	-200° ~+200°
	J5	-118° ~+118°
	J6	-350° ~+350°
Maximum operating speed	J1	450° /s
	J2	450° /s
	J3	525° /s
	J4	600° /s
	J5	600° /s
	J6	800° /s
Handling weight	Output flange	3kg
Drive method		Use AC servo motor for electrical servo drive
Repeatability		± 0.02mm
Robot quality		38kg
Noise		70dB (A)
IP protection level		IP4X
Installation conditions		■ Ambient temperature: 0~40℃ ■ Humidity: within 95% at constant temperature, no condensation ■ Allowable height: below 1000m above sea level


Prompt

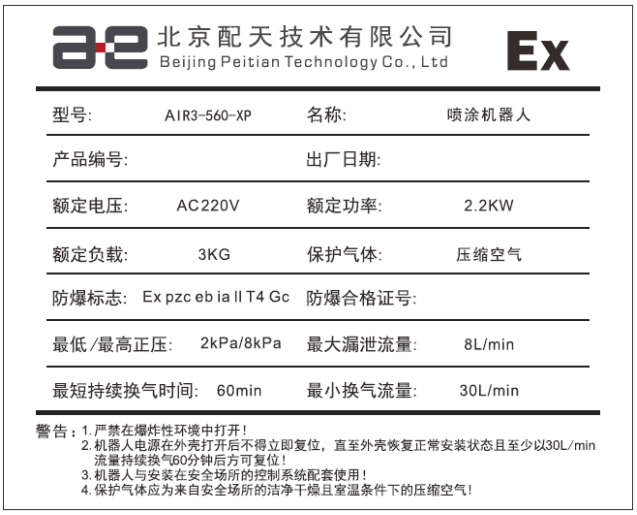
"*" stipulates that if the mechanical limit of the J1 axis is removed, the movement range of the J1 axis can reach -180° ~ 180° .

2 Introduction and structure of spraying robot

2.1 Introduction to spraying robot

The AIR3-560-XP spraying robot is designed, manufactured and produced in accordance with the requirements of the enterprise standard Q/BJAE1-2022. It complies with the technical requirements of GB/T3836.1-2021, GB/T3836.3-2021, GB/T3836.4-2021, and GB/T3836.5-2021, and is suitable for explosive gas environment zone 2. The explosion-proof mark is ExpzcebiaIIT4Gc.

The robot is mainly designed to have a positive pressure "p" structure, which is a structure that prevents external explosive environments from entering the shell by keeping the pressure of the protective gas inside the shell higher than the external pressure. The protective gas is clean, dry air at room temperature. An external air source (such as an air compressor or gas cylinder, not exceeding 0.8MPa) installed in a safe place is introduced through the air inlet. During normal operation, the maximum positive pressure is 8kPa, the minimum positive pressure is 2kPa, the maximum leakage flow is 8L/min, the air flow is 30L/min, and the minimum continuous ventilation time is 60min. For specific parameters, see the nameplate of the robot. See Figure 2-1 for the nameplate style.


北京配天技术有限公司
Beijing Peitian Technology Co., Ltd
Ex

型号:	AIR3-560-XP	名称:	喷涂机器人
产品编号:		出厂日期:	
额定电压:	AC220V	额定功率:	2.2KW
额定负载:	3KG	保护气体:	压缩空气
防爆标志:	Ex pzc eb ia II T4 Gc	防爆合格证号:	
最低/最高正压:	2kPa/8kPa	最大漏泄流量:	8L/min
最短持续换气时间:	60min	最小换气流量:	30L/min

警告：1. 严禁在爆炸性环境中打开！
2. 机器人电源在外壳打开后不得立即复位，直至外壳恢复正常安装状态且至少以30L/min流量持续换气60分钟后方可复位！
3. 机器人与安装在安全场所的控制系统配套使用！
4. 保护气体应为来自安全场所的洁净干燥且室温条件下的压缩空气！

Figure 2-1 AIR3-560-XP spray robot nameplate

2.2 Basic configuration of manipulator

The names of AIR3-560-XP spray robot and each part of it are shown in Figure 2-2.

For the basic specifications of the AIR3-560-XP spray robot, please refer to Chapter 1.3 of this manual. For the dimensions and working range of each axis, please refer to Chapter1.1 of this manual.

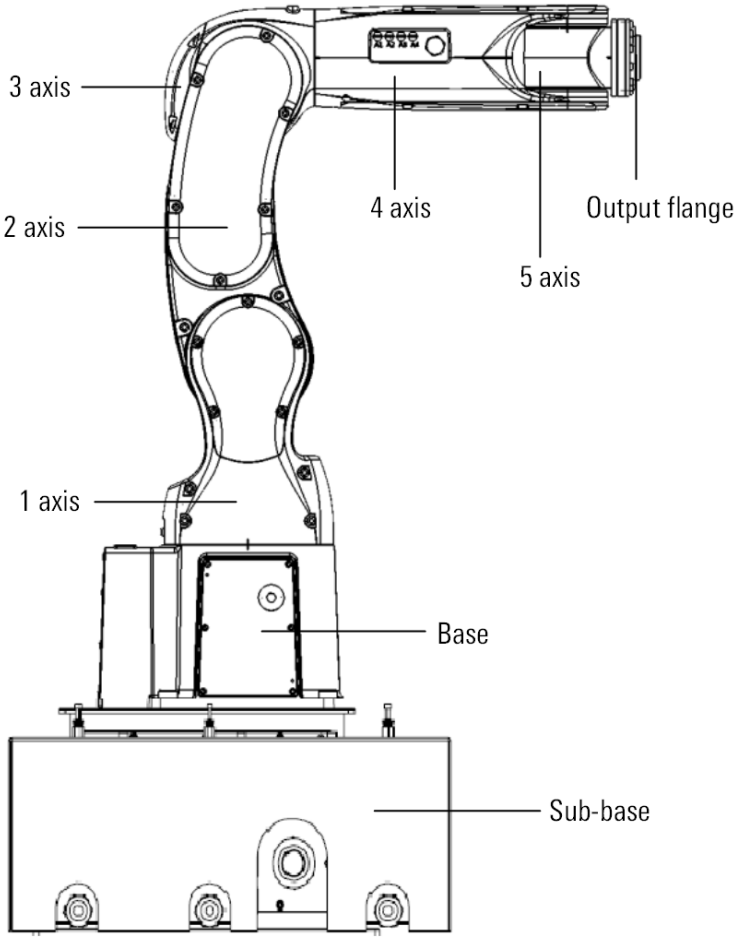


Figure 2-2 AIR3-560-XP spray robot and its parts

2.3 Special precautions for use

When the spray robot is used in an explosive environment, special attention should be paid to:

- In order to prevent the shell from being ignited by the explosive gas outside, it is strictly prohibited to open the shell (the robot shell) in an explosive environment.
- In order to ensure adequate ventilation inside the robot shell, the robot's power supply should not be reset after the shell is opened until the shell is ventilated at a flow rate of at least 30L/min for at least 60 minutes before it can be reset. The prerequisite for resetting the robot is to power on and reset the controller system.
- The protective gas should be non-flammable, and its own chemical characteristics or contained impurities should not affect the positive pressure explosion-proof effect. Then it is specified that the protective gas should be clean, dry and compressed at room temperature (not exceeding 40°C) from a safe place.

3 Preparation before use

3.1 Safety protection measures before use

In order to ensure that the robot avoids accidental impact damage and protects the personal safety of on-site workers, outside the robot's movement range, it is necessary to fully study the on-site working conditions and the safety protection requirements of workers, and design corresponding measures to prevent motion collisions, such as protective nets, Guardrails or light curtains.

Figure 3-1 is a schematic diagram of the safe working of the AIR3-560-XP industrial robot.

Prompt

Equipment such as the teach pendant, control cabinet, and safety barrier must be operated in the safe area. Only the manipulator is allowed to work in the dangerous area.

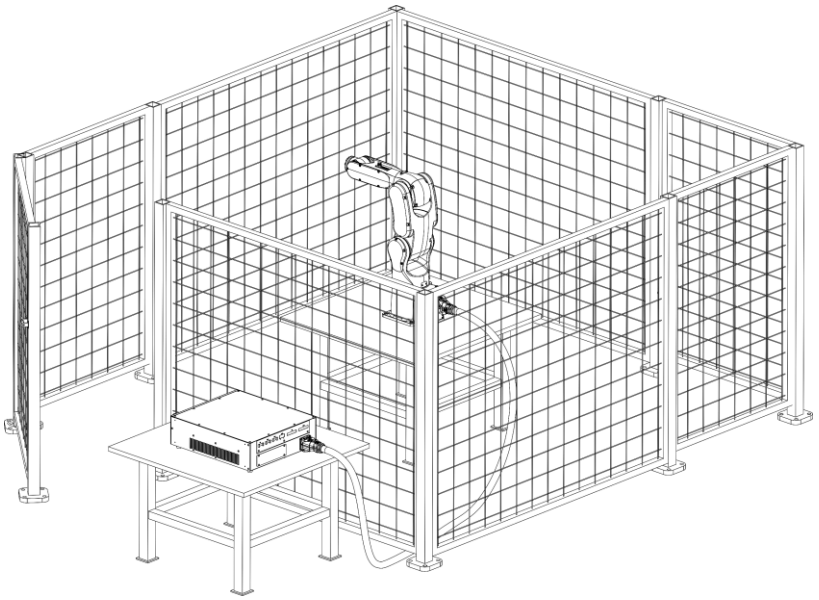


Figure 3-1 Diagram of safe work of industrial robots

3.2 Preparations before installation

3.2.1 Installation precautions

Before installing the robot, the following items must be strictly observed:

- Ensure that the installation personnel must pass the company's relevant training and can only perform installation work in compliance with international and local laws and regulations.
- After unpacking, make sure the robot is not bumped or damaged.
- Make sure that the brackets and lifting eye screws used for transportation are installed on the robot as required.
- Make sure the robot installation environment meets the requirements in Chapter 1.2 of this manual.
- Make sure that the installation location of the robot can withstand the pressure or tension caused by the robot and its load.

3.2.2 Installation tools and required connectors

Tools may be required to install the robot (more tools may be required, depending on the installation method):

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

The following types of connectors may be needed to install the robot (more connectors may be needed, depending on the specific installation):

- A number of M10 or other size cylindrical head hexagon socket screws of appropriate length and strength grade 12.9.
- Several chemical bolts of appropriate length and strength grade no less than 4.8.
- Several spring washers of Φ10 or other specifications.
- Several cylindrical pins with a diameter of 6mm, please refer to Chapter3.3.2 of this manual for details.

3.3 Installation and assembly

3.3.1 Technical specifications

Prompt

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

The dimensions of the AIR3-560-XP spraying robot base are shown in Figure 3-2.

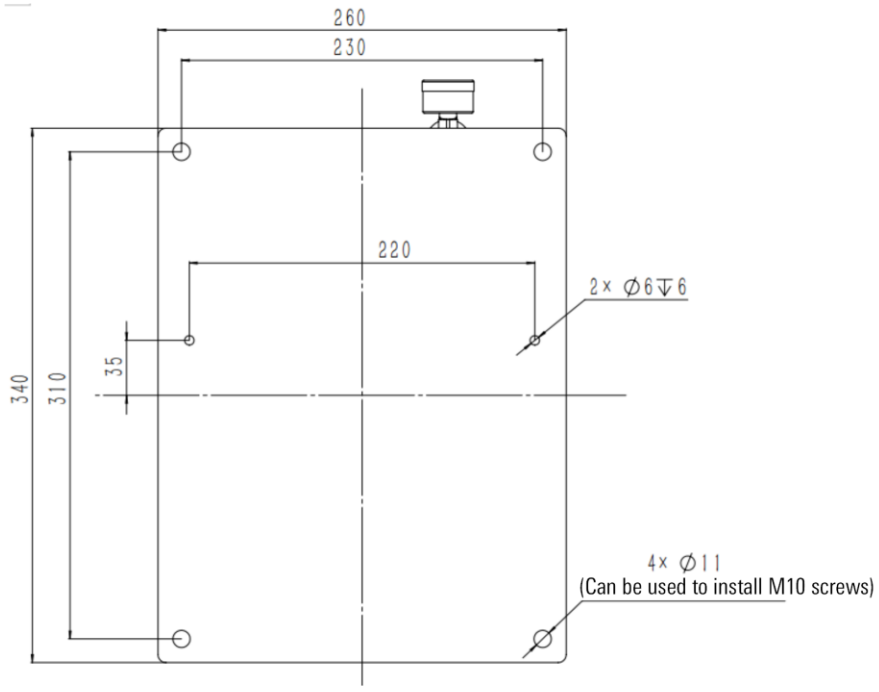


Figure 3-2 AIR3-560-XP spraying robot base interface size

3.3.2 Fixed way

The manipulator provides two fixing methods: "ground fixing" and "bracket fixing".

Prompt

- The specific fixing method should be appropriately selected according to the environment used by the user.
- The strength of chemical bolts is affected by the strength of concrete. For the construction of chemical bolts, please refer to the design guidelines of each manufacturer and fully consider the safety before use.

Table 3-1 shows the names and specifications of the parts and components required to fix the manipulator.

Table 3-1 Parts required for AIR3-560-XP spraying robot fixing

Parts name	Remarks	Ground fixed	Bracket fixed
Fixing screws	4 M10x30 (grade 12.9)	○	○
Chemical bolt	4 M20 (strength grade not less than 4.8)	○	
Robot fixed plate	20mm thickness, 1 piece	○	
Mounting brackets	Mounting plate thickness 20mm		○

Prompt

- There shall be no insulation material between the robot fixing plate and the mounting bracket and the manipulator.
- The representatives with "○" mark need this part.
- The bracket shall be stably installed on the ground, and the strength shall not be less than that of the robot fixing plate and the ground in the ground fixation.

Ground fixed

Fixing steps:

Step1.According to the recommended size shown in Figure 3-3, arrange M20 chemical bolts (strength grade not less than 4.8) on the concrete foundation. Please strictly follow the instructions for the selected chemical bolts for installation;

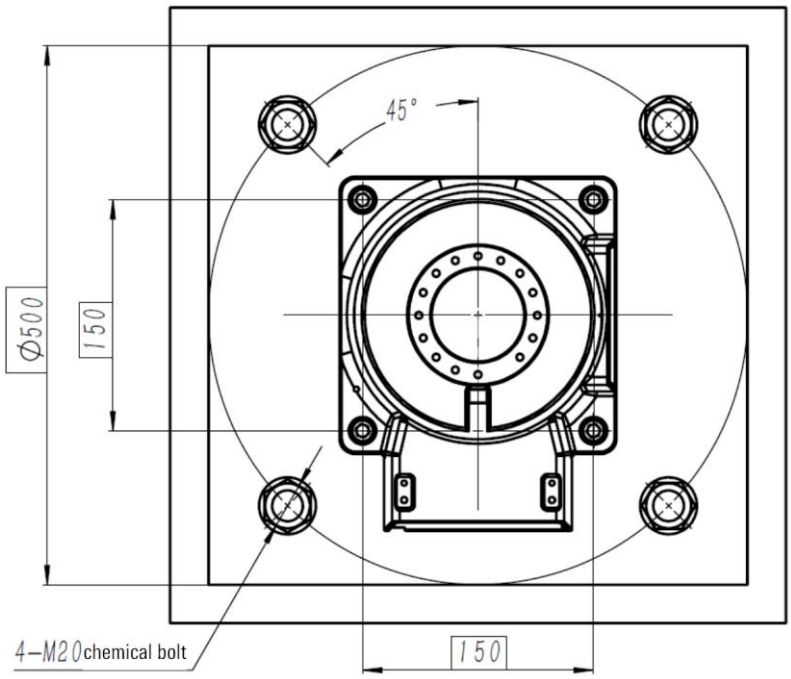
Step2.Place the robot fixing plate close to the installation plane. After placing it securely, fix it with four M20 hexagon nuts (strength grade not less than 4.8) and M20 flat washers;

Step3.In the handling attitude (refer to Chapter 6), transfer the manipulator to the upper part of the robot fixing plate and adjust the direction of the manipulator so that the through hole position of the base ϕ11 is aligned with the threaded hole position of the robot fixing plate M10;

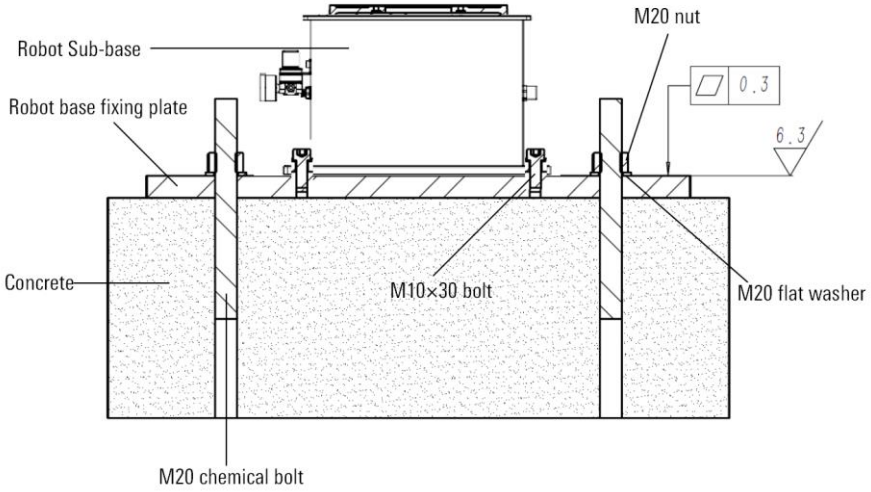
Step4.Check that the base is tightly attached to the retainer plate without shaking and mount the manipulator base fixedly to the retainer plate using four M10 x 30 bolts (strength class 12.9).

Prompt

The mounting surface of the bracket shall meet certain planarity requirements, and the planarity of the mounting surface shall be within 0.3.



(a) Layout size



(b) Section view

Figure 3-3 Ground fixed diagram

Bracket fixed

Warning

- The length of the manipulator fixing screw M10 should not be shorter than 30mm. Too short length will cause accidents such as poor fixing.
- When installing the manipulator on the ceiling, it is necessary to increase the length of the manipulator fixing screw to 35mm, while ensuring that the thickness of the mounting plate is not less than 25mm.

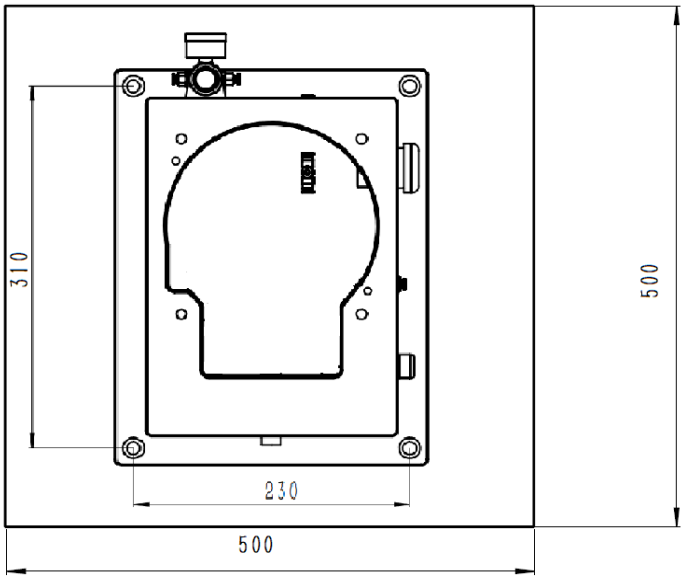
Fixing steps:

Step1.In handling posture, transfer the manipulator to the mounting bracket and adjust the direction of the manipulator to align the hole position of the through hole of the base ϕ11 with the hole position of the threaded hole of the mounting bracket M10.

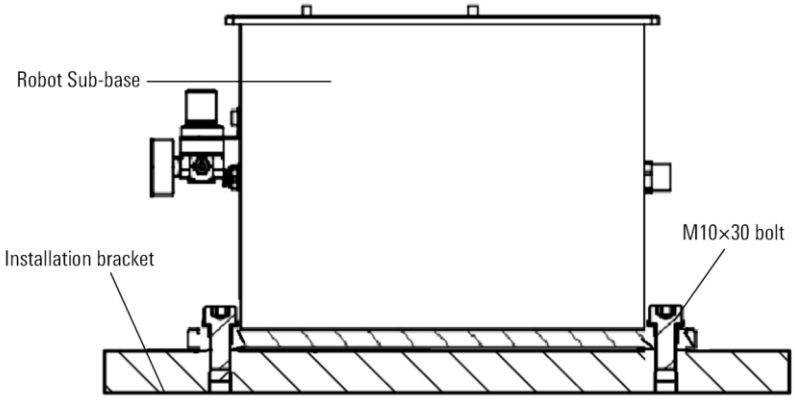
Step2.Check that the base fits snugly on the surface of the mounting bracket without shaking and fix the manipulator base to the bracket using four M10 x 30 bolts (strength class 12.9).

Prompt

The mounting surface of the bracket shall meet certain planarity requirements, and the planarity of the mounting surface shall be within 0.3.



(a)



(b)

Figure 3-4 Diagram of manipulator bracket fixation

4 Product connection

4.1 Robot system composition

The robot system consists of the AIR3-560-XP spraying robot and the controller system (including control cabinet, teach pendant, electrical junction box, heavy-duty line, and pressure signal line), as shown in Figure 4-1. The robot is used in conjunction with a controller system installed in a safe place. The controller system provides power, control, and signal transmission to the product through cables.

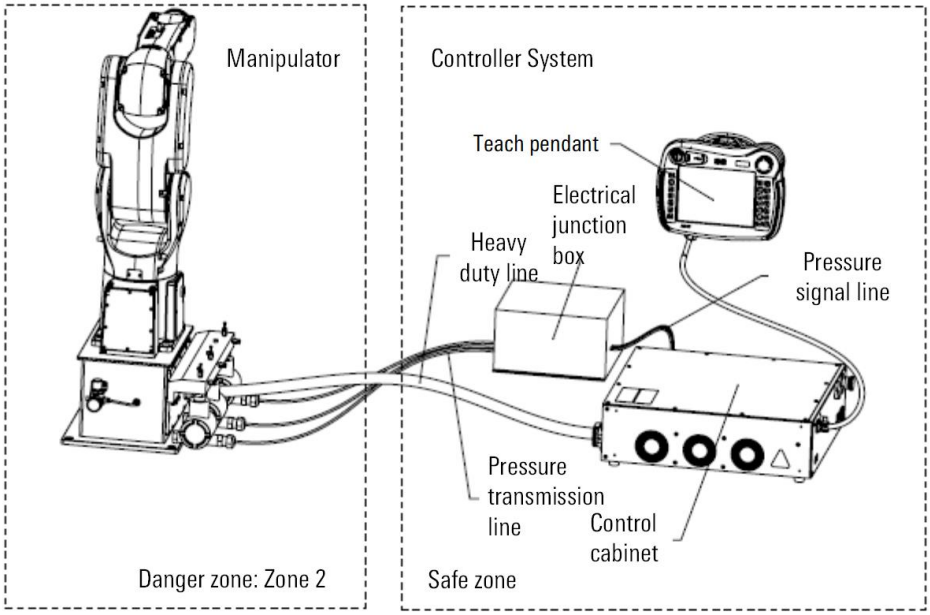


Figure 4-1 Robot system composition

4.2 Connection between manipulator and control cabinet

See Figure 4-2 for the definition of each interface on the control cabinet.

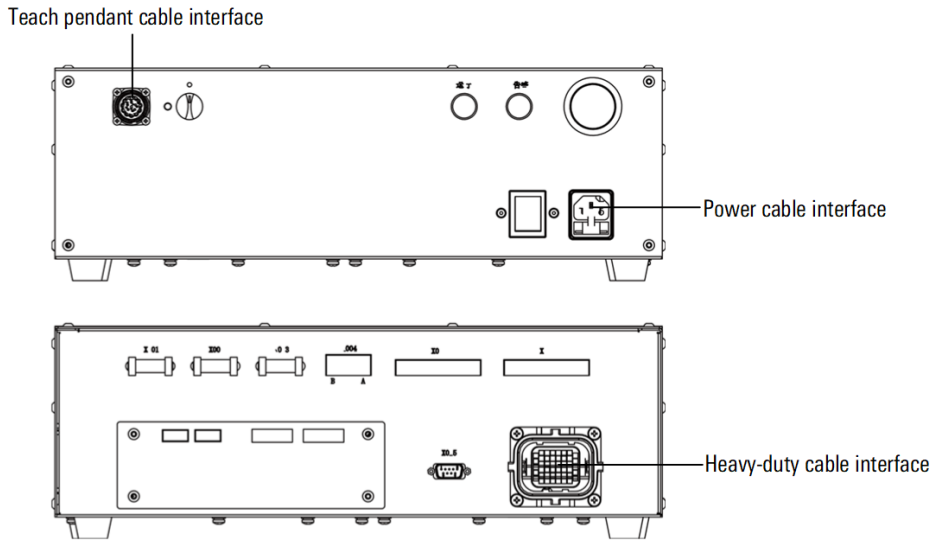


Figure 4-2 AIR3-560-XP control cabinet cable connector definition

Connection steps:

Step1.Connect the heavy-duty line to the control cabinet: Insert the heavy-duty line plug into the heavy-duty line connection port of the control cabinet (see Figure 4-3) and tighten the lock.

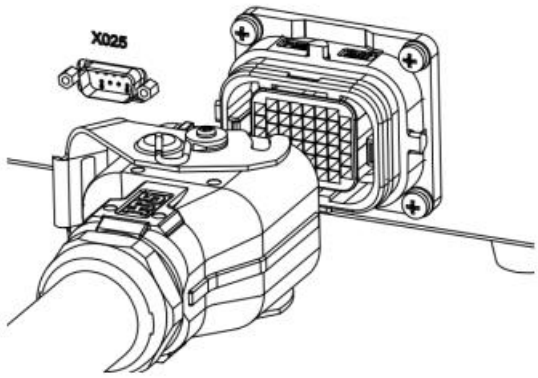


Figure 4-3 Control cabinet heavy duty connector interface

Step2.Connect the pressure signal line to the control cabinet: Insert the signal line plug into the X006 interface of the control cabinet (see Figure 4-4).

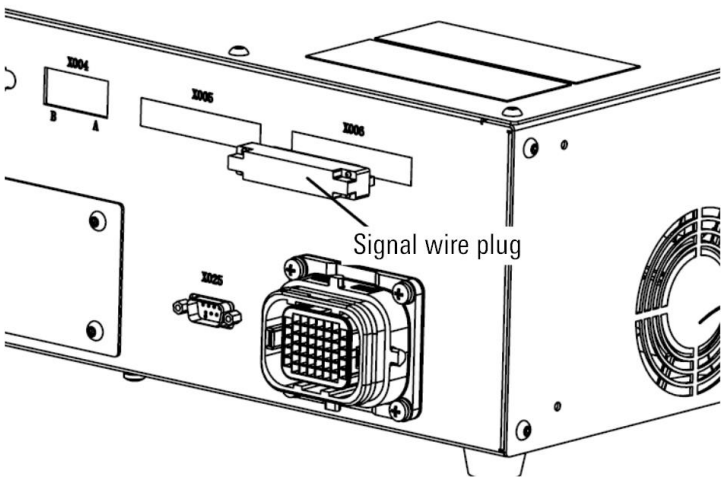


Figure 4-4 Control cabinet signal line interface

Step3.Connect the teach pendant to the control cabinet: Align the triangle alignment symbols on the plug and socket, then push the connector in, rotate the plug 45 degrees clockwise, and tighten the plug and socket (see Figure 4-5).

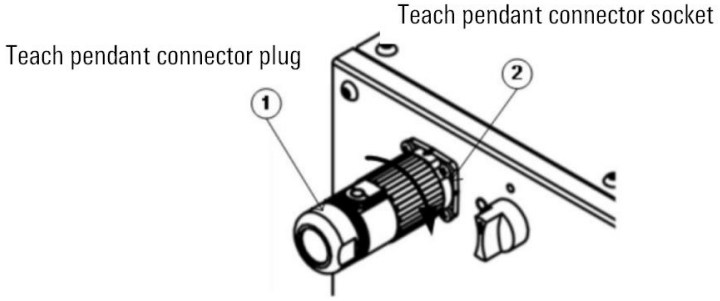


Figure 4-5 Teach pendant connection interface

Step4.Connect the power cord to the control cabinet: Insert the power cord plug into the power cord connection port of the control cabinet (see Figure 4-6).

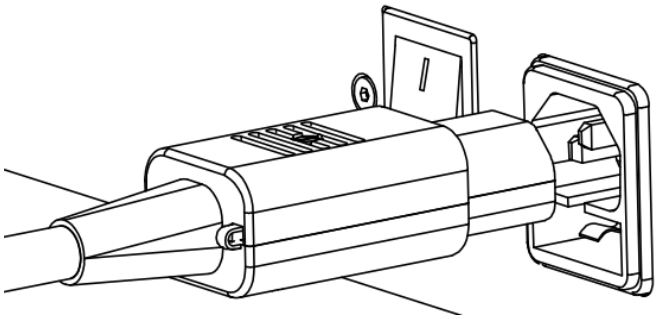


Figure 4-6 Power cord connection interface

Step5.Connect the power supply: Insert the three-prong plug of the power cord into the power socket.

Step6.After power is supplied, switch the rocker switch from "O" to "I" (as shown in Figure 4-7) and start the control cabinet. At the same time, the switch's own light will light up and the teach pendant will start.

Figure 4-7 Control cabinet power switch

5 Job description

5.1 Safety precautions

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.

5.2 Safe operation

5.2.1 Dimensions and working range of each axis

The motion range of each axis of AIR3-560-XP spraying robot is shown in Table 5-1.

Table 5-1 Motion range of each axis of AIR3-560-XP manipulator

Axis No.	Motion range(°)
J1	-170° ~+170°
J2	-110° ~+120°
J3	-108° ~+152°
J4	-200° ~+200°
J5	-118° ~+118°
J6	-350° ~+350°

The motion range of the manipulator is shown in Figure 5-1.

When installing peripheral equipment, be careful not to interfere with the main body of the robot and its range of motion. Unit: mm.

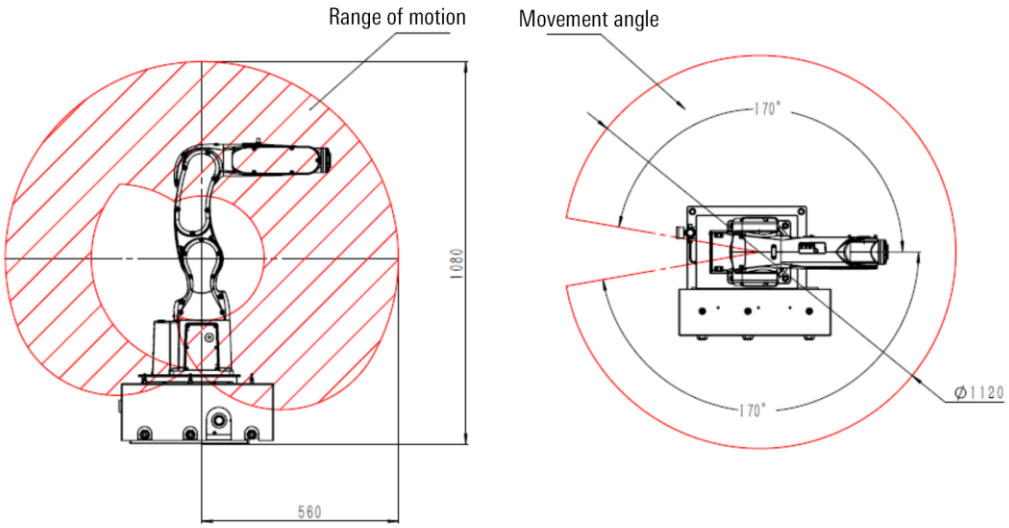


Figure 5-1 Working range of the AIR3-560-XP manipulator

5.2.2 Mechanical limit

On each axis of the manipulator, a zero point and a movable range are respectively provided. As long as the origin position is not lost due to a servo system error or a system error, the robot is controlled to move within the range of motion. In addition, in order to further ensure safety, a mechanical brake is provided on some axes to limit the movable range.

Figure 5-2 shows the position of mechanical brake.

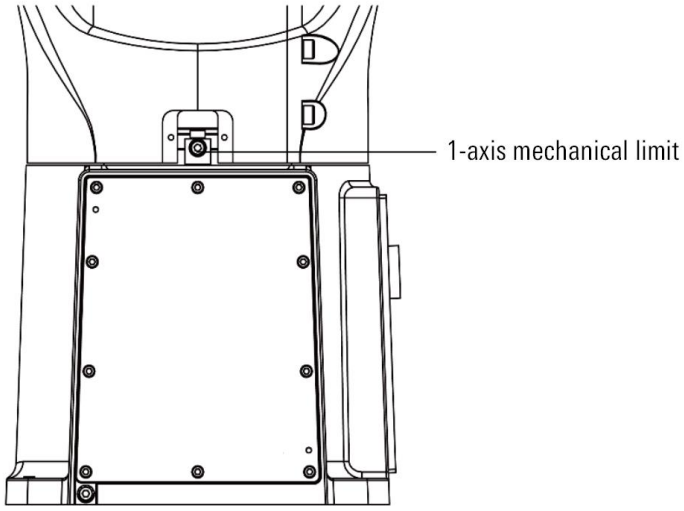


Figure 5-2 AIR3-560-XP mechanical brake on manipulator

Caution	Do not modify the mechanical brake. Otherwise the robot may not stop properly.

5.2.3 Grounding type

Robots require reliable grounding. The purposes of grounding include but are not limited to the following:

- Prevent the robot shell from becoming electrified due to wire insulation failure and protect operators from electric shock;
- Provide a common reference zero potential for the circuit so that there is no potential difference between the grounds of each circuit and ensure the stable operation of the system;
- Prevent external electromagnetic fields from interfering with internal sensitive electrical equipment;
- Reduce the lightning-induced current that may damage the equipment and avoid damaging the internal electronic equipment.

The external grounding point/connection point of the robot is on the robot base in Figure 5-3. The user needs to ground one end of the wire and fix the other end to the base through a suitable terminal and M5 bolt. The contact surface between the terminal and the base must be cleaned to ensure continuity.

The grounding method of the internal power lines of the robot is as follows: the grounding wires of each axis motor are gathered into a single wire and then connected to the metal shell of the heavy-duty connector. The metal shell is connected to the flange in the robot base to form an equal potential. The flange connection between the connector metal shell and the robot base is shown in Figure 5-4.

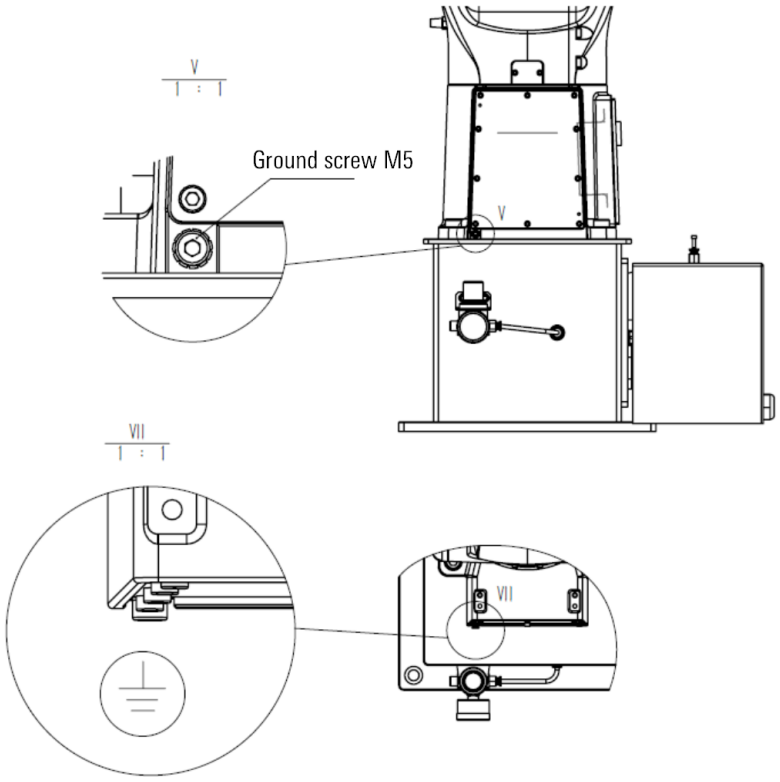


Figure 5-3 Ground connection diagram

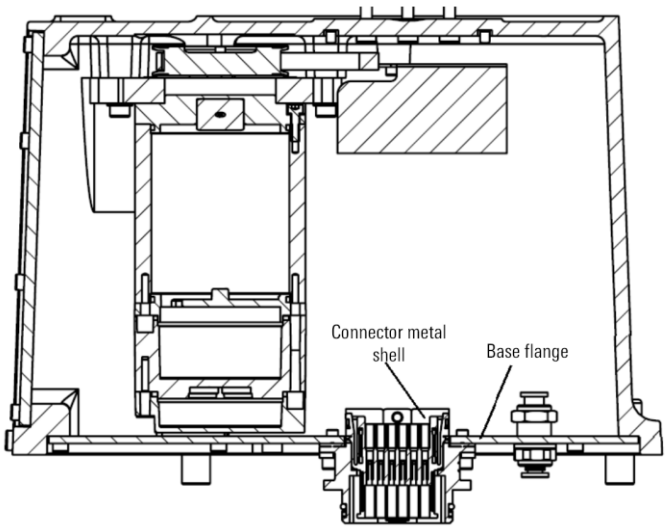


Figure 5-4 Connector shell connection diagram

5.2.4 Run steps

In order to ensure the explosion-proof performance and safe operation of the robot, when: ① When using the robot for the first time, ② After a power outage due to abnormal pressure inside the robot, ③ After the robot cover is removed for maintenance and inspection, the internal cavity of the robot must be fully inspected. Only after ventilation is maintained and the specified positive pressure is maintained, the controller system is allowed to power on the manipulator. The operation process of robot ventilation and maintaining positive pressure is shown in Figure 5-5.

Caution

The specific pressure values in the figure are only examples. For example, 6kPa corresponds to the internal pressure value when ventilation is performed according to the minimum ventilation flow. The specific pressure value is based on the factory calibration settings of the robot.

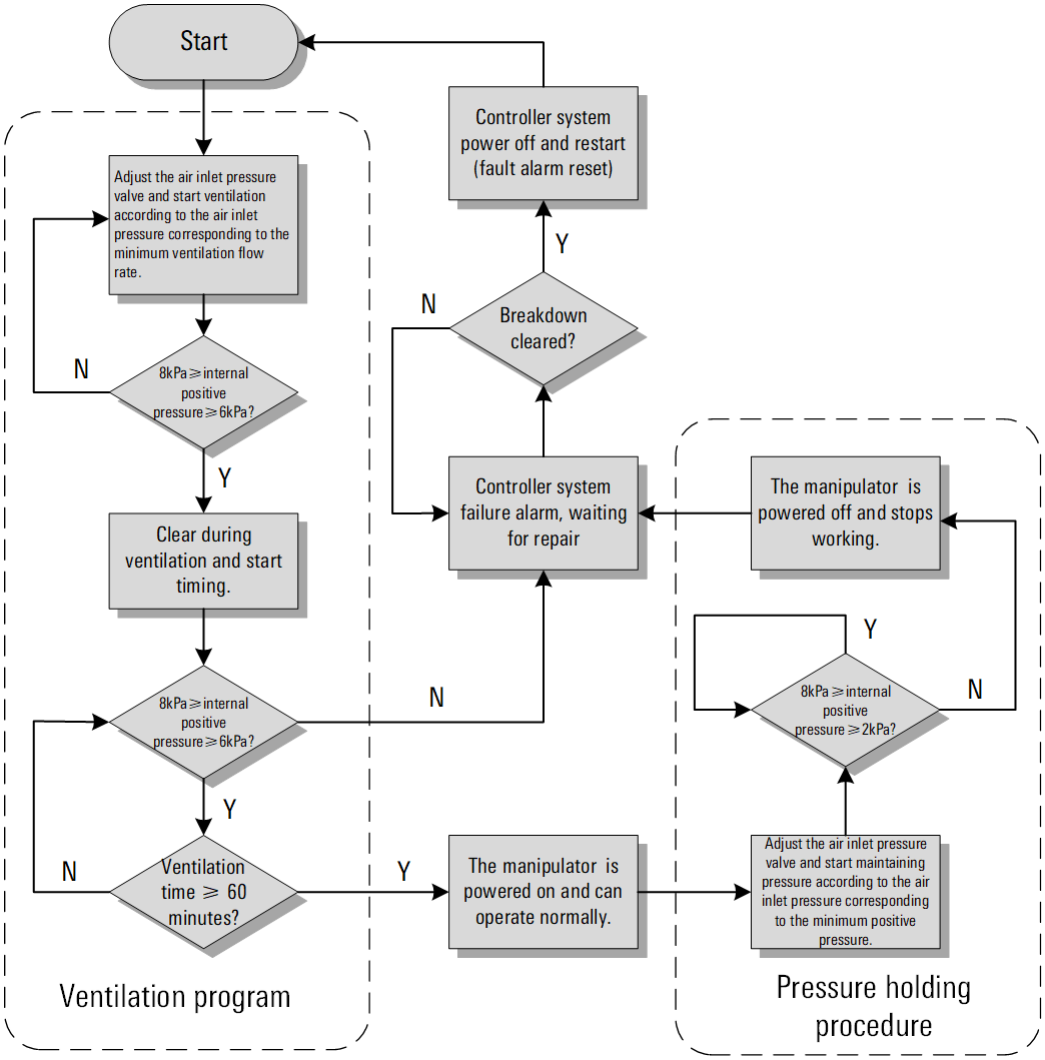


Figure 5-5 Run flow chart

When the internal pressure of the robot is abnormal, alarm prompts will appear on both the teach pendant and the control cabinet, that is, the alarm light will show red, and the robot will not be powered on. The alarm prompt cannot be automatically reset. It needs to wait until the fault is resolved and the control cabinet is powered on again before it can be reset. The alarm prompt is shown in Figure 5-6.

(a) Teach pendant alarm indicator light

(b) Teach pendant alarm indicator light

Figure 5-6 Alarm prompt

The specific operation process of the ventilation machine pressure maintenance is as follows:

Step1.Check and confirm that the cover plates on each axis are properly installed and all screws are tightened.

Step2.Connect the pressure reducing valve on the auxiliary base to the external gas source (such as an air compressor or gas cylinder, not exceeding 0.8MPa) installed in a secure location.

Step3.Rotate the knob on the pressure relief valve on the rotating base to adjust the pressure value of the intake pressure regulating valve within the range of the ventilation pressure value specified on the pressure adjustment instruction label. An example of the pressure adjustment label (specific pressure values are based on the factory calibration settings and documentation) is shown in Figure 5-7, installed near the intake pressure regulating valve.

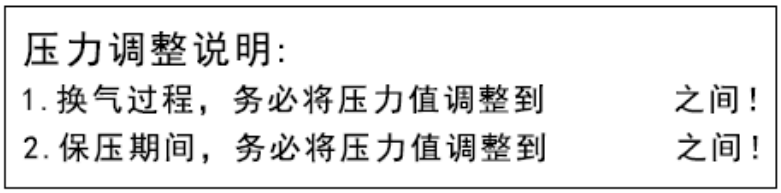


Figure 5-7 Stress adjustment label

Step4.At this time, the teach pendant interface is displayed as shown in Figure 5-8. At this time, the robot cannot be powered on.

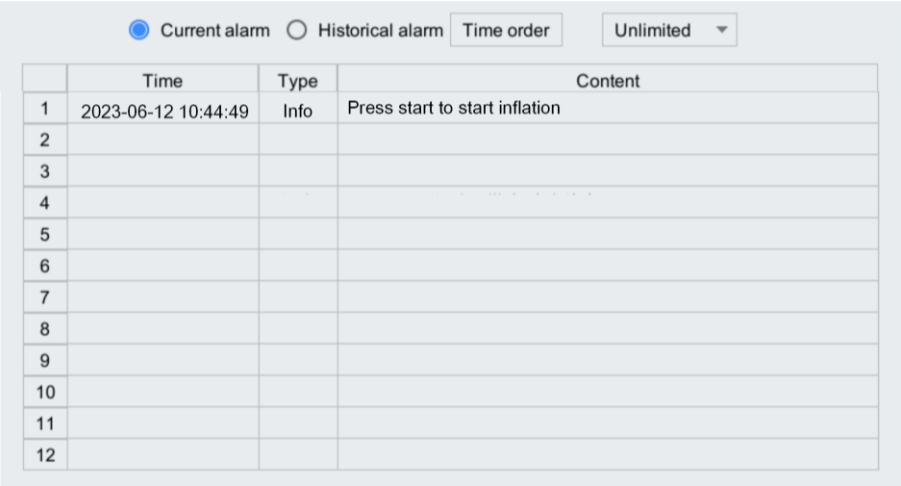


Figure 5-8 Teach pendant Interface: primary and backup start and run

Step5.Press the <Run> button on the teach pendent, and the system starts ventilation and begins timing according to the minimum ventilation duration (60 minutes). During the entire ventilation process, the internal pressure of the robot is monitored in real time to ensure that it remains within the specified ventilation pressure range. The teach denpent interface is displayed as shown in Figure 5-9. At this time, the robot cannot be powered on.

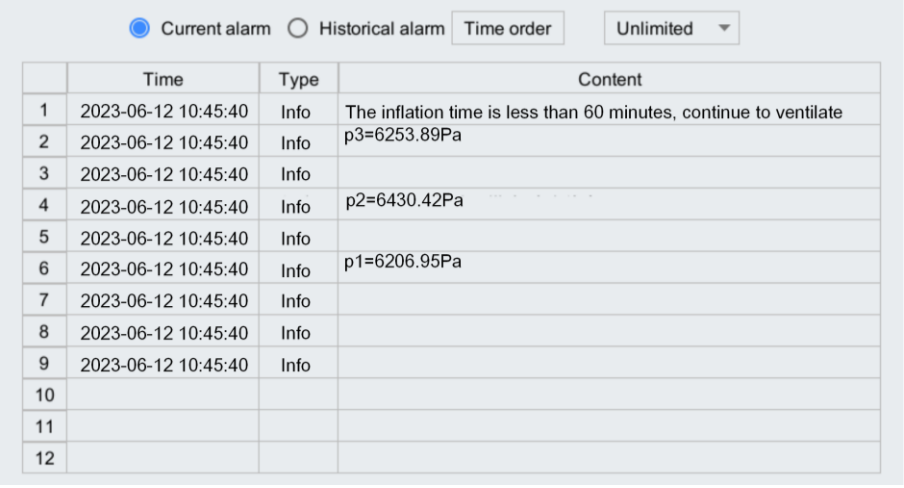
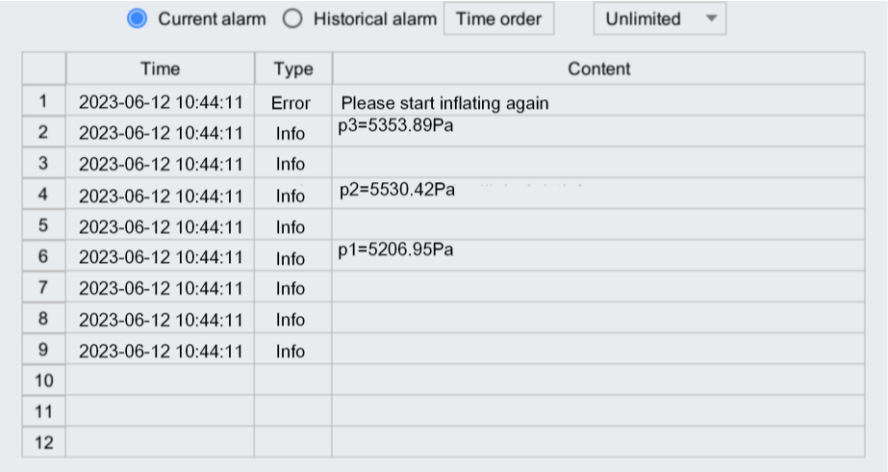


Figure 5-9 Teach pendant interface: normal ventilation

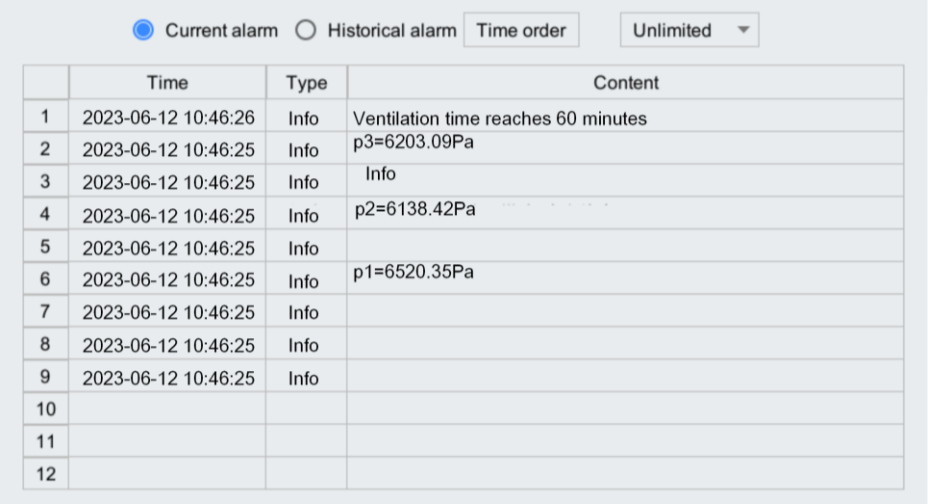
Step6.Once the internal pressure of the robot is abnormal during the ventilation process (lower than 6kPa or higher than 8kPa), the teaching pendant interface will be displayed as shown in Figure 5-10. At this time, the system alarms and the ventilation are ineffective. It is necessary to eliminate the fault and restart the control cabinet and teach pendant before restarting the ventilation.



	Time	Type	Content
1	2023-06-12 10:44:11	Error	Please start inflating again
2	2023-06-12 10:44:11	Info	p3=5353.89Pa
3	2023-06-12 10:44:11	Info	
4	2023-06-12 10:44:11	Info	p2=5530.42Pa
5	2023-06-12 10:44:11	Info	
6	2023-06-12 10:44:11	Info	p1=5206.95Pa
7	2023-06-12 10:44:11	Info	
8	2023-06-12 10:44:11	Info	
9	2023-06-12 10:44:11	Info	
10			
11			
12			

Figure 5-10 Teach pendant interface: abnormal ventilation (example internal pressure is too small)

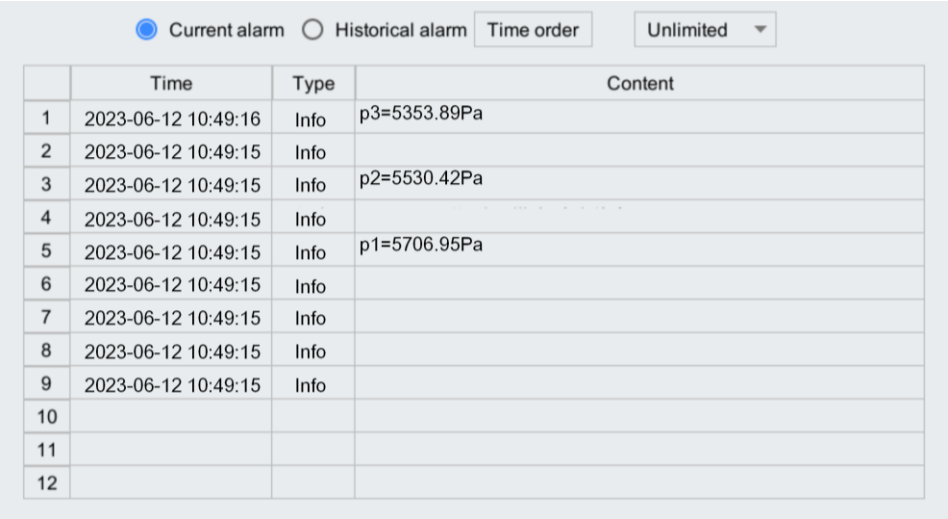
Step7.Under normal ventilation conditions, after reaching the minimum continuous ventilation time, the teach pendant screen prompts "Ventilation Completed", as shown in Figure 5-11. At this time, the robot is powered on normally.



	Time	Type	Content
1	2023-06-12 10:46:26	Info	Ventilation time reaches 60 minutes
2	2023-06-12 10:46:25	Info	p3=6203.09Pa
3	2023-06-12 10:46:25	Info	Info
4	2023-06-12 10:46:25	Info	p2=6138.42Pa
5	2023-06-12 10:46:25	Info	
6	2023-06-12 10:46:25	Info	p1=6520.35Pa
7	2023-06-12 10:46:25	Info	
8	2023-06-12 10:46:25	Info	
9	2023-06-12 10:46:25	Info	
10			
11			
12			

Figure 5-11 Teach pendant interface: normal ventilation completed

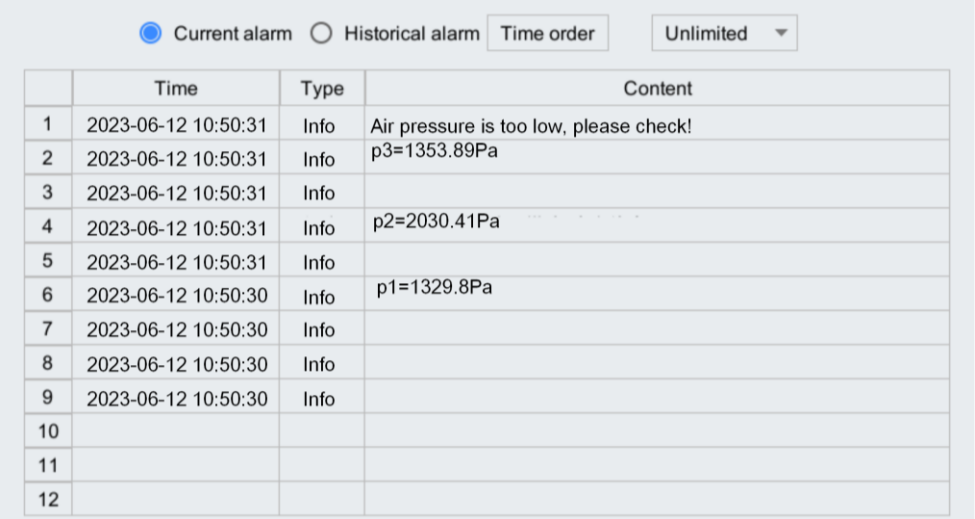
Step8.At this time, turn the knob on the pressure reducing valve on the sub-base and be sure to adjust the pressure value of the air inlet pressure regulating valve to the holding pressure value range specified on the pressure adjustment instruction label. The robot is in the normal pressure maintaining process and the robot can work normally. Monitor the internal pressure of the robot in real time to ensure that it is always within the specified ventilation pressure range. The teach pendant interface is displayed as shown in Figure 5-12.



	Time	Type	Content
1	2023-06-12 10:49:16	Info	p3=5353.89Pa
2	2023-06-12 10:49:15	Info	
3	2023-06-12 10:49:15	Info	p2=5530.42Pa
4	2023-06-12 10:49:15	Info	
5	2023-06-12 10:49:15	Info	p1=5706.95Pa
6	2023-06-12 10:49:15	Info	
7	2023-06-12 10:49:15	Info	
8	2023-06-12 10:49:15	Info	
9	2023-06-12 10:49:15	Info	
10			
11			
12			

Figure 5-12 Teach pendant interface: normal pressure maintenance and normal operation

Step9.When the robot is working normally (maintaining pressure), once its internal pressure is abnormal (lower than 2kPa or higher than 8kPa), the control cabinet immediately cuts off the power supply and signal transmission of the robot. The screen display of the teach pendant is as shown in Figure 5-13. At this time, the system alarm, the robot has a positive pressure failure. It is necessary to eliminate the fault and restart the control cabinet and teach pendant before re-ventilating and maintaining pressure. In addition, the manipulator also needs to be re-zero calibrated.



	Time	Type	Content
1	2023-06-12 10:50:31	Info	Air pressure is too low, please check!
2	2023-06-12 10:50:31	Info	p3=1353.89Pa
3	2023-06-12 10:50:31	Info	
4	2023-06-12 10:50:31	Info	p2=2030.41Pa
5	2023-06-12 10:50:31	Info	
6	2023-06-12 10:50:30	Info	p1=1329.8Pa
7	2023-06-12 10:50:30	Info	
8	2023-06-12 10:50:30	Info	
9	2023-06-12 10:50:30	Info	
10			
11			
12			

Figure 5-13 Teach pendant interface: pressure maintenance failure (example internal pressure is too small)

5.2.5 Stop method

According to GB5226.1-2008 "Mechanical and Electrical Safety - Part 1: General Technical Conditions" 9.2.2, the stop function definition is defined, and combined with the specific design of the robot, three stop modes are defined and corresponding explanations are shown in Table 5-2:

Table 5-2 Stop method and corresponding instructions

Type	Explain	
STOP0	Case1	If the control cabinet MCBS fails, the DCB execution stops immediately, does not

Type	Explain	
		maintain the trajectory, and cuts off the power supply, which is an uncontrollable stop.
	Case2	A fault occurs in the control cabinet DCB, triggering a free stop or a brake stop, which is an uncontrollable stop.
	Case3	A sudden external power outage (such as a power outage, turning off the power supply of the control cabinet) triggers the brake to stop, which is an uncontrollable stop.
STOP1	Case1	Press the emergency stop button on the teach pendant, the robot will stop quickly, maintain the current planned path, and cut off the power supply through the main circuit relay, which is a controlled stop.
	Case2	The internal pressure of the robot is abnormal, and the robot stops quickly, maintains the current planned path, and cuts off the power supply through the main circuit relay, which is a controlled stop.
STOP2	Press the pause button on the teach pendant, and the robot will stop quickly and maintain the current planned path without cutting off the power supply, which is a controlled stop.	

5.3 Calibration

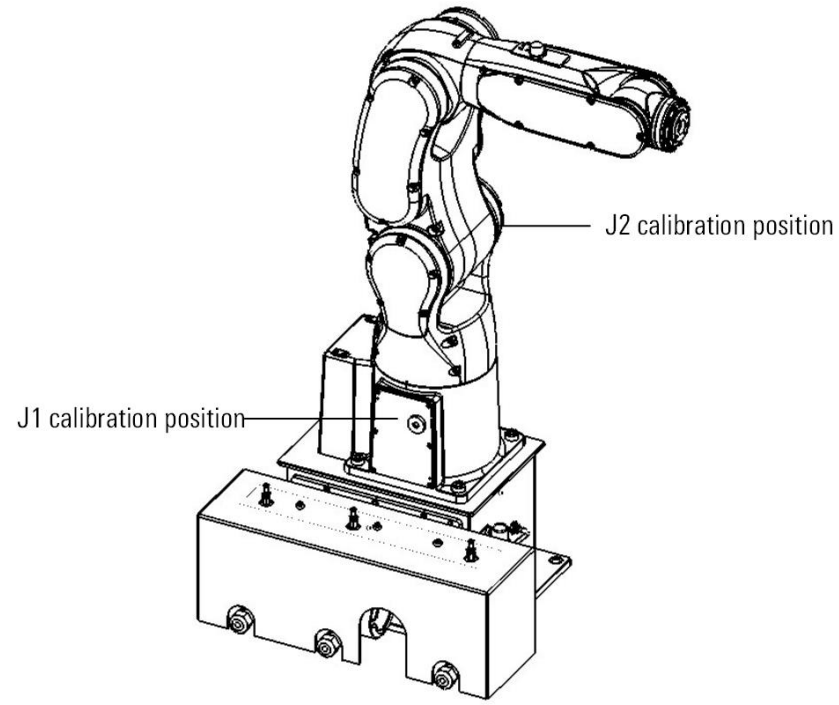
5.3.1 When calibration is required

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

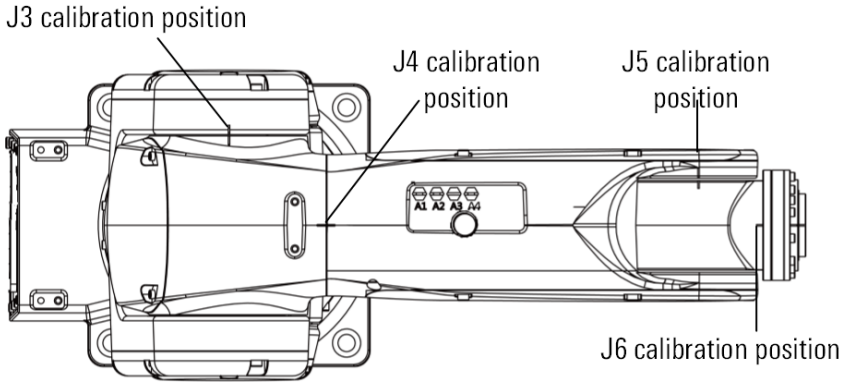
- There have been repairs such as motor replacement or pulley removal.
- The motor encoder wire is loose or has been reinstalled.
- The robot has had a strong collision.
- The control cabinet or control system (such as industrial computer) has been replaced.
- Power outage due to abnormal pressure inside the robot.

5.3.2 Calibration position of each axis

The position of each axis of the manipulator is shown in Figure 5-14 below, in which, except for the J3 axis, it is 90 °, and the other axes are 0 °.



(a)



(b)

Figure 5-14 Diagram of zero points for each axis of AIR3-560-XP

Caution

- The robot calibration must always be performed at the same temperature conditions to avoid errors due to thermal expansion and contraction.
- The AIR3-560-XP industrial robot calibration must be calibrated in sequence from the J1 axis to the J6 axis.

5.4 Output flange size

The output flange connection dimensions and diagram of the AIR3-560-XP spraying robot are shown in Table 5-3 and Figure 5-15.

Table 5-3 AIR3-560-XP output mechanical interface specifications

Parameter	Illustrate
Locating circle diameter	20mm

Parameter	Illustrate
Diameter of graduation circle of threaded hole	31.5mm
Screw grade	12.9
Screw diameter	M5
Screw quantity	4
Locating pin	5mm
Screw standard	GB/T 70.1-2008

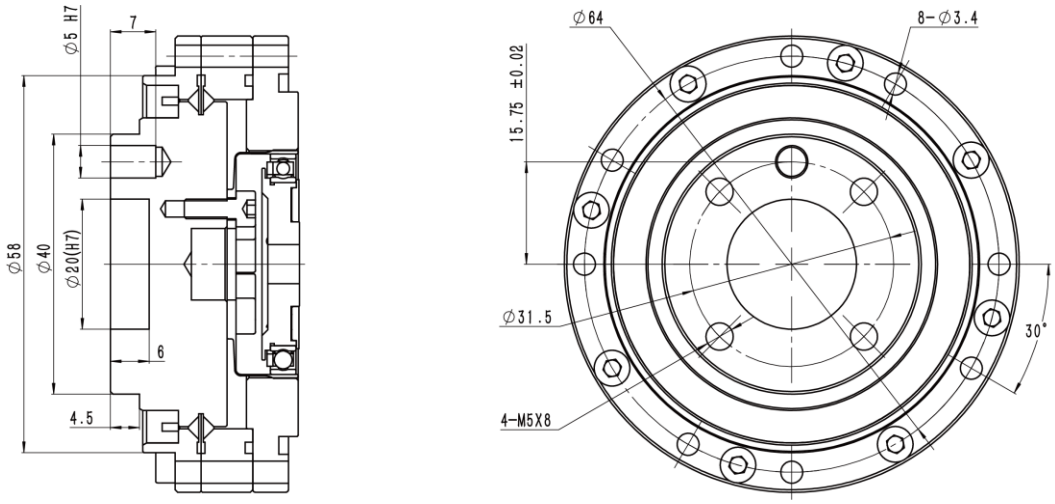


Figure 5-15 Diagram of wrist flange dimensions of AIR3-560-XP spraying robot

Warning

When installing the fixture, the depth of the threaded hole and pin hole shall be fully considered for the screws and locating pins used. It is forbidden to install the length beyond the depth of the threaded hole (8mm) and the depth of the pin hole (7mm), otherwise the wrist of the manipulator will be damaged.

5.5 load installation

Installation of wrist load on the manipulator

Installation requirements:

- The load conditions should be within the range shown in Figure 5-16 and Table 5-4.
- The 4th axis allows a wrist torque less than 4.7Nm, the 5th axis allows a wrist torque less than 4.7Nm, and the 6th axis allows a wrist torque less than 1.8Nm.
- The 4-axis allows a load moment of inertia less than 0.076kgm², the 5-axis allows a load moment of inertia less than 0.076kgm², and the 6-axis allows a load moment of inertia less than 0.01kgm².
- The allowable load moment of inertia of the 4-axis is less than 0.23kgm², the allowable load moment of inertia of the 5-axis is less than 0.23kgm², and the allowable load moment of inertia of the 6-axis is less than 0.032kgm².

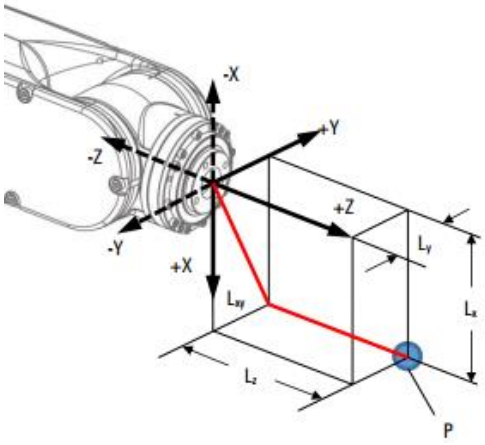
Table 5-4 AIR3-560-XP manipulator load torque and load moment of inertia data

Manipulator model	Axis	Load torque	Rated load moment of inertia	Maximum moment of inertia
Wrist load 3kg		Nm	kgm²	kgm²

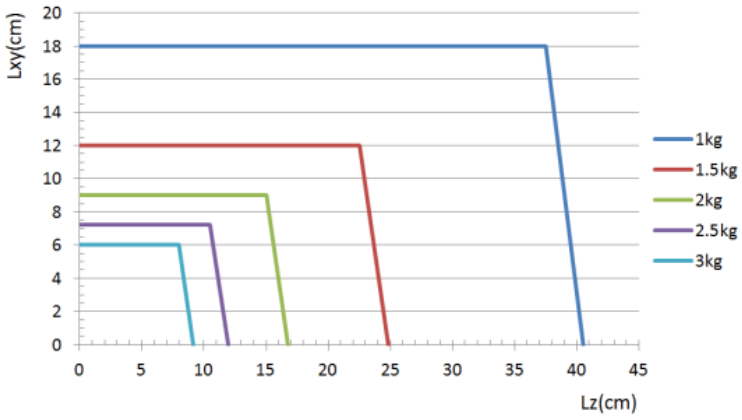
Manipulator model	Axis	Load torque	Rated load moment of inertia	Maximum moment of inertia
AIR3-560-XP	J4	4.7	0.076	0.23
	J5	4.7	0.076	0.23
	J6	1.8	0.01	0.032

Prompt

The data in Table 5-4 is the maximum load torque and moment of inertia data corresponding to J4, J5, and J6 under rated working conditions when a 3kg load (Lz=80mm, Lxy=60mm) is installed.



(a)



(b)

Figure 5-16 Diagram of the load center position of the output flange of the AIR3-560-XP spraying robot

6 Transportation and handling

Caution

When transporting the manipulator, a matching transport bracket (optional accessory) must be installed. Incorrect transport methods may cause damage to the manipulator. The posture of the manipulator during transport shall be subject to the description in "6.1 Transport posture" of this manual. Things that should be paid attention to when transporting the manipulator are shown in Figure 6-1.

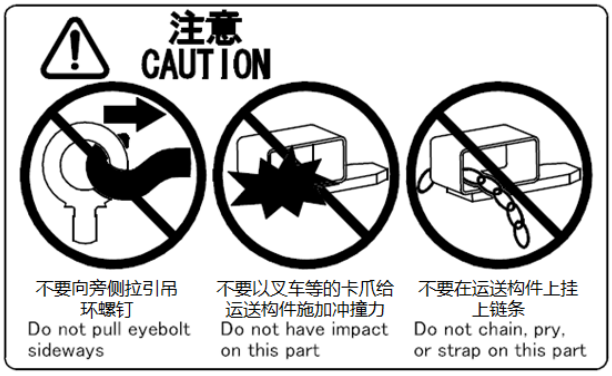


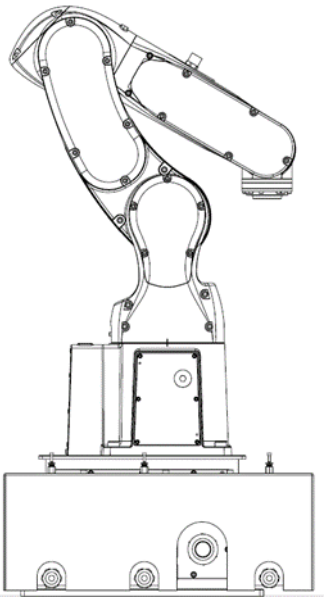
Figure 6-1 Precautions when transporting the manipulator

6.1 Transport attitude

The postures of one to six axes when handling the AIR3-560-XP are as shown in Table 6-1.

Table 6-1 Angle value of each axis during robot transportation

A1	A2	A3	A4	A5	A6
0	-30°	150°	0	60°	0



Please see Figure 6-2 for the rendering of the one to six-axis attitude of the AIR3-560-XP when being transported.

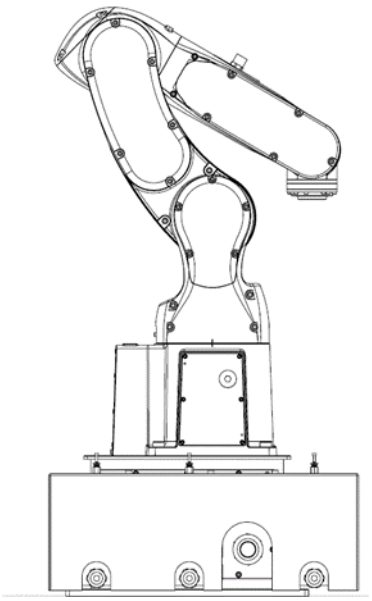


Figure 6-2 AIR3-560-XP manipulator handling posture diagram

6.2 Transport dimensions

Please refer to Figure 6-3 for the dimensions that each part of the manipulator needs to meet when it is being transported.

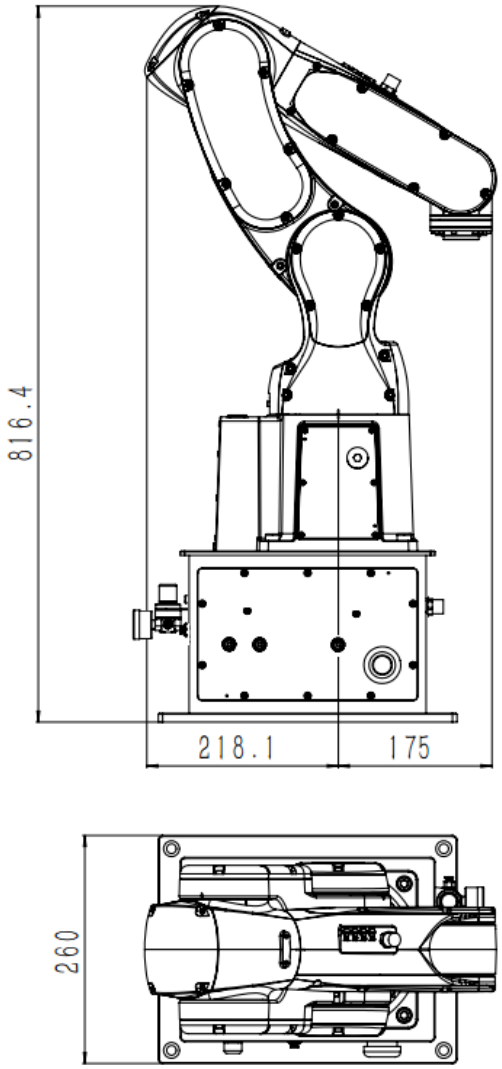


Figure 6-3 AIR3-560-XP handling manipulator dimensions

Caution	The actual size may be slightly larger than the size in Figure 6-3, please note.

6.3 Handling method

Forklift transportation

The diagram when using a forklift to transport is as shown in Figure 6-4. The forklift should be able to meet the weight requirement of the manipulator (38kg), and the total weight of the manipulator and the handling device is about 46kg.

Caution	When transporting the manipulator, a matching transport bracket (optional accessory) must be installed. Incorrect transport methods may cause damage to the manipulator. The posture of the manipulator during transport shall be subject to the description in "6.1 Transport posture" of this manual. The sensor components are individually packaged before the robot is fixed into the packaging box.

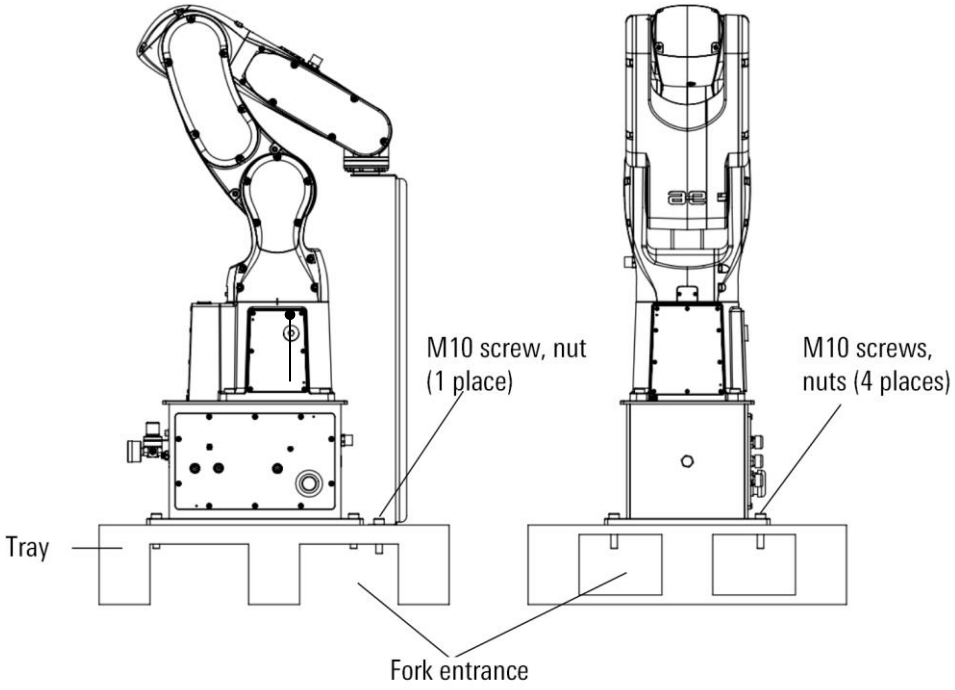


Figure 6-4 AIR3-560-XP forklift handling diagram

Ring handling

The diagram when the manipulator is transported using a lifting ring is shown in Figure 6-5 below. The lifting device should be able to meet the weight requirement of the manipulator (38kg). The total weight of the manipulator and transporting device is about 65kg.

A single sling can carry a weight of more than 150kg, and a crane can carry a weight of more than 200kg.

Caution

- When the manipulator is transported using a lifting ring, insert a soft object between the contact area between the lifting rope and the manipulator to prevent the lifting rope from scratching the manipulator.
- The manipulator may tip over when transported using lifting rings. Please be particularly careful to keep the manipulator stable during transportation.
- Do not pull the lifting ring sideways to avoid damage to the manipulator and unexpected malfunctions.

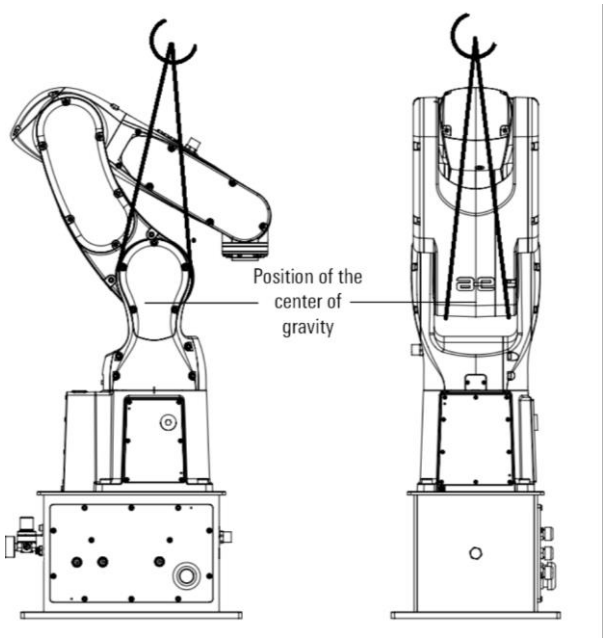


Figure 6-5 AIR3-560-XP lifting ring handling diagram

7 Fault finding, diagnosis and repair

The malfunction of the manipulator is sometimes caused by multiple different reasons. It is often difficult to thoroughly investigate the cause. If the error handling method is adopted, the malfunction may be further deteriorated. Therefore, it is very important to analyze the malfunction in detail and find the real cause.

The possible faults and causes of the manipulator are shown in Table 7-1-Table 7-7. If you are not sure of the cause or how to deal with it, please contact our company.

Table 7-1 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 7-2 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 7-3 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 7-4 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 7-5 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 7-6 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 axis	■ 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 7-7 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

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