



Mechanical Maintenance

Manual for GR Painting

Robot Series

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CMA

CMA (WUHU) Robotics Company Limited

Supplier of Intelligent Painting Robots

Statement

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This manual is an indispensable part of the whole manual collection and all the professionals involved in operation, teaching, maintenance, and inspection are required take CMA special training on the knowledge instructed by the following manuals:

- ☐ ZL-GR-001-V1: Safety Manual for GR Painting Robot Series
- ☐ ZL-GR-002-V1: Maintenance Manual for GR Painting Robot Series
- ☐ ZL-GR-003-V1: Explosion Protection Manual for GR Painting Robot Series
- ☐ ZL-GR-004-V1: Remote Assistance Manual for GR Painting Robot Series
- ☐ ZL-GR-005-V1: IO Communication Instruction Manual for GR Painting Robot Series
- ☐ ZL-GR-006-V1: Program Editor Instruction Manual for GR Painting Robot Series
- ☐ ZL-GR6150-001-V1: Installation and Connection Instruction Manual for GR6150 Robot
- ☒ ZL-GR6150-002-V1: Mechanical Maintenance Manual for GR6150 Robot
- ☐ ZL-GR6150-003-V1: Electrical Maintenance Manual for GR6150 Robot
- ☐ ZL-GR6150-004-V1: Electrical Schematic Diagram for GR6150 Robot

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About the Manual

The target readers of the manual include professionals involved in robot operation, maintenance and technical service.

This manual intends to explain the mechanical maintenance during use for all the GR6150 painting robots designed by CMA.

In order to effectively draw the attention of the users of the manual to a specific subject or aspect, the following symbols will be used, each with the following meanings.

Safety precautions in this manual are classified into four categories, “danger”, “caution”, “attention” and “important” respectively.

 Danger	Danger! This warning means death might occur, if an operation is not properly performed.
 Caution	Caution! This warning means death or server physical injury might occur, if an operation is not properly performed.
 Attention	Attention! This warning means minor physical injury or minor material damage may occur, if an operation is not properly performed.
 Important	Important! This warning means special attention should be paid to a certain operation.

Warnings titled by “attention” might also lead to severe consequence in different cases. Therefore it is strongly recommended that anything titled by “attention” should be handled with extreme caution.

- Please read the manual and the files attached carefully and master all the required knowledge about the robot and the safety instructions before use.
- A cover or safety shield is taken out only for the purpose of illustration. Please ensure to restore the cover or safety shield before any operation.
- The figures and photos contained in this manual are for the purpose of illustration only and they might be different from the product purchased.
- The manual is subject to change without prior notice for the purpose of product improvement, specification change and instruction update.
- The manual will be reissued and a new version number will be specified if the contents are

renewed.

- If you need to order the manual due to damage, loss, etc., please contact our agent or the nearest sales office on the back cover of the manual, and order according to the data number on the cover.
- CMA is not responsible for any consequence caused by any unauthorized modification or change of the robot.

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Chapter One Safety

1.1 Instructions for Safe Use of Robots

Before performing installation, operation, maintenance, and overhaul operations, please be sure to read this manual and other attached documents thoroughly and use this product correctly. Please fully grasp the equipment knowledge, safety information and all precautions before using this product. This manual uses the following symbols to indicate their importance.

 Danger	It means that if the handling is wrong, it will cause the user's death or serious injury, and the situation is very dangerous.
 Warning	It indicates a situation that will cause death or serious injury to the user if the handling is incorrect.
 Attention	It indicates a situation that will cause minor injuries or property damage to the user if the handling is incorrect.

1.1.1 Safety Precautions during Adjustment, Operation, Maintenance, etc.

- (1) Operators must wear work clothes, safety helmets, safety shoes, etc.
- (2) When turning on the power, make sure that there are no workers within the robot's operating range.
- (3) The power must be cut off before entering the robot's range of motion for work.
- (4) When overhaul, maintenance and other operations must be carried out under the power-on state, two persons should work in a team at this time. One person maintains a posture that can immediately press the emergency stop button, while the other person is within the robot's range of motion, staying vigilant and working quickly. In addition, you should confirm the retreat path before proceeding.
- (5) The load on the wrist and the robot arm must be controlled within the allowable carrying weight and torque. If the allowable carrying weight and torque regulations are not observed, it will lead to abnormal action or premature damage of mechanical components.
- (6) It is forbidden to disassemble and work on parts not covered in the maintenance manual.

The robot is equipped with various self-diagnostic functions and abnormality detection functions, so that it can stop safely even if an abnormality occurs. Even so, accidents caused by robots still occur from time to time.

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 Danger	Most robot accidents are as follows: 1、 The automatic operation was performed without confirming whether there is anyone in the robot's motion range. 2、 It enters the robot's motion range in the automatic operation state, and the robot starts suddenly during the operation. 3、 You just notice the robot in front of you, ignoring the others.
--	---

The above-mentioned accidents were all caused by the same reasons as "ignorance of safety operation procedures" and "no idea that the robot would move suddenly". In other words, they are all accidents caused by man-made unsafe behaviors such as "temporary negligence" and "failure to follow the prescribed steps."

"Emergency situations" make it too late for operators to implement "emergency stop", "flee" and other behaviors to avoid the accident, which may lead to major accidents. "Emergency situations" generally have the following types.

- (1) Low-speed action suddenly becomes high-speed action.
- (2) Other operators performed the operation.
- (3) A different program was started due to an abnormality or program error in the peripheral equipment.
- (4) Abnormal operation due to noise, malfunction, defect, etc.
- (5) Misoperation.
- (6) Originally planned to regenerate at low speed to perform the action, but it performed the high-speed action.
- (7) The work pieces transported by the robot fall and scatter.
- (8) When the work piece is in the stopped state of clamping and interlocking standby, it suddenly loses control.
- (9) The next or behind robot performed the action.

The above are only some examples, and there are many forms of "emergency situations". In most cases, it is impossible to "stop" or "escape" a robot that moves suddenly, so the following best countermeasures should be implemented to avoid such accidents.

 Danger	Be careful and approach the robot cautiously.
 Danger	When the robot is not in use, measures such as "press the emergency stop button" and "cut off the power" should be taken to prevent the robot from moving.

 Danger	During the operation of the robot, please configure a monitor (the third party) who can immediately press the emergency stop button to monitor the safety status.
 Danger	During the operation of the robot, the operation should be carried out in a state where the emergency stop button can be pressed immediately.

In order to comply with these principles, it is necessary to fully understand the following precautions and follow them.

1.1.2 Safety Countermeasures of Robot Body

 Attention	The design of the robot should remove unnecessary protrusions or sharp parts, use materials that adapt to the working environment, and adopt a fail-safe protection structure that is not prone to damage or accidents during operation. In addition, it should be equipped with misoperation detection stop function and emergency stop function when the robot is in use, as well as interlocking function to prevent the danger of the robot when the peripheral equipment is abnormal, so as to ensure safe operation.
 Warning	The main body of the robot is a multi-joint manipulator structure, and the angle of each joint in the movement is constantly changing. When you must approach the robot for teaching and other tasks, be careful not to get caught by the joints. Because there are mechanical stops at the action ends of the axis 1、 2 and 3, which has a high risk of being clamped, so special attention should be paid to it. In addition, if the servo motor is removed or the brake is released, the robot arm may fall due to its own weight or move in an uncertain direction. Therefore, measures to prevent falling must be implemented, and the surrounding safety conditions must be confirmed before operation.
 Attention	When installing the attached machine on the end effector and the mechanical arm, the size and quantity of screws specified in this book should be strictly observed, and the torque wrench should be used to tighten according to the specified torque. Unspecified tightening and imperfect methods will loosen the screws and cause major accidents.

 Attention	When designing and manufacturing the end effector, it is controlled within the allowable payload range of the robot wrist.
 Attention	The fail-safe protection structure should be adopted, even if the power supply or compressed air supply of the end effector is cut off, the installation object will not be released or fly out, and the corner or protruding part should be treated to prevent damage to people and objects.
 Attention	The fail-safe protection structure should be adopted, even if the power supply or compressed air supply of the end effector is cut off, the installation object will not be released or fly out, and the corner or protruding part should be treated to prevent damage to people and objects.
 Attention	It is strictly forbidden to supply power, compressed air, and welding cooling water outside the specifications, which will affect the performance of the robot and cause abnormal operations, malfunctions, damage and other dangerous situations.
 Attention	Although electromagnetic interference is related to its type or intensity, there is no perfect countermeasure with current technology. When the robot is in operation or when the power is on, the operation precautions and regulations should be followed. Due to electromagnetic waves, other noises, and substrate defects, the recorded data will be lost. Therefore, please back up programs or frequently used data to an external storage medium such as a Compact flash card.
 Attention	In a large-scale system, multiple operators are involved in the work. When it is necessary to talk at a distance, the intention should be correctly conveyed by means of gestures, etc. Factors such as noise in the environment can make it impossible to convey the meaning correctly and cause accidents.

 Attention	Industrial robot gesture method (example) <table border="1"> <tr> <td data-bbox="343 293 683 593"> 1.接通  做出接通开关的工作 </td><td data-bbox="683 293 1023 593"> 2.不行！断开  右手高举，左右大力地挥动 </td></tr> <tr> <td data-bbox="343 593 683 893"> 3.可以吗（确认）  右手向前高高地举起 </td><td data-bbox="683 593 1023 893"> 4.可以（OK）  右手向前高高地举起 拇指和食指合成一个圈 </td></tr> <tr> <td data-bbox="343 893 683 1205"> 5.稍等  右手朝向对方的方向 手臂水平伸展 </td><td data-bbox="683 893 1023 1205"> 6.离开  右臂水平伸展，并向左侧挥动 </td></tr> </table> 1. Connect: Do the work related to the connection 2. No way! Disconnect: Raise your right hand and wave vigorously left and right 3. Is that OK? (to confirm): Raise your right hand up high forward 4. OK: Raise your right hand up high forward Use your thumb and index finger to form a circle 5. Wait a moment: The right hand is facing the opponent Straight up arms horizontally 6. Leave: Stretch your right arm horizontally and weave to the left	1.接通  做出接通开关的工作	2.不行！断开  右手高举，左右大力地挥动	3.可以吗（确认）  右手向前高高地举起	4.可以（OK）  右手向前高高地举起 拇指和食指合成一个圈	5.稍等  右手朝向对方的方向 手臂水平伸展	6.离开  右臂水平伸展，并向左侧挥动
1.接通  做出接通开关的工作	2.不行！断开  右手高举，左右大力地挥动						
3.可以吗（确认）  右手向前高高地举起	4.可以（OK）  右手向前高高地举起 拇指和食指合成一个圈						
5.稍等  右手朝向对方的方向 手臂水平伸展	6.离开  右臂水平伸展，并向左侧挥动						
 Attention	Operators should also maintain awareness of escape at all times during operations. It must be ensured that in an emergency, you can escape immediately.						
 Attention	Always pay attention to the actions of the robot, and do not work with your back to the robot. Slow response to robot movements can also lead to accidents.						
 Attention	When an abnormality is found, the emergency stop button should be pressed immediately. This requirement must be thoroughly implemented.						

 Attention	According to the setting place and operating content, the relevant operation regulations and checklists such as starting method, operation method, solution in case of abnormality, etc. of the robot should be compiled. And carry out the operation according to the operating regulations. Operation only based on the memory and knowledge of the operator can cause accidents due to forgetting and mistakes.
 Attention	For the completed program, use the storage protection function to prevent accidental editing.
 Attention	When teaching, confirm the program number or step number before proceeding. Editing procedures and steps incorrectly can cause accidents.
 Attention	When it is not necessary to make the robot move and operate, please turn off the power before performing the work.
 Attention	After the teaching operation is completed, the robot movement should be manually checked at a low speed. If you run at 100% speed in automatic mode immediately, accidents will occur due to program errors and other factors.
 Attention	After the teaching work is over, clean up and check if you have forgotten to take the tool. The work area is contaminated by oil, and tools are forgotten, etc., which can cause accidents such as falls. Ensuring safety starts with tidying up.

1.2 Shift, Transfer, and Sale of Robots

 Attention	When the robot is shifted, transferred, or sold, it is necessary to ensure that the auxiliary documents of the robot, such as the mechanical operation manual, electrical maintenance manual, and robot programming manual, are transferred to the new user. When shifting, transferring, or selling to a foreign country, the customer must be responsible for preparing mechanical operation manuals, electrical maintenance manuals, and robot programming manuals in appropriate languages, modifying the display language, and ensuring compliance with local laws and regulations. The new user does not read the instruction manual and performs wrong operation or unsafe operation, which may lead to accidents.
 Attention	When the robot is shifted, transferred, or sold abroad, if there are no special provisions in the contract terms at the time of the initial sale, the security-related terms shall not be inherited by the new recipient. The original customer and the new recipient must sign a new contract.

1.3 Abandonment of Robots

 Attention	Do not decompose, heat or incinerate the batteries used for the control device and robot body. Otherwise, fire, rupture and burning accidents will occur.
 Attention	Do not disassemble the board and components of the control device before discarding it. Sharp parts such as cracks or cuts, wires, etc. may cause injury.
 Attention	After the cables and external wiring are removed from the connector and junction box, do not disassemble them further and then discard them. Otherwise, it may cause injury to hands or eyes due to conductors, etc.

 Attention	When carrying out abandoned work, please pay full attention not to be pinched or injured.
 Attention	Waste products should be discarded in a safe state.

Chapter Two Basic Description

2.1 Robot System Composition

The industrial robot is composed of the following components, See Figure 2-1:

- ✓ Robot body
 - ✓ Robot electric control cabinet
 - ✓ Explosion-proof control cabinet
 - ✓ Teach pendant
 - ✓ Connection (power supply) cables, etc.
 - ✓ Air pipe, etc.

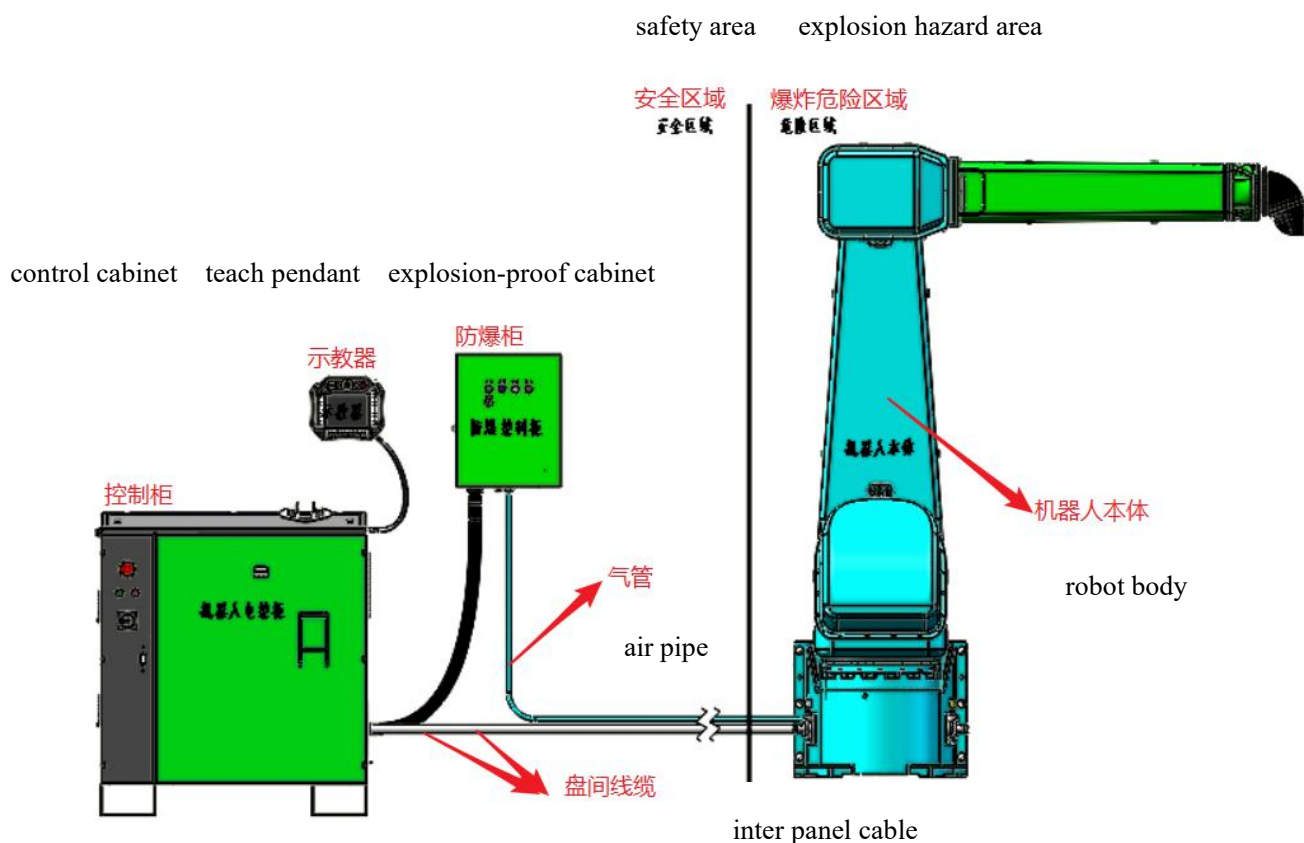


Fig. 2-1 Industrial Robot System Composition

2.2 Unpacking Check

- 1、 Before unpacking, please confirm whether the outer packaging of the product is intact;
- 2、 After unpacking, please confirm whether all parts of the robot are complete. If you find missing or wrong parts, please contact the supplier in time.

GR6150 Robot Packing List

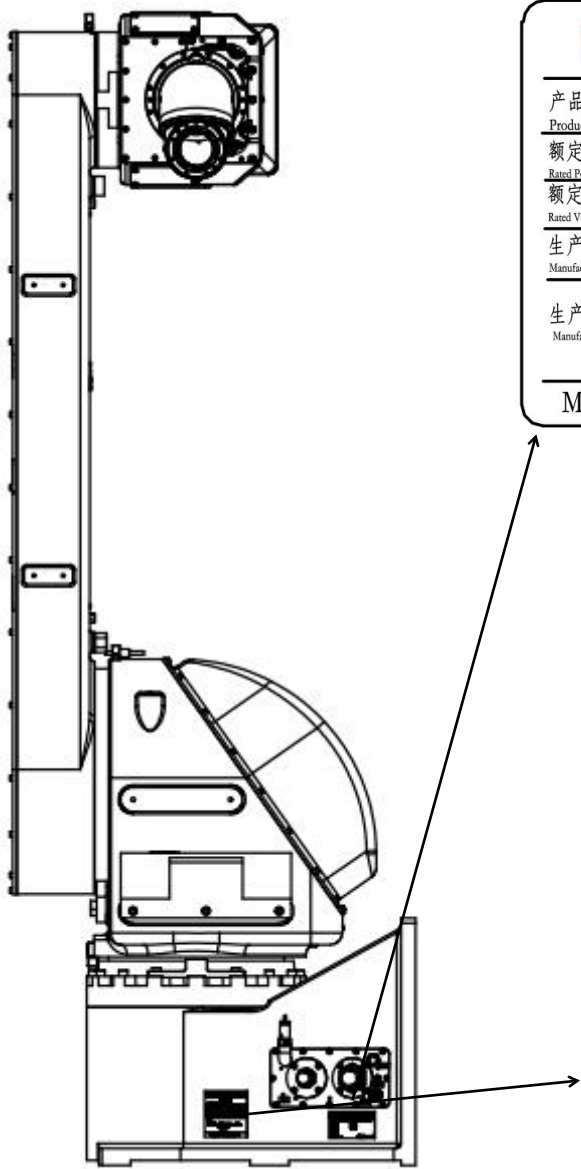
No.	Name	Configuration type	Quantity	Unit	Remarks
1	robot body	standard configuration	one	set	
2	robot electric control cabinet	standard configuration	one	set	
3	explosion-proof control cabinet	standard configuration	one	set	
4	Connecting cable from robot body to electric control cabinet	code cable	one	set	
5		power cable	one	set	
6		Ground cable	one	piece	
7	Connecting air pipe from robot body to explosion proof control cabinet	Φ 6	one	piece	
8		Φ 10	one	piece	
9		Φ 16	one	piece	
10	robot teach pendant and cable	standard configuration	one	set	
11	robot pins	standard configuration	one	set	
12	user's manual	standard configuration	one	set	
13	factory inspection report	enterprise standard	one	piece	
14	Product certification	enterprise standard	one	piece	
15	robot accessory	accessory box	one	piece	
16	380V main power circular connector	standard configuration	one	set	In the accessory box
17	home position bolt	standard configuration	one	piece	In the accessory box

18	other	The body color is green; Fuses (in the robot electric control cabinet: two in each 5A and 10A glass tube fuse; five 2A glass tube fuses; two in each 2A and 32A fuse cores); Attached an electrical schematic diagram and three backup circular connector boards
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Note: The above is the standard configuration list, excluding the case of customized models. For details, please refer to the actual "GR6150 Robot Packing List".

2.3 Machine Body Nameplate

The name plate of the operator can be seen on the robot body, which contains the corresponding model type, weight, voltage, production number, manufacturing date and explosion-proof parameters, etc. As shown in Figure 2-2 below.



 希美埃(芜湖)机器人技术有限公司
CMA (WuHu) Robotics Co.,Ltd

产品名称 Product Name	工业机器人	产品型号 MODEL-Type	GR6150
额定功率 Rated Power	8KW	最大负载 Max.Load	15KG
额定电压 Rated Voltage/Rate	380V	设备重量 Weight	640KG
生产日期 Manufacturing Date			
生产编号 Manufacturing No.			

Made in China服务热线(4000528877)

 希美埃（芜湖）机器人技术有限公司

防 爆 机 器 人

产 品 型 号： GR6150	
额 定 频 率： 50/60HZ	额 定 电 压： 380VAC
最小换气流量： 140L/min	外部气源压力： 4~8bar
最大泄露流量： 30L/min	吹 扫 压 力： 0.6~0.7bar
吹 扫 时 间： 420S	工 作 压 力： 0.2~0.4bar
环 境 温 度： 0℃~+40℃	密封腔容积量： 0.1764m³
出 厂 编 号：	出 厂 日 期：

Ex 机器人防爆标志为： Ex ib mb Px II c T4 Gb
防爆合格证编号：

安徽省芜湖市鸠江经济开发区万春东路96号

Fig. 2-2 Robot Body Nameplate

CMC (WuHu) Robotics Co., Ltd

Explosion-proof robot

Model type: GR 6150

Rated frequency: 50/60 HZ

Minimum ventilation flow: 140 L/min

Maximum leakage flow: 30 L/min

Purge time: 420 S

Ambient temperature: 0 °C-+40°C

Factory number:

EX

Rated voltage: 380 VAC

External air source pressure: 4-8 bar

Purge pressure: 0.6-0.7 bar

Working pressure: 0.2-0.4 bar

Volume of the sealed cavity:0.1764m³

Factory date:

Robot explosion-proof sign: Ex ib mb Px II c T4 Gb

Explosion-proof certificate number

CMA (WUHU) No.96, East Wanchun Road, Jiujiang Economic Development District, Wuhu, Anhui Province

2.4 Body Part Composition and Direction Identification of Each Axis

The robot mechanical body is mainly composed of base part , rotating part, upper arm part, functional forearm part, and wrist part. The joints of the machine body are driven by servo motors, and the joints cooperate with each other to realize the adjustment of the position and posture of the robot end in space.

The names of the various components of the machine body and the identification of each axis direction are shown in Figure2-3:

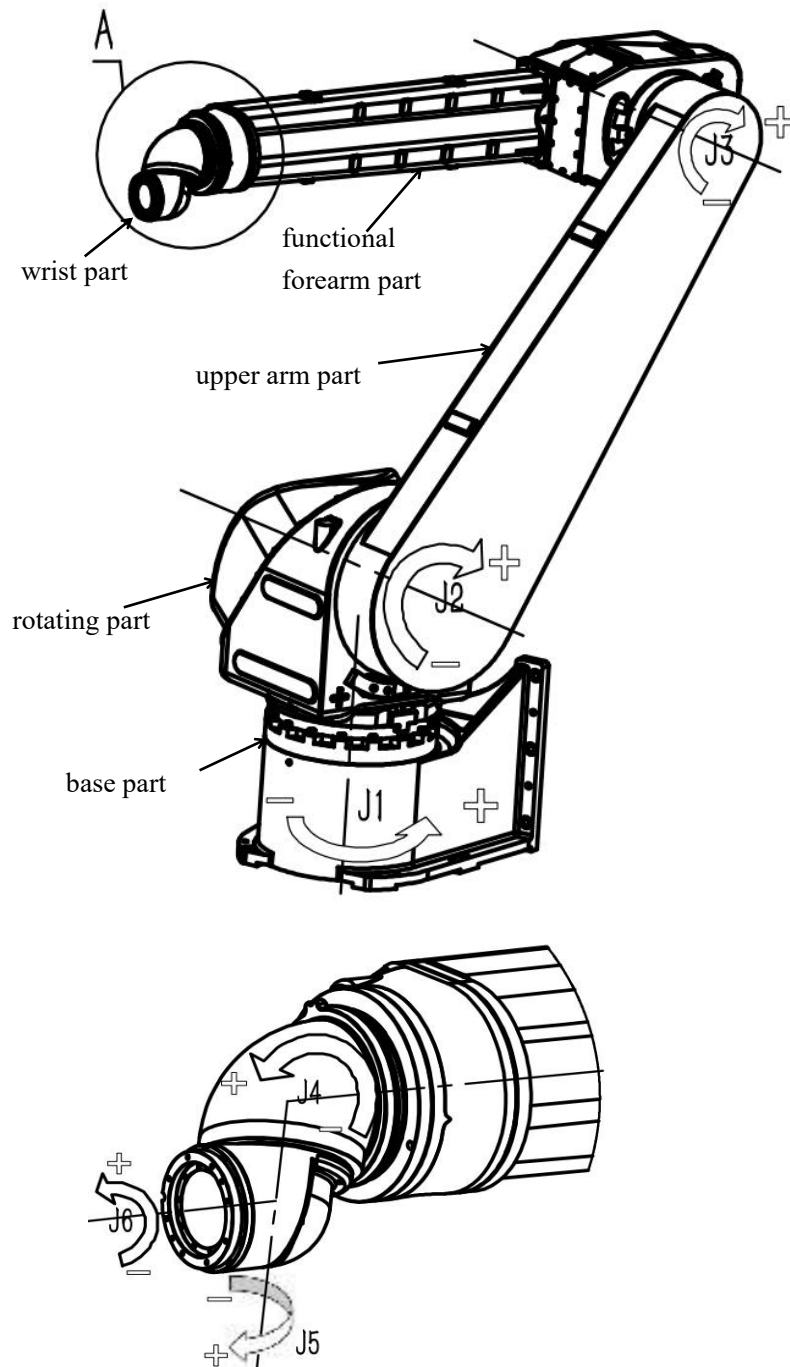


Fig. 2-3 Components of the Machine Body of GR 6150

2.5 Robot Axis Range Limit and Home Position

Each axis of the robot body has a home position and range limit. When the robot system is running normally, each axis of the robot is controlled to move within the allowable range. In addition, in order to ensure further safety, mechanical end stops are provided on some axes (see Fig. 2-4) to prevent the robot from operating beyond the allowable range when the robot (control) system is abnormal.

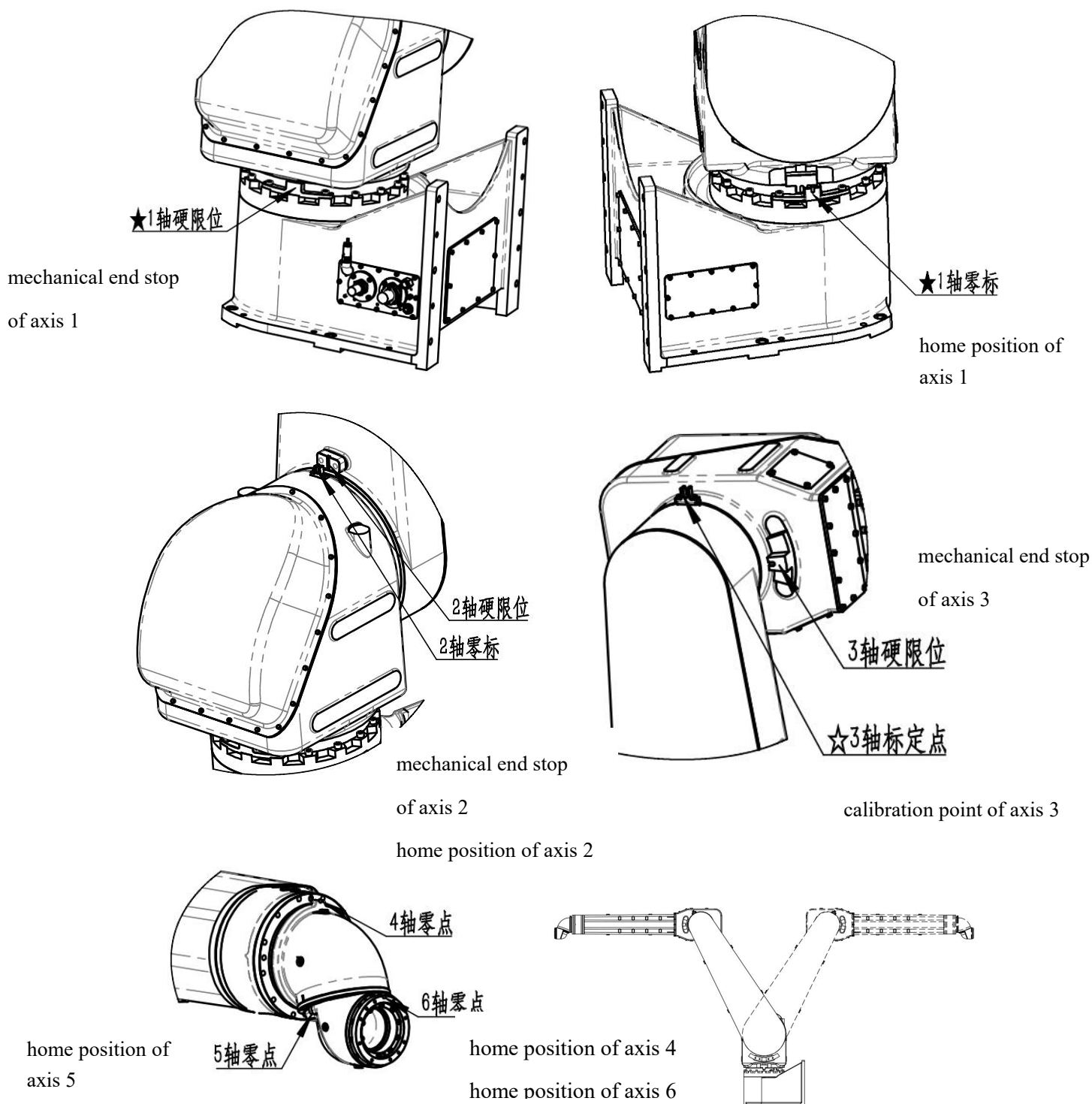


Fig.2-4 Mechanical End Stop Position and Home Position

Note: Special instructions about mechanical end stop position and home position.

(1) Mechanical end stop and home position of axis 1: Due to the symmetrical structure design of this robot, the mechanical end stop and home position of axis 1 installation position can be installed and adjusted according to the actual usage (see Figure 2-5). The installation requires professional tools. If you need adjustment, please contact our company in time.

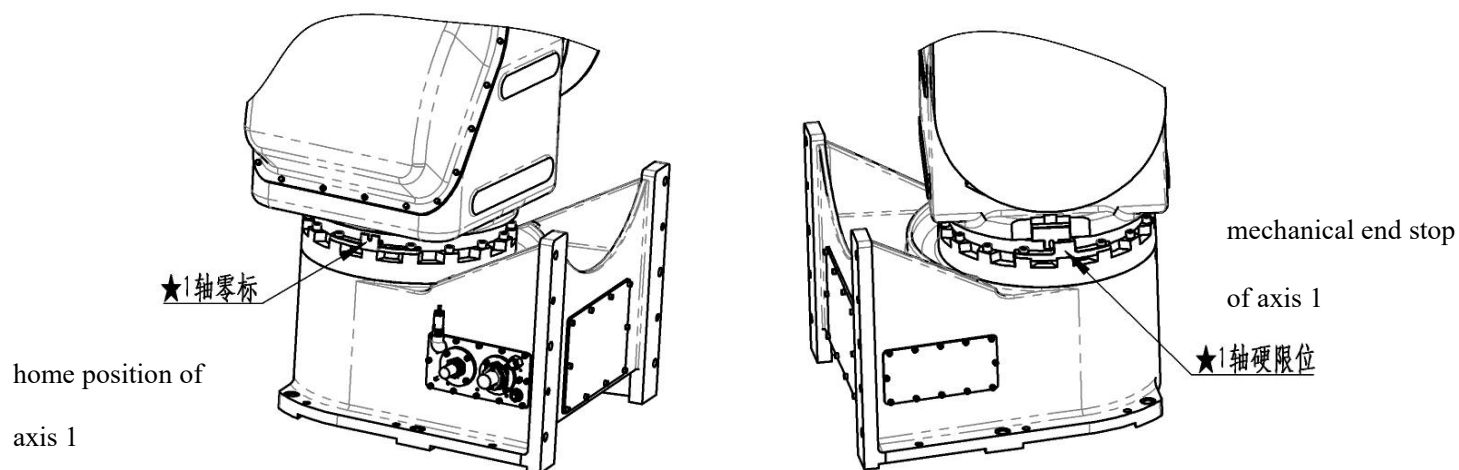
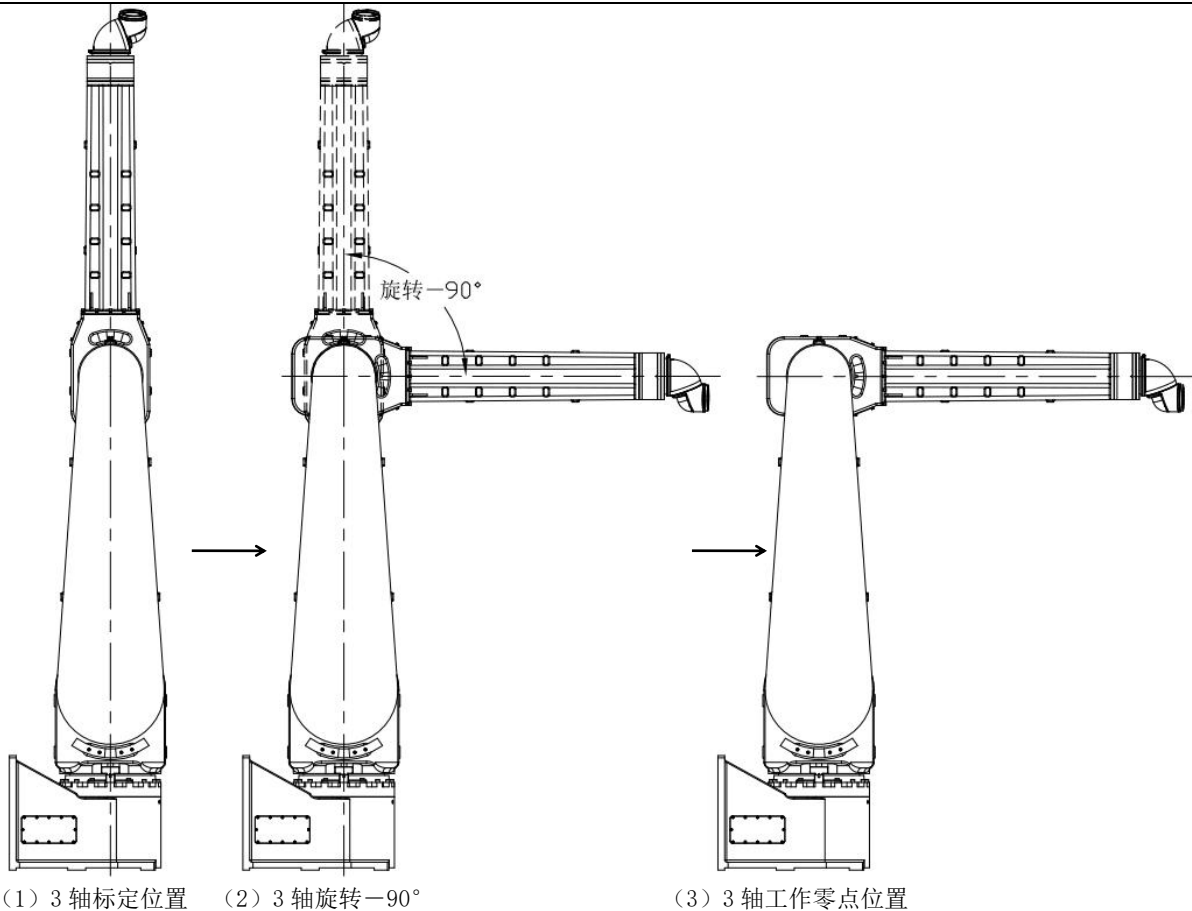


Fig.2-5 Mechanical End Stop and Home Position of Axis 1 After Adjustment

(2) Calibration point of axis 3: The robot's calibration point of axis 3 is only used for robot's home position calibration, which is not the actual home position used by the robot. The actual home position used by the robot is the robot's 3-axis rotation of -90° after calibration, as shown in Figure 2-6:



(1) Calibration Position of Axis 3 (2) Axis 3 Rotate-90° (3) Working Home Position of Axis 3

Fig.2-6 Home Position Calibration of Axis 3

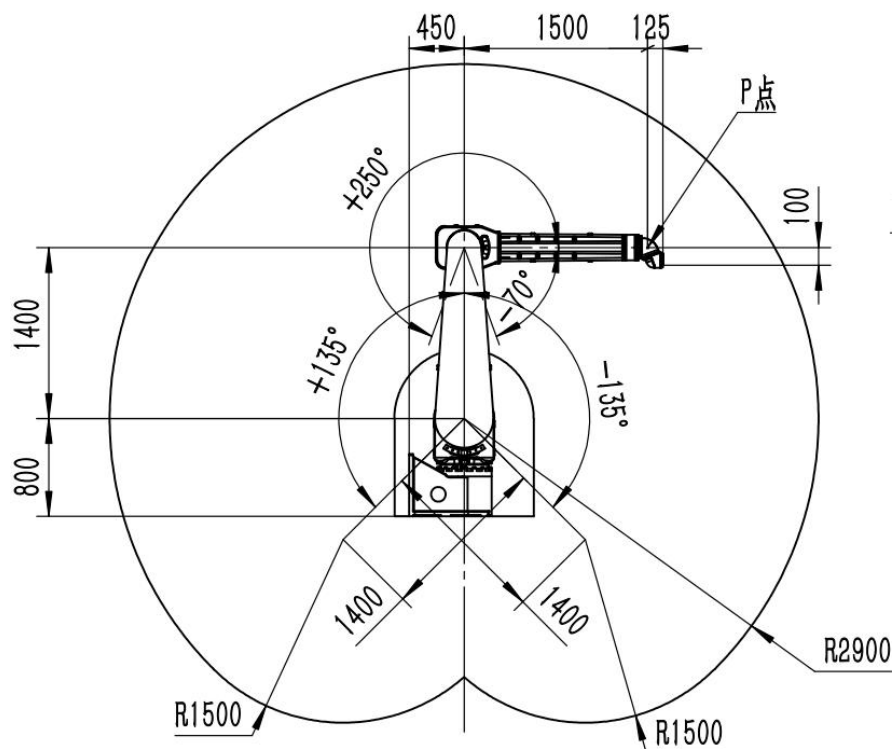
2.6 Robot Performance Parameters

(1) Robot Performance Parameter Table

Performance Parameter Table		
Model		GR6150
Action type		Articular type
Control axis		Six Axis
Maximum speed of motion	J1 axis	120° /s
	J2 axis	120° /s
	J3 axis	120° /s
	J4 axis	360° /s
	J5 axis	420° /s
	J6 axis	530° /s
Maximum range of motion	J1 axis	±160°
	J2 axis	±135°
	J3 axis	-70° /+250°
	J4 axis	±540°

	J5 axis	$\pm 540^\circ$
	J6 axis	$\pm 540^\circ$
Maximum radius of activity		2900mm
Diameter of hollow wrist thread hole		$\Phi 65\text{mm}$
Maximum payload on wrist		15 kg
Installation conditions		Wall installation, ground installation、inclined installation、suspended installation
Protection level		IP65 (wrist part) / IP65 (body part)
Repeat accuracy		$\pm 0.25\text{mm}$
Body weight		640kg

(1) Robot Workspace



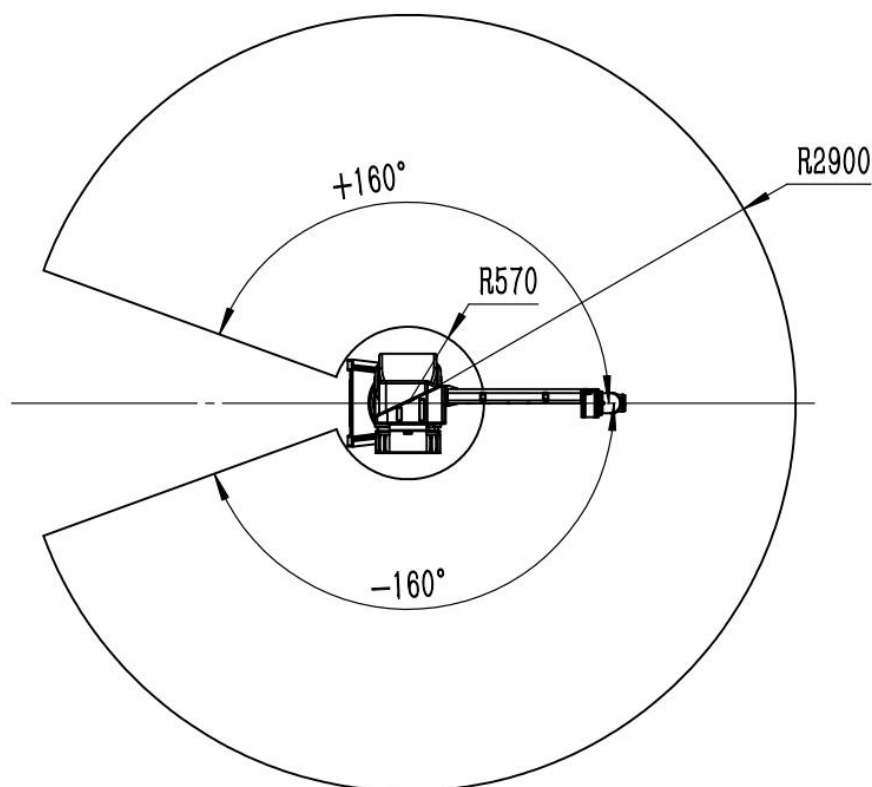


Fig.2-7 Robot Motion Range Diagram

Note: The workspace shown in this figure is the maximum that can be reached theoretically. It will change due to the influence of the installation method in actual operation. In actual use, please consider the influence of the installation method on the working space.

2.7 Allowable Value of Wrist Payload

	The installation payload at the front end of the robot wrist is affected by the allowable weight of the wrist, the allowable payload torque value, and the allowable moment of inertia. The allowable payload torque value changes according to the actual payload moment of inertia. The wrist payload should be strictly controlled within each allowable value. When using the robot with a wrist payload other than the allowable value, normal operation cannot be guaranteed.
Attention	

2.7.1 Allowable Weight

Robot model	Allowable weight
GR6150	15 kg

2.7.2 Allowable Maximum of Static Payload Torque

Robot model	Allowable torque of static payload		
	J4 axis rotation	J5 axis rotation	J6 axis rotation

GR6150	44.2 Nm	28.8 Nm	15.1Nm
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2.7.3 Allowable Maximum of Moment of Inertia

Robot model	Allowable moment of inertia		
	J4 axis rotation	J5 axis rotation	J6 axis rotation
GR6150	1.17 kgm ²	0.87 kgm ²	0.15 kgm ²

2.7.4 Allowable Payload Curve Diagram

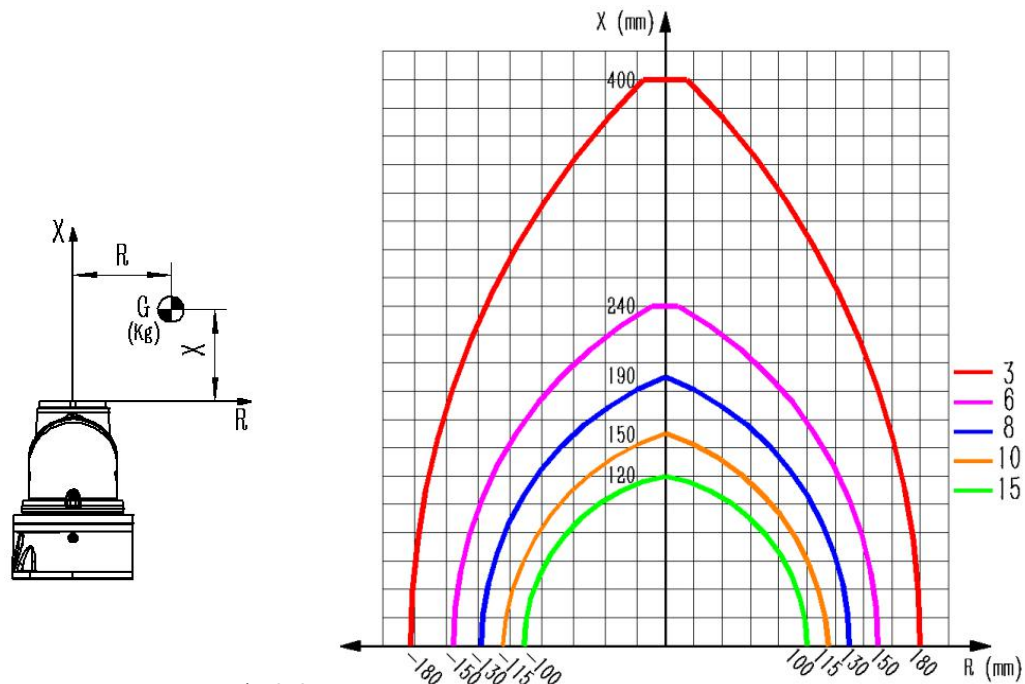


Fig.2-8 Wrist Axis Torque Diagram of GR 6150

Chapter Three Handling and Installation

3.1 Robot Handling

3.1.1 Handling Precautions

The following are precautions for robot handling operations. Please work safely after fully understanding the following:

 Attention	The handling of robots and control devices must be carried out by qualified personnel for hook, lifting operation, forklift, etc. Carrying operations by operators who do not have the correct skills may cause accidents such as tipping and falling.
 Attention	When transporting the robot and control device, please follow the method described in the manual and confirm the weight and steps before proceeding. If the operation cannot be performed in accordance with the specified method, the robot and the control device may tip over or fall during the handling process, resulting in accidents.
 Attention	When carrying out transportation and installation operations, care should be taken to avoid damaging the wiring. In addition, after the device is assembled, protective measures such as covering the protective cover should be taken to avoid damage to the wiring by operators and forklifts.

3.1.2 Handling Method

(1) Handling method one

When transporting the robot, first set up the robot according to the posture shown in the following table, and then install four M16 eyebolts on the main frame, and use 4 steel cables for lifting. It is suggested that the length of the sling should not be less than 4m, and rubber hose should be put on the contact part between the steel cable and the main body of the robot for protection.

position	J1 axis	J2 axis	J3 axis	J4 axis	J5 axis	J6 axis
Articular angle/°	0	+52	-56	0	0	0

 Attention	In Figure 3-1, there are no other devices installed on the end effector and robotic arm, so once other devices are installed, please pay more attention to safety.
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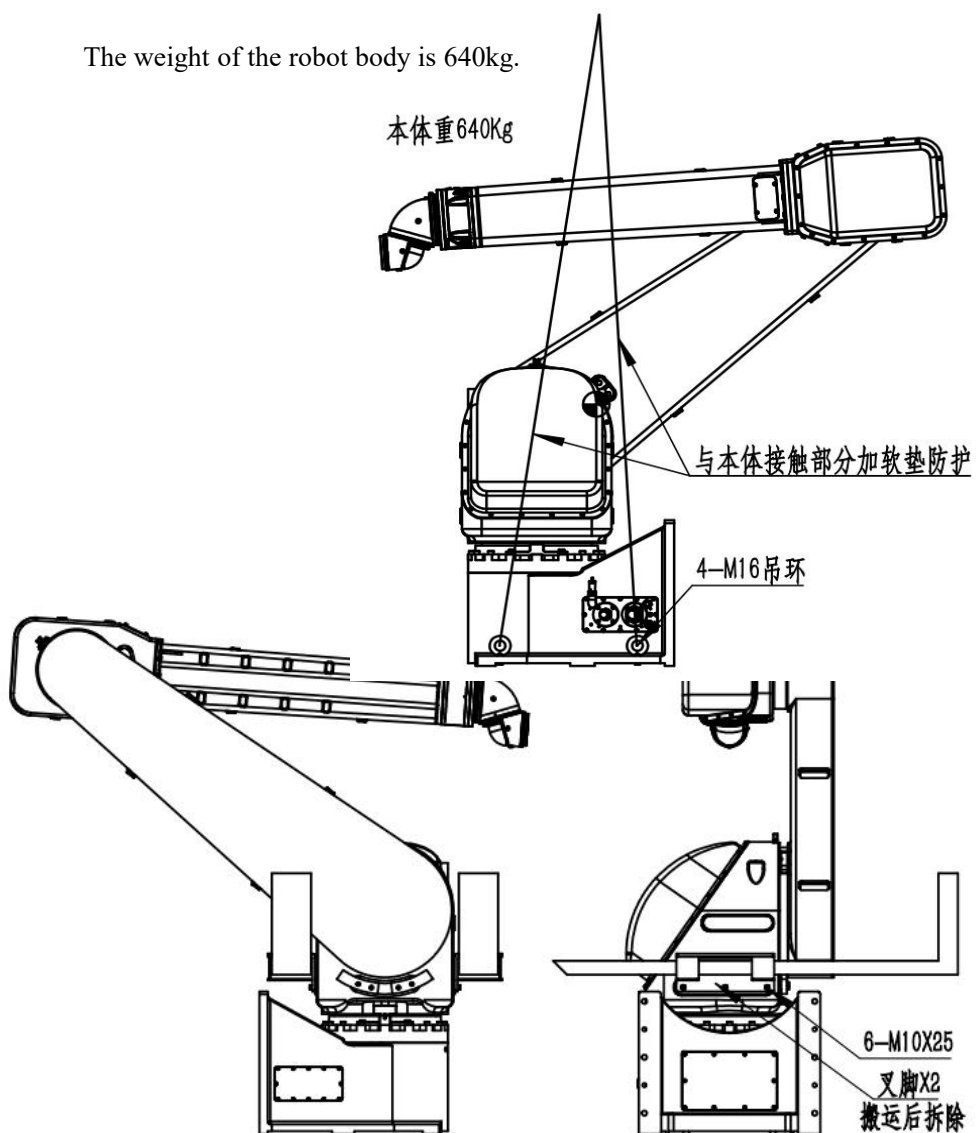
(2) Handling method two

Set the robot to the posture shown in Fig.3-2 and use a forklift to carry it.

The angles of each axis of the handling posture are set as follows:

position	J1 axis	J2 axis	J3 axis	J4 axis	J5 axis	J6 axis
Articular angle/°	0	+52	-56	0	0	0

The weight of the robot body is 640kg.



Add protective cushion to the contact part of the body

4-M16 sling

Folk foot *2

Remove after use

 Attention	When transporting, be sure to install a fixed fixture for transport! When using other handling methods instead of cranes and forklifts, please note that the robot's arms and motors cannot be subjected to external forces! After unpacking and installation, be sure to remove the fixed fixture for transport and rubber pad! The fixed fixture will be used for robot handling in the future, please keep it properly!
---	--

3.2 Robot Installation

 Danger	1、Set up safety fence Otherwise, accidents such as personal injury and equipment damage may occur. The robot should be placed in a position where the tool and the tip of work piece of the robot arm will not touch the safety fence even if the robot arm reaches the longest. Otherwise, accidents such as personal injury and equipment damage may occur. 2、If the robot is not fixed, it cannot be electrified and operated. Otherwise, accidents such as toppling, personal injury, and equipment damage may occur. 3、When choosing the suspended or wall-mounted installation method, it should be fixed on the ceiling and wall with sufficient strength, and the treatment plan to prevent falling should also be considered. Otherwise, accidents such as personal injury and equipment damage may occur.
--	--

3.2.1 Setting-up of Safety Fence

It is necessary to comply with the national standard of the People's Republic of China GB11291.2-2013-that is "Safety Requirements for Robots and Robot Equipment; Industrial Robots, Part 2: Robot System and Integration", and see more in 5.10 Regulations on safety protection devices: "When the industrial robot is in automatic operation, because the operator has the danger of contacting the robot, it must be equipped with safety measures to prevent the operator from approaching."

In order to avoid equipment damage and personal injury to the operator and surrounding personnel during the operation of the robot, please be sure to set up a safety fence (and with safety settings such as interlocking doors)!

Note: GB 11291.2-2013 is equivalent to ISO 10218-2:2011;

3.2.2 Robot Installation Method

In order to maintain the best function of the robot in normal operation, the robot base and the foundation(or mounting table)must withstand the dead weight of robot and its fixture and payload and the reaction force during acceleration and deceleration. If the installation surface of the robot is not flat, the robot may deform and its performance may be affected. Please ensure that the flatness of the robot installation is less than 0.5mm.

The dimensions of the base installation interface are shown in Figure 3-3 as follows:

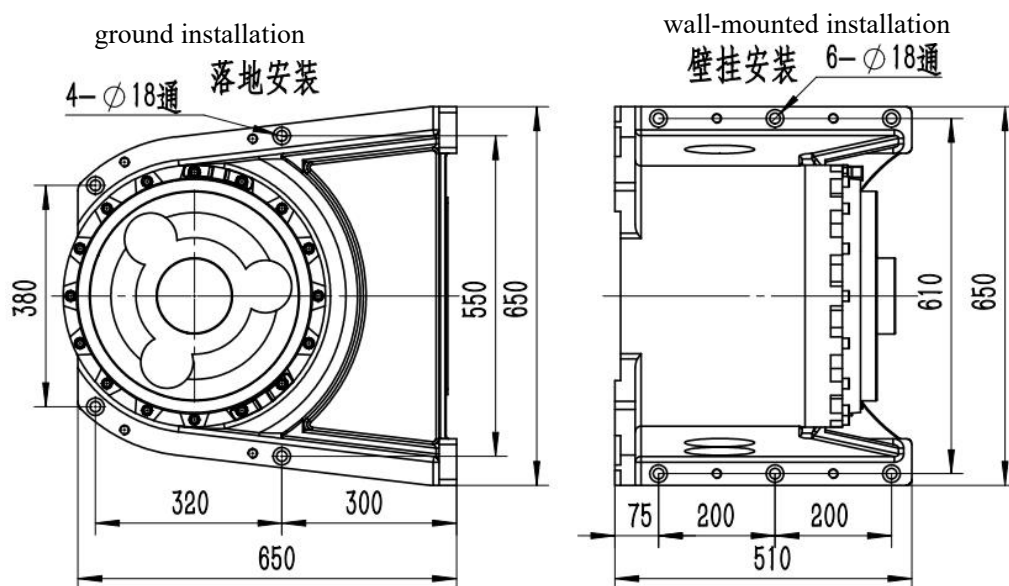
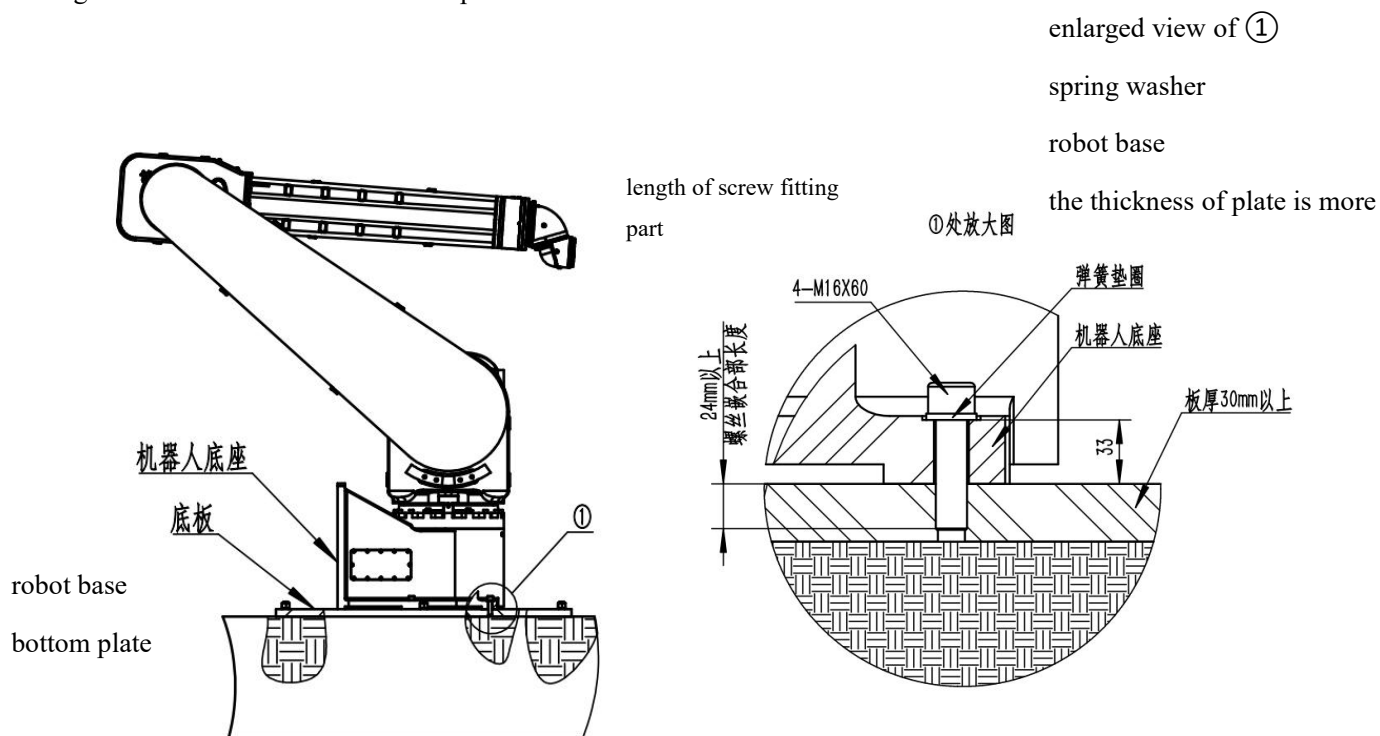


Fig.3-3 Robot Base Size

3.2.3 Ground Mounting

First, fix the bottom plate on the ground. We recommend that the thickness of the bottom plate should be more than 30mm. Use 8 chemical bolts of M20 or more to fix the bottom plate on the ground. The base of the robot is firmly fixed on the bottom plate with M16 hexagon socket screws of strength grade 12.9 through the four mounting holes (the length of the screw must ensure that the screw thread length reaches 1.5 times the nominal diameter of the thread). If there is no loosening during operation, please fully fix and prevent loosening as shown in Figure 3-4 "Robot Installation Example".



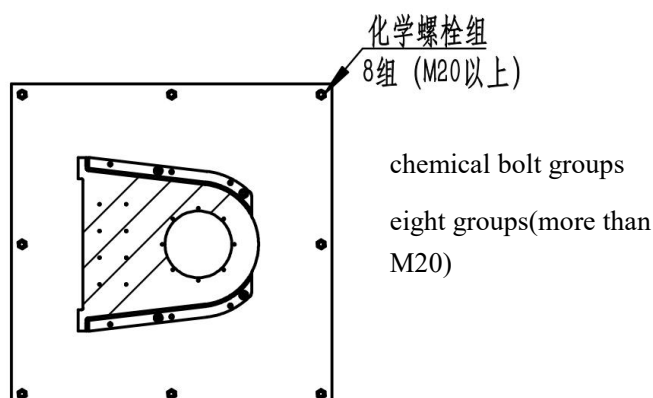


Fig.3-4 “Robot Installation Example”

 Attention	Too long or too short screws for fixing the base of the robot will cause bad fixing accidents! The connection strength of chemical bolts depends on the strength of concrete. When the strength of concrete is insufficient, it can be strengthened by the following methods: Increase the number of chemical bolt groups; Increase the embedded depth of chemical bolts;
--	---

3.2.4 Supporter Installation

When the height of the bracket is less than 600mm, its fixing mode is similar to the ground mounting mode, which is divided into two parts: robot base installation, bracket and ground mounting;

When the height of the bracket is above 600mm, the connection strength between the bracket and the ground shall be strictly checked to ensure the safety and reliability of the connection between the bracket and the ground;

 Attention	Increase the embedded depth of chemical bolts; Measures such as the specification, quantity, and embedded depth of the chemical bolt group can be appropriately increased; Improve the strength of the concrete foundation, the strength of concrete foundation is higher than that of chemical bolt components;
--	--

3.2.5 Wall-mounted/ Suspended Installation

In order to ensure safety, the following precautions should be taken when implementing suspended and wall mounted installations;

- (1) Ensure that the mounting bracket (installation wall) is safe and reliable;
- (2) The connecting screws need to use 12.9-strength screws, and the screw tightening torque needs to meet the pre-tightening force requirements of the screws of this specification!

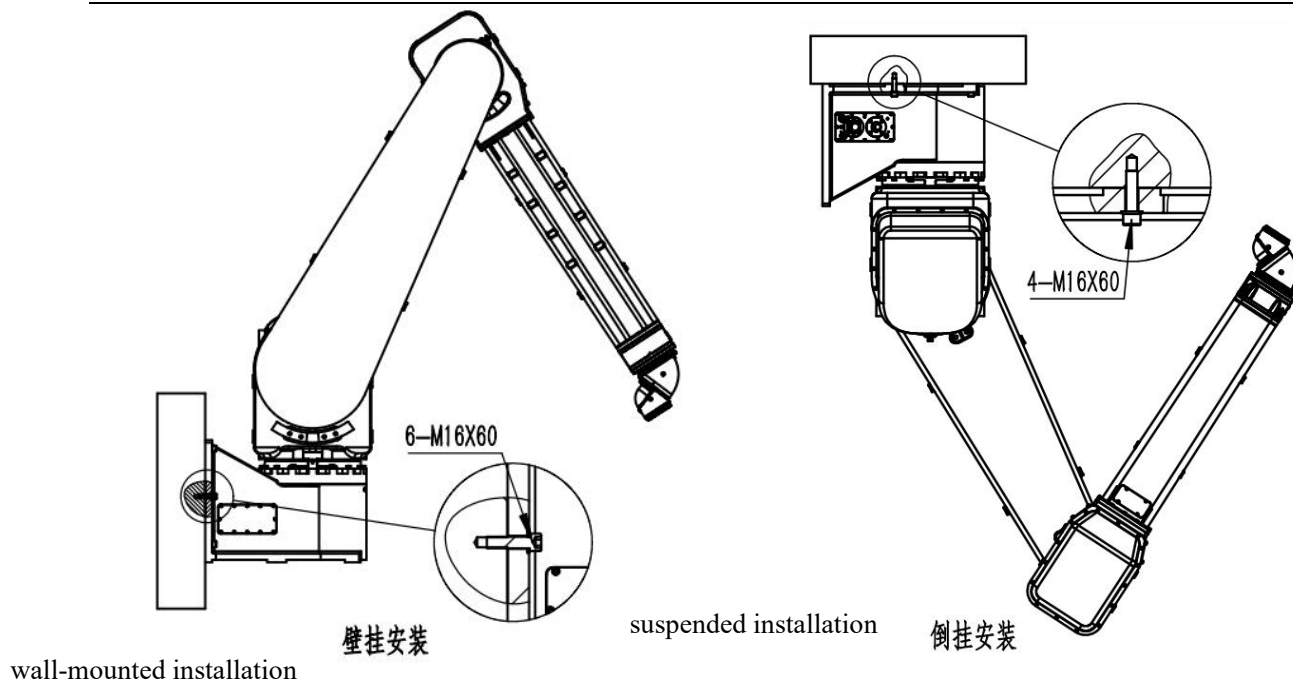


Fig.3-5 Wall-mounted/ Suspended Installation

**Attention**

Please ensure that the flatness of the installation plane of the robot base is $\leq 0.5\text{mm}$, otherwise the robot may be damaged.

3.3 Installation Site and Environment

The robot should be able to keep normal when used, transported and stored under the specified environmental conditions, and its performance should meet the requirements.

Robot Environmental Conditions		
environmental conditions	working conditions	storage and transportation conditions
ambient temperature	0~40℃	-10~55 ℃
relative humidity	20%~80% (40℃)	/
atmospheric pressure	86~106 kPa	
vibration	less than 0.5G, 4.9m/s ²	
others	no corrosive gas (Note)	



Attention

For the robot to be used, if there is strong vibration, a lot of dust, cutting oil splashing, or other objects in the use environment, please contact our service personnel to use a robot cover or other methods to protect the robot parts.

3.4 Integrated Application Installation Interface

3.4.1 Tool installation at the End of the Robot Wrist



Attention

When installing tools for the robot, you must make sure that the power supply of the robot control cabinet and the main power supply have been cut off, and proceed in accordance with the relevant installation requirements.

1) Installation Interface of End Flange

The flange of the installation tool is at the end of the robot's wrist. The installation interface is shown in Figure 3-6. Tighten the fastening screws in the threaded holes on the $\Phi 104$ circumference of the flange. At the same time, use the positioning pin and the stop in the shaft to position the end tool.

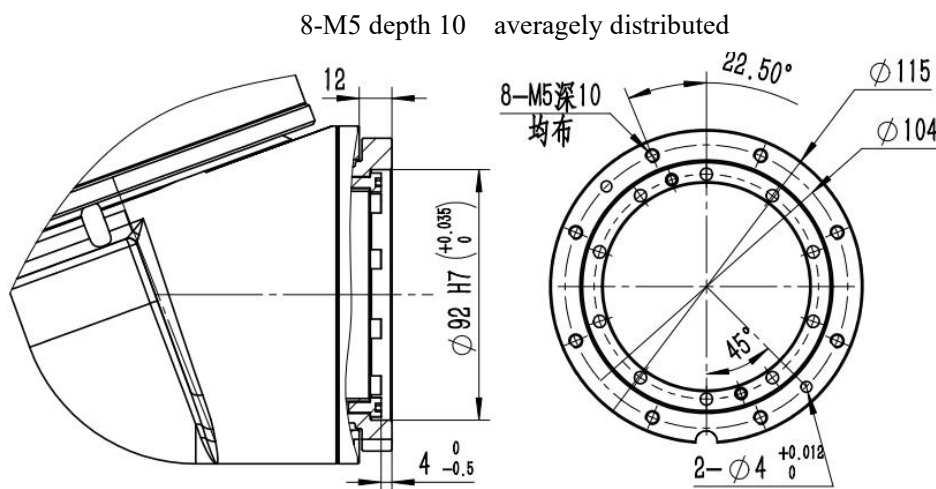


Fig.3-6 End Load Installation Flange Size

2) Description of Fixing Screws

Please select the length of the fixing screw according to the depth of the screw hole of the mounting flange to ensure a reliable threaded connection, as shown in Figure 3-7. At the same time, tighten the screws in the threaded holes according to the specified torque shown in the appendix "Tightening Torque

Table of Screws".

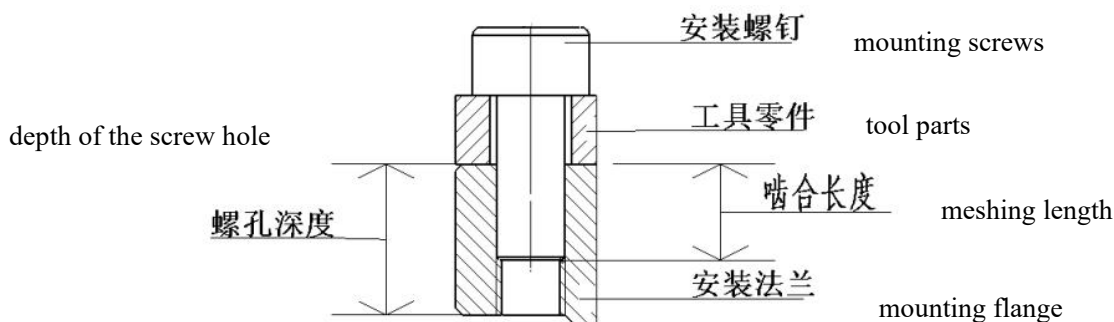


Fig. 3-7 Schematic Diagram of End Load Mounting Screws



Attention

If the fastening screw is too long, the fastening screw will hit the bottom, causing the tool to not to be installed safely on the flange, which will interfere with the rotation of the 6-axis.

3) The Fixing Screw Explains the Load Specification of the Wrist Axis

- (1) The maximum load capacity of the robot end includes the total weight of the spray gun, mounting bracket and other components. The maximum load of the GR6150 end is 15kg;
- (2) Strictly observe the restrictions on the load weight of the robot, the load moment of each wrist axis (J4, J5, J6) and the load inertia in the robot manual.



Warning

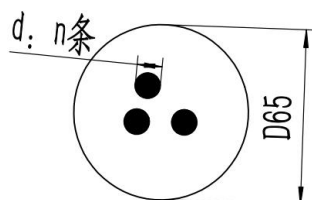
When the load at the end of the robot exceeds the rated load capacity, it may cause the robot performance to deteriorate and shorten the life of the robot. The specified load capacity includes the total mass of the spray gun, gun holder, air pipe, wiring harness, etc. If the total mass exceeds the specified load capacity, please consult CMA before operation.

4) The Load Capacity of Functional Forearm

For the load on the functional forearm, the load mass $M \leq M_{\max}$, the maximum load mass $M_{\max} = 15\text{kg}$.

5) Spray Pipe and Wire Harness in the Wrist

- (1) The hollow diameter in the wrist is $\phi 65\text{mm}$, and it is recommended that the FAR of the built-in air pipe in the wrist should be less than 25%. The FAR is calculated according to the following formula.



$$\text{FAR} = \frac{\text{容积率} = \frac{d^2}{4} \pi n \div \frac{D^2}{4} \pi \times 100 [\%]}{\text{气管截面面积 手腕内腔截面面积}}$$

cross-sectional area of air pipe
wrist cavity cross-sectional
area

	1、As calculated above, if the total cross-sectional area of the air pipe exceeds 25% of the cross-sectional area of the inner hole of the wrist, the life of the air pipe will be shortened. Even if the FAR is less than 25%, the life span of the air pipe will be shortened to varying degrees with the posture angle of the wrist. Therefore, before starting the operation, please check and inspect the air pipe and its arrangement thoroughly. 2、If the FAR exceeds 25% or if you use a gas pipe with a diameter $\geq \phi 12$, please consult CMA before operation.
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(2) The recommended material for the built-in air pipe is polyester amine.

	The use of non-polyester amine air pipe may significantly shorten their life.
---	---

(3) When installing a built-in air pipe in the wrist, be sure to lubricate the entire air pipe.

Lubricants such as petroleum jelly can be used. Please check the built-in air pipe regularly, and replace it with a new one immediately if there are signs of failure or damage. Inspection cycle: once every 500 hours, air pipe replacement cycle (recommended standard): once every 10,000 hours.

	The above replacement cycle is only a recommended standard, and does not refer to the life cycle of the air pipe.
---	---

3.4.2 Other Auxiliary Interfaces

External Interface Size Table

Robot external interface size	As shown in the figure	Remarks
dimensions of the external component installed on the upper arm	Fig.3-8	external component installation size
dimensions of the external component installed on the motor base	Fig.3-9	external component installation size
dimensions of the external component installed on the functional forearm	Fig.3-10	external component installation size
dimensions of the external component installed on the	Fig.3-11	external component installation

		size
dimensions of the external component installed on the upper arm	Fig.3-12	internal component installation size
Dimension drawing of reserved opening for motor base	Fig.3-13	reserved opening size

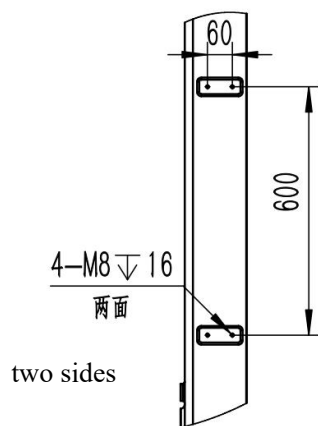


Fig.3-8

Dimensions of the External Component Installed on the Upper Arm

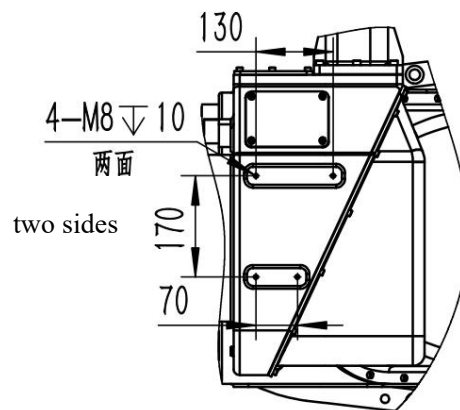


Fig.3-9

Dimensions of the External Component Installed on the Motor Base

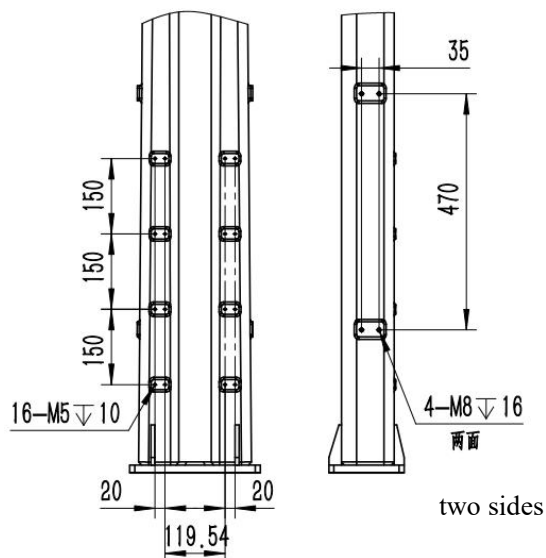


Fig.3-10

Dimensions of the External Component Installed
CMA (WUHU) Robotics Company Limited

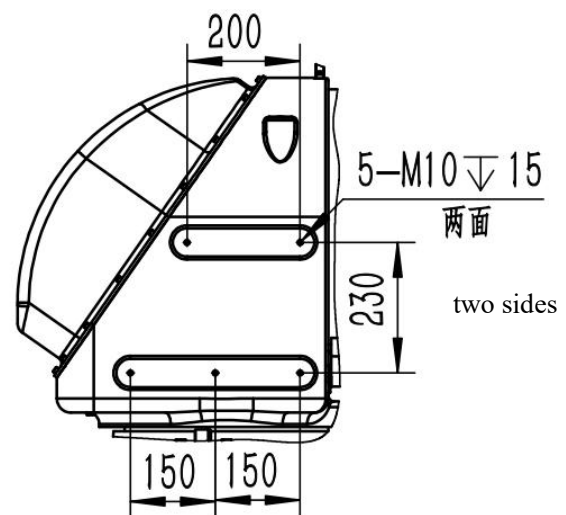


Fig.3-11

Dimensions of the External Component Installed

on the Functional Forearm

on the Rotating Base

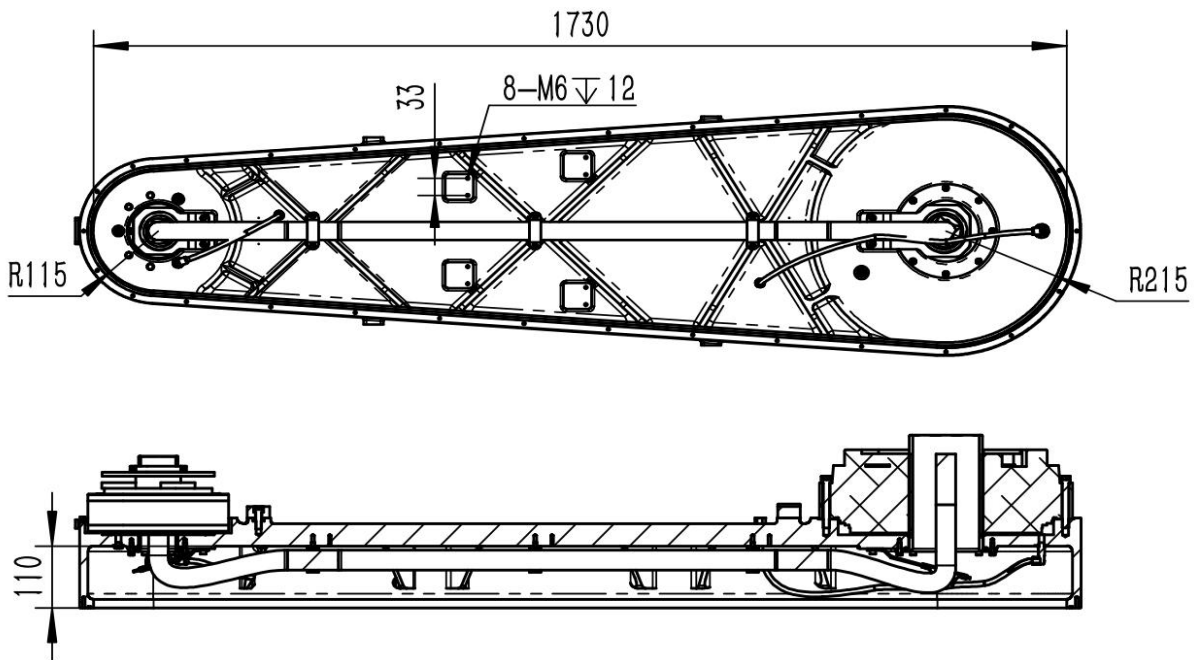
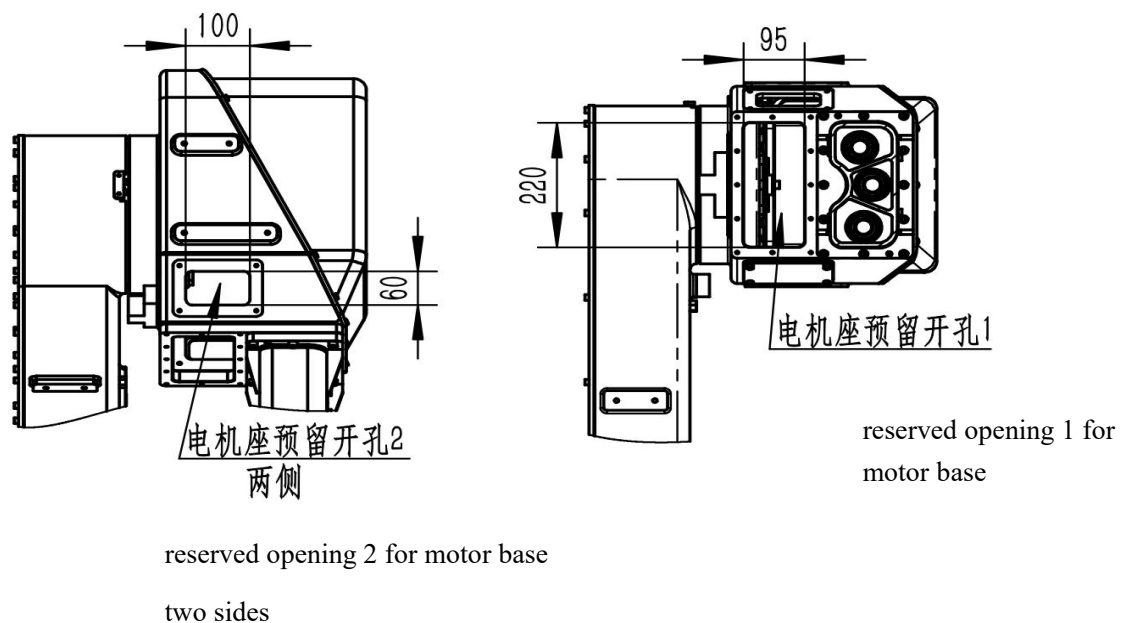


Fig.3-12 Dimensions of the External Component Installed on the Upper Arm



(Note: The reserved openings of the motor base are sealed with cover plates. The opening cover can be designed, processed and used according to actual use. If you have any questions, please contact our company.)

Fig.3-13 Dimension Drawing of Reserved Opening for Motor Base

**Attention**

The robot has the function of explosion-proof, and the opening of the robot cover plate needs to be operated by professionals, otherwise the explosion-proof function may not work normally.

Chapter Four Overhaul and Maintenance

Overhaul is divided into daily overhaul and regular overhaul. Inspectors must prepare overhaul plans and carry out overhaul. Please refer to the table below for overhaul items and overhaul periods.

In addition, the overhaul must be carried out every 40,000 hours of work or every 8 years (the principle of choosing which way to reach the deadline first). The overhaul period is based on the glaze spraying operation. It is recommended to implement maintenance and overhaul in a period of about 1/2 for high frequency operations such as glaze spraying operations.

In addition, if the inspection and adjustment method is unclear, please contact the company service department.

4.1 Preventive Maintenance

Follow the method introduced in this chapter and perform regular maintenance steps to maintain the best performance of the robot.

4.1.1 Daily Inspection

Table 4.1 Daily Inspection Table

Number	Inspection items	Inspection positions
1	abnormal noise inspection	check whether the transmission mechanism has abnormal noise
2	interference inspection	check whether the transmission mechanism is running smoothly and whether there is abnormal vibration
3	air cooling inspection	check whether the fan behind the control cabinet is well ventilated
4	pipeline accessories inspection	check whether it is complete , whether it is worn or not, whether there is rust
5	peripheral electrical accessories inspection	check the external wiring of the robot and whether the buttons are normal
6	leak inspection	check whether there is lubricating oil leakage on the body

4.1.2 Quarterly Inspection

Table 4.2 Quarterly Inspection Table

Number	Inspection items	Inspection positions
1	control unit cable	check whether the teach pendant cable is improperly twisted
2	ventilation unit of control unit	If the ventilation unit is dirty, cut off the power supply and clean the ventilation unit
3	cables in the mechanical unit	check whether the socket of the mechanical unit is damaged, whether it is bent abnormally, and whether the servo motor connector and the circular connector are connected reliably
4	cleaning and overhaul	check whether there is a problem with the component and

	of various components	deal with it
5	tightening of external main screws	tighten the end effector screws and external main screws

4.1.3 Annual Inspection

Table 4.3 Annual Inspection Table

Number	Inspection items	Inspection positions
1	cleaning and overhaul of various components	Check whether there is a problem with the component and deal with it
2	tightening of external main screws	Tighten the end effector screws and external main screws

4.1.4 Inspect Every Two Years

Table 4.4 Table of Inspect Every Two Years

Number	Inspection items	Inspection positions
1	replace the lubricant of the reducer and gear box	replace according to lubrication requirements
2	replace the lubricant of the wrist parts	replace according to lubrication requirements

Note:

- 1) Regarding cleaning parts, mainly at the oil seal of the mechanical wrist, cleaning chips and splashes.
- 2) Regarding the fastening parts, tighten the installing screws of end effector, installing screws of robot body, and screws that have been removed for overhaul. All screws exposed to the outside of the robot should be tightened. For installation torque, refer to the screw tightening torque table in the appendix. And paint the corresponding fastening glue or sealant.

4.2 Overhaul of Main Bolts

Table 4.5 Main Screw Inspection Position

Number	Inspection position	Number	Inspection position
1	For robot installation	6	For installation of J5 axis servo motor
2	For installation of J1 axis servo motor	7	For installation of J6 axis servo motor
3	For installation of J2 axis servo motor	8	For wrist parts installation
4	For installation of J3 axis servo motor	9	For end load installation
5	For installation of J4 axis servo motor		

 Attention	To tighten and replace the screws, you must use a torque wrench to tighten with the correct torque, and then paint to fix it. In addition, it should be noted that bolts that are not loose should not be tightened with a torque higher than the required torque.
---	---

4.3 Lubricant Inspection

Every 5000 hours of operation or every 1 year (for glaze spraying, every 2500 hours of operation or every six months), please measure the concentration of iron powder in the lubricating oil of the reducer. If it exceeds the standard value, it is necessary to replace the lubricating oil or reducer, please contact our service center.

Required tools:

- Lubricating oil iron powder concentration meter: recommended lubricating oil iron powder concentration meter: OM-810 (Idemitsu Kosan Co., Ltd.)
- Lubricating oil gun (nozzle diameter ϕ 17mm or less, with oil supply confirmation counting function)
- Sealing tape

 Attention	During maintenance, if more than the necessary amount of lubricating oil flows out of the machine body, please use a lubricating gun to replenish the outflowing part. At this time, the nozzle diameter of the lubricating oil gun used should be ϕ17mm or less. If the amount of replenishing lubricating oil is more than the outflow amount, it may cause lubricating oil leakage or poor trajectory during robot operation, etc. Be careful.
 Attention	After maintenance or refueling, in order to prevent oil leakage, be sure to wrap sealing tape on the lubricating oil pipe joints and plugs with holes before installation. It is recommended to use a lubricating gun that can determine the amount of oil added. When it is not possible to prepare a grease gun that can determine the amount of lubrication, the amount of lubricating oil can be confirmed by measuring the change in the weight of the lubricating oil before and after refueling.
 Attention	When the pressure inside the reducer cavity rises within a short period of time when the robot has just stopped, the lubricating oil may be sprayed out at the moment when the screw plug of the inspection port is removed. The internal pressure of the reducer should be slowly released before refueling.

**Attention**

The robot maintenance needs to be regularly lubricated and overhauled in accordance with the following regulations to ensure efficiency.

4.4 Change the Lubricant

4.4.1 The Oil Supply Quantity of Lubricant

Table 4.6 Oil Supply Table of Changing the Lubricant

The position	Amount of oil	Name for the lubricant	Remarks
J1 axis reducer	4800cc	MOLYWHITERE No.00	Rapid oiling will cause the pressure in the oil tank to rise, the crack of sealing ring, and the leakage of lubricating oil . The oil supply speed should be controlled below 40cc/10 seconds.
J2 axis reducer	5100cc		
J3 axis reducer	1500cc		
wrist mount	300cc	ALVANIA RA-J	/
wrist body of axis 4	200cc		
wrist body of axis 5	150cc		

4.4.2 Space Orientation of Lubrication

For lubricating oil replacement or replenishment operations, it is recommended to use the orientation given below.

Table 4.7 The Orientation of Each Axis When Filling Lubricant

The position	Orientation					
	J1	J2	J3	J4	J5	J6
J1 axis reducer	Any	Any	Any	Any	Any	Any
J2 axis reducer		0°				
J3 axis reducer		Any				
wrist parts			Any	180°	0°	Any

4.4.3 Lubricant Replacement Steps for J1~J4 Axis Reducer and Wrist Parts

- (1) Move the robot to the lubrication position described in Table 4.7.
- (2) Cut off the power.
- (3) Remove the hexagon socket screw plugs of the lubricant filling and drain ports, see Figure 4-1.
- (4) Provide the new lubricant until the new one flows out of the oil drain port.

- (5) Install the hexagon socket screw plug on the lubricant filling and drain port.
- (6) After the oil is supplied, follow the steps in item 4.4.4 to release the residual pressure in the lubricant chamber.

If the lubrication operation is not performed correctly, the internal pressure of the lubrication cavity may suddenly increase, which may damage the sealing part, resulting in lubricant leakage and abnormal operation. Therefore, when performing lubrication operations, please observe the following:

- (1) Before performing the lubrication operation, open the oil drain port (remove the oil drain plug or screw plug).
- (2) Provide lubricant slowly, the oil supply speed should be controlled below 40cc/10 seconds, do not use too much force, you must use a lubricating gun that can clearly determine oil quantity. If there is no oil gun that can clarify the amount of lubrication, the amount of lubricant should be confirmed by measuring the change in the weight of the lubricant before and after refueling.
- (3) If the oil supply does not reach the required amount, you can use a precision regulator for air supply to squeeze out the gas in the cavity and then supply the oil. When using the regulator, the air pressure should be controlled below the maximum 0.025MPa.
- (4) Use only specified types of lubricants. If you use other lubricant other than the specified type, it may damage the reducer or cause other problems.
- (5) When installing the hexagon socket screw plug after the oil is supplied, pay attention to winding the sealing tape to avoid oil leakage at the oil inlet and outlet.
- (6) In order to avoid accidents caused by slips and falls, the excess lubricant on the ground and the robot should be completely removed.
- (7) After the oil is supplied, follow the steps in item 4.4.4 to release the residual pressure in the lubricating oil tank and install the hexagon socket screw plug. Pay attention to winding the sealing tape to avoid grease leakage of the supply and drain oil ports.

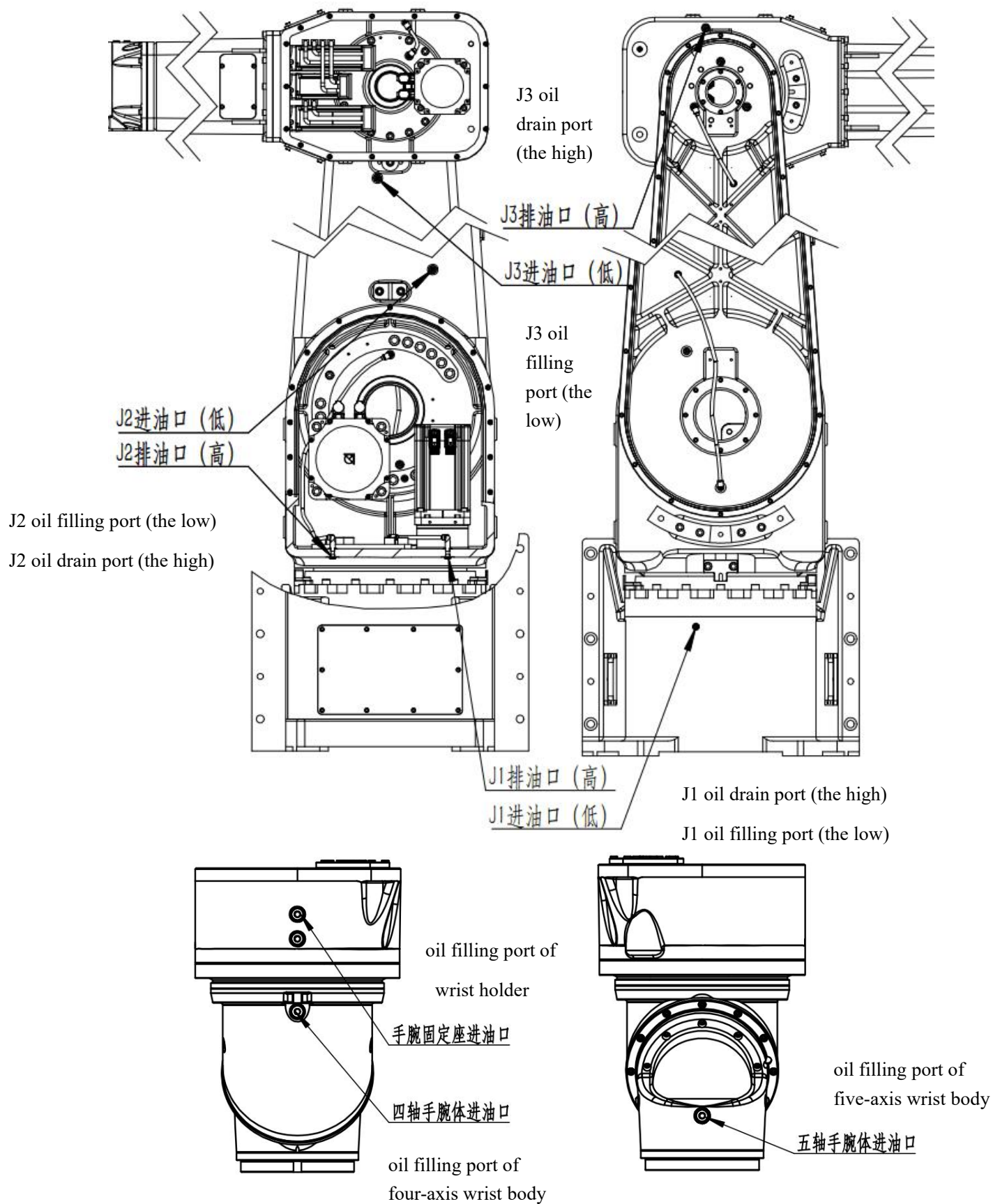


Fig. 4-1 Distribution Map of Oil Filling Port and Oil Drain Port

The tools required are as follows:

Number	Specification	Remarks
1	lubricant gun	with the function of checking and counting oil
2	oil supply joint [M10x1]	one piece
3	oil supply hose [ϕ 8x1m]	one strip
4	weight meter	measure the weight of lubricant
5	sealing tape	/
6	gas source	/

4.4.4 Release the Residual Pressure in Lubricating Oil Cavity

After the oil is supplied, in order to release the residual pressure in the lubrication tank, the robot should be properly operated. At this time, install a recovery bag under the lubricant inlet and outlet to avoid the spilled lubricating oil from scattering.

In order to release the residual pressure, when the oil drain port is opened, the J1 axis is in the range of $\pm 30^\circ$, the J2 axis and J3 axis are in the range of $\pm 5^\circ$ for more than 20 minutes, and the speed is controlled in the low-speed movement state.

When the above actions cannot be performed due to the surrounding conditions, the robot should be operated for the same number of times (if the axis angle can only be half, the robot should be operated for twice the original time). After the above actions are completed, install the sealing screw plug on the oil drain port (use a combination pad or wrap a sealing tape).

4.5 Robot Maintenance and Use Area

The maintenance area and use area of the mechanical unit are shown in Figure 4-2. The use area of the robot can be adjusted according to the user's working environment.

1、The use area must have the following safety conditions:

- (1) A safety fence and safety gate must be installed around the robot. If the safety gate is not opened, the operator cannot enter the safety fence. An interlock switch, safety latch, etc. are set on the safety gate. The robot will stop after opening the safety gate;
- (2) A safety carpet or photoelectric switch should be installed on the floor so that when the operator enters the robot's range of motion, an alarm will be issued through the buzzer and photoelectric switch to stop the robot from moving to ensure the safety of the operator;
- (3) The height of the safety fence is not less than 2 meters;

2、Qualification requirements and precautions for maintenance personnel:

- (1) To enter the safety fence, you must go through professional training;
- (2) When entering the robot's working area, it must be powered off and locked to prevent someone from turning on the switch by mistake;

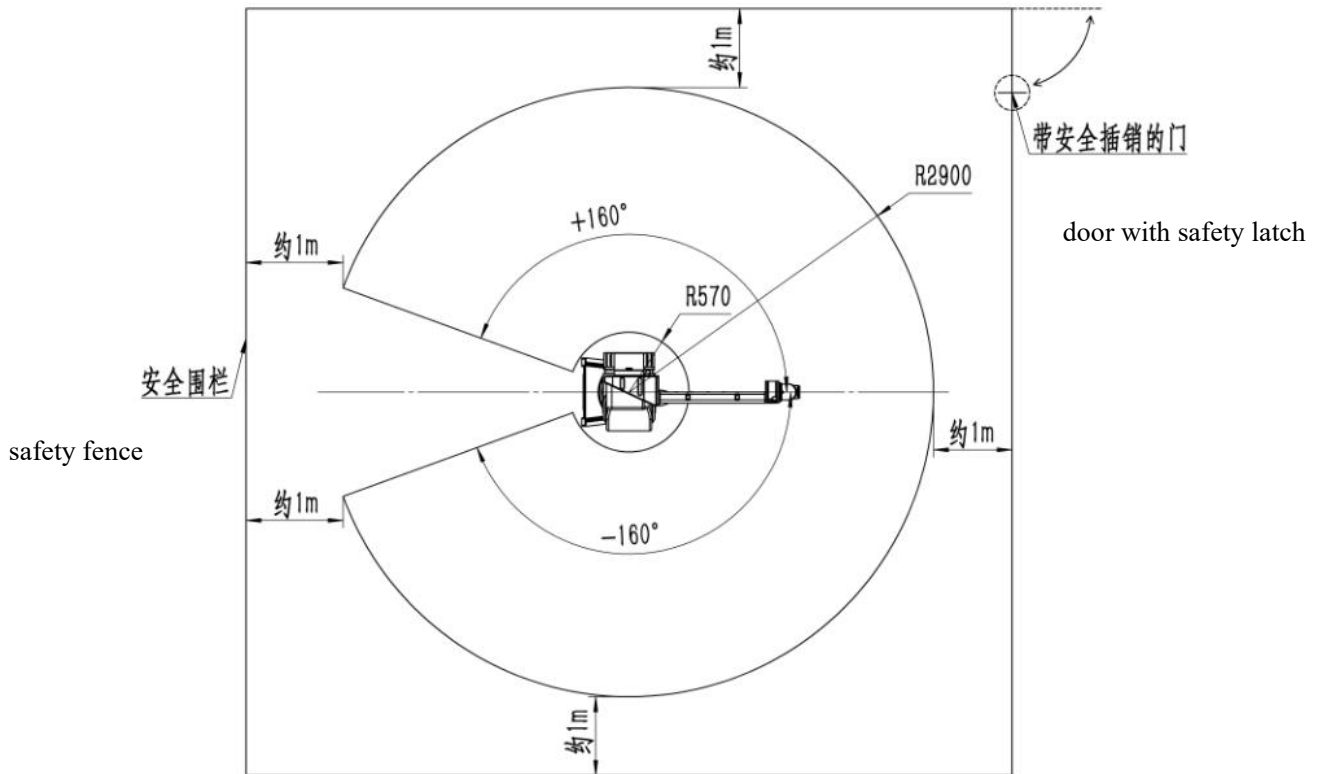


Fig. 4-2 Maintenance and Use Area

4.6 Home Position Calibration

Home position calibration refers to an operation performed to associate the angle of each robot axis with the encoder count value. The purpose of the home position calibration operation is to obtain the encoder count value corresponding to the home position.

"Home position calibration" is done before leaving the factory. In daily operations, there is generally no need to perform home position calibration operations. However, in the following cases, it is necessary to perform the home position calibration operation.

- (1) If the servo motor is replaced;
- (2) If the encoder is replaced.
- (3) If the reducer is replaced.
- (4) If the cable is replaced.

4.6.1 Home Position Calibration Method

Home position calibration is a relatively complicated process. According to the current actual situation and objective conditions, the following describes the tools and methods of home calibration, as well as some common problems and methods to solve these problems.

Software Home Position Calibration

The laser tracker needs to be used to establish the coordinate system of each joint of the robot, and the system encoder's reading is set to zero. The software calibration is more complicated and needs to be operated by professionals of our company.

Mechanical Home Position Calibration (Line Calibration)

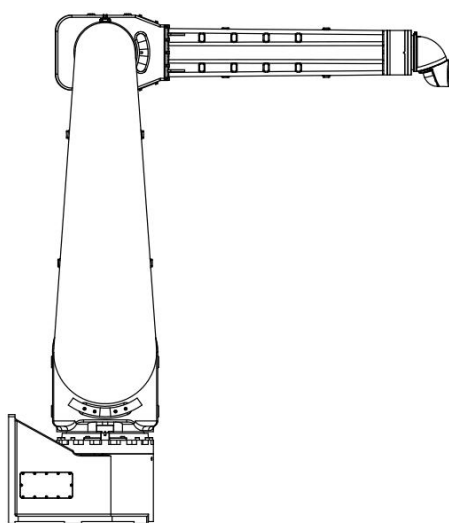
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Rotate the marking line of the home block to the fully aligned state, that is, the home position.

4.6.2 Mechanical Home Position Calibration of Each Axis

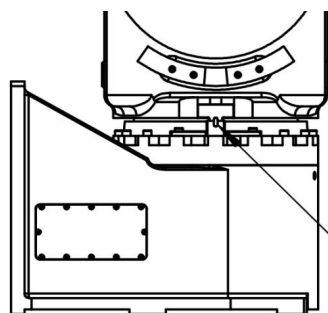
When re-calibrating the mechanical home position of each axis of the robot, operate the robot in the jog mode to make each axis of the robot run to the home position alignment mark of each axis, use home calibration tooling to zero, and then enter the home position information interface of the robot teaching box to record the coordinates of each axis. The specific home position calibration method can also refer to the electrical operation manual provided by our company.

The mechanical home position distribution of each axis is as the following Fig. 4-3:



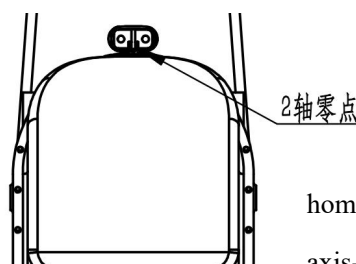
机器人零点位置姿态

The home position gesture of robot



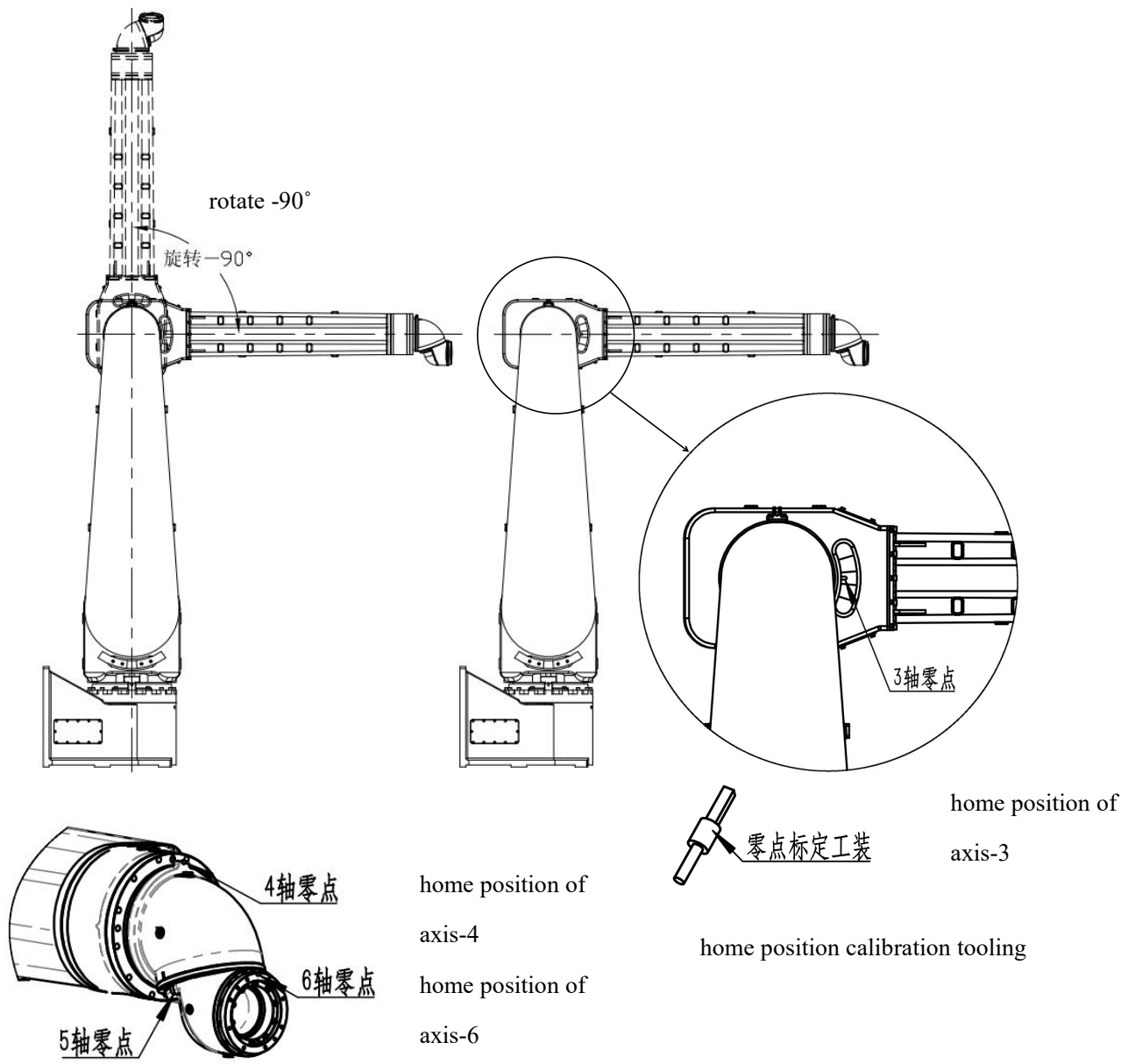
★1轴零点

home position of
axis-1



2轴零点

home position of
axis-2



home position of axis-5

Fig.4-3 Robot Home Position Map

Appendix

A Tightening Torque Table of Screws

Note:

Due to the special material of the motor flange, the tightening torque cannot be too large, please refer to the note in the table to add.

Screw 12.9 grade	Tightening torque (cast iron) (Nm)	Tightening torque (cast aluminum) (Nm)
M3	2 ± 0.18	2 ± 0.18
M4	4.5 ± 0.33	4 ± 0.33
M5	9.01 ± 0.49	7.35 ± 0.49
M6	15.6 ± 0.78	12.4 ± 0.78
M8	37.2 ± 1.86	30.4 ± 1.86
M10	73.5 ± 3.43	59.8 ± 3.43
M12	128.4 ± 6.37	104 ± 6.37
M14	204.8 ± 10.2	180 ± 10.2
M16	318.5 ± 15.9	259 ± 15.9

B Backup List

Table1 Servo Motor

Name	Material code	Unit per robot	Remarks
servo motor	10900016020	one	J6
servo motor	10900016019	two	J4/J5
servo motor	10900021643	one	J3
servo motor	10900021644	one	J1
servo motor	10900021645	one	J2

Table 2 Reducer and Input Gear

Name	Material code	Unit per robot	Remarks
reducer	10800000011	two	J1/J2
reducer	10800000001	one	J3
reducer	10800000145	three	J4/J5/J6
reducer and input	11200011799	one	J1

gear of axis-1			
reducer and input gear of axis-2	11200011800	one	J2
reducer and input gear of axis-3	11200011801	one	J3

Table 3 Hollow Wrist

Name	Material code	Unit per robot	Remarks
hollow wrist	11500010715	one	wrist part

Table 4 Sealant and others

Name	Model specification	Unit per robot	Application area
grease	MOLYWHITE RENO. 00	10kg	J1/J2/J3 axis
grease	ALVANIA RA-J	1kg	J4/J5/J6 axis
flat sealant	THREEBOND 1110F	one	/
thread sealant	THREEBOND 1374	one	
detergent	THREEBOND 6602T	two	
thread sealant	LOCTITE577	one	

Table 5 Oil Seals and Screw Plugs, etc.

Name	Material code	Unit per robot	Application area
framework oil seal	10300013001	two	reducer and input gear
framework oil seal	10300001438	one	RV sleeve of J3 axis
framework oil seal	10300001448	two	RV sleeve of J1/J2 axis
combined sealing washer	10300001486	ten	oil filling/drain ports
hexagon socket screw plug	10300000670	ten	oil filling/drain ports
plug	10600000169	four	oil filling/drain ports
O-ring rubber seal	10300015427	two	installation of base / rotating reducer
O-ring rubber seal	10300001333	two	installation of J1/J2 axis reducer
O-ring rubber seal	10300001366	one	installation of J3 axis reducer

O-ring rubber seal	10300001368	one	installation of J3 axis reducer
O-ring rubber seal	10300001340	two	RV sleeve of J1/J2 axis
O-ring rubber seal	10300001322	one	RV sleeve of J3 axis
O-ring rubber seal	10300013877	one	motor installation of axis-3
double-sided dust-proof coil	10300016064	one	J1 axis pipeline
double-sided dust-proof coil	10300016065	two	J2 axis pipeline
double-sided dust-proof coil	10300016066	two	J3 axis pipeline



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