Product Manual

Mechanical Manual for GBT-P7A Series Robots

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V1.2

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Safety instructions

It is necessary to read and understand the contents described in this chapter before using robots.

In this Manual, the robot system refers to an integrated system integrating the industrial robot and its controller, teach pendant, cables, software and other accessories. So, it is required to fully consider the safety precautions of the user and the system.

Nobody is allowed to modify the industrial robot without authorization from Agilebot Robotics Co., Ltd. Agilebot Robotics Co., Ltd. shall assume no responsibility for any damage to the industrial robot or its components due to the use of any other components (software, tools, etc.) not provided by Agilebot.

Agilebot Robotics Co., Ltd. assumes no responsibility for any consequences caused by misuse of the industrial robot. The misuse includes:

- Use the robot beyond the specified parameter range
- Use it as a carrier for humans or animals
- Use it as a climbing tool
- Use it in explosive environments
- Use it without safety protection

Besides safety precautions in this chapter, this Manual contains other safety instructions, which must be followed as well.

Definition of user

The operators are defined as follows:

- Operator

  Perform power-on/off operation on the robot.

  Start the robot program from the panel board.

- Robot Engineer

  Operate the robot.

  Perform teaching and programming debugging of the robot within the safety fence.

- Maintenance Engineer

  Operate the robot.

  Perform teaching of the robot within the safety fence.

  Carry out maintenance (repair, adjustment, replacement) operations on the robot.

The “Operator” is not allowed to enter the safety fence.

The "Robot Engineer" and "Maintenance Engineer" can carry out operations within the safety fence.

The operations within the safety fence include handling, setting, teaching, adjustment, maintenance, etc.

To carry out the operations within the safety fence, it is necessary to receive professional training on the robot.

When operating, programming and maintaining the robot, the operator, programmer and maintenance engineer must give a safety warning and wear at least the following protective articles.

- Work clothes suitable for operations
- Safety shoes
- Safety helmets

Definition of safety records

This Manual includes safety warnings to ensure personal safety of the users and avoid any damage to the machine tool and describes them with "Danger" and "Warning" in the main text based on their importance in safety.

In addition, relevant supplementary explanations are described as "Caution".

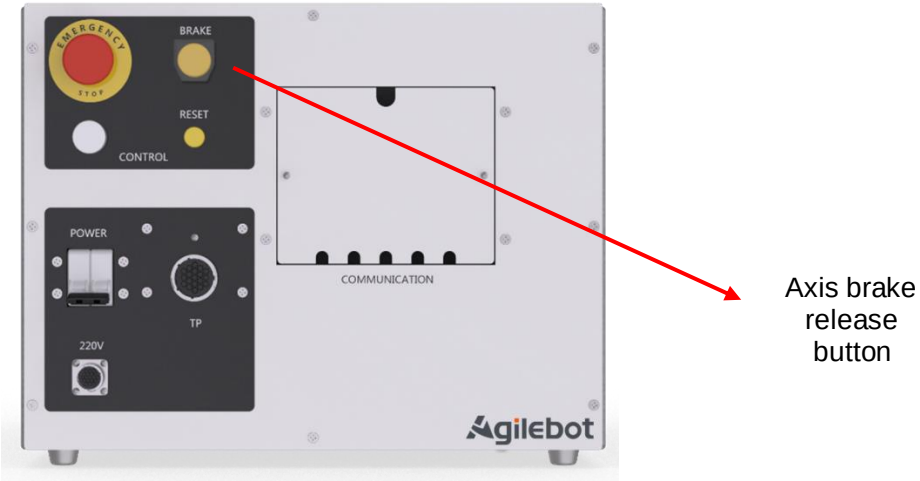
Before use, the user must thoroughly read the precautions described in "Danger", "Warning" and "Caution".

Identification	Definition
	It indicates dangerous situations possibly resulting in serious injury or death to the user during incorrect operation.
	It indicates dangerous situations possibly resulting in mild or moderate personal injury or property damage during incorrect operation.
	It provides supplementary explanations outside the scope of danger or warning.

Please read this Manual carefully and keep it secure for easy reference at any time.

Steps for robot axis operation in emergency and abnormal situations

In emergency and abnormal situations where a person is trapped or surrounded by the robot, it is required to immediately cut off the power supply to the robot controller, directly move the robot arm and change its posture to help the operator get out of danger. When the robot controller is powered on, press the axis brake release button as shown in the figure to release the brake.



Caution

Press the axis brake release button. All axis brakes of the robot will be released simultaneously. Please ensure that all axes of the robot are properly supported to avoid injury accidents.

Safety warning label

Both the robot and the controller bear several safety and information labels, which contain important information related to the product. This information is very useful for all persons operating the robot system, e.g. during mounting, maintenance or operation.

The safety labels are only graphical and applicable to all languages.

> ⚠ Caution
>
> It is required to observe the safety and health signs on the product label. In addition, it is also necessary to comply with the supplementary safety information provided by the system builder or integrator.

Sign	Description
	An electric shock may occur if the internally energized parts of the controller are touched when powered on.
	Operation against the instructions may result in an accident of injury and/or product damage. This is a warning message applicable to certain functional requirements.
	Grounding sign of controller
	
	Electric shock

Sign	Description
	Keep your hand away from moving parts, otherwise your hand or fingers may get stuck between the axis and the cover. The robots equipped with telescopic covers do not pose the risk of pinching hands or fingers. Therefore, they do not have this label.
	Never enter the work area while the robot is moving. Otherwise, the robot may collide with the operator. This is very dangerous and may cause serious safety issues.
	Beware of burns due to high temperature.
	Handling and hoisting
	Beware of collision in the work area.

1 Handling and mounting

1.1 Handling

Unpack the robot before handling:

1. Safety measures: gloves, work shoes and safety helmets
2. Tools: claw hammer, crowbar

During transportation and handling, ensure that the robot is fixed firmly and kept at the transportation posture, and that its end fixtures and peripheral devices are removed. Otherwise, the robot may lose its balance and flip over, causing serious injury or significant damage.

Before the robot is lifted and transported, it is required to confirm that the screws and locating pins fixing the robot have been removed. The robot can be handled for a short distance by two adults or transported for a long distance by a forklift.

Robot model	Weight
GBT-P7A-700	45.6kg
GBT-P7A-900	49kg

Table 1.1 Weights of P7A Series Robots

Handling

1. Safety measures: gloves, work shoes and safety helmets
2. Tools: 2 adjustable wrenches
3. Devices: Forklift (over 2t) or crane (over 2t)
4. Jointly use two adjustable wrenches to remove the nuts fixing the robot to the bottom plate of the wooden box (see Fig. 1.1)
5. Use a forklift or crane (or assign two adults) to move (lift) the robot and controller to the mounting position

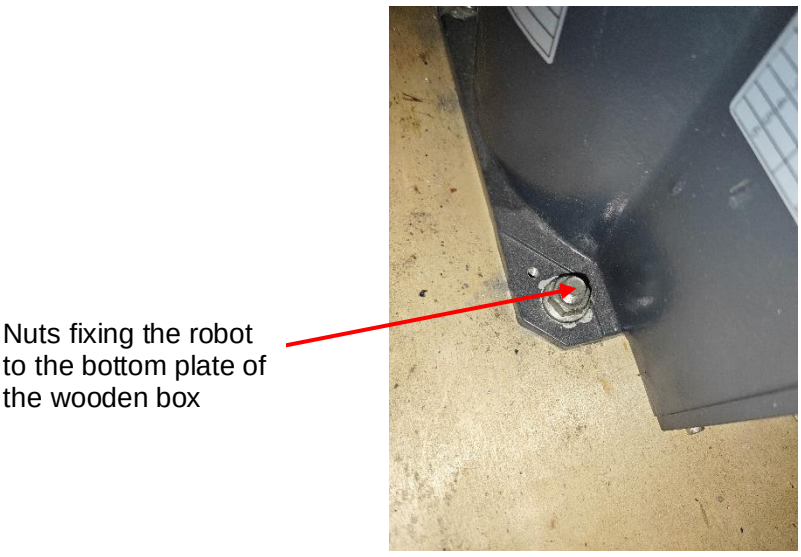


Fig. 1.1 Nuts Fixing the Robot to Wooden Tray

Caution

Properly choose the pickup points when manually handling the robot. Unsuitable pickup points may easily result in finger pinching or other injuries as well as damage to the robot.

When a forklift is used, the robot must be firmly fixed on the forklift and must not shake or move relative to the forklift during transportation.

The transport posture of GBT-P7A robot is shown in Fig. 1.2:

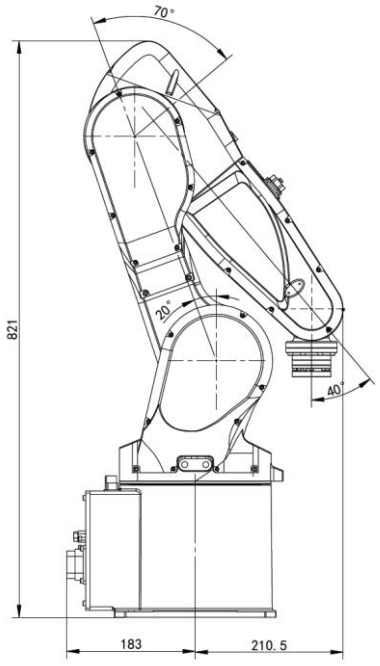


Fig. 1.2 Transport Posture of GBT-P7A Robot

Axis No.	1	2	3	4	5	6
Angle/stroke	0°	20°	-70°	0°	-40°	0°

Table 1.2 Axis Data at Transport Posture

Caution

The dimensional units for all measurements of the drawings in this section are in millimeters (mm).

1.2 Mounting

Requirements for mounting ground

When mounting on the ground, the payload requirements for the reference base coordinate system are shown in Table 1.3, and the direction is shown in Fig. 1.3. For other mounting forms, please consult Agilebot.

Force or moment	Persistent payload	Maximum payload (emergency stop)
Force on xy	±900N	±1600N
Force on z	-500±950N	-500±1600N
Moment on xy	±550Nm	±1500Nm
Moment on z	±250Nm	±550Nm

Table 1.3 Load Requirements in Base Coordinate System

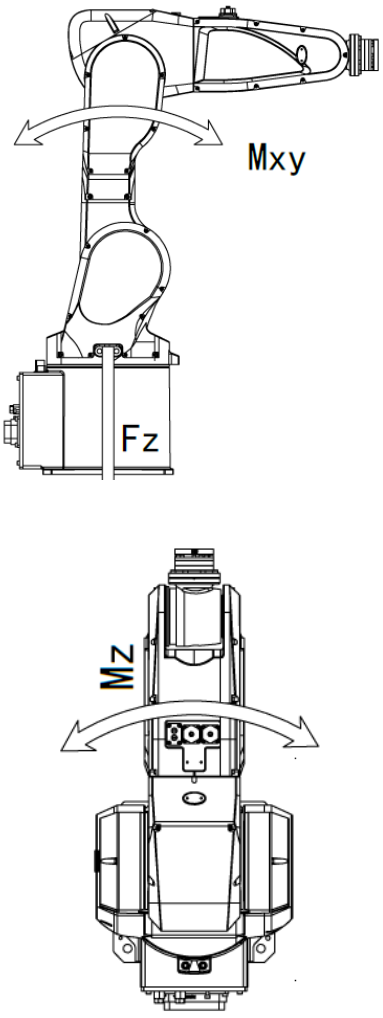


Fig. 1.3 Moment Directions of GBT-P7A

Mounting preparation and steps:

1. Safety measures: gloves, work shoes and safety helmets
2. Tools: Allen wrench, mounting bolts, nuts and washers

3. Mounting the robot to the floor or base (see Fig. 1.4)

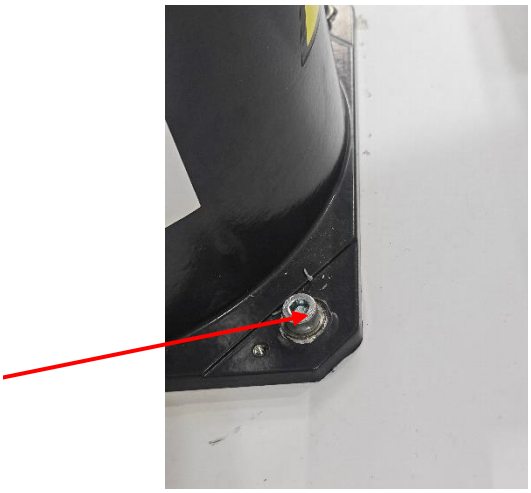


Fig. 1.4 Nuts Fixing Robot to Base or Bottom Plate

Parts required for mounting the robot:

S/N	Name	Number (pcs)
1	Hexagon socket screw M10x20~25 (GB/T 70.1-2008[NOTE])	4
2	Flat washer M10	4
3	Cylindrical pin φ6M6	2

[NOTE]

GB/T 70.1-2008 Correspondence standard: ISO 4762:1997 Hexagon socket head cap screws

The mounting dimensions are shown in Fig. 1.5.

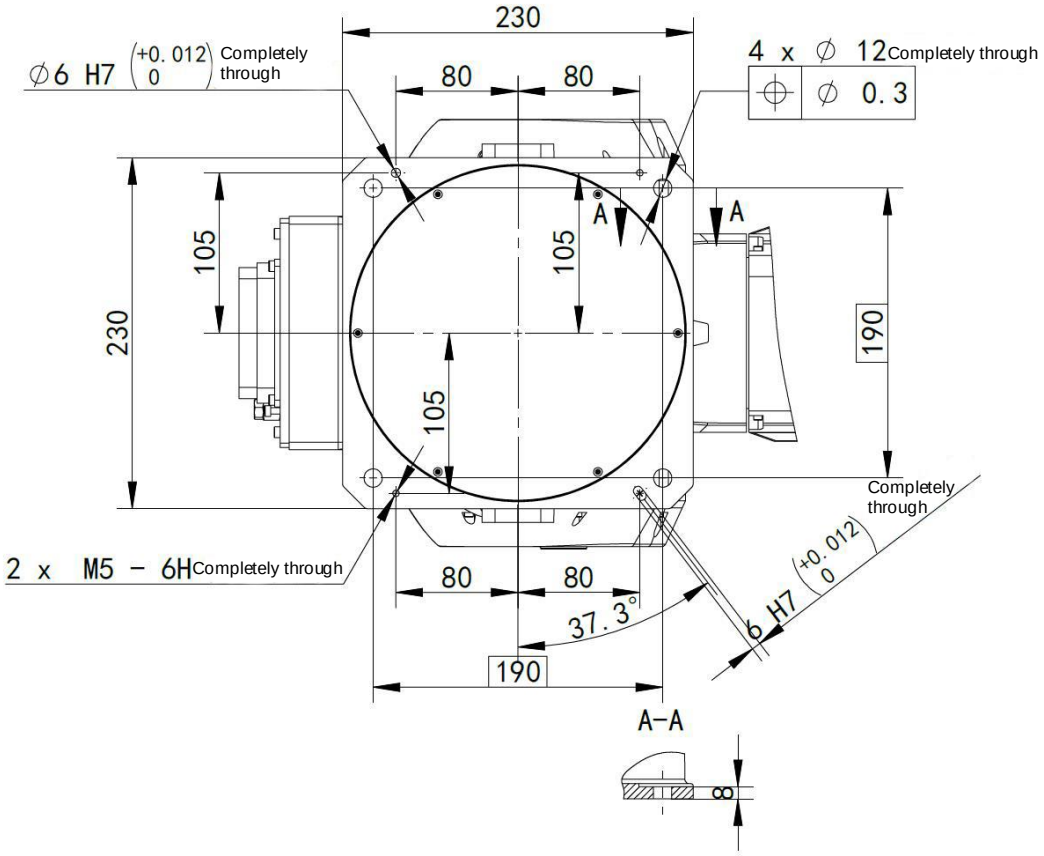


Fig. 1.5 Mounting Dimensions of GBT-P7A Robot

> **Caution**
>
> The dimensional units for all measurements of the drawings in this section are in millimeters (mm).

Mounting requirements:

Requirements for mounting ground base	Permissible flatness	≤0.5mm
	Allowable inclination angle	≤0.5°
	Allowable resonance frequency	100-150Hz (vibration acceleration 0.5G)
Storage conditions	Storage temperature range	-20℃~50℃
	Allowable maximum humidity	90% RH (non-condensation)
Operating conditions	Operation temperature range	0℃~40℃
	Allowable maximum humidity	80% RH (non-condensation)
Environmental conditions	Indoors; avoid direct sunlight, dust, salt, metal powder or other pollutants; stay away from water, flammable or other highly corrosive liquids and gases; avoid shock and vibration.	

Warning

Those designing or manufacturing the robot system with this product must read this Manual to understand basic precautions before work. Otherwise, it is very dangerous and may result in serious injury or significant damage.

Please use the robot system under the environmental conditions recorded in the Manual. This product is designed and manufactured firstly for the purpose of typical indoor environments. Operation in an environment unsatisfying the environmental conditions may not only shorten the service life, but also cause serious safety issues.

Please use the robot system within the specified specifications. Operation beyond the specifications may not only shorten the service life, but also cause serious safety issues.

When mounting the robot system, you must wear at least the following protective devices.

- Work clothes suitable for operations

- Safety helmets

- Protective shoes

Be sure to mount an emergency stop device so that the operator can immediately stop the system. Otherwise, it is very dangerous and may cause serious injury or significant damage to the robot system. Ensure that the emergency stop switch of the teach pendant connected to the TP port can operate properly when safety doors and other emergency stop or safety input signals are connected to the emergency stop circuit connector.

Mount the robot in a position with sufficient space and ensure that the surrounding area of the end fixture or the workpiece does not collide with walls or safety guards when the robot moves the workpiece and is extending. A collision (if any) may cause serious personal injury or significant equipment damage.

Fix the robot firmly before power-on or operation. Otherwise, it is very dangerous - the robot may fall, resulting in serious injury or significant damage to the robotic arm system.

Before mounting and operation, please ensure that all components of the robot are in place and free from external defects. Missing or defective components may lead to improper operation of the robot. It is very dangerous and may cause serious injury or significant damage.

Never use the robot near the devices generating powerful electromagnetic forces. Otherwise, it may cause malfunction or defect of the robot.

Never use the robot in places subject to electromagnetic interference, electrostatic discharge or radio frequency interference risk. Otherwise, it may cause malfunction of the robot.

Never use the robot in places exposed to flammable gases, dust, gasoline or solvents that may explode or catch fire. Otherwise, it may cause serious accidents or fires involving injury (including death).

Never place your hands or fingers near the moving parts of the robot. Otherwise, it may cause hand pinching and other injuries.

Never mount the robot controller upside down or tilted.

Warning

Make sure to connect the power cable to an electrical component that can be quickly disconnected. Never connect it directly to the main power supply of the factory or share the same electrical protector with other equipment at the first connection point.

Do not open the controller or robot cover except for maintenance. It is very dangerous when the controller cover is opened. Even if the main power is turned off, the internal high-voltage charging unit may cause electric shock as well.

Before connecting or disconnecting the cable, ensure that the power to the upper port of the connection point is turned off. It is very dangerous to connect or disconnect the cable in the power-on state. It may lead to electric shock or controller failure.

Ensure that the power supply is connected by a qualified operator.

The robot must be grounded properly or provided with a residual current protector to ensure safety according to field conditions.

Make sure to disconnect the power when opening the front cover of the controller. It is very dangerous to touch the power terminal inside the controller during power-on. It may cause electric shock or serious safety issues.

Make sure to mount the controller and connect its cable when mounting the robot. Prevent the connector from being impacted or loaded during cabling. Never forcefully pull the cable during connection.

Please make sure to turn off the power of the controller and related equipment and pull up the warning sign (e.g. no power-on) before wiring. It is very dangerous for wiring in the power-on state. It may lead to electric shock or robot system malfunction. (Wiring refers to all wiring actions related to the robot.)

Caution

The corresponding robot S/N is indicated on the controller label. Connect the controller and the robot correctly. In case of a mistake in the connection relationship, not only the robot system may not function properly, but also it may cause safety issues.

According to the rigidity of the mounting platform, vibration (resonance) may occur during operation. In case of vibration, increase the rigidity of the platform or change the speed or acceleration and deceleration settings.

Please confirm that the pins are not bent before the connector is connected. If the pins are bent during connection, it may damage the connector or cause the robot system to malfunction.

2 Connection to controller

2.1 Connection to controller

The connecting cables between the robot and the controller include power cables and signal cables. Please connect each cable to the connector on the back of the mounting base.

> ⚠ Warning
>
> Before connecting the power of the controller, please connect the robot and the controller with a ground wire. Electric shock may occur if the ground wire is not connected.

> ⚠ Warning
>
> The connection of cables must be performed after disconnecting the power.

Do not wind the excess part (over 10m) of the robot cable into a loop. Otherwise, it may cause a significant increase in cable temperature during certain robot actions, resulting in adverse effects on cable sleeve.

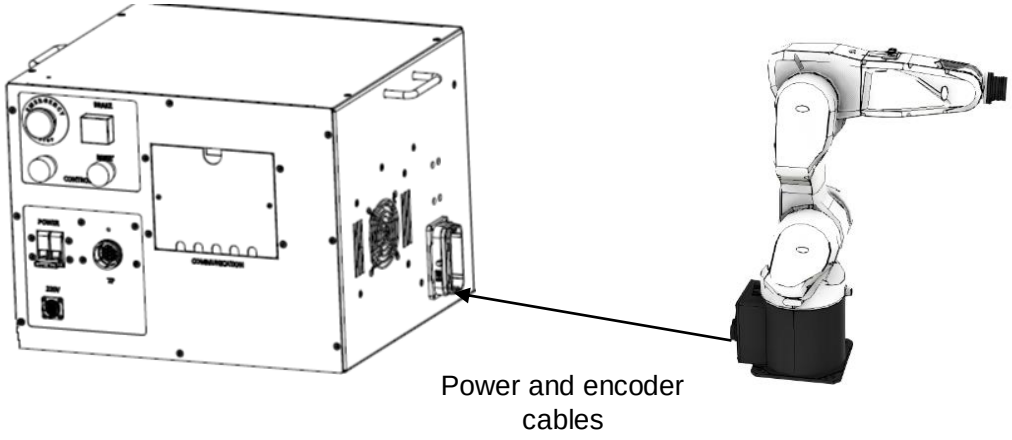


Fig. 2.1 Diagram for Connection between GBT-P7A Robot and Controller

3 Basic specification

3.1 Composition of robot

The mechanical system of the robot refers to the mechanical body, which is composed of a base, a swivel, a lower arm, an elbow joint seat, an upper arm, a wrist and a pipeline package. Totally, 6 servo motors can drive the movement of 6 axes to achieve different forms of motion. Fig. 3.1 shows various components of the robot, and Fig. 3.2 shows the defined positive and negative directions of each motion joint.

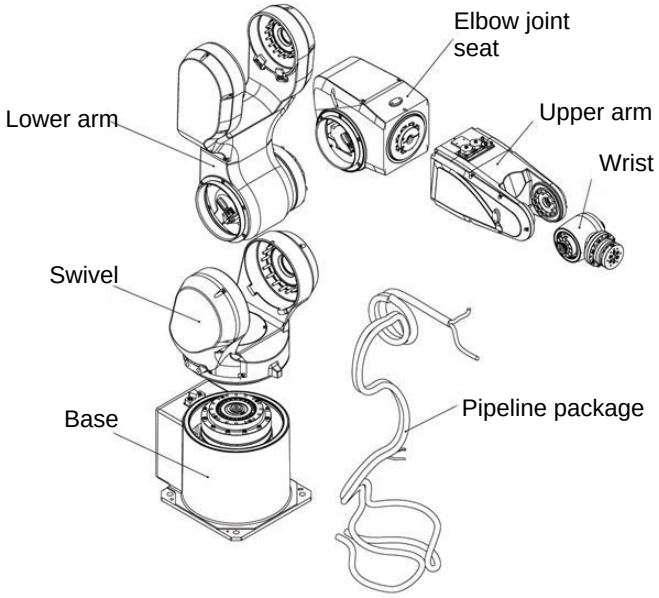


Fig. 3.1 Diagram for Joints of GBT-P7A Robot

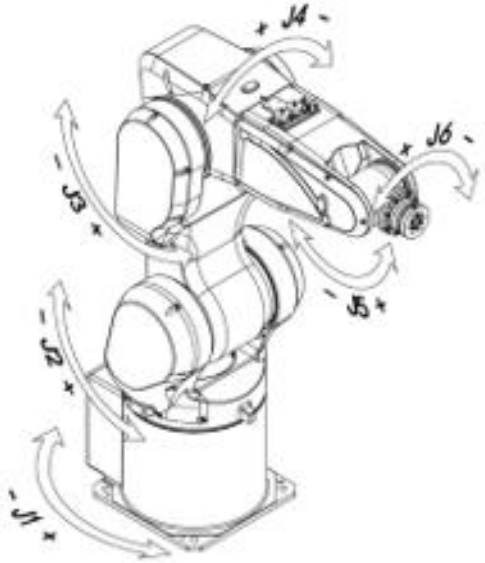


Fig. 3.2 Various Motion Joints and Forward Motion Direction of GBT-P7A

Caution

The weight of this robot only refers to its body weight and excludes the weight of the controller.

When operated at a low temperature, the robot may give an alarm at beginning due to high resistance of the gearbox. In this case, warm-up is required.

Technical Specifications:

		GBT-P7A-700	GBT-P7A-900
Basic Specifications			
Axes		6	6
Reach (max)		721mm	901mm
Payload	Rated	3.5kg	3.5kg
	Maximum	7kg	7kg
Degree of Protection		IP67	IP67
Mounting		Ground	Ground
Motion Parameters			
Axis Motion Range	J1	340° (- 170° /+170°)	340° (- 170° /+170°)
	J2	235° (- 135° /+100°)	235° (- 135° /+100°)
	J3	270° (- 70° /+200°)	270° (- 70° /+200°)
	J4	380° (- 190° /+190°)	380° (- 190° /+190°)
	J5	230° (- 115° /+115°)	230° (- 115° /+115°)
	J6	720° (- 360° /+360°)	720° (- 360° /+360°)
Axis Maximum Speed	J1	333° /s	333° /s
	J2	267° /s	267° /s
	J3	333° /s	333° /s
	J4	450° /s	450° /s
	J5	405° /s	405° /s
	J6	605° /s	605° /s
Position Repeatability		0.02mm	0.025mm

Model		GBT-P7A-700	GBT-P7A-900
Customer Interface			
Air		ϕ4x2	ϕ4x2
Communication		6RI/6RO,24V×2,0V×2	6RI/6RO,24V×2,0V×2
Physical Characteristics			
Weight		45.6kg	49.0kg
Base Mounting Area		230mmx230mm	230mmx230mm
Other Information			
Applicable Controller		IRC-I8A-S	IRC-I8A-S
Power Requirements	Voltage	220V~ / 50Hz	220V~ / 50Hz
Operating Environment	Temperature	0° C~45° C	0° C~45° C

Caution

1. Even when the robot is used within the specification range, certain action programs may shorten the lifespan of the gearbox or cause overheating alarms.

2. Sometimes, it is impossible to reach maximum speed of each axis at a short action distance.

3. No matter that the robot is operated at a low temperature (near 0 ℃) or after a long stop in an environment below 0 ℃ on a rest day or at night, collisions or detection alarms may occur at the beginning due to high resistance of moving parts. In this case, warm-up is required for a few minutes before operating.

4. Please consult our company for use in the environments with high/low temperature, vibration, dust, high concentration of cutting oil, etc.

3.2 Diagram for overall dimensions and action range

Caution

The workspace shown in this figure is the maximum space that can be theoretically reached. It may vary depending on the mounting method during actual operation. In practical application, please consider the impact of mounting method on the workspace.

Caution

The dimensional units for all measurements of the drawings in this section are in millimeters (mm).

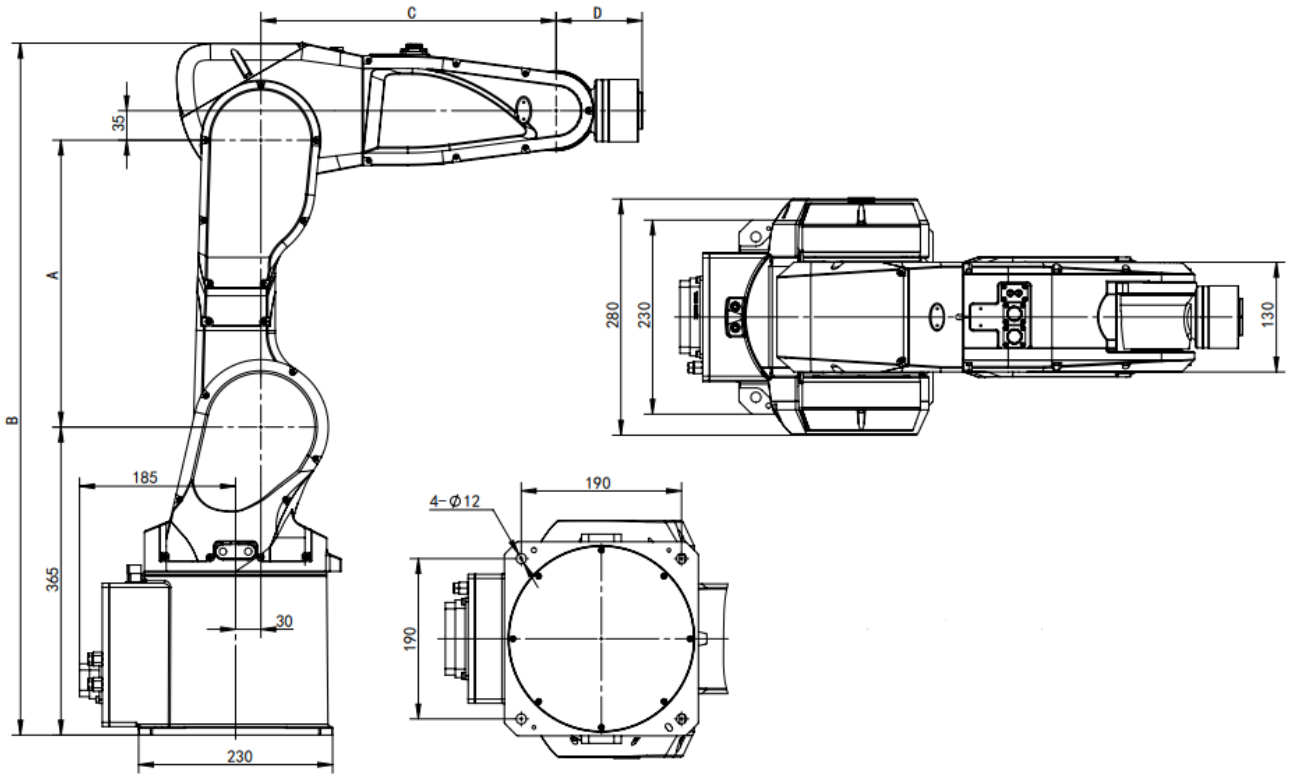


Fig. 3.4 Overall Dimensions of GBT-P7A Series

Series	A	B	C	D
GBT-P7A-700 (IP65)	340	820	350	96.5
GBT-P7A-700 (IP67)	340	820	350	102
GBT-P7A-900	450	930	420	102

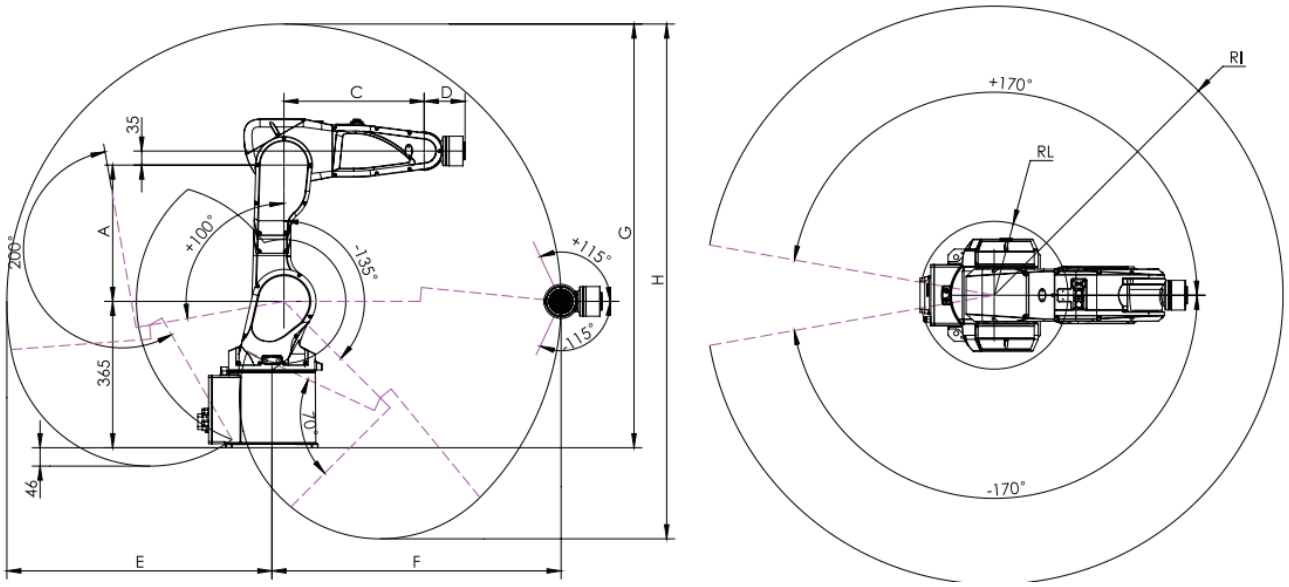


Fig. 3.5 Operating Space of GBT-P7A Series

Series	E	F	G	H	RL	RI
GBT-P7A-700 (IP65)	662	721	1056	1284	184	721
GBT-P7A-700 (IP67)	662	721	1056	1284	184	721
GBT-P7A-900	842	901	1236	1611	219	901

3.3 Origin position and ROM

An origin position and an ROM are provided on each control axis. The ROM is a function limiting maximum motion range of each joint of the robot through software. It is called overtravel (OT) if the control axis reaches the limit of its ROM. As long as the origin position is not lost due to abnormalities in the servo system or system errors, the robot's action may not exceed the ROM. In addition, to further ensure safety, ROM limits are also provided by the mechanical brake.

The following figure presents the position of the mechanical brake. Do not modify the mechanical brake, etc. Otherwise, the robot may not stop normally.

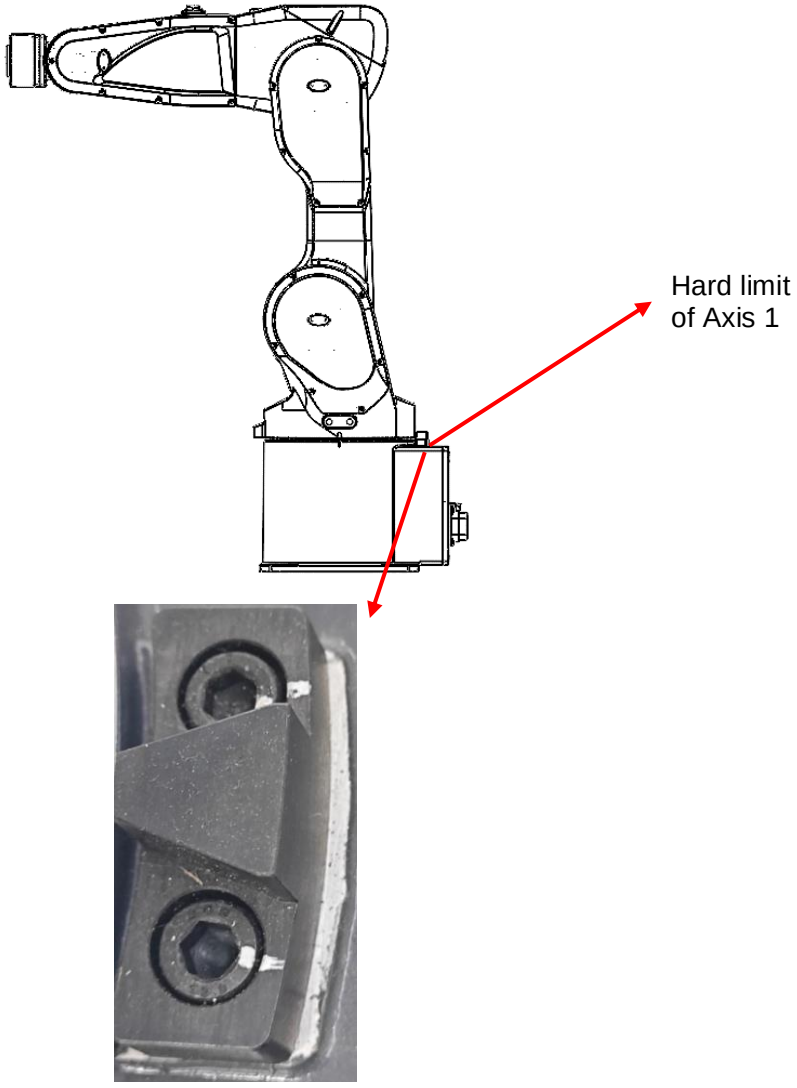


Fig. 3.6 Enlarged View of Hard Limits of GBT-P7A Series

3.4 Wrist payload conditions

The payload of GBT-P7A robot must comply with the payload curve diagram. It is important to carefully confirm the mass and inertia of the payload before operation. Overload may lead to excessive operation of the motor, the gearbox and relevant structures. It may also affect their service life, seriously damage the robot and even cause injury.

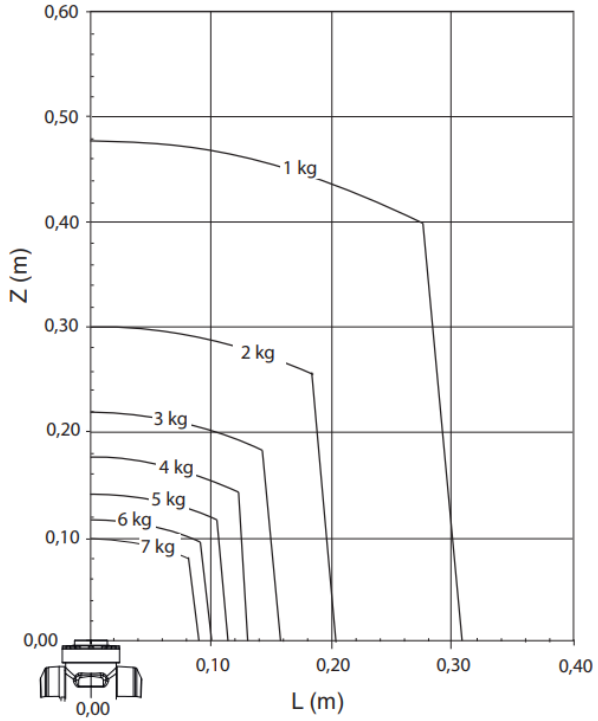


Fig. 3.7 Payload Curve of P7A

4 Mount the device onto the robot

4.1 Mount the end-effector to the front end of the wrist

The following figure shows the mounting surface of the end-effector at the front end of the wrist. Select the lengths of the bolts and positioning pins after sufficiently considering the depths of the screw hole and pin hole. In addition, please tighten the bolts for fixing the end-effector as per the allowable tightening torque.

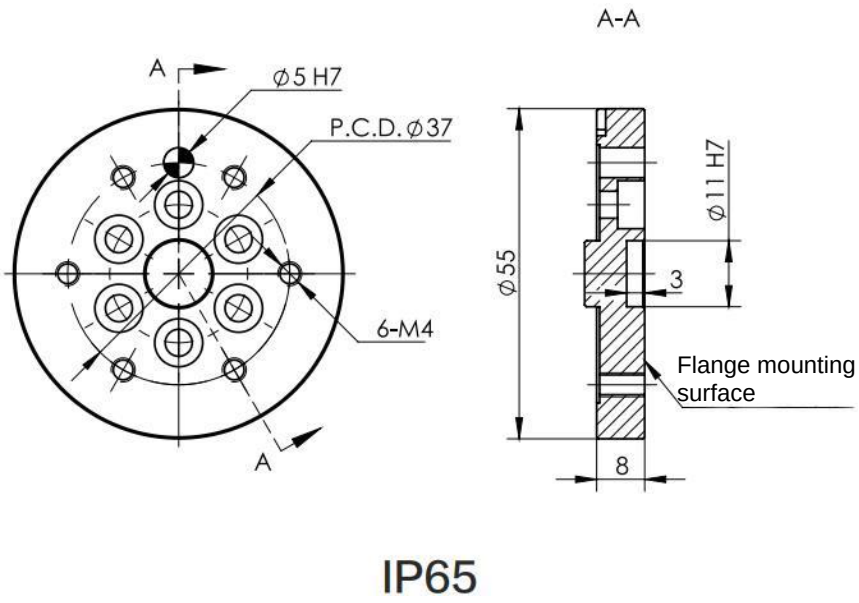


Fig. 4.1 Dimensions of P7A-700 (IP65) Flange

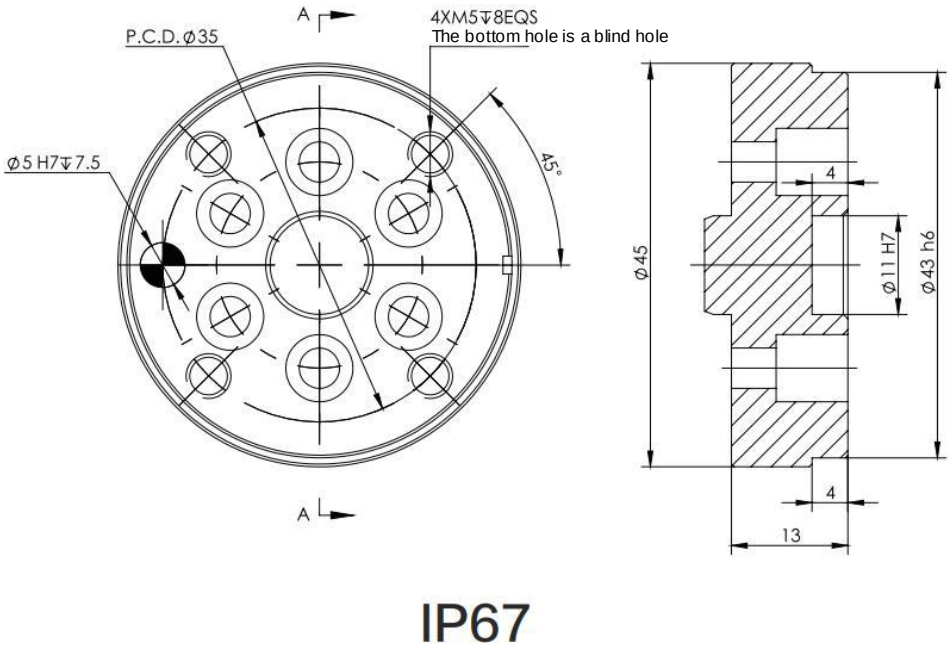


Fig. 4.2 Dimensions of P7A-700(IP67)/P7A-900 Flange

Parts required for mounting of end-effector

S/N	Name	Number
1	Hexagon socket screw M4 (GB/T 70.1-2008[NOTE]) (IP65)	6
2	Hexagon socket screw M5 (GB/T 70.1-2008[NOTE]) (IP67)	4
3	Spring washer M4 (IP65)	6
4	Spring washer M5 (IP67)	4
5	Flat washer M4 (GB/T 70.1-2008[NOTE])(IP65)	6
6	Flat washer M5 (GB/T 70.1-2008[NOTE])(IP67)	4

[NOTE]

GB/T 70.1-2008 Correspondence standard: ISO 4762:1997 Hexagon socket head cap screws

4.2 Mounting surface

Caution

1. Never increase machining holes or screw holes on the robot body, for it may cause adverse effects on the safety and functionality of the robot.

2. When mounting the device onto the robot, it is warned to avoid interference with the cables inside the mechanism. The interference (if any) may cause cable break within the mechanism, which will lead to unexpected malfunctions.

4.3 About payload setting

> Caution
>
> Before operation, it is important to correctly set the payload for the robot. Do not operate under payloads inconsistent with the set payload or under overload conditions. The weight of the payloads, including cables connecting surrounding devices, cannot exceed the transportable weight of the robot. Otherwise, it may shorten the lifespan of the gearbox.

Specific setting methods are as follows:

Click on the upper left corner of the screen to enter the menu screen, as shown in Fig. 1. Click on the System button as shown in Fig. 2. After all System functions pop out, click on Basic Setting as shown in Fig. 3. Then click on Payload Setting as shown in Fig. 4 to enter the Payload Setting screen. Create a new Payload, input and edit the parameters based on actual circumstances, and save it as shown in Fig. 5. The parameters must be activated first before they can be successfully saved and the set payload becomes valid.

Fig. 1

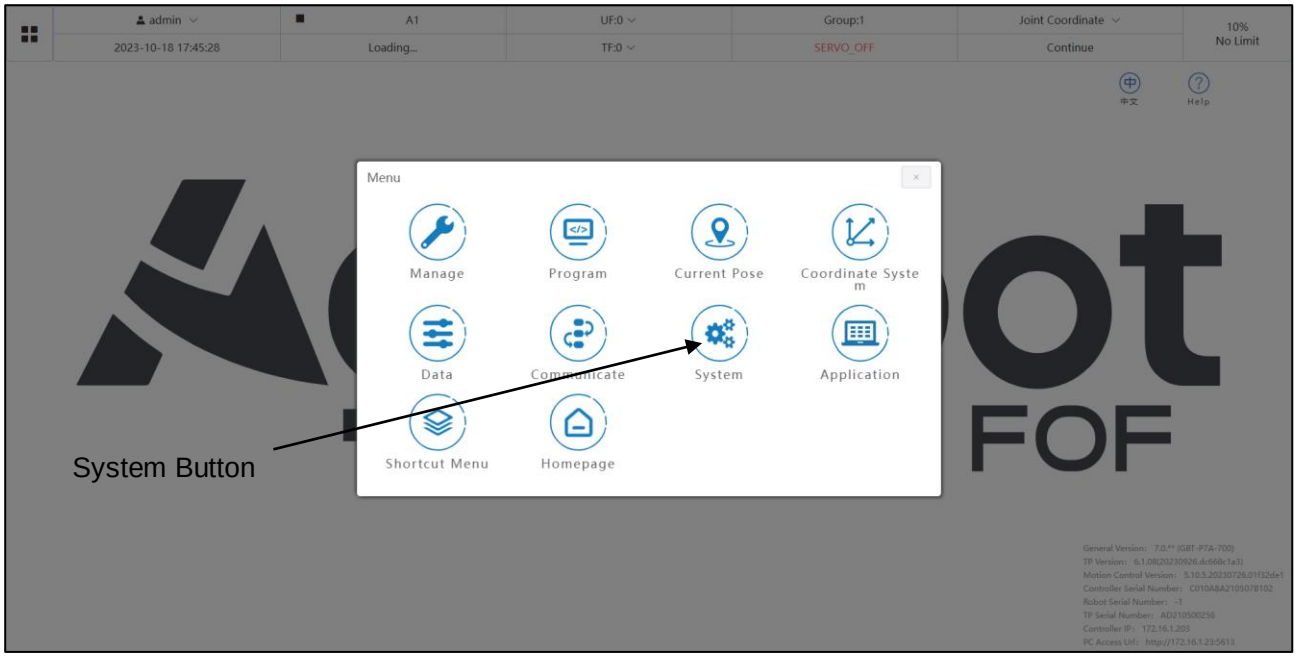

admin
2023-10-18 17:45:28
A1
Loading...
UF:0
TF:0
Group:1
SERVO_OFF
Joint Coordinate
Continue
10%
No Limit
Menu
Manage
Program
Current Pose
Coordinate System
Data
Communicate
System
Application
Shortcut Menu
Homepage
System Button

Fig. 2

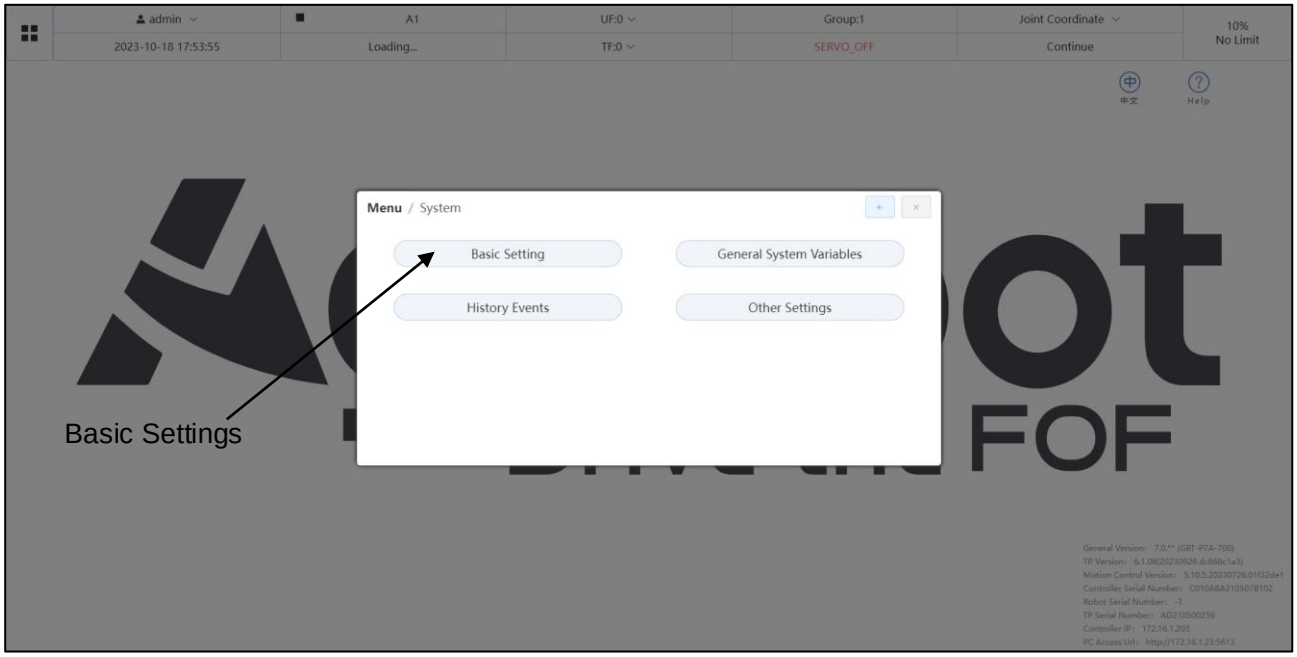

admin
2023-10-18 17:53:55
A1
Loading...
UF:0
TF:0
Group:1
SERVO_OFF
Joint Coordinate
Continue
10%
No Limit
Menu / System
Basic Setting
General System Variables
History Events
Other Settings
Basic Settings

Fig. 3

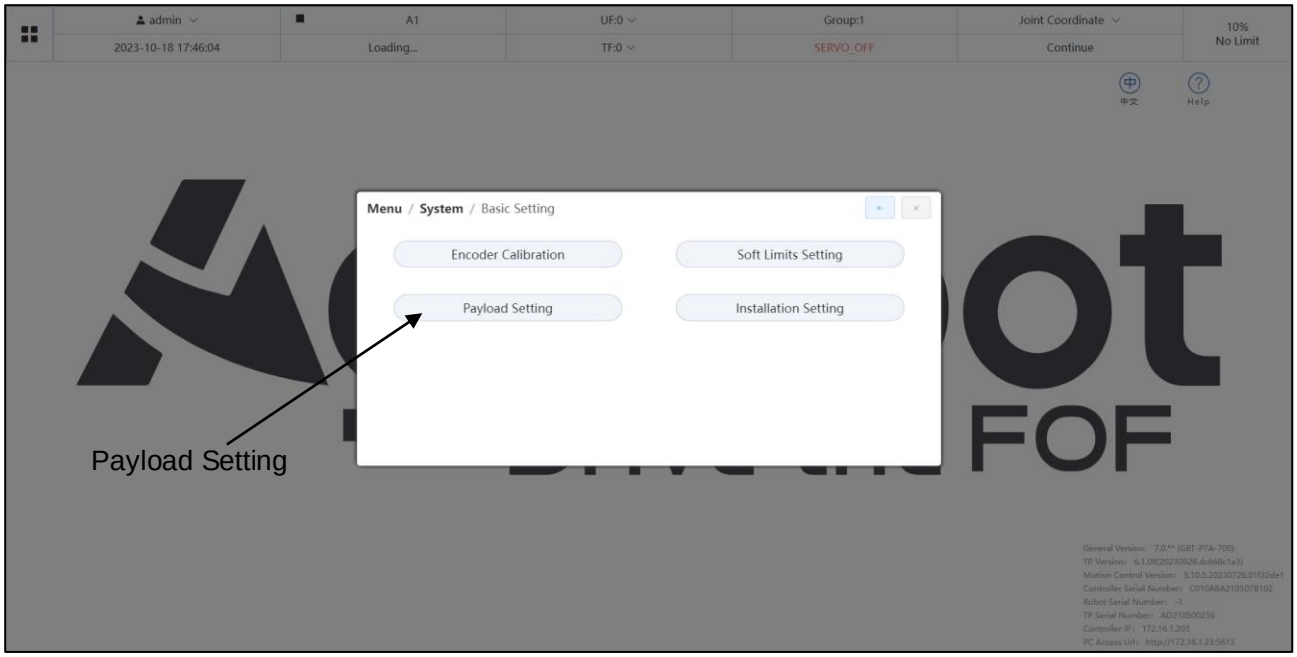

admin
2023-10-18 17:46:04
A1
Loading...
UF:0
TF:0
Group:1
SERVO_OFF
Joint Coordinate
Continue
10%
No Limit
Menu / System / Basic Setting
Encoder Calibration
Soft Limits Setting
Payload Setting
Installation Setting
Payload Setting

Fig. 4

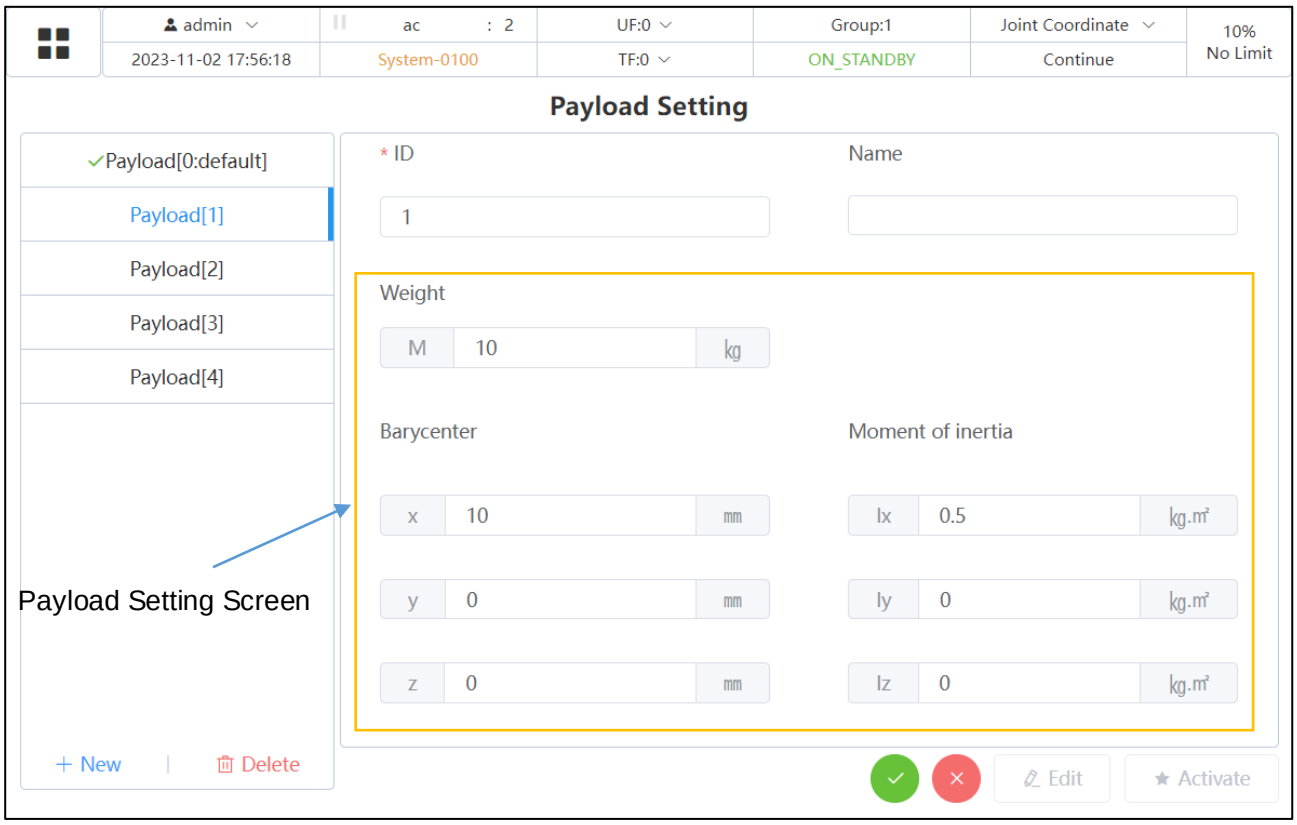

admin
2023-11-02 17:56:18
ac : 2
System-0100
UF:0
TF:0
Group:1
ON_STANDBY
Joint Coordinate
Continue
10%
No Limit
Payload Setting
Payload[0:default]
Payload[1]
Payload[2]
Payload[3]
Payload[4]
* ID
Name
1
Weight
M
10
kg
Barycenter
Moment of inertia
x
10
mm
Ix
0.5
kg.m²
y
0
mm
Iy
0
kg.m²
z
0
mm
Iz
0
kg.m²
Payload Setting Screen
New
Delete
Edit
Activate

Fig. 5

5 Cabling and piping to end-effector

Warning

- Do not add cables or hoses inside the robot mechanism.
- When mounting cables outside the robot mechanism, take care not to obstruct the motion of the robot.
- Take care not to interfere with other parts when laying cables or air pipes on the robot during integration.
- Please cut off any excess part of the end-effector cable and insulate it, e.g. wrapping insulation tape.
- If it is impossible to prevent the end-effector or workpiece from being electrified, please try to route the end-effector cable as far away as possible from the end-effector or workpiece. Carry out insulation treatment between the cable and the end-effector or workpiece when the cable has to be routed near the end-effector or workpiece.
- Perform daily inspection to confirm if the connector gets loose or the outer protective layer of the end-effector (manipulator) cable is damaged.
- Cable damage due to non-compliance with the above precautions may cause wrong actions of the end-effector and alarm/stop or incorrect actions of the robot. In addition, there is a risk of electric shock if exposed to damaged power cables.

5.1 Air pipe and EE interface

The following figure indicates the positions of air pressure supply and EE interface on the robot, which can be used as the expansion air circuit and expansion signal. The EE signal has been directly connected to the controller and properly defined. For detailed definition of signal wire sequences, please refer to the *IRC-I8A-S Controller Manual*.

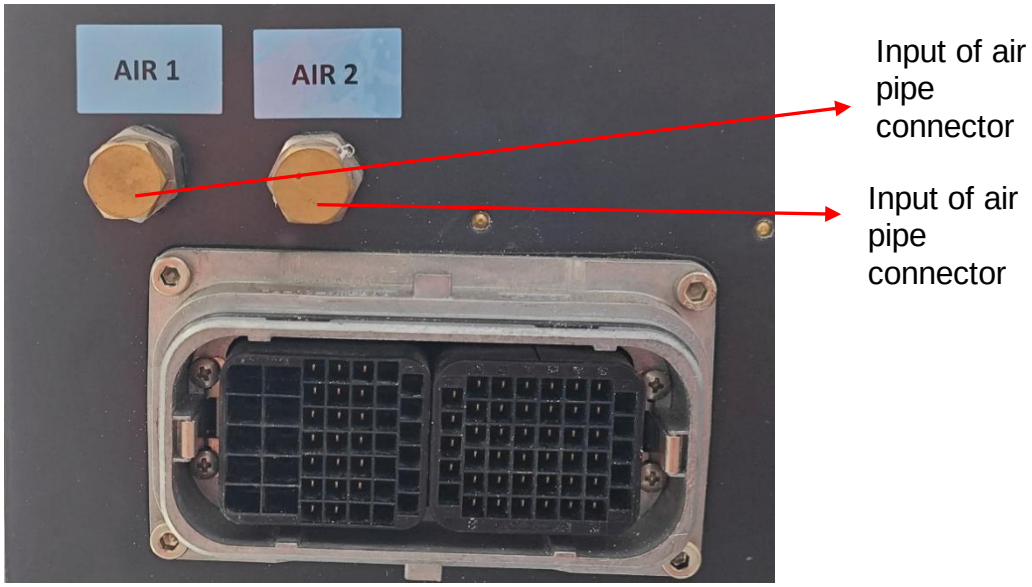


Fig. 5.1 Positions of Air Pipe and RI Interfaces on the Base

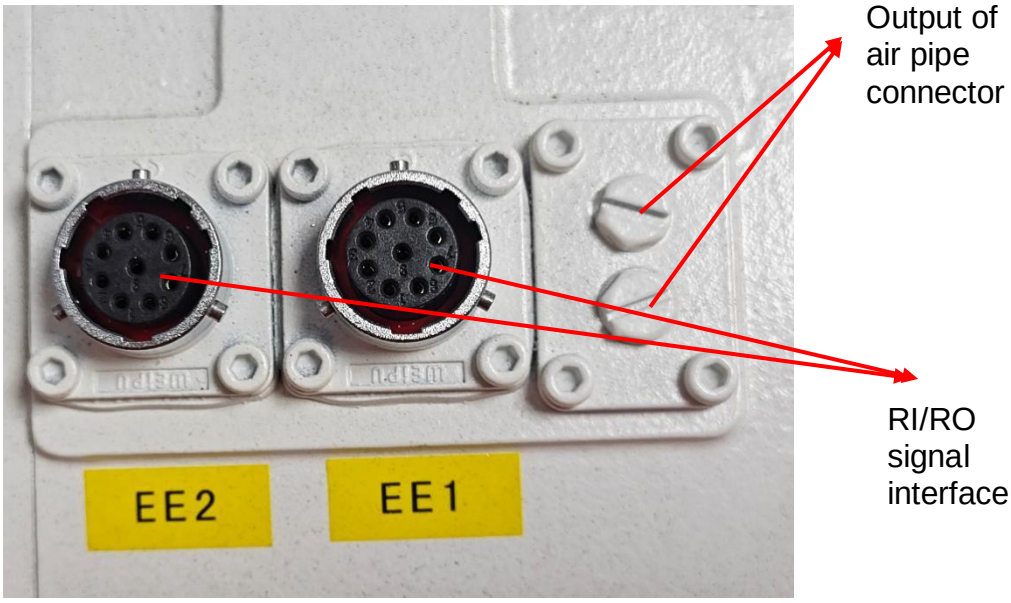


Fig. 5.2 Positions of Air Pipe and Arm Interfaces on Axis 4

6 Maintenance and repair

It is possible to maintain the performance of the robot in a stable state through maintenance and repair.

Warning

The cumulative operating time of the GBT robot is assumed to be 3000h in a year. If the annual operating time is longer than 3000h, it is necessary to shorten the maintenance cycle according to the operating time. For example, the maintenance and repair cycle is shortened by half when the cumulative operating time is 6000h in a year.

6.1 Maintenance and repair contents

Daily maintenance

Before daily maintenance, please read this chapter carefully to fully understand safe maintenance methods.

Only those who have passed robot system training of our company and the distributors are allowed to maintain the robot system.

Warning

- Never remove any components unless otherwise specified in the Maintenance Manual. Please strictly follow the maintenance steps specified. Incorrect disassembly or maintenance (if any) may lead to not only malfunction of the robot system but also serious safety issues.
- Untrained persons must not approach the robot powered on. Also, do not enter the action area. Even if the robot seems to have stopped, it is still very dangerous for the robot may move again and possibly cause serious safety issues. To prevent hazards caused by unexpected motion of the robot or improper operation of the operator, please develop and follow a Safe Operation Guideline.
- Please confirm the robot's action outside the safety fence after replacement of any part. Otherwise, the robot may perform unexpected actions and possibly cause serious safety issues.
- Before normal operation, please confirm that the emergency stop switch and safety fence switch operate normally. If the robot system is operated in a state where the switches cannot operate normally, it is very dangerous that the switches cannot perform their safety function in case of an emergency, which may possibly lead to serious injury or significant damage to the robot system.
- If it is necessary to touch the external terminals of the controller or connector during maintenance, please turn off the controller and cut off its power to avoid electric shock. Be sure to cut off the power supply before cleaning or tightening the terminal screws. If all relevant power supplies are not cut off, it may cause electric shock, product damage or malfunction.
- Before replacement, set up a signboard that indicates “Replacement in Progress”, turn off the robot system and cut off the power supply of relevant devices. Operations in the power-on state may lead to electric shock or robot system malfunction. Do not connect or disconnect the robot cables in the power-on state. Otherwise, it is very dangerous for the robot may malfunction. In addition, operations in the power-on state may lead to electric shock.
- Make sure to correctly connect the robot cable to the controller and the robot body. Please warn not to forcefully bend the cable to avoid additional payload to it. (Additionally, do not place any heavy object on the cable or forcefully bend or pull the cable to avoid bending, pulling or squeezing of the cable. Otherwise, it may cause cable damage, breakage or poor contact. These are very dangerous and may lead to electric shock or robot system malfunction.)

Caution

- Please use alcohol, liquid gasket and adhesive carefully according to respective operating specifications, instructions and the following descriptions. Improper use of alcohol, liquid gasket or adhesive may lead to fire or safety issues.
  - It is prohibited to keep alcohol, liquid gasket or adhesive near fire sources.
  - Perform indoor ventilation when using alcohol, liquid gasket or adhesive.
  - Please wear protective devices, such as masks, goggles and oil-resistant gloves.
  - Thoroughly clean with water and soap the alcohol, liquid gasket or adhesive flashed on the skin.
  - If alcohol, liquid gasket or adhesive is splashed into the eyes or mouth, thoroughly rinse the eyes or mouth with water and seek medical attention immediately.
- Please wear protective devices during grease filling, such as masks, goggles and oil-resistant gloves. Once lubricating grease enters eyes or mouth or is stained on the skin, please perform the following treatment.
  - When entering the eyes:

    Please thoroughly clean the eyes with clean water and seek medical attention.
  - When swallowing:

    Do not forcefully induce vomiting and seek medical attention immediately.
  - When entering the mouth:

    Please rinse the mouth thoroughly with water.
  - When adhering to the skin:

    Please rinse thoroughly with water and soap.
- The robot may generate heat due to motor heating or similar reasons. Do not touch the robot before it cools down. In addition, ensure that the robot has cooled down and is not hot when touched. Then, perform teaching or maintenance.
- When performing robot maintenance, ensure a space of approximately 50cm around the robot.

Regular maintenance · repair

Carry out maintenance and repair for the items below according to the shorter term of the specified period or cumulative operating time. (Please refer to Appendix A for detailed documents)

Maintenance · repair cycle	Maintenance · repair items	Maintenance · repair methods
3 months	Clean the body	Wipe away dirt and clear away accumulated splashes, dust, chips, etc.
3 months	Secureness of end tools	Apply certain forces to the end tool in front, back, left, right, up and down directions and confirm that it doesn’t shake.
1 year	Robot cables	Confirm if they are worn
1 year	Warning sign	Confirm if it is broken or lost
1 year	Hard limit and buffer block	Confirm if they are loose, damaged or broken
1 year	Timing belt	Wearing and reasonable tensioning of 3 timing belts

6.2 Repair

Battery replacement

(1-year regular maintenance period for specified built-in battery)

The position data of the robot axes is saved through a backup battery. The built-in battery (if used) should be replaced regularly every year. In addition, the backup battery should be replaced as well when the voltage-drop alarm is displayed.

Warning

Do not put the power supply of the robot to the OFF state. If the battery is replaced when the power supply of the robot is in the OFF state, it may result in the loss of zero point data of the robot. So, the battery must be replaced when the power supply of the robot is in the ON state.

1. Please press the emergency stop button to prevent danger.

2. Remove the battery cover. Gently tap the battery chamber cover horizontally with a plastic hammer when it cannot be removed.

3. Do not mistake positive and negative electrodes of the battery.

The following is the method for replacing the battery:

To avoid loss of zero-point data, please restore the robot to the zero position and make a backup before battery replacement. As shown in Fig. 1, open the bottom rear shell of the body, take out the old battery, unplug it and fix a new one in the wiring chamber. The replacement steps for the old version of the mechanical body (without battery chamber) are as follows:

1) Remove the fixing screws on the base cover as shown in Fig. 6.1 and pull out the base cover;

2) Cut the strap fixing to the battery to the battery board;

3) Pull out the battery power plug from the encoder management board and remove the old battery;

4) Insert the power plug of the new battery into the battery power inlet on the encoder management board;

5) Tie and fix the new battery to the battery board with a strap;

6) Restore the base cover and tighten the screws on the base cover as shown in Fig. 6.1;

7) Turn on the power to check if the zero position is lost and restore the machine.

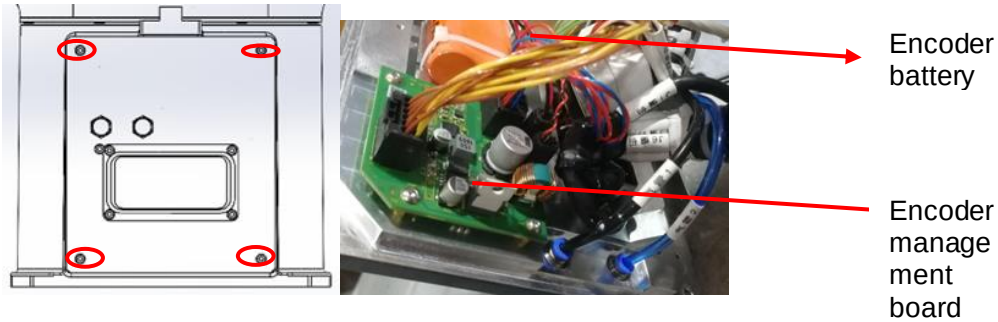


Fig. 6.1 Fixing of Internal Battery

The replacement steps for new version of the mechanical body (with battery chamber) are as follows:

1) Remove the screws on the battery chamber cover as shown in Fig. 6.2 and pull the encoder out of the battery chamber cover;

2) Cut the strap fixing the battery;

3) Pull out the battery power plug as shown in Fig. 6.2 and remove the old battery;

4) Insert the power plug of the new battery into the battery power inlet as shown in Fig. 6.2;

5) Tie and fix the new battery to the battery board with a strap;

6) Restore the battery chamber cover and tighten the screws on the battery chamber cover as shown in Fig. 6.2;

7) Turn on the power to check if the zero position is lost and restore the machine.

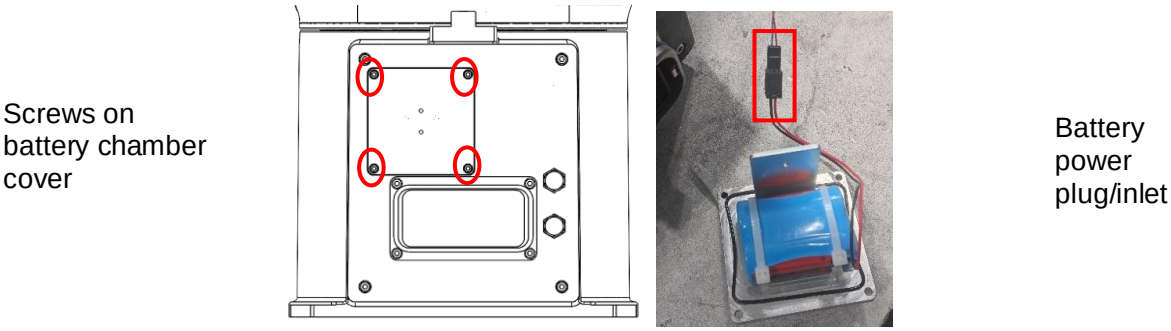


Fig. 6.2 Screws on Encoder Battery Chamber of New Version Mechanical Body

Replacement of timing belt

Correct and reasonable use of timing belts can not only ensure smooth production and transmission, but also reduce the failure rate of the device and extend the service life of timing belts.

Warning

1. It is required to notify the technician of Agilebot in advance before replacement of timing belts. Replacement can only be performed with written permission from Agilebot. Otherwise, we will assume no responsibility for any loss or downtime caused by this.

2. When purchasing a timing belt, select the belt with clean surfaces, no distortion or deformation and a material number provided by us. (The material numbers for timing belts of Axis 4, Axis 5 and Axis 6 are 2080100015, 2080100016 and 2080100017 for P7A-700 (IP67) and P7A-900, and 2080100001, 2080100002 and 2080100003 for P7A-700 (IP65).)

3. During replacement, the timing belt can be taken out only after its tension is minimized. It is strictly prohibited to forcefully pry off the timing belt under high tension with a non-professional tool.

4. When the timing belt is fixed, the center distance between two pulleys must be narrowed first if possible, and reset after the timing belt has been fixed.

5. The pre-tension force should be adjusted first during fixing. The pre-tension force is 30N for replacing a new timing belt on Axis 5 or Axis 6 of GBT-P7A-700. The replacement of the Axis 4 timing belt of GBT - P7A-700 involves the unplugging and plugging of cable connectors. Please contact Agilebot if necessary.

6. After replacement, the robot must be reset to zero by a professional technician and then can be operated normally. Otherwise, the zero point of the robot may be lost, resulting in a danger.

Follow the following steps to replace the timing belt:

Replace the timing belt on Axis 4.

1. Preliminary preparation:

Reset all axes to zero positions and back up current system of the robot; turn off the power, air and hydraulic supplies of the robot;

2. Remove the screws on the cover and motor mounting plate on Axis 4 (see Fig. 6.3) and take out the timing belt;

3. Put one end of Axis 4's new timing belt on the motor assembly 4 and the other end on Axis 4's driven pulley, and lock it with 3 sets of M5x16 screws and flat washers (not tightened temporarily);

4. Put a strap around the motor near the flange, control the tension to 60N with a tension gauge and then tighten the screws.

5. Fix the cover and run it to check for any abnormalities.

Screws on motor mounting plate of Axis 4

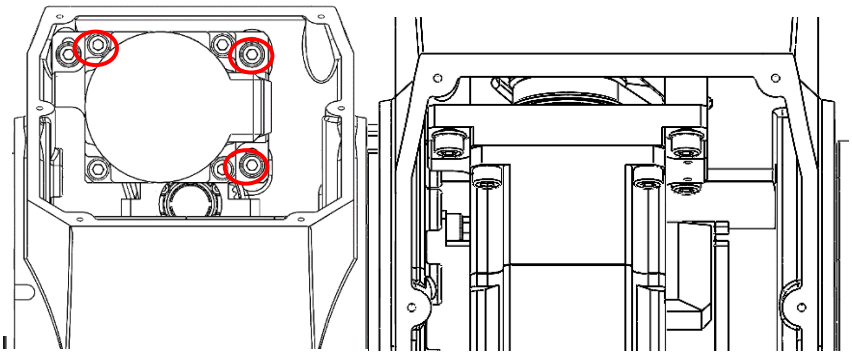


Fig. 6.3 Screw Positions on Motor Mounting Plate of Axis 4 Timing belt

Replace timing belts on Axis 5 and Axis 6.

Screws on motor mounting plate of Axis 5

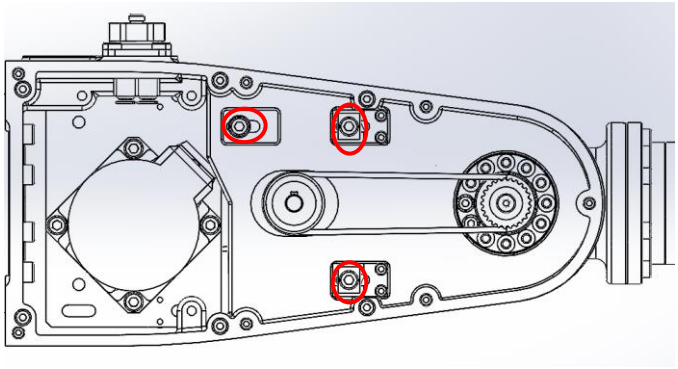


Fig. 6.4 Screw Positions on Motor Mounting Plate of Axis 5 Timing belt

Screws on motor mounting plate of Axis 6

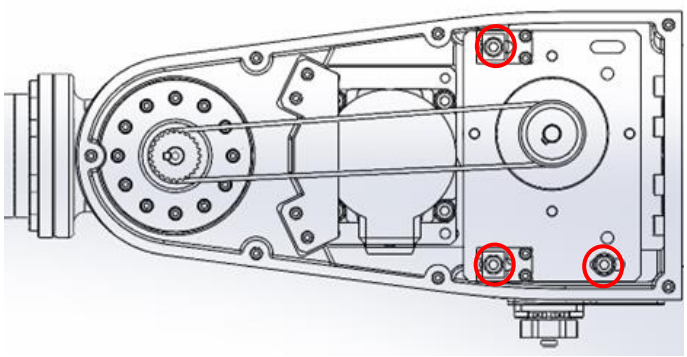


Fig. 6.5 Screw Positions on Motor Mounting Plate of Axis 6 Timing belt

1. Preliminary preparation:

Reset all axes to zero positions and back up current system of the robot; turn off the power, air and hydraulic supplies of the robot;

2. Remove the cover of Axis 5 (6), loosen the screws on the motor mounting plate of Axis 5 (6) (see Fig. 6.4 and Fig. 6.5), then slowly move the motor towards the gear direction, and take out the timing belt after it gets loose.

3. Fix the timing belt of Axis 5 (6) on the driving and driven wheels of Axis 5 (6), put a strap around the motor near the flange, control the tension to 30N with a tension gauge and then tighten the

screws.

4. Confirm that all bolts are tightened.
5. Fix the cover again, power on and run it to check for any abnormalities.
6. Reset the robot to zero. Ensure that all safety requirements are satisfied during the first operation after recovery.

7 Zero calibration method

7.1 Summary

Zero calibration is an operation associating the angle of each robot joint with the pulse count.

The zero calibration operation is to obtain the pulse count corresponding to the zero position.

The “zero calibration” is completed before ex-factory. It is unnecessary to perform zero calibration in daily operations. However, zero calibration should be performed in the following situations.

Please contact us for performing high-precision calibration in the following situations: the motor, pulse encoder or gearbox is replaced, or the battery used for pulse count backup is depleted.

Warning

The data of the robot and the pulse encoder, including zero calibration data, are saved through their respective backup batteries. The battery depletion may cause data loss. The batteries in the controller and mechanism should be replaced regularly. When the battery voltage drops, the system will give an alarm to notify the user - please replace the battery timely.

Zero calibration method

- General calibration method
- Direct writing method of zero encoding data

7.2 General calibration method

Select one or several axes and record their current readings as new zero data in the parameter file of the robot's Flash. The recording objects include main axis and additional axes of the robot (if any). It is possible to calibrate a single axis. (For example, if a user moves a robot to coincide the zero scale of a certain axis and then uses this function to achieve zero calibration of the robot.)

It is required to perform zero calibration when the loss of zero calibration data for a specific axis or all axes is caused by the voltage drop of the battery for the pulse counter after a period of use or the replacement of the encoder management board. Select “General Encoder Calibration” method and check multiple axes or a single axis for calibration. Then click “Calibrate” to complete the calibration (please refer to the general calibration steps for specific operations).

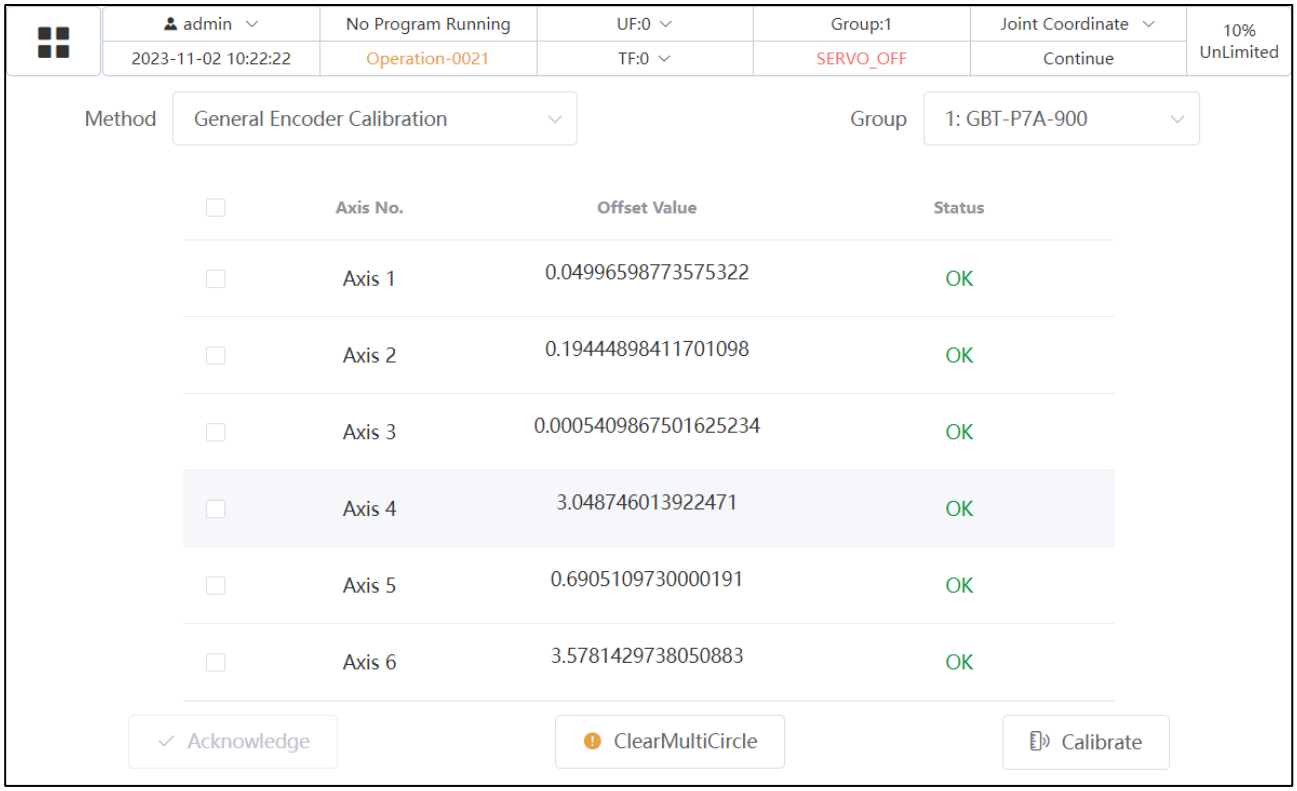


Fig. 7.1 Interface of General Calibration Method

The steps for general calibration method are as follows:

1. For a six-axis robot, align the zero-point reference marks of all axes (see Fig. 7.8)
2. Successively click "Menu" → "System" → "Basic Settings" → "Encoder Calibration" to enter the screen as shown in Fig. 7.2.

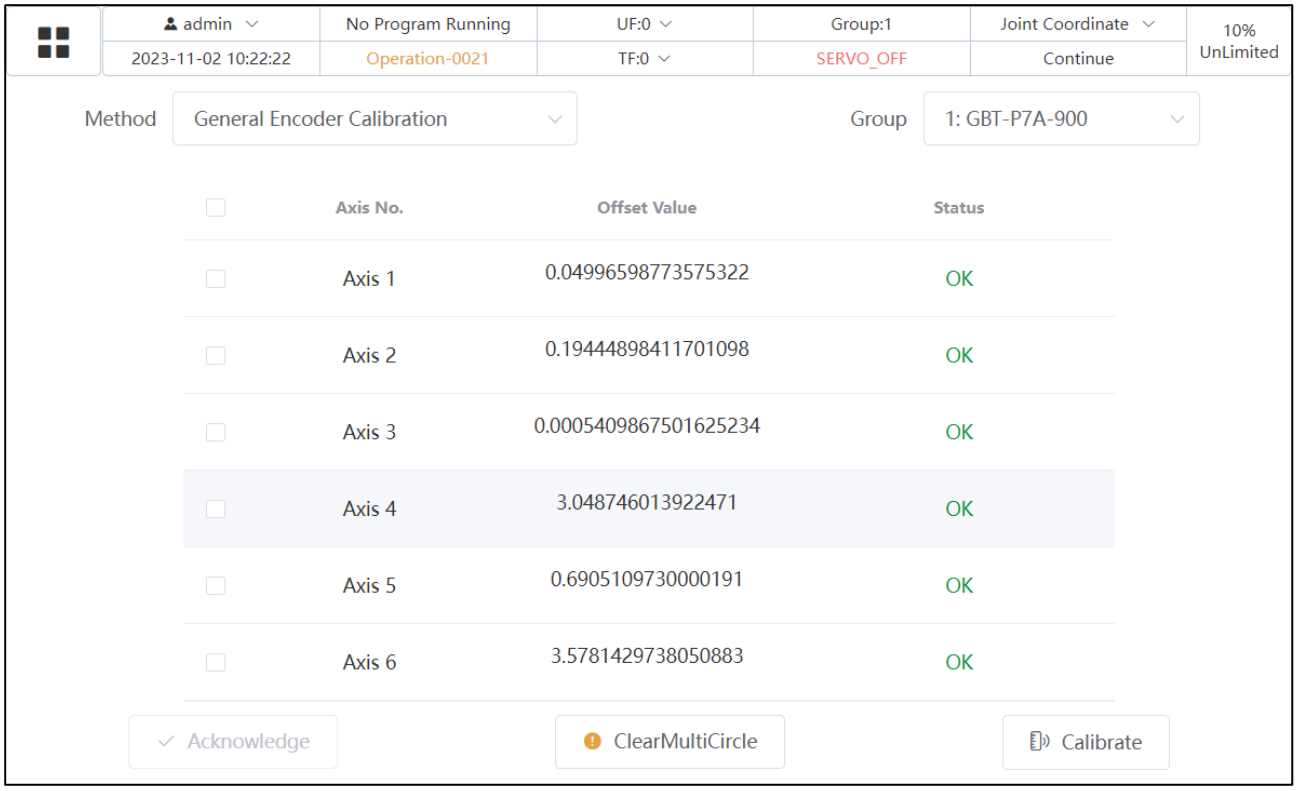


Fig. 7.2 Zero-point Status Screen

3. Select “General Encoder Calibration” method in the upper left corner of the screen.

Fig. 7.3 Selection of Calibration Method

4. Click the box on the left of each axis number to select all axes to be calibrated as shown in 7.4; you could also select one single axis to be calibrated as shown in Fig. 7.5.

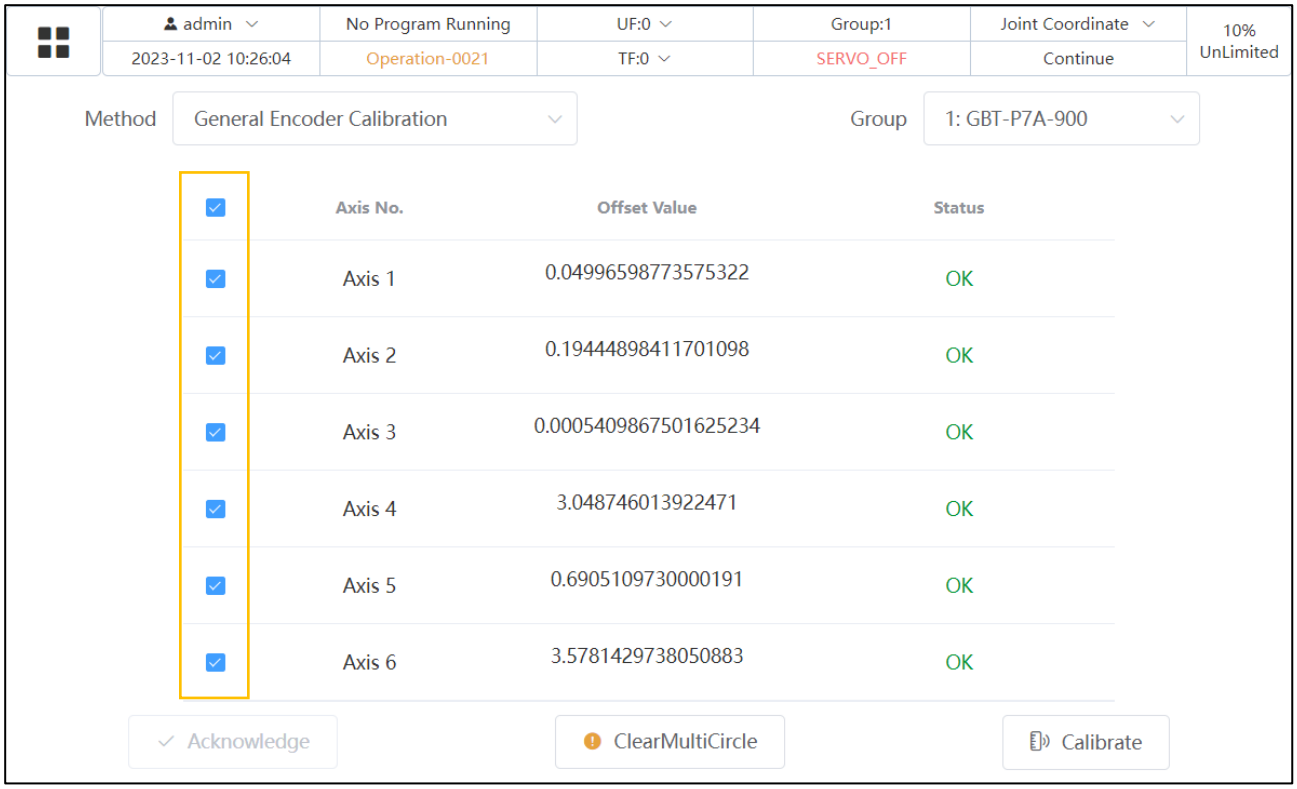


Fig. 7.4 Selection of multiple axes

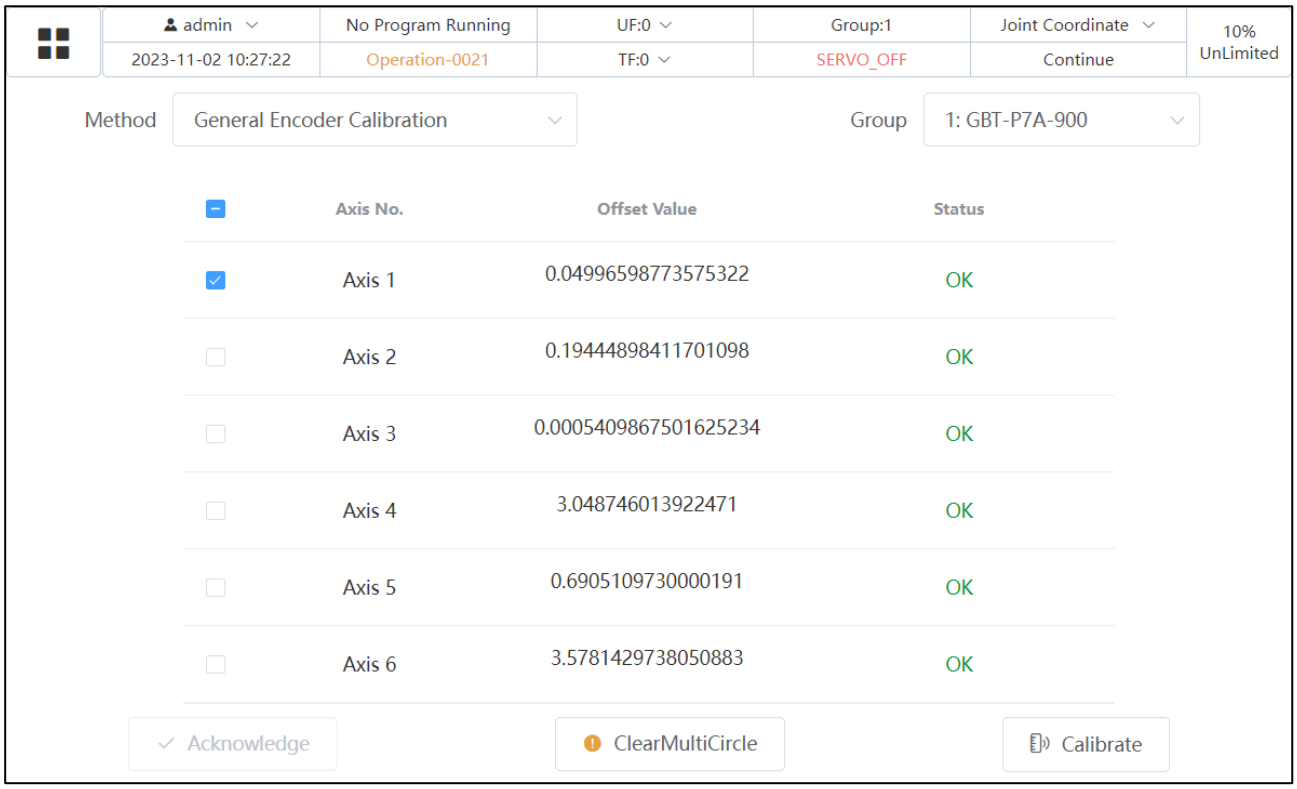


Fig. 7.5 Selection of one single axis

5. After selecting the axis to be calibrated, click "Calibrate ". If the "Calibration success" message pops up, the zero-point status of the calibrated axis may change to "To be Saved", as shown in Fig.

7.6.

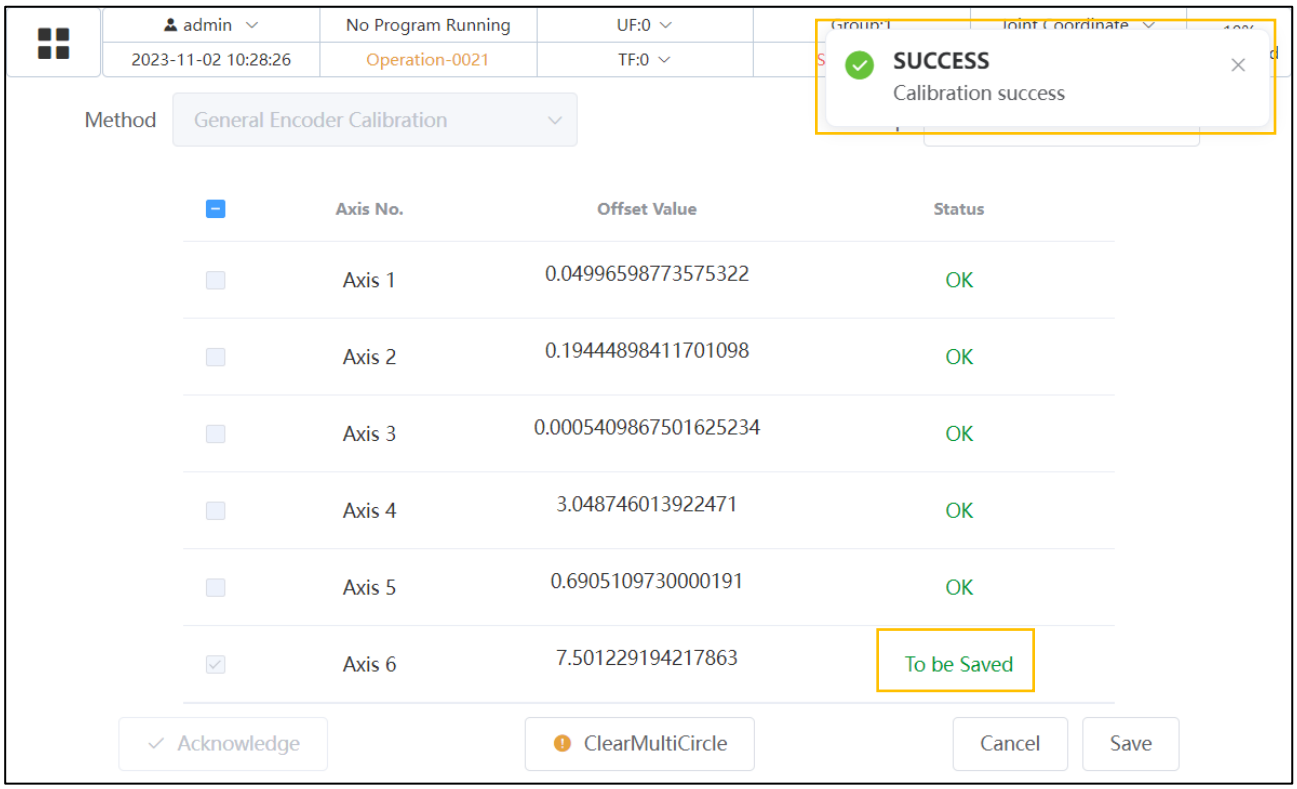


Fig. 7.6 Status Changes to “To be Saved”

6. Click “Save” to complete the calibration.

7.3 Zero encoded data direct write

As for the direct writing of zero calibration data, the zero calibration data can be directly entered into the system variables. This operation is used in the situations where zero calibration data is lost while pulse data is still maintained.

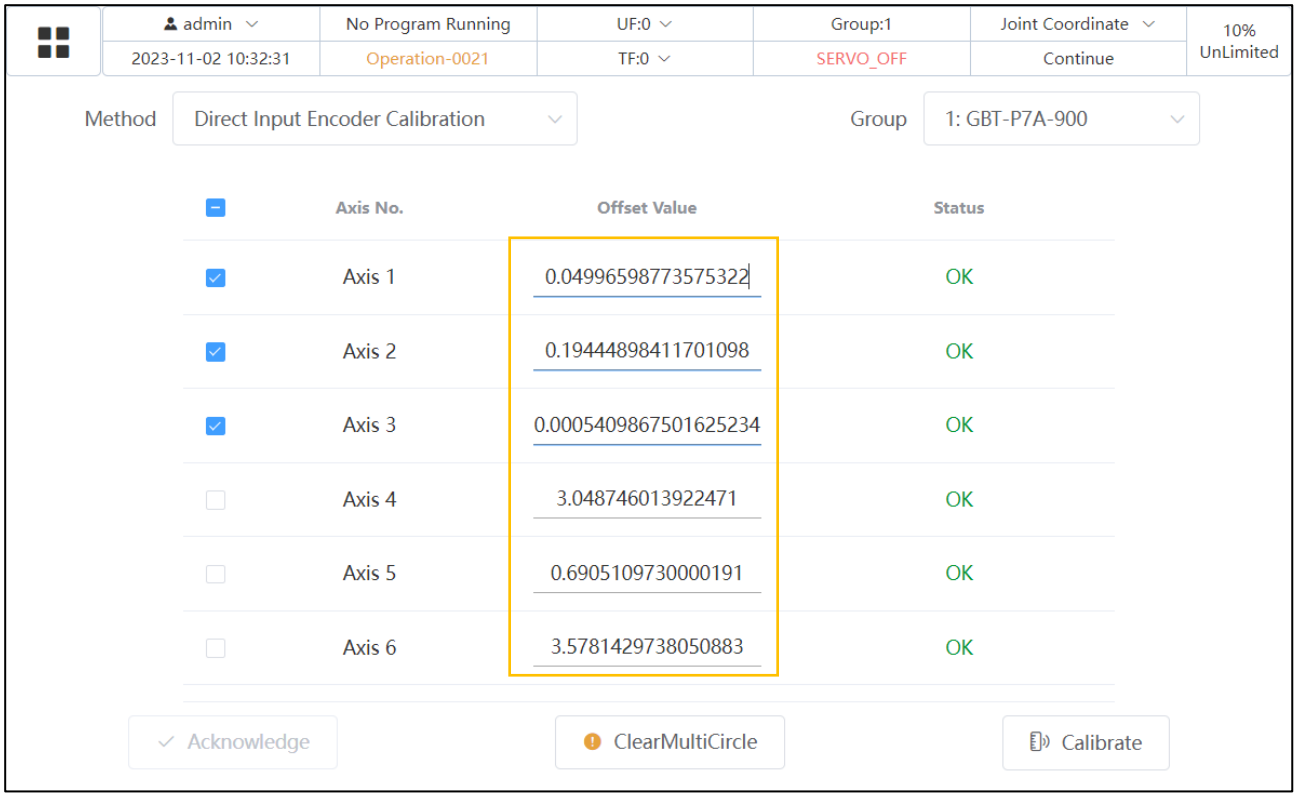


Fig. 7.7 Zero-encoded Data Direct Write Interface

7.4 Confirmation of zero calibration results

Confirm whether the zero calibration is carried out normally:

Usually, it is required to determine whether the zero calibration has been completed normally and check whether the current position display is consistent with the actual position of the robot by the following method.

- Make specific points in the program reappear again and confirm their consistency with the positions taught.
- Move the robot to a position where all axes are at 0° and visually confirm whether the zero marks shown in the following figure are consistent.

Check the synchronous positions before starting any programming of the robot system. It is allowed to move the robot to the specified zero position by the manual operation window on TP.

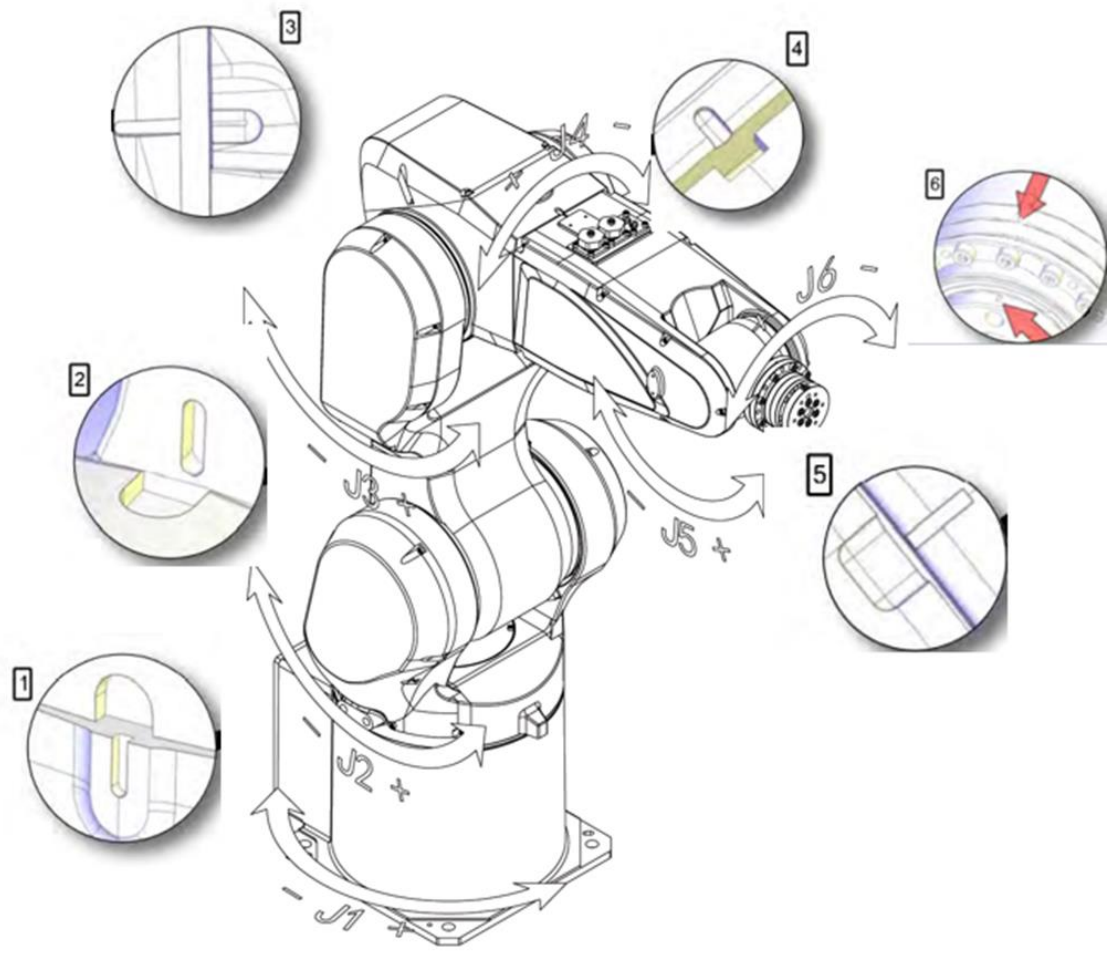


Fig. 7.8 Mechanical Zero Position Mark of GBT-P7A

8 Resolution of common faults

A fault in the mechanism is sometimes caused by multiple different causes together. So, it is often difficult to thoroughly investigate them. In addition, incorrect measures (if taken) may actually lead to further deterioration of the fault. Therefore, it is important to analyze the fault in detail and clarify its true cause.

The solutions for common faults in the mechanism are shown in the following. Please contact us if you cannot find the reason and don't know how to take countermeasures.

Phenomenon	Description	Cause analysis	Solution
Vibration	The base is not firmly fixed to the ground.	The connection between the base and the ground gets loose due to frequent vibration during robot operation.	Reinforce the connection between the robot and the ground again.
	The robot vibrates significantly beyond a certain speed.	The routing program used by the robot poses a heavy payload on the robot hardware.	Adjust the programmed route of the robot.
	The robot vibrates significantly at a specific position.	The payload on the robot is probably too heavy.	Reduce the payload on the robot.
	The robot vibrates after collision or long overload.	Collision or overload causes damage to the joint structure or gearbox.	Replace the gearbox or repair the structure in the area causing vibration.
	The vibration of the robot may be related to other running machines around.	The operations of the robot and the machine around may resonate.	Change the distance between the robot and other machine.
	When turning off the robot, manually move the robot and find that it is shaking.	Overload or impact causes the screws on robot joints to get loose.	Check if the screws at each joint are loose (motor screws, gearbox screws and connecting screws). If loose, tighten them according to regulations.
Abnormal noise	The robot generates an abnormal noise when exceeding a certain speed.	The routing program used by the robot poses a heavy payload on the robot hardware.	Adjust the programmed route of the robot.
	The robot generates an abnormal noise at a specific position.	The payload on the robot is probably too heavy.	Reduce the payload on the robot.
	The robot generates an abnormal noise after collision or long overload.	Collision or overload causes damage to the joint structure or gearbox.	Replace the gearbox or repair the structure in the area causing vibration.
Motor overheating	The temperature rises in the operating environment of the robot or its heat dissipation is influenced for the servo motor is covered by some object.	The motor temperature rises due to an increase in environmental temperature or poor heat dissipation of the motor.	Reduce environmental temperature, enhance heat dissipation and remove coverings on the motor.
	The control program or payload of the robot has been changed.	The program or payload exceeds the acceptable range of the robot.	Adjust the program and reduce the payload.

	The parameters imported into the controller have changed, causing motor overheating.	The imported parameters don't match the model of the robot	Re-import correct parameters
Jiggling	When cutting off the power supply of the robot, press it with a hand to find some robot mechanisms jiggling. There is a gap on the connecting surface of the parts.	Probably, overload or collision causes connecting bolts of robot components to get loose.	For each axis, confirm whether the bolts in the following positions are loose. If loose, use anti-loosening adhesive and tighten them with appropriate torque. ·Fixing bolts on motor ·Fixing bolts on gearbox ·Fixing bolts on base ·Fixing bolts on arm ·Fixing bolts on cover ·Fixing bolts on end-effector
Grease leaking	Grease leaks from the mechanism.	[Poor sealing] It may be caused by cracked casting, damaged O-ring seal, broken oil seal, loose sealing bolts, etc. The cracked casting may be caused by excessive external force on the mechanism due to collision or other reasons. The broken oil seal may be caused by scratches on the lip of the oil seal due to the invasion of dust or other foreign objects. When the sealing bolt is loose, lubricating oil may leak out along the screw.	
Position offset	The robot moves in a position deviating from the teach position. Repetitive positioning accuracy is greaer than the allowed value.	[Mechanical fault] Unstable accuracy of repetitive positioning may be caused by abnormal driving systems, loose bolts or other faults on the mechanical part. If the repetitive positioning accuracy is stable after certain offset, it may be due to the mechanical deformation caused by excessive payload in case of collision. It may be caused by an abnormal pulse encoder.	
	The position is only offsetting for specific peripheral devices.	[Position offset of peripheral device] It may be because external forces acting on peripheral	

		devices cause offsetting of relative positions.	
	Position offset occurs after the variable is changed.	[Variable] It may be because the robot's origin is lost due to rewriting of zero calibration data.	

Appendice

A. Regular Maintenance Sheet

Robot Maintenance Schedule

Category	Inspection items	Interval	Contents
Inspection	Clean the body	3 months	Wipe away dirt and clear away accumulated splashes, dust, chips, etc.
Inspection	Bolt	3 months	Tighten all exposed bolts on the robot.
Inspection	Gap	3 months	Apply certain forces to the end tool in front, back, left, right, up and down directions and confirm that it doesn't shake.
Inspection	Robot cables	1 year	Confirm if they are worn
Inspection	Warning sign	1 year	Confirm if it is broken or lost
Inspection	Hard limit and buffer block	1 year	Confirm if they are damaged or broken
Inspection	Timing belt and pulley on Axis 5/6	1 year	Wearing of belts and pulleys and reasonable tensioning of timing belts
Replacement	Encoder battery	1 year	Replace according to actual usage

B. List of Bolt Strengths and Tightening Torques

Please use the following strengths for bolts:

Bolts below M22 (inclusive): tensile strength higher than 1200N/mm²

Bolts above M24 (inclusive): tensile strength higher than 1000N/mm²

Hexagonal head bolts, stainless steel bolts, special shaped bolts (flat head bolts, countersunk bolts, etc.): tensile strength higher than 400N/mm²

If it is required to tighten screws after reassembly, please use hexagonal socket screws (GB/T 70.1-2008**[NOTE]**) - Grade 12.9. The torques of different screws are shown in the table below:

[NOTE]

GB/T 70.1-2008 Correspondence standard: ISO 4762:1997 Hexagon socket head cap screws

List of Recommended Screw Tightening Torques (Nm)

Specification	Base material of steel parts	Base material of aluminum parts
M3	2±0.18	1.57±0.18
M4	4.5±0.33	3.63±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

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