



# Delta Robot - RD403-GB Series

User Manual

Original Instruction





## Multi-Axis Robot

- Pick-and-place / Assembly / Array and packaging / Semiconductor / Electro-Optical industry / Automotive industry / Food industry
- Articulated Robot
  - Delta Robot
  - SCARA Robot
  - Wafer Robot
  - Electric Gripper
  - Integrated Electric Gripper
  - Rotary Joint



## Single-Axis Robot

- Precision / Semiconductor / Medical / FPD
- KK, SK
  - KS, KA
  - KU, KE, KC



## Direct Drive Rotary Table

- Aerospace / Medical / Automotive industry / Machine tools / Machinery industry
- RAB Series
  - RAS Series
  - RCV Series
  - RCH Series



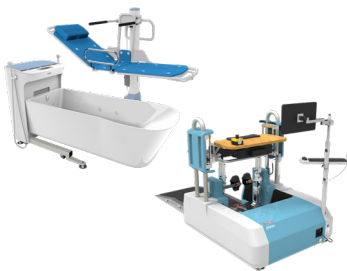
## Ballscrew

- Precision Ground / Rolled
- Super S series
  - Super T series
  - Mini Roller
  - Ecological & Economical lubrication Module E2
  - Rotating Nut (R1)
  - Energy-Saving & Thermal-Controlling (C1)
  - Heavy Load Series (RD)
  - Ball Spline



## Linear Guideway

- Automation / Semiconductor / Medical
- Ball Type--HG, EG, WE, MG, CG
  - Quiet Type--QH, QE, QW, QR
  - Other--RG, E2, PG, SE, RC



## Medical Equipment

- Hospital / Rehabilitation centers / Nursing homes
- Robotic Gait Training System
  - Hygiene System
  - Robotic Endoscope Holder



## Bearing

- Machine tools / Robot
- Crossed Roller Bearings
  - Ball Screw Bearings
  - Linear Bearing
  - Support Unit



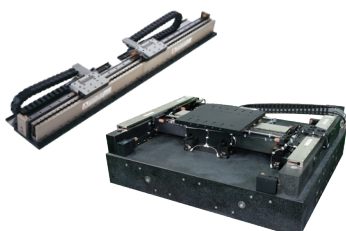
## AC Servo Motor & Drive

- Semiconductor / Packaging machine / SMT / Food industry / LCD
- Drives-D1, D1-N, D2T
  - Motors-50W-2000W



## Driven Tool Holders

- All kinds of turret
- VDI Systems
  - Radial Series, Axial Series, MT
  - BMT Systems
  - DS, NM, GW, FO, MT, OM, MS



## Linear Motor

- Automated transport / AOI application / Precision / Semiconductor
- Iron-core Linear Motor
  - Coreless Linear Motor
  - Linear Turbo Motor LMT
  - Planar Servo Motor
  - Air Bearing Platform
  - X-Y Stage
  - Gantry Systems



## Torque Motor (Direct Drive Motor)

- Inspection / Testing equipment / Machine tools / Robot
- Rotary Tables-TMS,TMY,TMN
  - TMRW Series
  - TMRI Series

## Warranty Terms and Conditions

The period of warranty shall commence at the received date of HIWIN product (hereafter called “product”) and shall cover a period of 12 months. The warranty does not cover any of the damage and failure resulting from:

- The damage caused by using with the production line or the peripheral equipment not constructed by HIWIN.
- Operating method, environment and storage specifications not specifically recommended in the product manual.
- The damage caused by changing installation place, changing working environment, or improper transfer after being installed by the professional installer.
- Product or peripheral equipment damaged due to collision or accident caused by improper operation or installation by the unauthorized staff.
- Installing non-genuine HIWIN products.

The following conditions are not covered by the warranty:

- Product serial number or date of manufacture (month and year) cannot be verified.
- Using non-genuine HIWIN products.
- Adding or removing any components into/out the product without authorized.
- Any modification of the wiring and the cable of the product.
- Any modification of the appearance of the product; removal of the components inside the product. e.g., remove the outer cover, product drilling or cutting.
- Damage caused by any natural disaster. i.e., fire, earthquake, tsunami, lightning, windstorms and floods, tornado, typhoon, hurricane etc.

HIWIN does not provide any warranty or compensation to all the damage caused by above-mentioned circumstances unless the user can prove that the product is defective.

For more information towards warranty terms and conditions, please contact the technical staff or the dealer who you purchased with.



## WARNING

- ❖ Improper modification or disassemble the robot might reduce the robot function, stability or lifespan.
- ❖ The end-effector or the cable for devices should be installed and designed by a professional staff to avoid damaging the robot and robot malfunction.
- ❖ Please contact the technical staff for special modification coming from production line set up.
- ❖ For the safety reason, any modification for HIWIN product is strictly prohibited.

## Safety Precautions




### 1. Safety Information

- Safety Responsibility and Effect
  - ⊙ This chapter explains how to use the robot safely. Be sure to read this chapter carefully before using the robot.
  - ⊙ The user of the HIWIN industrial robot has responsibility to design and install the safety device meeting the industrial safety regulations in order to ensure personal safety.
  - ⊙ In compliance with the safety information on industrial robot described in this manual can't guarantee that *HIWIN* robot will not occur any safety problems.
  - ⊙ This machine is defined as a partly completed machinery, the associated hazards must be handled by system integrator in accordance with ISO 102018-1/-2.
  - ⊙ A safety-related part of control system (SRP/CS) should conform to the requirement of performance level d and category 3 according to ISO 13849-1.
  - ⊙ The installation for emergency functions shall be defined by the system integrator in accordance with ISO 10218-1/2.
  
- Safety Operation Principle
  - ⊙ Before connecting the power supply for HIWIN industrial robot startup assembly procedure, check whether the specification of factory output voltage matches the specification of input voltage of the product. If it does not match, ensure to use the corresponding transformer (HIWIN optional transformer is recommended).
  - ⊙ Emergency Stop button (on Teach Pendant or from external emergency stop switch) must be pressed before turning off the power, and then switch off the power switch.
  - ⊙ While connecting to the external I/O or the signal, please operate in the condition that the power switch is turned off to prevent from a shortcut caused by mistaken touch in the process, and resulting in damage.

## 2. Description Related to Safety

### I. Safety Symbols

- ⦿ Carefully read the instructions in the user manual prior to robot use. The following shows the safety symbols used in this user manual.

Symbol	Description
 <b>DANGER</b>	Failure to follow instructions with this symbol may result in serious hazard or personal injury. Please be sure to comply with these instructions.
 <b>WARNING</b>	Failure to follow instructions with this symbol may result in personal injury or product damage. Please be sure to comply with these instructions.
 <b>CAUTION</b>	Failure to follow instructions with this symbol may result in poor product performance. Please be sure to comply with these instructions.

### II. Working Person

- ⦿ The personnel can be classified as follows

- Operator:

- Turns robot controller ON/OFF
- Starts robot program from operator's panel
- Reset system alarm

- Programmer or teaching operator:

- Turns robot controller ON/OFF
- Starts robot program from operator's panel
- Reset system alarm
- Teaches robot


- Maintenance engineer:


- Turns robot controller ON/OFF
- Starts robot program from operator's panel
- Reset system alarm
- Teaches robot
- Does maintenance, adjustment, replacement

- ⦿ Programmer and the maintenance engineer must be trained for proper robot operation.

### 3. Precautions

#### 3.1 Common Safety Issues


 <b>DANGER</b>	<ul style="list-style-type: none"> <li>❖ All operating procedures should be assessed by professional and in compliance with related industrial safety regulations.</li> <li>❖ When operating robot, operator needs to wear safety equipment, such as workwear for working environment, safety shoes and helmets.</li> <li>❖ When encountering danger or other emergency or abnormal situation, please press the emergency stop button immediately. After danger is eliminated, move the robot away with low speed in manual mode.</li> <li>❖ When considering safety of the robot, the robot and the system must be considered at the same time. Be sure to install safety fence or other safety equipment and the operator must stand outside the safety fence while operating the robot.</li> <li>❖ A safety zone should be established around the robot with an appropriate safety device to stop the unauthorized personnel from access.</li> <li>❖ While installing or removing mechanical components, be aware of a falling piece which may cause injury to operator.</li> <li>❖ Ensure the weight of workpiece does not exceed the rated load or allowable load moment at wrist. Exceeding these values could lead to the driver alarm or malfunction of the robot.</li> <li>❖ Do not climb on manipulator.</li> <li>❖ Do not store the machine in the environment with corrosion and flammable gas or close to the flammable object.</li> <li>❖ Do not operate the machine in the environment with moisture, water or grease.</li> <li>❖ Do not operate the machine at the place where vibration or the strong impact occurs.</li> </ul>
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	<ul style="list-style-type: none"> <li>❖ Do not immerse the electric wires into grease or water.</li> <li>❖ Do not connect or operate the machine with wet hands.</li> <li>❖ Do not operate the machine in potentially explosive environment.</li> <li>❖ Please ensure the controller is grounded.</li> <li>❖ Keep hands away from the inner part of the controller while it is connecting to the power or during operating.</li> <li>❖ Do not touch the heat sink, regenerative resistance, the power supply or the computer inside the controller while it is operating due to its high temperature.</li> <li>❖ Be sure power is disconnected prior to repair and maintenance, and ensure to operate under the condition of no electrical shock risk.</li> <li>❖ Do not disassembly the controller without permission. If there's any issues, please contact our engineers.</li> </ul>
<p> <b>WARNING</b></p>	<ul style="list-style-type: none"> <li>❖ The personnel installing robot should be trained and licensed.</li> <li>❖ To ensure personal safety, robot installation must comply with this manual and related industrial safety regulations.</li> <li>❖ The control cabinet should not be placed near high voltage or machines that generate electromagnetic fields to prevent interference that could cause the robot to deviation or malfunction.</li> <li>❖ Using non-HIWIN spare parts to repair may cause robot damage or malfunction.</li> <li>❖ Beware of the heat generated by the controller and servo motor.</li> <li>❖ Do not overbend the cable to avoid poor circuit contact or unexpected damage.</li> </ul>




	<ul style="list-style-type: none"><li>❖ Do not stand on the controller or put heavy objects on it.</li><li>❖ Do not block the vent or put foreign objects into the controller.</li><li>❖ Please ensure the controller is fixed on the base.</li><li>❖ Do not pull the connector violently or twist the electric wires excessively.</li><li>❖ Do not frequently switch ON/OFF the power switch and the control button.</li><li>❖ Please ensure that the robot, the emergency stop switch and the controller are functioning properly before performing any work.</li><li>❖ Do not shutdown the power switch during the operation.</li><li>❖ Do not open, modify, disassemble and maintain the machine without permission.</li><li>❖ The power must be disconnected when the machine does not operate in a long time.</li><li>❖ Do not turn off the power of the controller when modifying the program or parameter. Otherwise, the data stored in the controller will be damaged.</li><li>❖ After the brake of a servo motor is released, the robot will be moved due to gravity and it may injured the operator.</li><li>❖ The industrial robots can be applied for the different industrial environments.</li><li>❖ When the operating procedures are interrupted, the special attention should be paid during the troubleshooting.</li></ul>
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### 3.2 Operation

 <b>DANGER</b>	<ul style="list-style-type: none"><li>❖ Teaching, jogging or programming should be done outside of the safety fence. If it is inevitable to enter the safety fence, press the emergency stop button before entrance. Operation should be restricted at low speed and beware of surrounding safety.</li><li>❖ All operations shall be executed by trained staff.</li></ul>
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### 3.3 Maintenance

 <b>DANGER</b>	<ul style="list-style-type: none"><li>❖ Please contact us if the procedure not specified by HIWIN is needed.</li><li>❖ Please contact us if the replacement of the component not specified by HIWIN is needed.</li><li>❖ Be sure to carry out regular maintenance, otherwise it will affect the service life of the robot or other unexpected danger.</li><li>❖ Prior to repair and maintenance, please switch off power supply.</li><li>❖ Maintenance and repair should be performed by a qualified operator with a complete understanding of the entire system to avoid risk of robot damage and personal injury.</li><li>❖ When replacing the components, avoid foreign object going into the robot.</li></ul>
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### 3.4 End Effector


The end effector can be classified as two types:

- A. Gripper: Used to load and unload, such as pneumatic gripper, electric gripper and vacuum sucker.
- B. Tool: Used to process, such as welding, cutting and surface treatment.


 <p><b>DANGER</b></p>	<ul style="list-style-type: none"> <li>❖ More attention must be paid to the design of the end effector to prevent power loss or any other errors that could lead to workpiece falling or damage.</li> <li>❖ The tool-type end effector is usually equipped with high voltage, high temperature and active rotary shaft. Special attention should be paid to the operating safety.</li> <li>❖ The end effector should be mounted firmly on the robot to avoid workpiece fall during operation which may cause personal injury or hazard.</li> </ul>
 <p><b>WARNING</b></p>	<ul style="list-style-type: none"> <li>❖ The end effector may be equipped with its own control unit. During installation, pay attention to installed location. Ensure that the control unit does not interfere with robot operation.</li> <li>❖ The gripper-type end effector should prevent the workpiece from dropping or damaging when the robot experiences a power error or other errors. If potential dangers or abnormal situations exist when using end effector, the associated hazards must be handled by the system integrator in accordance with the related standards.</li> </ul>


### 3.5 Pneumatic, Hydraulic System

 <p><b>DANGER</b></p>	<ul style="list-style-type: none"> <li>❖ When using the pneumatic or hydraulic system, the gripped workpiece may fall due to insufficient pressure or gravity.</li> <li>❖ The pneumatic or hydraulic system must be equipped with the relief valve, so that it can be applied in an emergency.</li> </ul>
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 <p><b>WARNING</b></p>	<ul style="list-style-type: none"> <li>❖ More attention should be paid to the pressure remained in the pneumatic systems after the power is disconnected.</li> <li>❖ The internal pressure must be released before the pneumatic systems are maintained.</li> <li>❖ More attention should be paid to the pressure in the pneumatic system as it is several times more than the atmosphere pressure.</li> </ul>
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### 3.6 Emergency Stop Switch

 <p><b>DANGER</b></p>	<ul style="list-style-type: none"> <li>❖ The robot or other control component should have at least one device for immediate halt, such as an emergency stop switch.</li> <li>❖ The emergency stop button must be installed in an easily accessible location for quick stop.</li> <li>❖ While executing an emergency stop, power to the servo motor will be cut, and all movements will be stopped. And the control system will be shut down. Emergency stop should be reset if the restoration of operating procedure is wanted.</li> <li>❖ Avoid using emergency stop to replace a normal stop procedure. This could reduce the lifespan of the robot.</li> </ul>
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 <p><b>WARNING</b></p>	<ul style="list-style-type: none"> <li>❖ The drive power and the control system will be disconnected to stop all actions during the emergency stop.</li> <li>❖ If you want to restart the procedures, you should reset the emergency stop switch.</li> <li>❖ Emergency stop established an immediate stop: Immediately stop the robot system, and disconnect the driver power.</li> <li>❖ The emergency stop switch is used for emergency stop only.</li> <li>❖ The <i>HIWIN</i> robot is equipped with two emergency stop switches, where one is installed on the teach pendant and the other is directly connected to the</li> </ul>
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	<p>controller via a cable. If additional emergency stop switches are required, other connecting method can be applied for the same purpose.</p> <ul style="list-style-type: none"><li>❖ Based on the relevant industrial safety regulations, the emergency stop switch is directly connected to the controller of the robot via the physical wires.</li><li>❖ If the version of the braking is not applied to the whole axis, once the emergency stop is executed and the heavy objects are loaded on the robot end, the axis without brake will move due to gravity. This attention must be paid for safety issue.</li></ul>
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#### 4. Intended use

HIWIN robots are industrial robots and intended for pick-and-place, handling, assembling, deburring, grinding and polishing. Use is only permitted under the specified environment, for more detailed information please see section 2.5 environmental conditions.

Use is not permitted under the following conditions:

- Use in potentially explosive environments
- Use without performing risk assessments
- Transportation of people and animals
- Operation outside the allowed operating parameters

#### 5. Disposal

The disposal of HIWIN robot shall be in accordance with the local environmental regulations.

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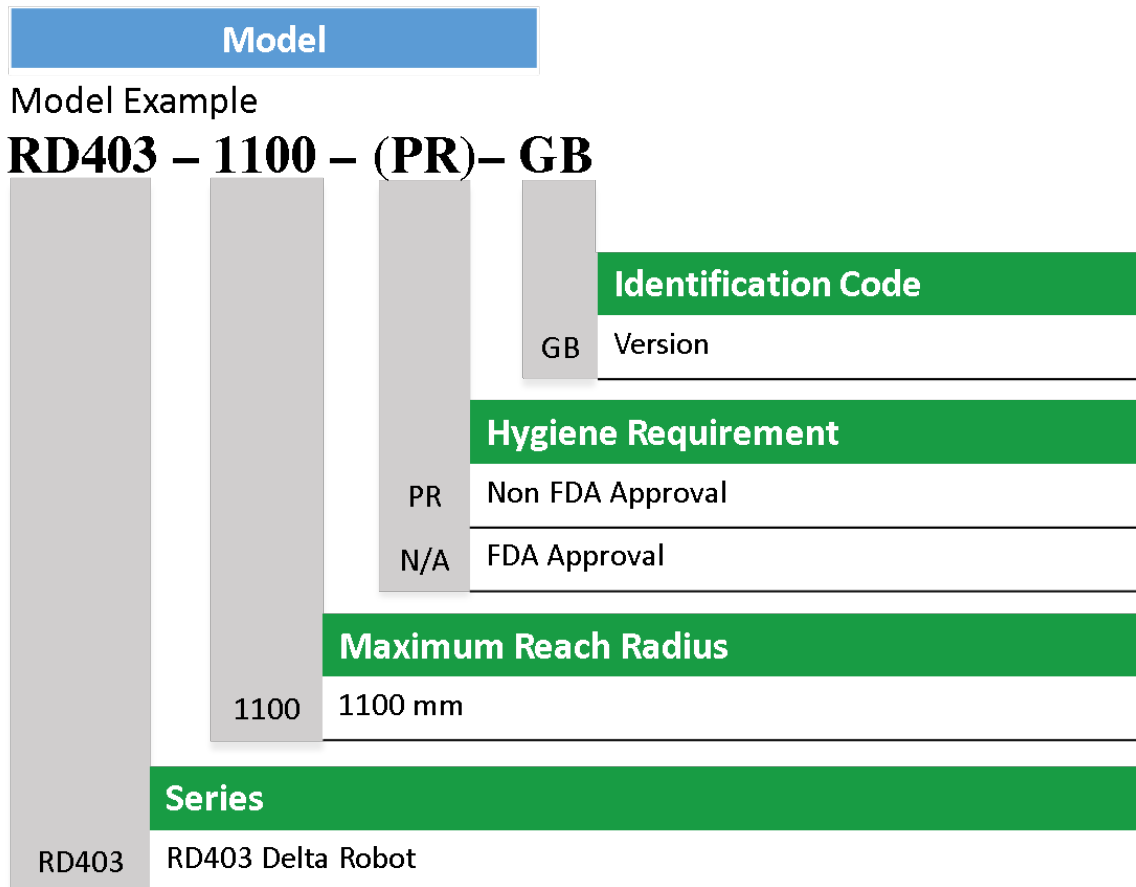
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Version	Date	Product	Remark
1.0.0	2018.01.19	RD403 Series	First edition
2.0.0	2018.02.23	RD403 Series	Add RD403-1100-PR-GBd description
3.0.0	2018.05.03	RD403 Series	Add motion speed warning ( 1.2 ) Modified frame reference image(2.1) Modified 4th Axis Cable Connection image (3.2.4)
3.0.1	2018.06.11	RD403 Series	Modified Chp1.1 Serial Number and Model Name
3.0.2	2018.11.28	RD403 Series	Add Chapter 4 Safety Certification

# 1. Introduction

## 1.1 Serial Number and Model Name

Explanation of model name is shown in the figure below.





## 1.2 Product Specifications

The product specifications are shown in Table 1-1.

Table 1-1 Product specifications

Model Name.		Unit	RD403-1100-GB	RD403-1100-PR-GB
Degrees of Freedom			4	
Maximum Load Capacity		kg	3	
Motion Range	Horizontal	mm	Ø1100	
	Vertical		300	
Cycle Time*		sec.	0.3	
Repeatability		mm	±0.1	
Power Supply		V	3φ , 200 - 240	
Power Frequency		Hz	50/60 (+/-1%)	
Total Current		A	Max 4.5	
Weight		kg	95(not including controller)	
Protection Rating			IP 65	

\*The cycle time is based on back-and-forth movement over a vertical distance of 25mm and horizontal distance of 300mm with 0.1 kg load.

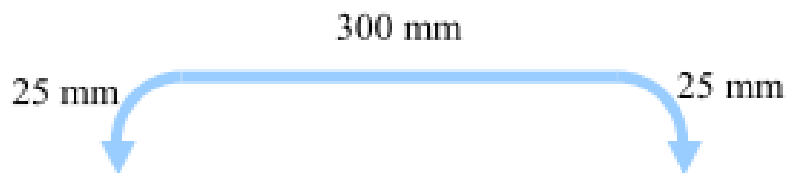


Figure 1-2 Cycle Time trajectory.

### 1.3 Appearance Dimension/Motion Range

The appearance dimensions and motion range of RD403-1100-GB are shown in Figure 1-3.

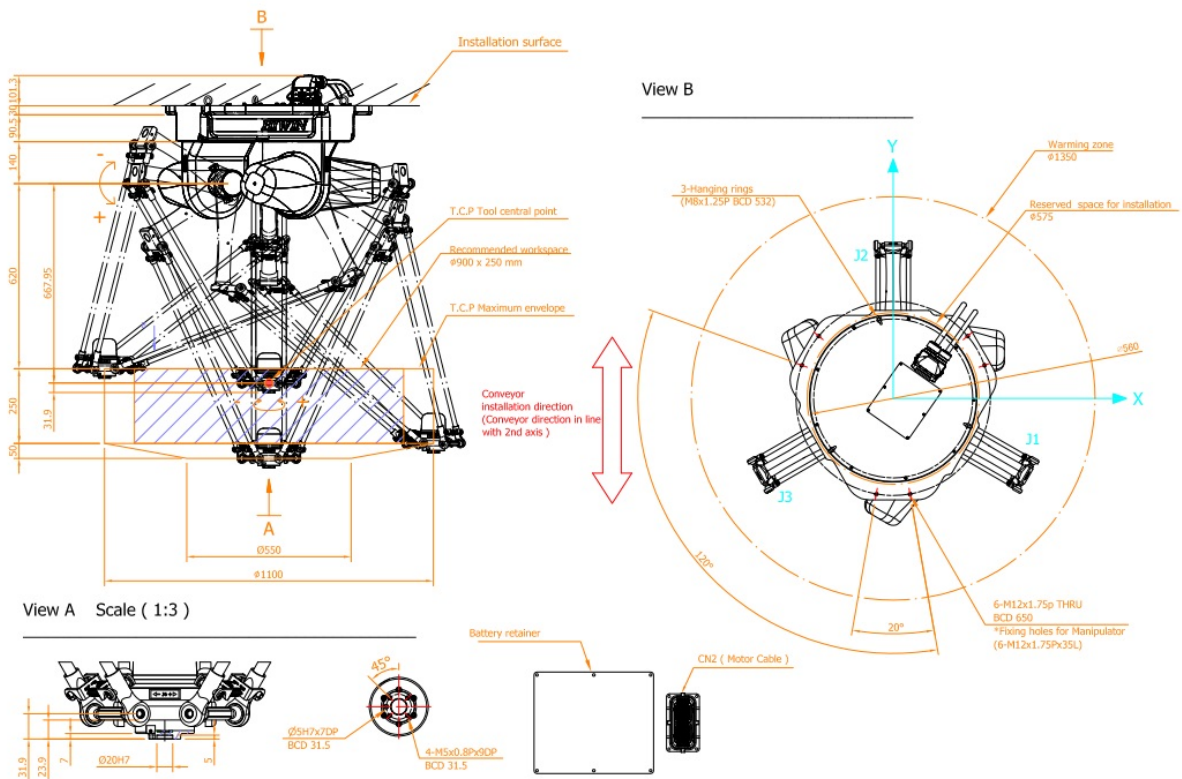


Figure 1-3 Appearance dimensions and motion range of RD403-1100-GB

Appearance dimensions and motion range of RD403-1100-PR-GB are shown in Figure 1-4.

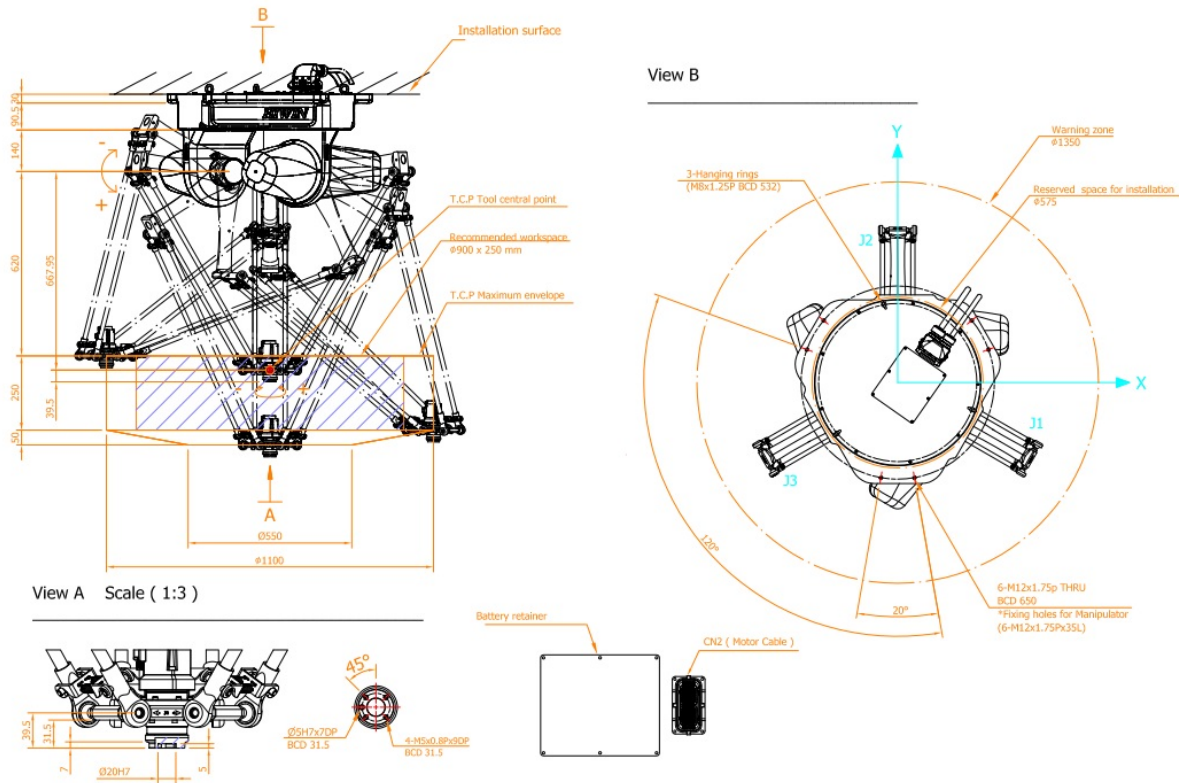



Figure 1-4 Appearance dimensions and motion range of RD403-1100-PR-GB

 <p><b>WARNING</b></p>	<p>❖ Please note that improper setting can cause over-current and decomposition when setting motion parameter command (programmed by keyboard). Please adjust the motion parameter in accordance with the payload to ensure personal safety and to prevent device damaged. Motion parameter contains SET_ACC, SET_SPEED etc.</p>
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### 1.4 Allowable Load of 4<sup>th</sup> Axis

Inertia from the size and weight of end effector and workpiece will affect robot performance. Please refer to the following table when designing end effector or evaluating clamped object.

Table 1-2 RD403-1100-GB Allowable 4th Axis load

	Allowable Moment(N-m)	Allowable Moment of Inertia(kg-m <sup>2</sup> )
4 <sup>th</sup> Axis	2.86	3kg : 5.63x10 <sup>-4</sup> 2kg : 6.41x10 <sup>-4</sup> 1kg : 7.27x10 <sup>-4</sup>

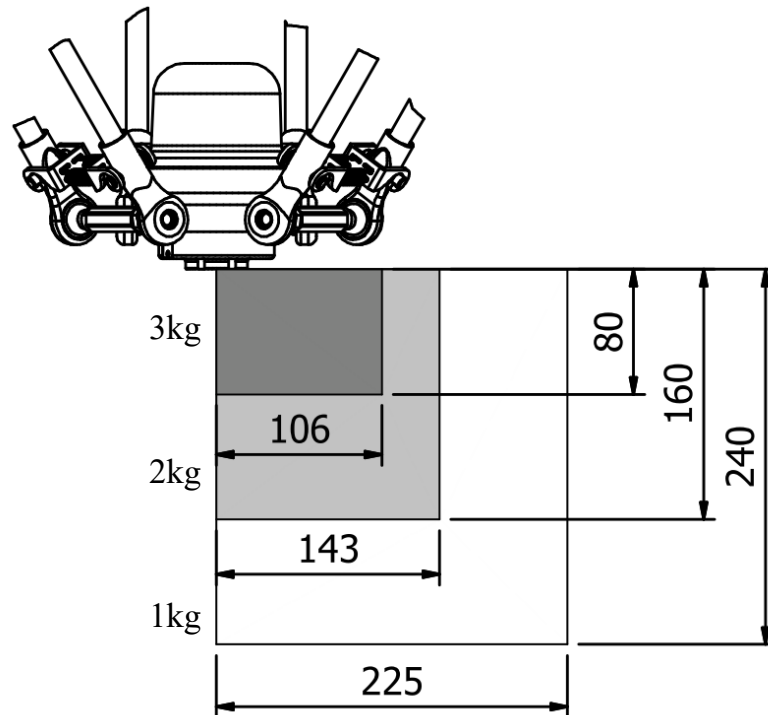


Figure 1-5 Offset Distance and Allowable 4<sup>th</sup> Axis Load

Table 1-3 RD403-1100-PR-GB Allowable 4th Axis load

	Allowable Moment(N-m)	Allowable Moment of Inertia(kg-m <sup>2</sup> )
4 <sup>th</sup> Axis	1.42	3kg : $8.47 \times 10^{-4}$ 2kg : $9.67 \times 10^{-4}$ 1kg : $1.10 \times 10^{-3}$

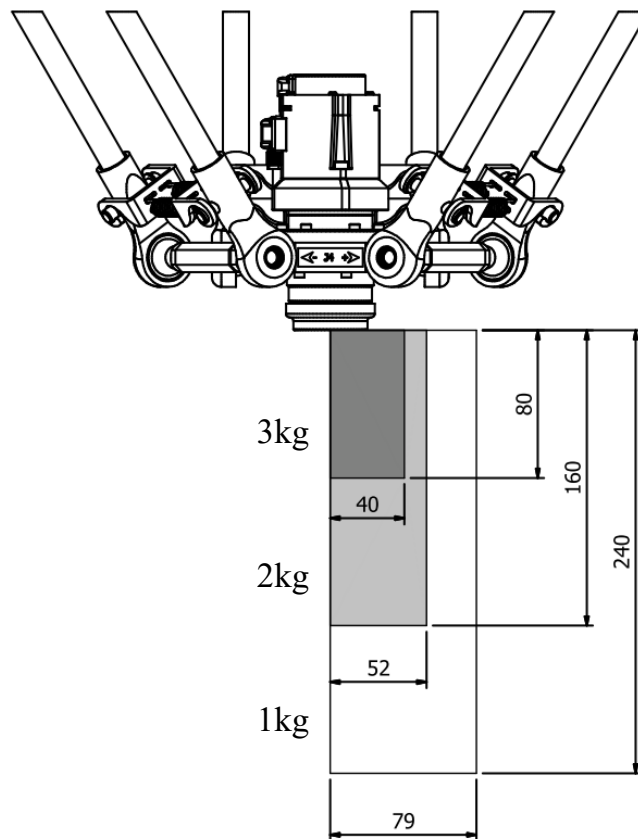


Figure 1-6 Offset Distance and Allowable 4<sup>th</sup> Axis Load

## 1.5 Robot and Accessories

The robot and its accessories are shown in Table 1-4, Table 1-5, Table 1-6, Table 1-7 and Table 1-8.

Table 1-4 Robot and Accessory kit

No.	Item	Model Name	Quantity	Remark
1	Manipulator	RD403-1100-GB RD403-1100-PR-GB	1	
2	Mounting accessory kit		1	Please refer to 1-5
3	Power cable	CN2	1	

Table 1- 5 Mounting accessory kit

No.	Item	Model Name	Quantity	Remark
1	Calibration Set	RD403-CALI-SET I	1	
2	Calibration Set	RD403-CALI-SET II	1	
3	Cable ties		12	
4	Push-mount cable ties		4	
5	Captive screws		1	

Table 1- 6 Optional List

No.	Item	Model Name	Part Number	Quantity	Remark
1	Encoder battery pack		4C7014L3	1	
2	Limit accessory kit		4C201HM1	1	Please refer to 1-7
3	Consumable accessory kit		4C201HK1	1	Please refer to 1-8
4	Conveyor Tacking Encoder		462B00C7	1	
5	RD403-1100 frame		4C201B32	1	

Table 1- 7 Limit accessory kit

No.	Item	Model Name	Quantity	Remark
1	Hex head screw	M5x0.8Px20L SUS304	6	
2	Pin	D=5, L=10, R=0.8	12	
3	Mechanical stopper		6	

Table 1- 8 Consumables accessory kit

No.	Item	Model Name	Quantity	Remark
1	Plastic Washer		12	
2	Bushing		24	
3	Spring		12	
4	Button dust cover		3	

## 1.6 Nameplates and Labels

The position and description of nameplates and labels are shown in Figure 1-7 and Table 1-9.

They must not be removed or rendered illegally.

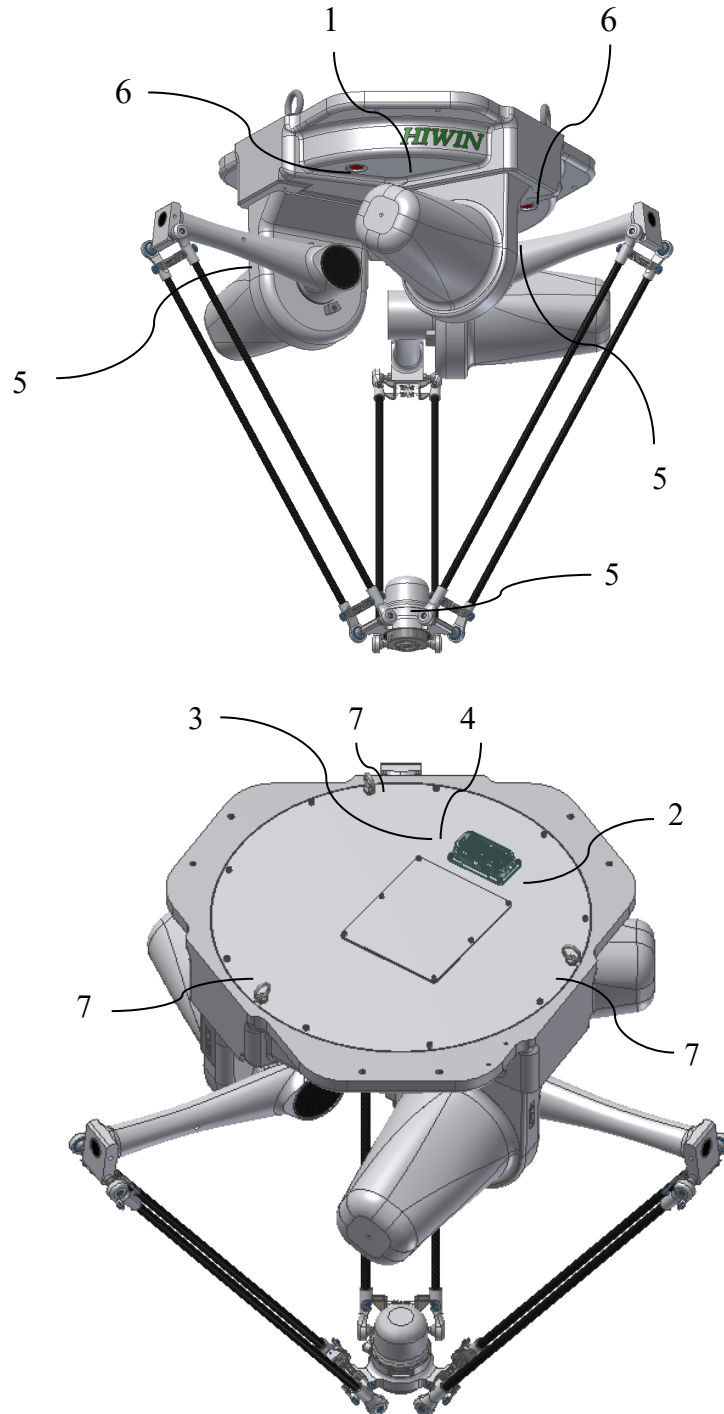


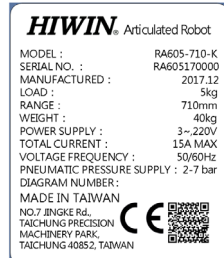

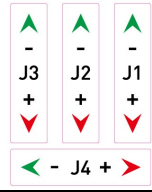




Figure 1-7 Nameplates and labels position



Table 1-9 Nameplates and labels description

No.	Nameplates and labels	Name	Description
1		<u>Collision</u>	Operator should keep a safe distance from robot system to prevent collision during operation.
2		<u>Electrical shock</u>	Please be aware of electric shock while installing or removing mechanical parts.
3		<u>Specification</u>	Robot specification and serial number.
4		<u>Read manual</u>	Read manual before operating the robot
5		<u>Direction of motion</u>	Direction of motion for individual axes.
6		<u>Axis Break Release Button</u>	Break release buttons locate at each axis for calibration or emergency.
7		<u>Hoisting point</u>	Robot hoisting point

## 2. Transportation and Installation

### 2.1 Frame

The robot does not include optional frame.

The manipulator has three mounting points. The rated load capacity of each mounting point on the Z-axis of the RD403 Series is 343N.

When the manipulator is installed, it must be moved to the bottom of the frame.

When designing the frame, please leave space for the manipulator to move.

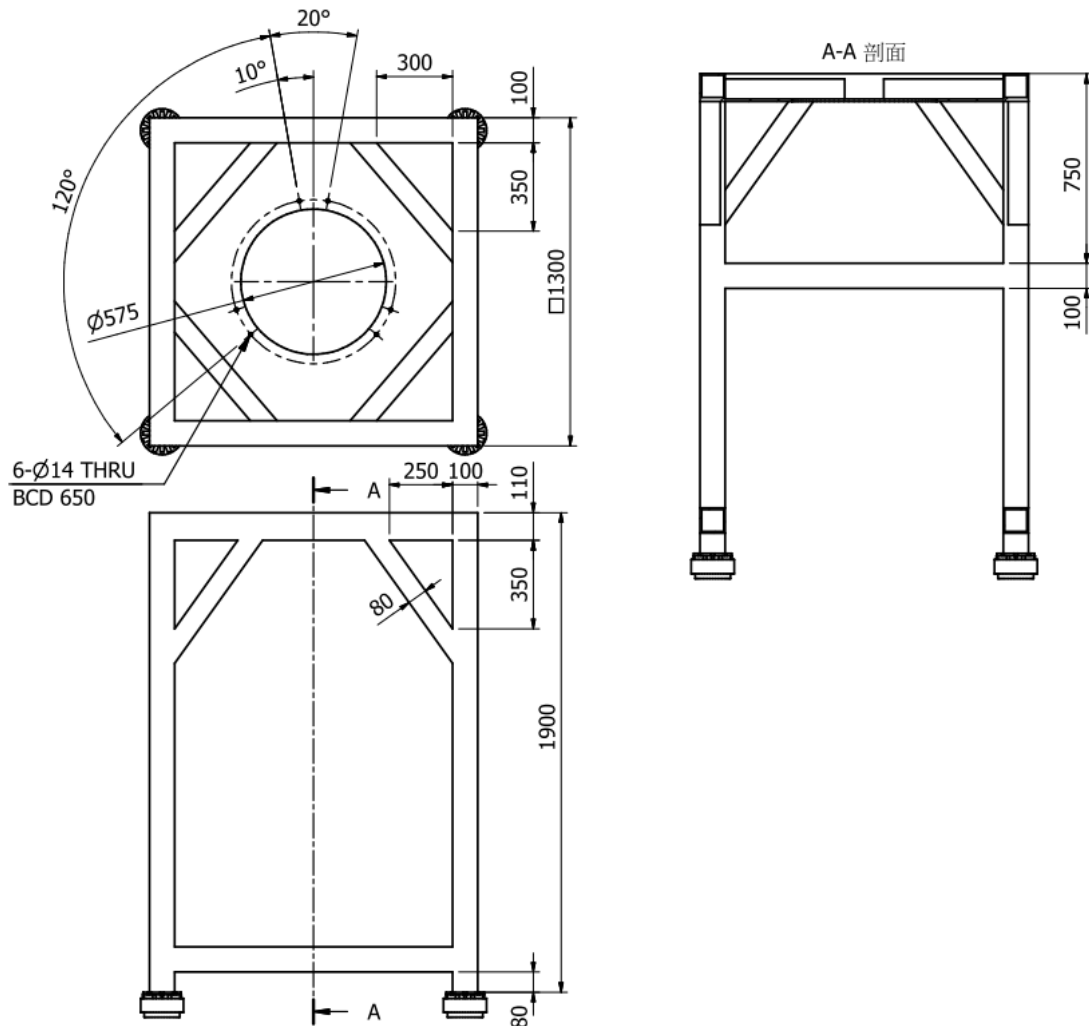



Figure 2- 1 Dimensional Drawing of Recommended RD403 Series Frame

## 2.2 Installation

### 2.2.1 Robot Installation Process

Item No.	Process	Remark
1	Confirm robustness and load capacity of frame.	Please refer to page 23
2	Prepare the necessary parts and tools for installation. E.g. sling, mounting bolts.	
3	Leave some space around installation area for peripheral equipments.	
4	Confirm if the arm posture will interfere with the frame	Please refer to page 25
5	Use lifting equipment to assemble the robot arm to the frame.	Please refer to page 27
6	Lock the mounting bolts to six fixing places on the base.	M12×1.75P×35L*6pcs Tightening Torque 62N-m
7	Place Controller.	
8	Connect Robot to Controller .	
9	Connect Teach Pendant to Controller.	

 <b>WARNING</b>	<ul style="list-style-type: none"> <li>❖ Please check and install the robot in accordance with the installation process.</li> <li>❖ When installing robot, please avoid using only manpower.</li> <li>❖ Before transportation, please confirm that the capacity of the crane should be greater than 150 kg.</li> </ul>
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## 2.2.2 Hang Posture for Robot

The swing angle of the upper arm and the overall motion range must be considered when establishing the installation space.

Please refer to chapter 1.2 for dimensions and motion range.

Figure 2-2 schematic diagram shows the upper mechanical limiting of the arm.

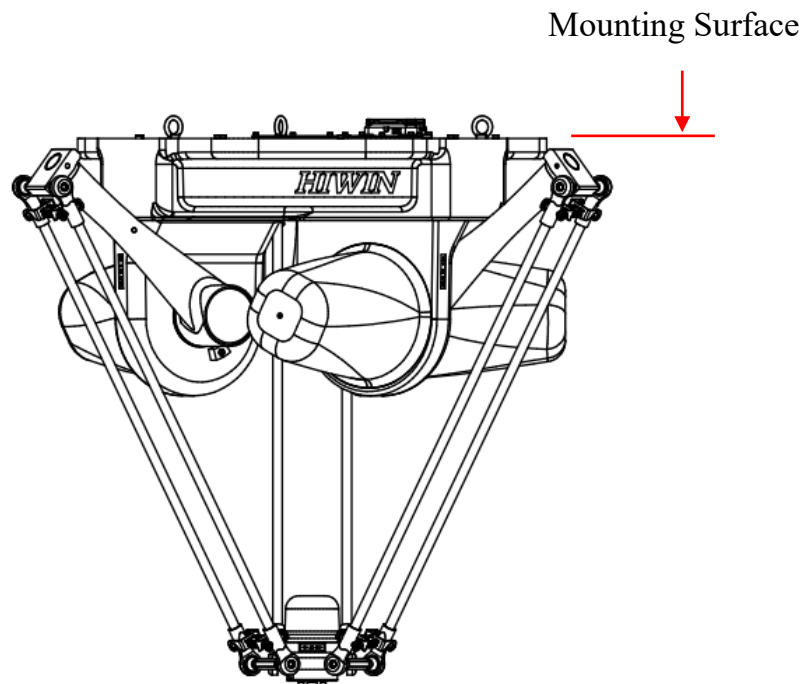


Figure 2- 2 Upper limits of the arm

End effector must always be in the center of the motion range when shipping. Figure 2-3 shows the robot transport posture with an upper arm swing angle of -7.8 degrees.

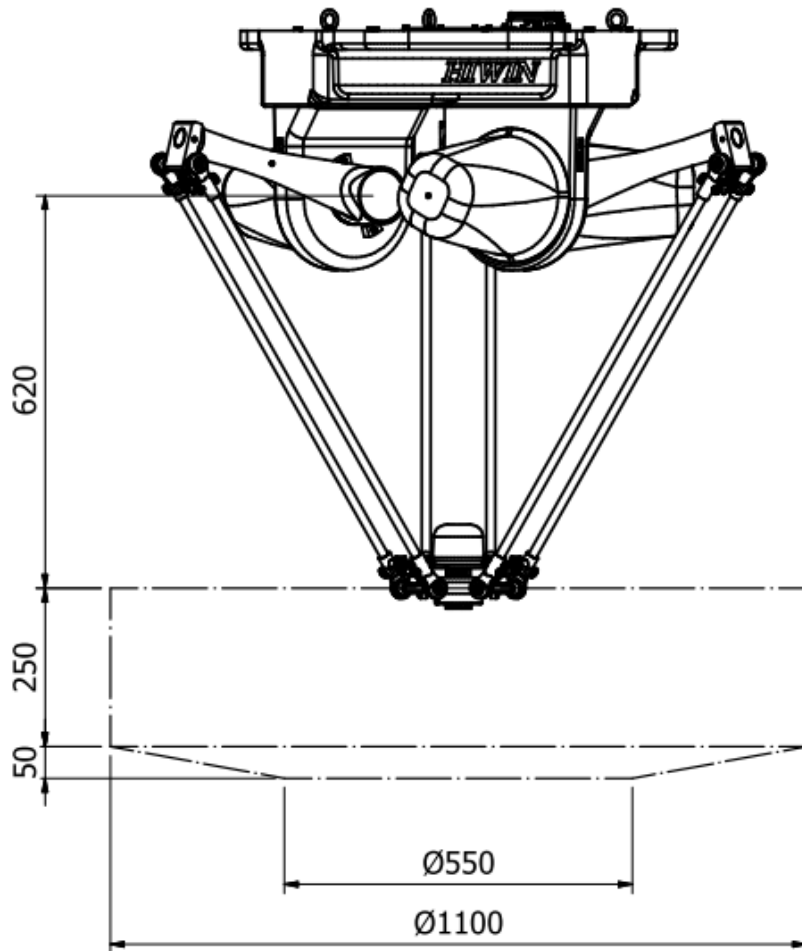


Figure 2- 3 Robot transport posture

To take the robot out from the box, please use a sling which is attached to the rings on the base to lift the robot.

Move the arm under the frame, and attach the sling to the rings, as shown in Figure 2-4.

Lift the robot, as shown in Figure 2-5. After moving the arm to the frame, use the attached M12x1.75Px35L bolts to lock it to the frame.

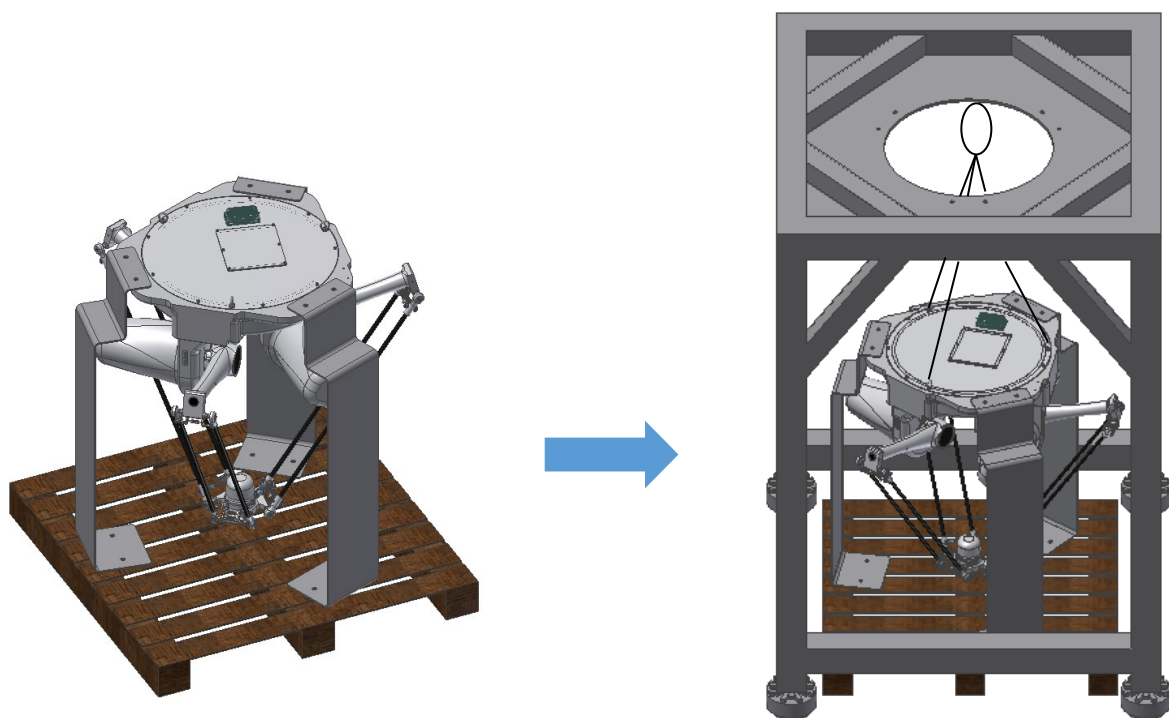


Figure 2-4 Hanging Schematic Diagram of Delta Robot

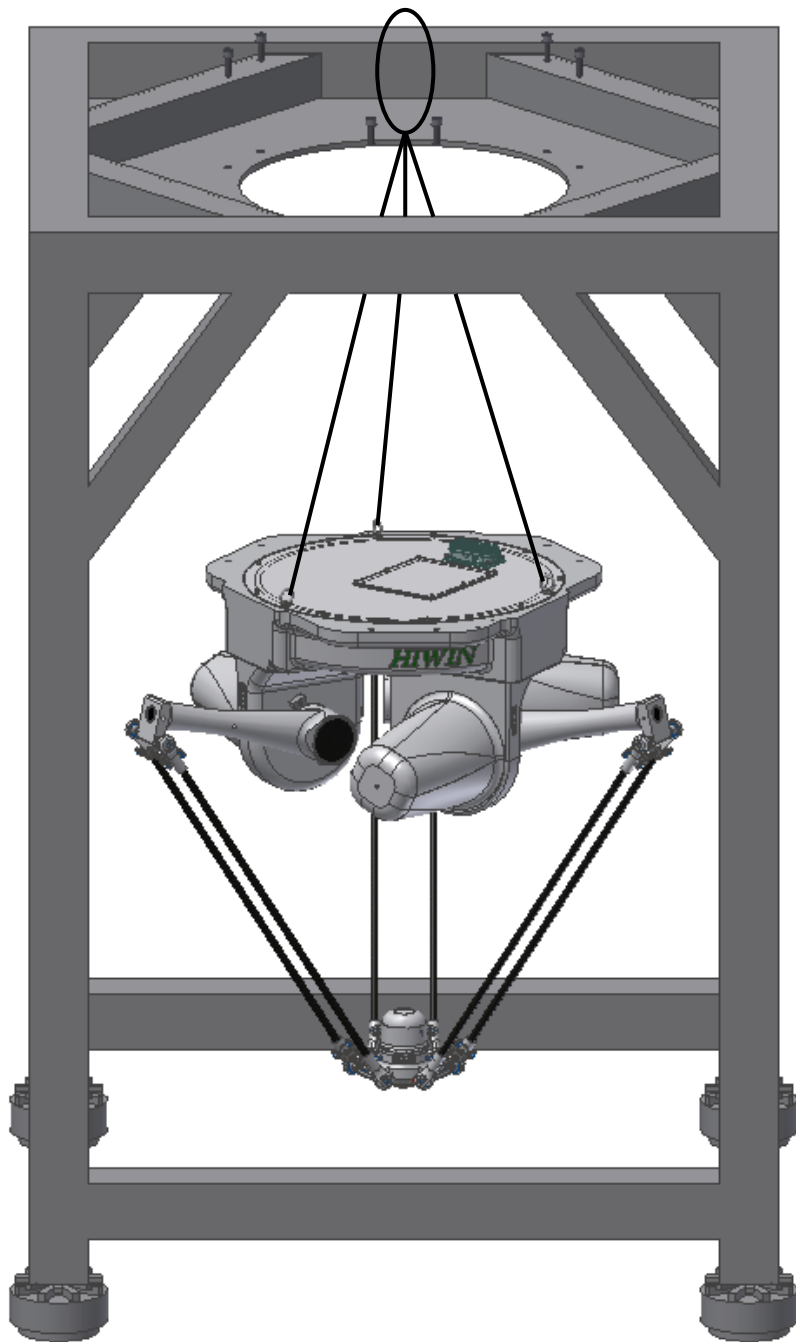



Figure 2-5 Hanging Schematic Diagram of Delta Robot

<p> <b>DANGER</b></p>	<p>❖ Please always maintain stable conditions and avoid excessive vibration or shock during transportation.</p>
--	---

Recommended installation direction for arm relative to conveyor is shown in the figure below.

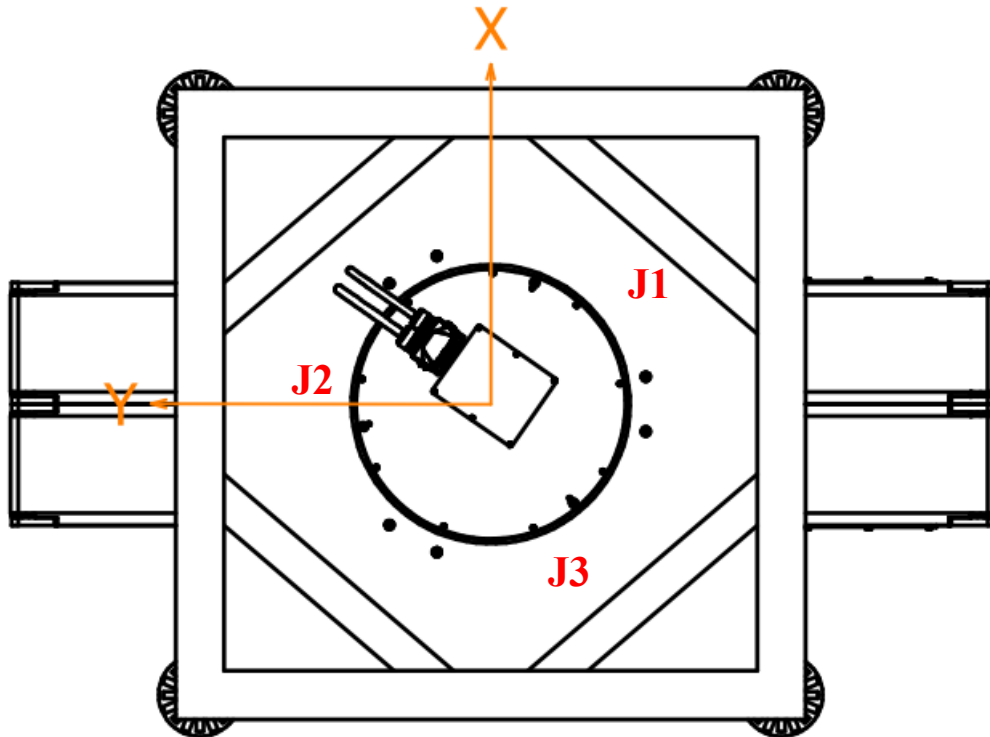



Figure 2-6 Recommended Installation Direction for Arm Relative to Conveyor of Delta Robot



## 2.3 Transportation

If transportation is required, please read the following notice carefully.

- Please check safety mounting points prior to transport.
- Please confirm that the capacity of the crane should be greater than 150 kg.
- During the transportation, do not remove the cover or reverse the robot.
- Personnel transporting the robot must have appropriate training and license
- When transporting by air, the robot must be under stable pressure.
- When transporting by sea, be aware of the sealability to protect electronic components from moisture.
- When transportation is required, please confirm that the robot is at the original transport posture, refer to chapter 2.2.

 <b>DANGER</b>	❖ Please transport in the correct transport posture to avoid damage to robot.
---	---

## 2.4 Environmental Conditions

Environmental Conditions is shown in Table 2-1.

Table 2-1 Environmental Conditions

<b>Installation/Storage/Transportation Environment</b>	
Ambient temperature	5~50 °C
Ambient humidity	20-75% R.H. (No dew, nor frost allowed)
Allowable altitude	Under 1000 m sea level
Other	<input type="checkbox"/> Do not use under corrosive environment <input type="checkbox"/> Do not use under flammable environment <input type="checkbox"/> Do not use under explosive environment <input type="checkbox"/> Do not use under radiative environment

### 3. Maintenance and Inspection

This chapter will introduce methods and the steps to maintain the robot, including cover removal, installation, maintenance, battery replacement and calibration under normal conditions.

### 3.1 Maintenance and Inspection Interval

Maintenance and inspection can be classified as daily inspection and periodic inspection. Items in the daily inspection include power on/off and operation. Inspection items before power on/off and programming are respectively shown in Table 3-1. Items in the periodic inspection include those for routine check A, B, C, D and E. The inspection contents are shown in Table 3-2. The timetable can be scheduled according to the periodic inspection, as shown in Figure 3-1. Successfully completing the inspection items ensures product safety during expected product life and helps avoid risk of product malfunction.

Table 3- 1 Daily Inspection Items

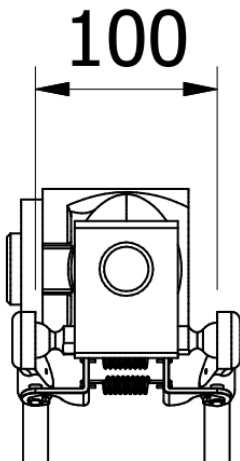
	Inspection items	Remedies
Inspection Before Turing the Power ON		
1	Are any of the robot frame screws loose?	Check the screw tightening torque value (62 N-m).
2	Is the power cable securely connected?	Securely connect.
3	Check the wear degree of plastic washer.	Replace it if damaged. If needed, replace damaged parts as described in chapter 3.2.2
4	Check the wear degree of bushing.	Replace it if damaged. If needed, replace damaged parts as described in chapter 3.2.2

5	Check the spring and hook integrity.	Replace it if damaged.  If needed, replace damaged parts as described in chapter 3.2.3
6	Check the wear degree of J4-axis cable.	Check for damages.  If a damage is discovered, please contact HIWIN directly.
7	Check the connecting cable between manipulator, controller and teach pendant.	Check for damages and wear.  If it is damaged, please contact HIWIN directly.

	Inspection items	Remedies
Inspection After Turning the Power ON		
1	Is there any unusual motion or noise when power is turned ON?	<ol style="list-style-type: none"> <li>1. It is likely that the robot installation screws are not securely fastened to the installation surface. Securely fasten the screws to the appropriate torque (62 N-m).</li> <li>2. It is likely that a foreign material is between the robot and the installation surface. Please remove it.</li> <li>3. If the above possibilities have been eliminated, it is likely that the rolling surface of the bearing or the gear tooth surface of reducer has been damaged. For this situation, please contact HIWIN directly.</li> </ol>

Table 3- 2 Periodic inspection items

	Inspection items	Remedies
Monthly Inspection Items (A)		
1	Are any of the screws on the manipulator loose?	Securely tighten the screws.
2	Are any of the connector screws loose?	Securely tighten the screws.
3	Check the wear degree of bushing.	If there is wear, please replace.
4	Check damages on spring and hook.	If there is wear, please replace.
5	Check the end effector.	Please refer to end effector manual.

	Inspection items	Remedies
<b>Quarterly Inspection Items (B)</b>		
1	<p>Replacement of plastic washer depends on the distance between two ball joints, shown as the figure below.</p> 	<p>Replace it if damaged.</p> <p>If needed, replace damaged parts as described in chapter 3.2.2</p> <p>When the distance between two ball joints is less than 100mm, it is recommended to replace the plastic washer.</p>
2	Check the outer surface of upper arm for cracks.	If there is damage, please contact HIWIN directly.
3	Check the surface of ball joint for cracks.	If there is damage, please contact HIWIN directly.
<b>Semi-annual Inspection Items (C)</b>		
1	Check if the outer surface of movable plate has a crack.	If there is damage, please contact HIWIN directly.
2	Check the sealability of waterproof connector.	If there is any damage, please contact HIWIN directly.
3	Check the wear degree of 4th cable.	If there is any damage, please contact HIWIN directly.

	Inspection items	Remedies
Annual Inspection Items (D)		
1	Replace the encoder battery in the manipulator.	Please refer to chapter 3.2.5 for backup battery replacement.

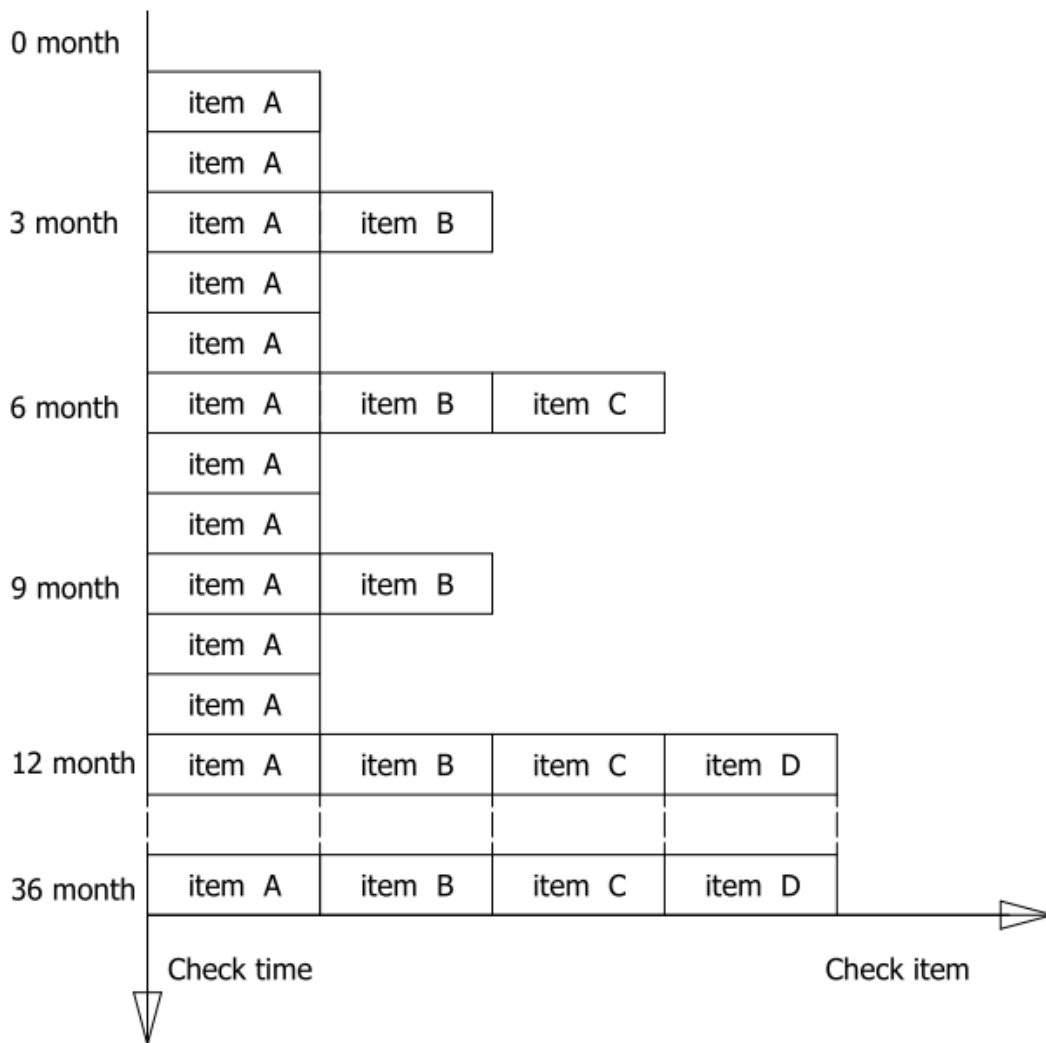



Figure 3- 1 Inspection schedule

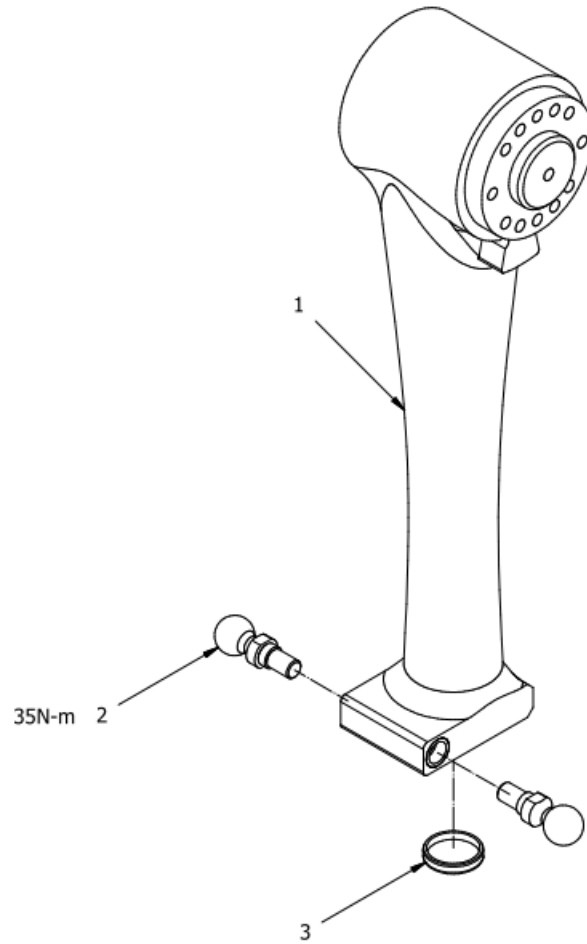


## 3.2 Maintenance

Maintenance, cleaning and battery replacement will be introduced in this section. Please carefully read the contents, and operate according to the description. If needed, please contact HIWIN.

 <b>CAUTION</b>	<ul style="list-style-type: none"><li>❖ Do not remove any part not described in this manual without permission.</li><li>❖ When performing maintenance and repair, the home position will be shifted, making it necessary to recalibrate the robot.</li><li>❖ Maintenance must be conducted by trained personnel</li></ul>
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### 3.2.1 Robot Upper Arm



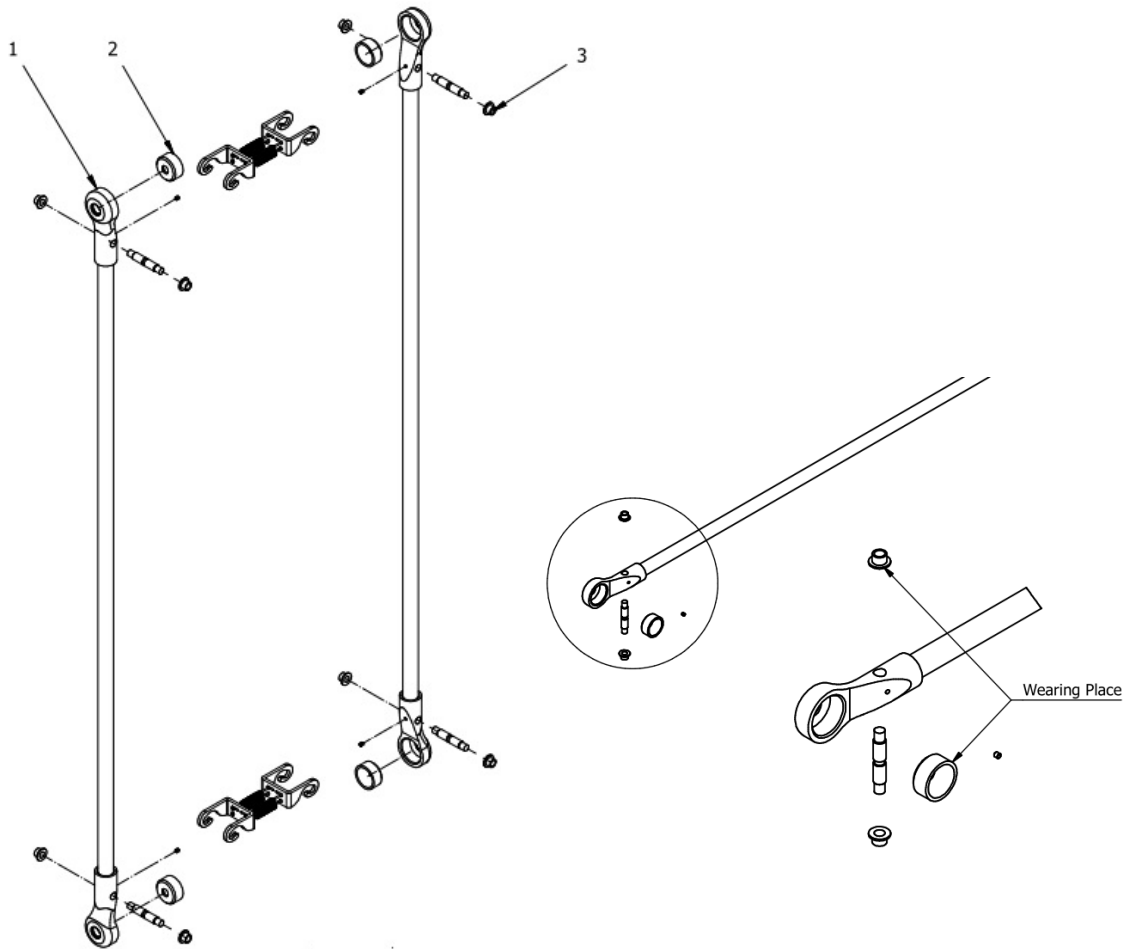
No.	Item	Quantity
1	Upper Arm	1
2	Ball Joint	2
3	Seal Cover	1



**Danger**

- ❖ Prior to maintenance, power, pneumatic and hydraulic systems should be stopped and all safety precautions should be taken.

### 3.2.2 Robot Lower Arm



No.	Item	Quantity
1	Lower Arm	6
2	Plastic Washer	12
3	Bushing	24



**Danger**

- ❖ Prior to maintenance, power, pneumatic, and hydraulic systems should be stopped and all safety precautions should be taken.
- ❖ Disassembly of lower arm should follow the figure as shown to avoid damaging parts.

Plastic Washer replacement method :

1. Insert a flathead screwdriver that has a tip less than 7mm into the hollow space of the plastic washer. Press the flathead screwdriver down toward the carbon fiber tube (the plastic washer should pop out from the slot) and remove the plastic washer, as shown in Figure 3-2.
2. Insert a new plastic washer into the slot. Use a rubber mallet to knock in the plastic washer. Make sure the flat surface of the plastic washer is on the same level as the flat surface of the lower arm, as shown in Figure 3-3.

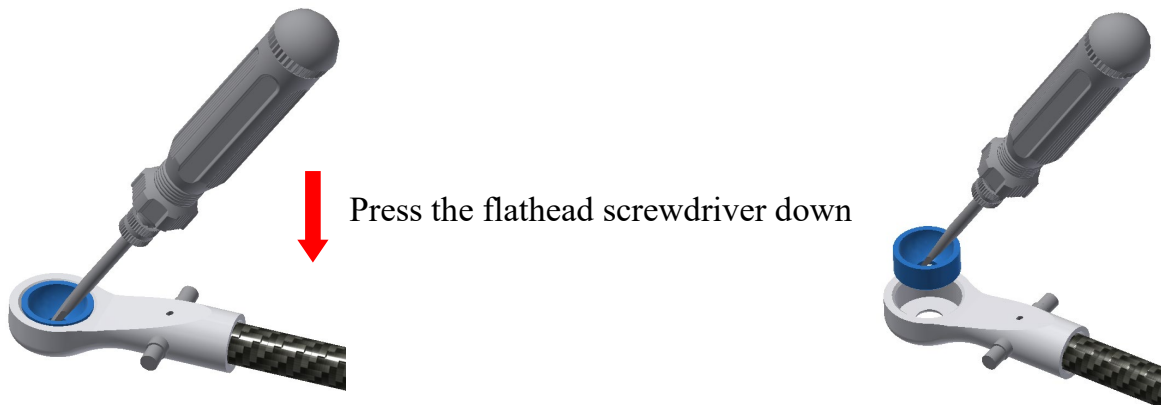


Figure 3- 2 Plastic washer replacement

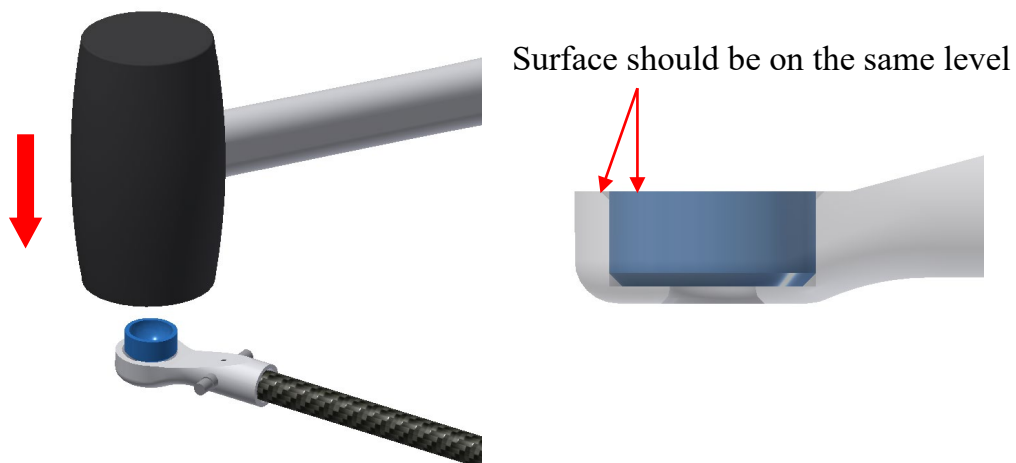



Figure 3- 3 Plastic washer installation

 <b>WARNING</b>	<ul style="list-style-type: none"><li>❖ When replacing the plastic washer, use a protective cushion between the flathead screwdriver and the lower arm surface to avoid paint damage on the lower arm.</li><li>❖ When replacing the plastic washer, use rubber mallet to avoid damage to the lower arm.</li></ul>
--	---

Bushing replacement method :

1. Push the hook to untighten the bushings. Remove the hook and the bushings, as shown in Figure 3-4.
2. Assemble bushings on both ends. Fasten the hook until the “click” sound appears. Make sure the hook and the bushings are completely tightened, as shown in Figure 3-5.

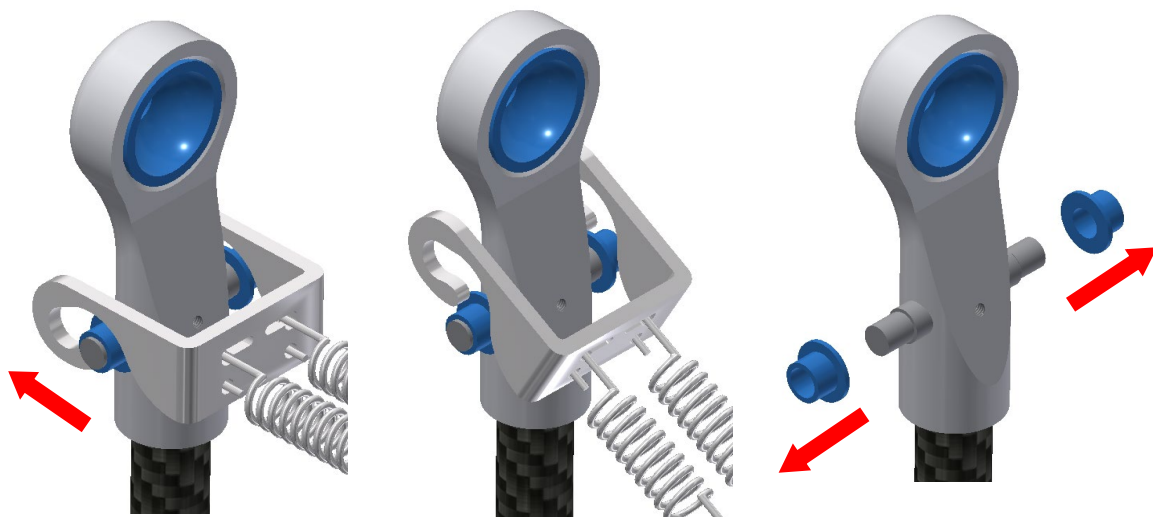


Figure 3- 4 Bushing replacement

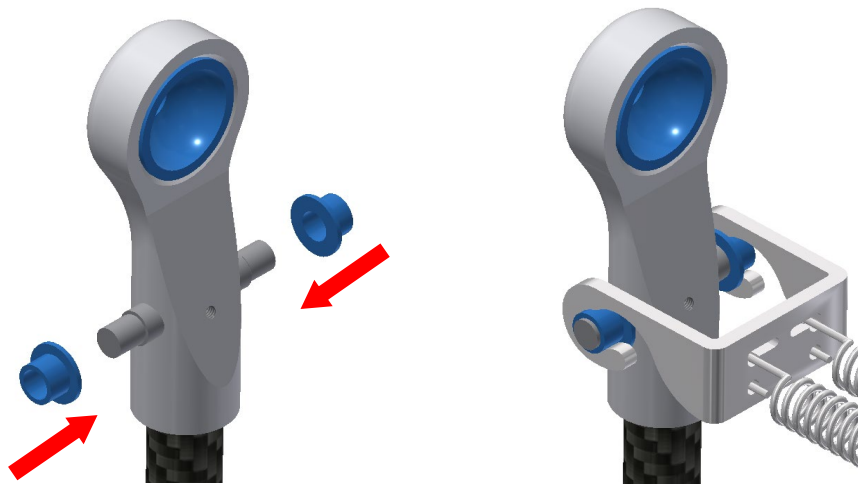


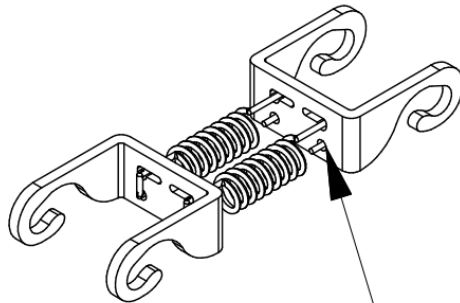
Figure 3- 5 Bushings installation



**WARNING**

- ❖ Make sure the hook and bushings are completely tightened to avoid disintegration and damage during operation.

### 3.2.3 Hook and Spring Unit



Check the spring is indeed engaged with the hook.

No.	Item	Quantity
1	Hook	12
2	Spring	12



**Danger**

- ❖ Prior to maintenance, power, pneumatic and hydraulic systems should be stopped and all safety precautions should be taken.



Hook and spring replacement method :

1. Push the two lower arms toward the middle and push the hook firmly to remove it, as shown in Figure 3-6.
2. Attach the new spring with the hook first. Insert the spring into the long hole of the hook, and turn the spring into the groove clockwise to complete the installation of the spring and hook, as shown in Figure 3-7.
3. Fasten the new hook and spring to the bushing, and make sure there is a "click" sound to confirm that the hook and bushing are actually engaged, as shown in Figure 3-8.

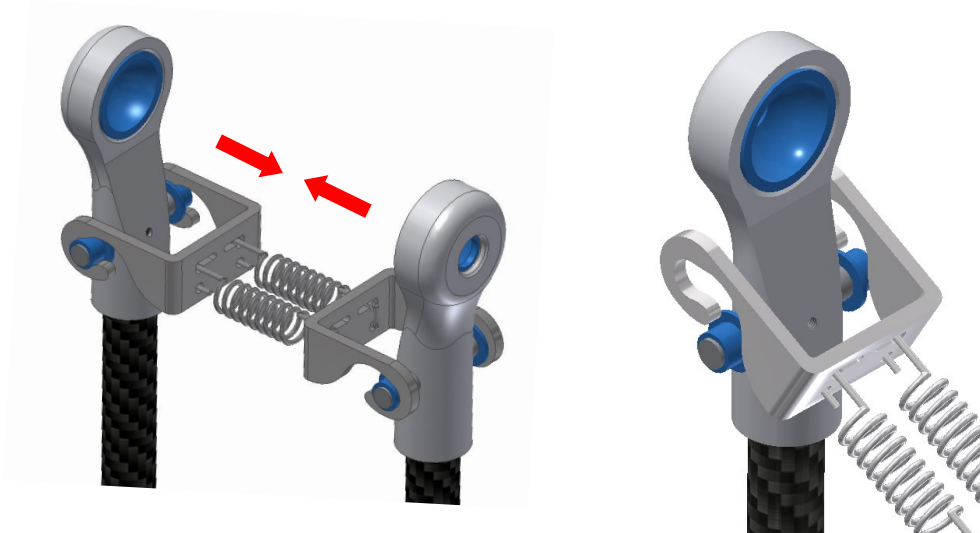


Figure 3- 6 Hook and spring replacement

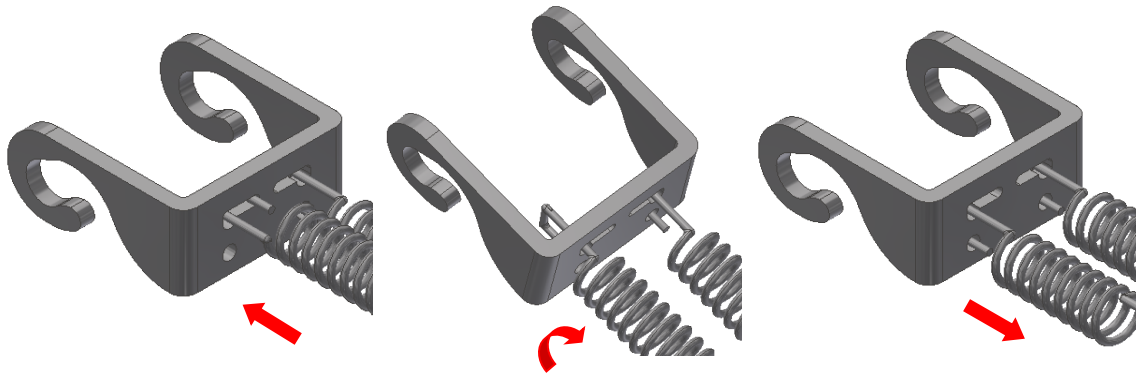


Figure 3- 7 Hook and spring installation

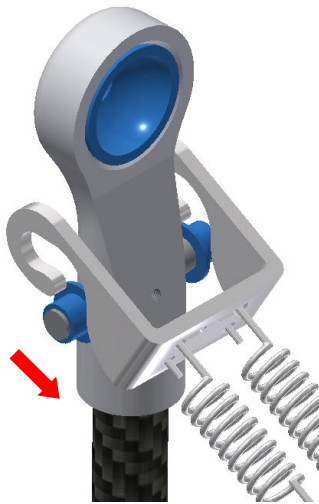

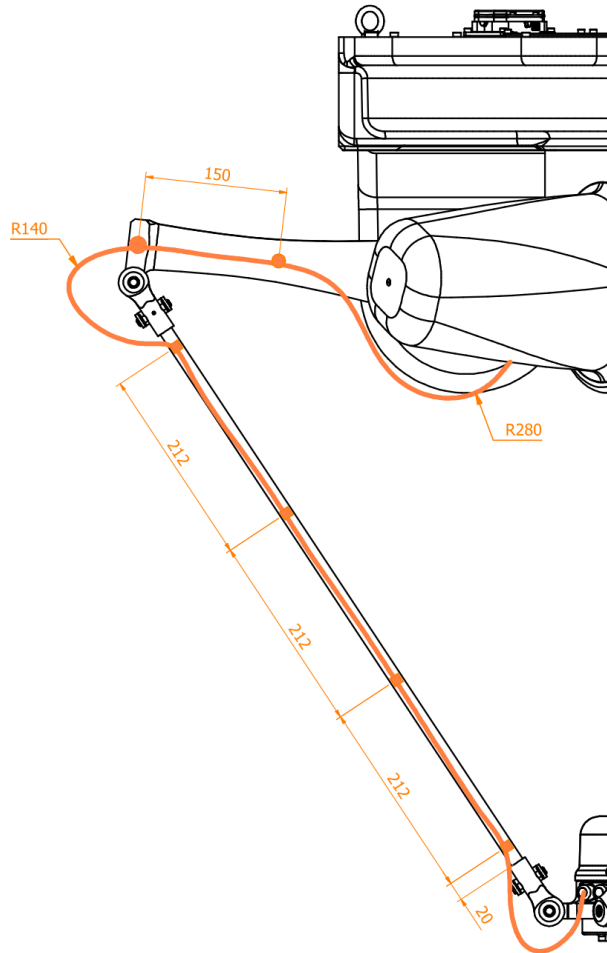



Figure 3- 8 Hook and bushing installation

 <b>WARNING</b>	<ul style="list-style-type: none"><li>❖ Make sure the spring is completely tightened to avoid disintegration and damage during arm operation.</li></ul>
--	---

### 3.2.4 4<sup>th</sup> Axis Cable Connection



 <p><b>Caution</b></p>	<ul style="list-style-type: none"><li>❖ Please start fixing the cable from the platform and set cable ties at the marks.</li><li>❖ The bending angle shall be reserved at the joint of 4<sup>th</sup> axis cable, and shall hold the position of the cable.</li><li>❖ When installing the 4<sup>th</sup> axis cable, the cable should be closely fitted to the lower arm and fixed. Please, do not allow the cable to wind to avoid damaging it and reducing the product life.</li><li>❖ After installation of 4<sup>th</sup> axis cable, please operate manually at the lowest speed (T1 mode) to ensure no winding of 4<sup>th</sup> axis cable. For software instructions, please refer to HIWIN Robot System Software.</li></ul>
---	--

Recommended wiring installation mode:

External pneumatic / electrical components can be attached to holes provided on the robot base. The cable ties included in the mounting accessory kit can be used to attach the cables. It is recommended that the user install the plug-type cable ties to the holes on J1 or J3 upper arm to avoid all cables being attached on the same arm or overlapping with the fourth axis motor cables attached to the J2 upper arm. Special attention must be paid to the reserved cable length at rotational axes to avoid cable damage due to arm swinging up and down.

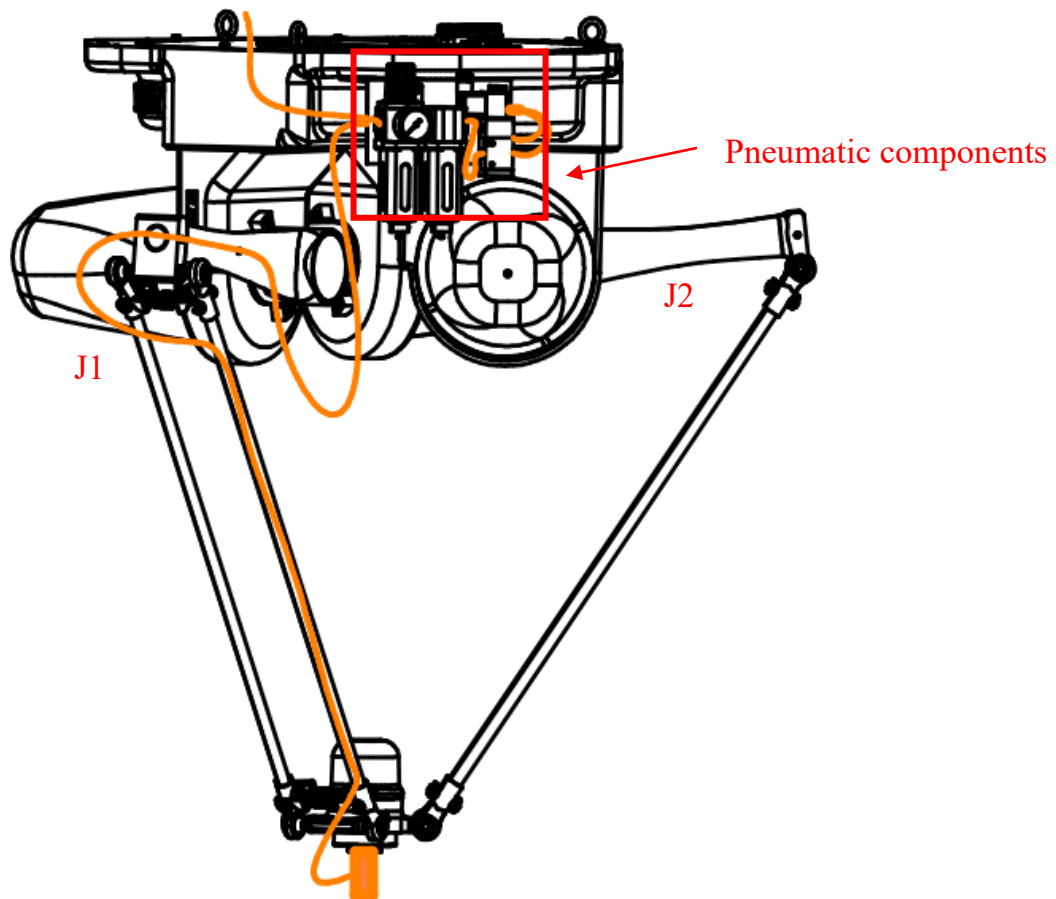


Figure 3- 9 Recommended installation of Delta robot wiring

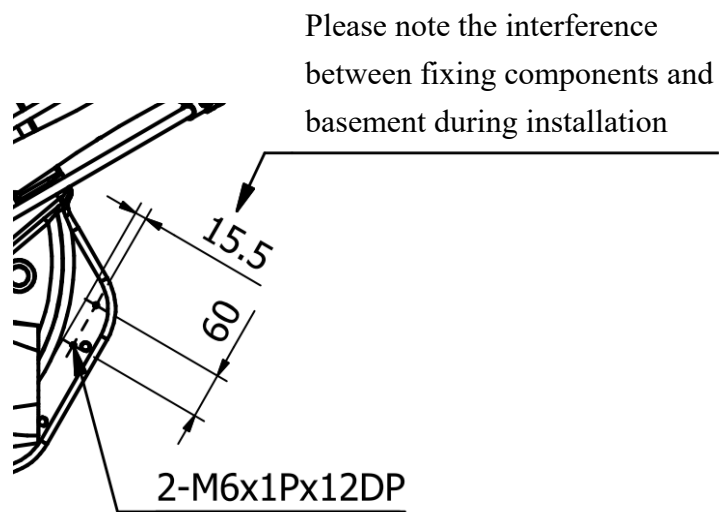
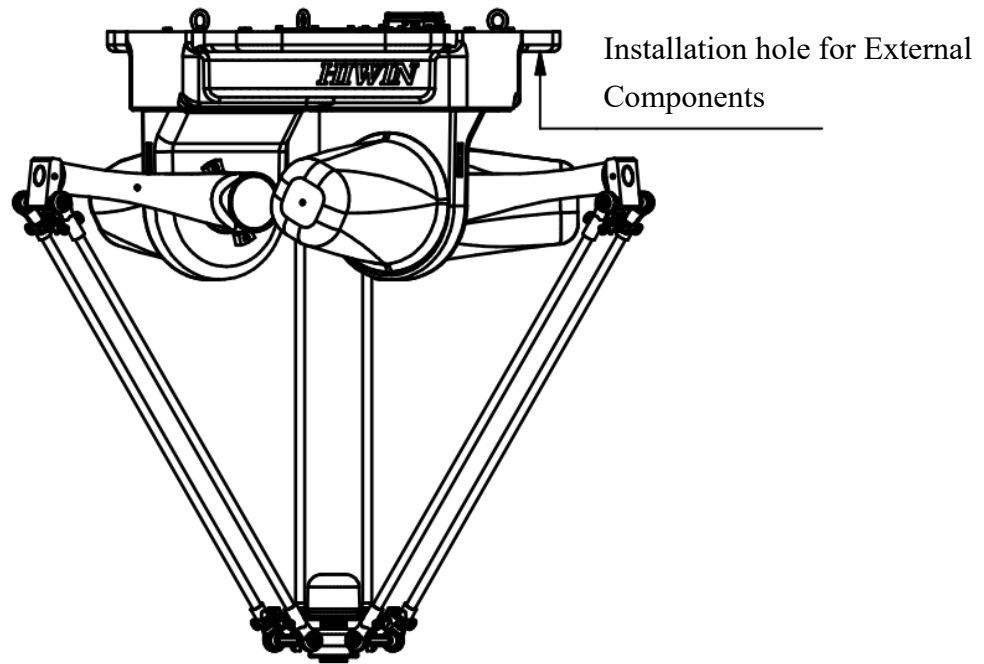


Figure 3- 10 Installation hole for External Components

### 3.2.5 Replacement of Backup Battery

Absolute encoders are used to record position. When power is disconnected, power from the lithium battery (3.6V) backup battery will be employed to record the current position in the encoders.

The battery installed on the robot has a service life of roughly 1 year. Actual life will depend on operating conditions. When battery power is low, the customer should replace during maintenance. Figure 3-11 shows the method to replace battery.

Procedures of battery replacement are described below.

1. Ensure the power is disconnected to the manipulator.
2. Remove the cover over the base.
3. Remove the old battery after connecting the new battery. If all batteries are removed, the encoder absolute data will be lost and the a calibration must be performed.
4. After the battery is replaced, please install the over the base.

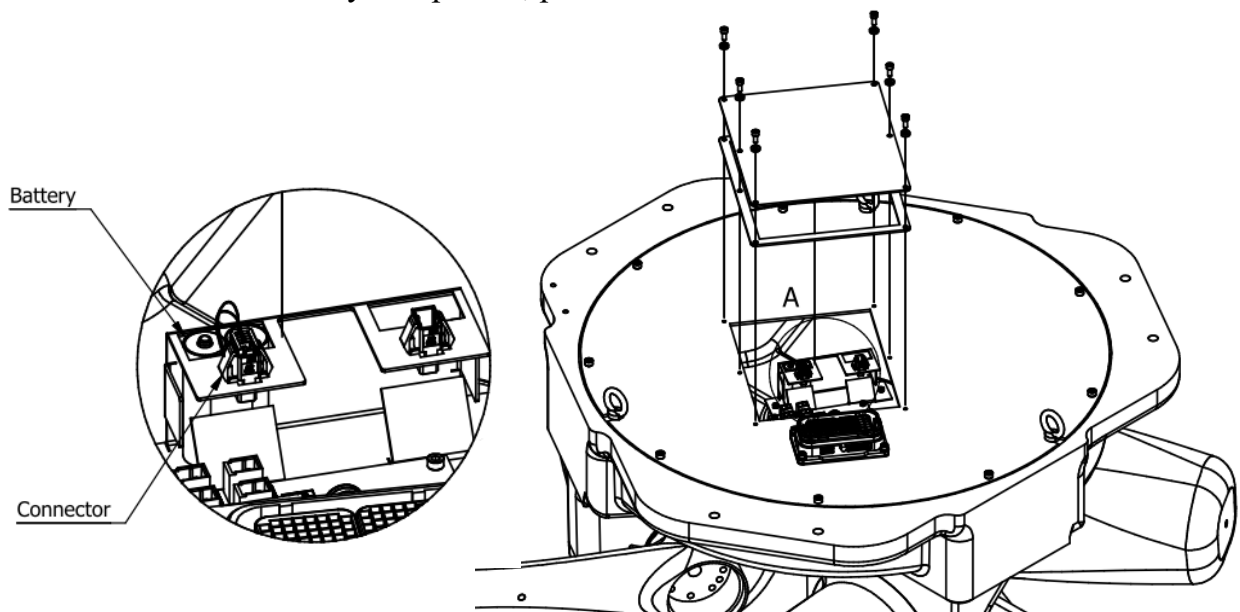


Figure 3- 11 Battery replacement

## 3.3 Cleaning

### 3.3.1 Cleaning of Robot

The RD403 series robots are designed to meet IP65 specifications.

The robot arm should meet the following conditions

- Dust can not enter. Prevent contact.
- Nozzle out of the water column is 6.3mm.
- Housing equipment should have no negative effect with water spray from any angle.

The RD403 series robots are designed to be compatible with neutral detergent commonly used in the cleaning of food processing equipment. All robot components are designed to handle daily exposure to cleaning agents. Exposure may result in some discoloration of the materials, but no significant coating or material removal.

The remaining parts of the robot can be cleaned according to instructions for washing down.


- Sprinkle water cleaning

Neutral detergent can be used to clean the robot arm with water.

The smooth design of the RD403 series robots eliminates the possibility of contaminants or water accumulation.

- Wipe cleaning

A wipe with a 70-75% alcohol by volume can be used to clean the robot arm.

 <b>Danger</b>	❖ Before cleaning the robot, stop the power, pneumatic and hydraulic systems and take all safety precautions.
---	---

### 3.3.2 Particular Clean Area

Some particular areas in RD403 series robot, such as the rotational parts and the gaps, can easily accumulate dirt in it. Please pay additional attention on the areas mentioned above while cleaning. A small brush and air duster gun can be used to remove the dirt. Then, rinse the components to ensure the good hygiene in production line.

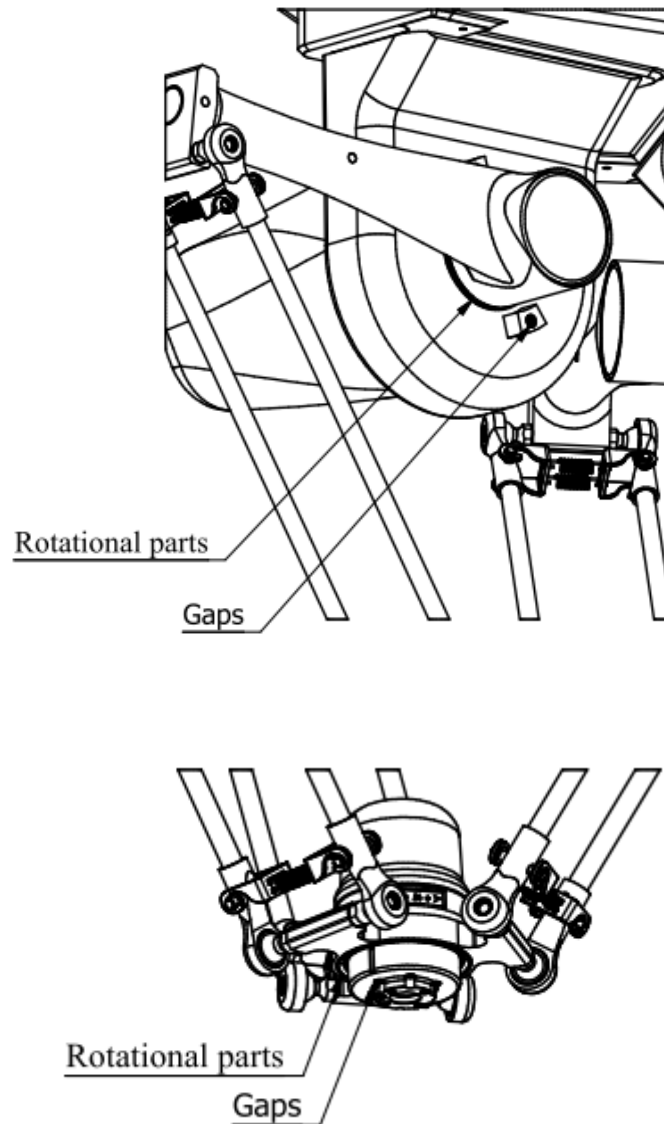


Figure 3- 12 Schematic of rotational part and gap



### 3.4 Home Calibration

There are jig tools for home calibration in the accessory kit, which are used for the calibration of the first to fourth axis. When performing calibration, the servo motor brake should be released manually.


- Calibration Timing

1. Change of Absolute Encoder Value: When replacing a transmission part (servo motor, reducer or upper arm), the absolute encoder value will be changed. It is required to perform a calibration in accordance with standard procedures.
2. Disappearance of Absolute Encoder Value: If the absolute encoder value disappears, it is required to perform a calibration in accordance with the standard procedures.

Reasons for disappearance of absolute encoder value are listed as follows:

1. Insufficient power of battery.
2. Encoder error.
3. Abnormal connection between encoder and encoder battery
4. When crash occurs to the robot.

When the 1st, 2nd and 3rd axis of RD403-1100-GB is located at the calibration position, it is at the angle of  $-11.47^{\circ}$  ; When the 4th axis of RD403-1100-GB is located at the calibration position, it is at the angle of  $0^{\circ}$ .

 <b>WARNING</b>	❖ Pay attention when manually releasing the brakes. The robot will move due to gravity or external force.
--	---

(1) Calibration of first to third-axis

Lock the calibration block(RD403-CALI-SET I) to the base to set the home position. Release the servo motor brake manually with the release button labeled BR1, BR2, and BR3. Move the arm to the calibration fixture, as shown in Figure 3-12.

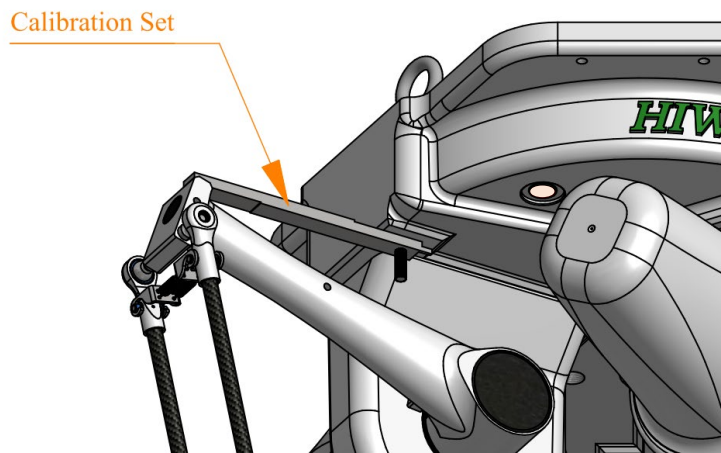




Figure 3- 12 Illustration of first to third-axis home calibration

 <p><b>Caution</b></p>	<ul style="list-style-type: none"><li>❖ Prior to performing calibration, the work process should be stopped and all safety precautions should be taken.</li><li>❖ When releasing the brake manually, the robot will move due to the influence of gravity or external force. Special attention is required for this operation.</li></ul>
---	---

● Calibration Standard Procedures

Item No.	Item
1	Press the emergency stop button.
2	Calibration is performed by using a calibration tool set (RD403-CALI-SET I) that is locked to the base.
3	Release the emergency stop button, and clear the software error.
4	Pressing the brake release button to release the brake and always release one axis a time.
5	Adjust the axis to the calibration position.
6	Release the brake release button to restore the brake.
7	Clear the absolute encoder value.
8	Restore the axis to a horizontal position.
9	Repeat step 2~8 in sequence for the other axes.
10	Determine the angle position of each axis in the software . (please refer to page No.51 Calibration for the angle value)
11	Remove the calibration tool set (RD403-CALI-SET I).
12	Complete calibration.

 <p><b>Caution</b></p>	<ul style="list-style-type: none"> <li>❖ Prior to performing calibration, the work process should be stopped and all safety precautions should be taken.</li> <li>❖ When releasing the brake manually, the robot will move due to the influence of gravity or external force. Special attention is required for this operation.</li> </ul>
---	--

(2) Calibration of fourth-axis

For fourth-axis calibration, set the fourth-axis speed to the minimum speed until the groove of platform matches the groove of the end flange so that the calibration block (RD403-CALI-SET II) can be set in the two-phase matching slot for home calibration. As shown in Figure 3-13.

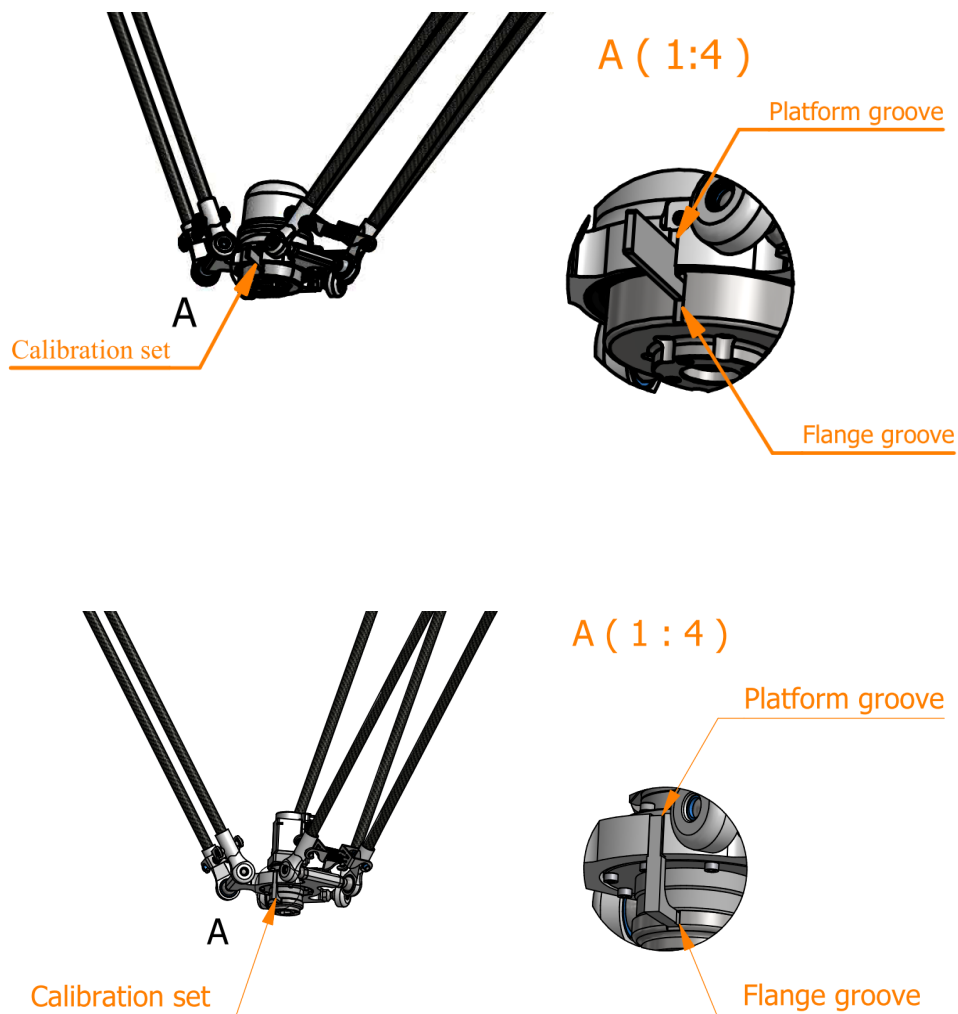



Figure 3- 13 Illustration of fourth-axis home calibration

● Calibration Standard Procedures

Item No.	Item
1	Adjust the axis to the calibration position at the minimum speed.
2	Place the calibration tool set (RD403-CALI-SET II) in the calibration position.
3	Clear the encoder value.
4	Remove the calibration tool set (RD403-CALI-SET II).
5	Determine the angle position of axis in the software . (please refer to page No.51 Calibration for the angle value)
6	Complete calibration.

 <b>Caution</b>	<ul style="list-style-type: none"> <li>❖ Prior to performing calibration, the work process should be stopped and all safety precautions should be taken.</li> <li>❖ When releasing the brake manually, the robot will move due to the influence of gravity or external force. Special attention is required for this operation.</li> </ul>
---	--

## 4. Safety Certification

RD403 achieve CE certification.

CE Compliance	
Machinery Directives	2006/42/EC
Low Voltage Directives (LVD)	2014/35/EU
Robots for Industrial Environment	EN ISO 10218-1:2011
Safety of Machinery	EN ISO 12100:2010
	EN ISO 13849-1:2015
	EN 60204-1:2006+AC:2010
Electromagnetic Compatibility Directives (EMC)	EN 61000-6-2:2005
	EN 61000-6-4:2007+A1:2011
Food Processing Machinery <sup>[Note1]</sup>	EN1672-2:2005+A1:2009

[Note1] RD403-1100-GB FDA approval.

## **Delta Robot - RD403-GB Series (Original Instruction) User Manual**

Publication Date : December 2018, first edition

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