



# Delta Robot

## Manipulator Manual

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Version	Date	Scope of Application	Remark
1.0.0	2015.07.21	RD401、RD403	First version issued
2.0.0	2015.11.19	RD401、RD403	Add 1.3.3 Symbols on the manipulator labels
2.0.1	2015.12.14	RD401、RD403	Modify 2.2.2 Illustration Modify 2.3.2 Illustration
2.0.2	2016.01.25	RD401、RD403	Modify 2.1.1 Specification Format Add 2.1.6 Part Checklist Item 10~13 Add 2.2.1 Arm Installation Precautions Add 3.2.5 4 <sup>th</sup> axis connecting cable precautions
3.0.2	2016.05.25	RD401、RD403	Add 2.1.5 Allowable 4 <sup>th</sup> Axis Load Add 2.3.2 4 <sup>th</sup> Axis installation precautions
4.0.0	2016.09.13	RD401-700、 RD403-900、 RD403-1300	Add RD403-900 Specifications
4.0.1	2017.01.16	RD401-700、 RD403-900、 RD403-1300	Modify 4.1.1 Calibration angle Update the part checklist Add 4 <sup>th</sup> Axis installation and calibration precautions

# **1. Safety Precautions**

## **1.1 Safety Information**

### **I. Safety Responsibility & Effect**

- This safety information does not include how to design, install and operate a complete work station or production line, and cannot assure the safety of whole system. In order to assure the personal safety, all equipment shall be designed and installed in accordance with the related industrial safety regulations.
- 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.
- Compliance with the safety information supplied in this manual will reduce the possibility of a safety incident.

### **II. Connection of External Safety Devices**

- In addition to the built-in safety circuit, the robot also provides an external signal interface for the use of external safety devices.
- The external safety devices include safety fence, safety switch etc., any device can be used to protect personal safety.

## 1.2 Description Related to Safety

### I. Safety Symbols

- Carefully read the instructions in the user manual prior to robot use. The safety symbols used by this user manual are listed as follows.

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. Safety Classification

- Common safety precautions are listed below. Please read and comply with these instructions prior to robot use.

 <p><b>Danger</b></p>	<ul style="list-style-type: none"> <li>❖ Prior to repair and maintenance, please turn off power supply.</li> <li>❖ The end effector should be mounted firmly on the robot to avoid workpiece release during operation that could cause personal injury or hazard.</li> <li>❖ While transporting robot, use the method recommended in this manual to avoid product damage.</li> </ul>
 <p><b>Warning</b></p>	<ul style="list-style-type: none"> <li>❖ The robot or other control component should have at least one device for immediate halt of function, such as an emergency stop switch.</li> <li>❖ Provide external safety fence for work station to prevent contact between the robot and operator during operation.</li> <li>❖ Prior to start, check if the robot and emergency stop switch are normal.</li> <li>❖ Operating the robot in inappropriate environmental conditions may cause personal injury or machine malfunction.</li> <li>❖ Securely mount the robot. Unstable installation may cause vibration and deviation of robot position.</li> <li>❖ Do not over bend the cable to avoid poor circuit contact.</li> <li>❖ Ensure workpiece weight or over torque the robot. this can cause a driver alert or arm malfunction.</li> <li>❖ Use of non-OEM repair parts may cause robot damage or malfunction.</li> </ul>



## Caution

- ❖ All operations should be performed by trained operators.
- ❖ 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 deviate or malfunction.
- ❖ The robot should be run at low speed as much as possible and be monitored regularly to avoid workpiece release during operation that could cause personal injury or hazard.
- ❖ When modifying program or parameters on robot controller, do not turn off the power supply to avoid data loss.

## 1.3 Common Safety Issues

### I. Safety Risk

#### i. Installation

- **General Risk**

- Robot installation procedures must comply with this manual.
- The emergency stop button must be installed in an easily accessible location for quick stop.
- Personnel operating robot should be trained and licensed.
- To ensure personal safety, robot installation must comply with this manual and related industrial safety regulations.

- **Risk with No Electric Shock Concern**

- A safety zone should be established around the robot with an appropriate safety device to limit access of unauthorized personnel.
- Release of the servo motor break will allow the robot to move with gravity, potentially causing operator injury.
- While installing or removing mechanical parts, be aware that a dropped part could cause operator injury.
- Beware high temperature generated by the controller.
- Do not climb on robot.

**ii. End Effector**

- The end effector can be basically categorized into two types as follows:
  - A.** Gripper Type: Mainly use for pick-and-place operation, such as pneumatic gripper, electric gripper, vacuum chuck etc.
  - B.** Tool Type: Mainly use for machining operation, such as welding, cutting, surface treatment etc.
- Special attention must be paid to the design of the end effector to prevent errors that could lead to workpiece release or damage.
- The end effector may be equipped with its own control unit. Be sure to control unit does not interfere with robot operation.



**Warning**

- ❖ The end effector of tool type normally has the high voltage, high temperature or active rotary shaft. Special attention should be paid to the operating safety.

**iii. Pneumatic, Hydraulic System**

- The pressure value of pneumatic, hydraulic system will be stored in the system after the power is turned off.
- Prior to maintenance, the pneumatic, hydraulic system, the remaining internal pressure should be released.
- When using the pneumatic, hydraulic system for operation, the gripping workpiece may fall due to insufficient pressure or gravity.
- The pneumatic, hydraulic systems must have a pressure relief valve for emergencies.



**Warning**

- ❖ The remaining internal pressure of pneumatic, hydraulic system is usually several times of atmospheric pressure. Special attention shall be paid to ensure safe operation.

**iv. Electric Components**

• **Risk of Electric Shock**

- Prior to troubleshooting, confirm that power to the robot is turned off.
- When perform the system maintenance, the power cord must be unplugged.
- The main power system of robot must be located outside of its operating range, so that power can be turned off safely in case of emergency.
- Prior to operation, please connect the ground wire of robot body and controller.

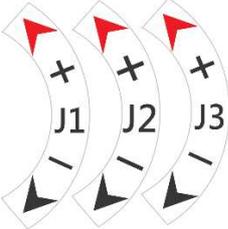
**v. Rick caused by Operating Environment**

- This product should be used at a site in compliance with recommended environmental conditions to avoid machine damage.
- All operating procedures should be established by professional assessment and in compliance with related industrial safety regulations.
- Maintenance and repair should be performed by a qualified operator with a complete understanding of the entire system to avoid risk of robot damage or personal injury.
- When operation is interrupted for troubleshooting, special attention should be paid to operating risk.

## **II. Emergency Stop**

- Definition of Emergency Stop
  - Performing an emergency stop will cut power to the controller, stop all movement, and disable control system.
  - Performing an emergency stop will cut all power except the manual release circuit.
  - Emergency stop should be reset if the operating procedure is being restored.
  - The emergency stop can be categorized into two types as follows:
    - A. Stop Immediately: Stop robot movement immediately and cut drive power.
    - B. Stop Delay: Robot will decelerate and then stop movement. Drive power will be cut after robot stops.
      - The emergency stop switch is only used for emergency stop.
      - Avoid using emergency stop to replace a normal stop procedure. This could lead to unnecessary loss to robot.
- Emergency Stop Switch
  - The HIWIN industrial robot of has two (2) emergency stop switches, one on the teach pendant, the other connected to the controller through a dedicated connecting cable. Additional emergency stops can be added through alternative connection.
  - Following related industrial safety regulations, the emergency stop switch should be connected to the control cabinet by the physical connection cable. Based on the related industrial safety regulations, the emergency stop switch shall be directly connected to the control cabinet of robot through the physical connecting cable.
  - Pressing the emergency stop switch of the HIWIN industrial robot will stop robot movement immediately and cut driver power.

### III. Arm Labeling Description

Name	Icon	Description
Electric Shock Sticker		Located by the motor power signal cable (CN2). Be aware of electric shock when connecting circuit.
Motor power Signal Cable		Connection location for the motor power signal cable (CN2).
Air Duct Connecting Port		Arm provides two sets of air connection ports. Accessories can be connected from outside the base to the air duct.
Battery Installation Place		Location for battery maintaining encoder data.
Axis Identification Sticker		Identification sticker for each axis. Denotes axis and direction of movement.
1 <sup>st</sup> Axis Break Release Button		Location of break release for each axis. Denotes location of break on each axis for use in calibration or in emergency.
2 <sup>nd</sup> Axis Break Release Button		
3 <sup>rd</sup> Axis Break Release Button		

## **2. Installation Precautions**

### **2.1 Confirm Procedures Prior to Installation**

- Foreword
  - Prior to perform the installation procedures, please read this manual carefully.
  - During installation, all safety procedures must be followed.
  - Personnel operating robot should be trained or licensed.

**I. Specification**

<b>Specification</b>					
<b>Version</b>	<b>Payload (kg)</b>	<b>Motion Diameter (mm)</b>	<b>Motion Height (mm)</b>	<b>Degree of Freedom</b>	
<b>RD401-700</b>	1	700	200	4	
<b>RD403-900</b>	3	900	300	4	
<b>RD403-1300</b>	3	1300	500	4	
<b>Installation Mode &amp; Environment</b>					
<b>Version</b>	<b>Installation</b>	<b>Weight (kg)</b>	<b>Relative Humidity (%)</b>	<b>Temperature (°C)</b>	<b>Noise (dB(A))</b>
<b>RD401-700</b>	Ceiling	60	MAX 95%	5~50	MAX 72
<b>RD403-900</b>		165			
<b>RD403-1300</b>		165			
<b>Performance</b>					
<b>Version</b>	<b>Repeatability</b>				
<b>RD401-700</b>	± 0.05 mm				
<b>RD403-900</b>	± 0.1 mm				
<b>RD403-1300</b>	± 0.1 mm				
<b>Cycle Time✳</b>					
<b>Version</b>	<b>Payload (kg) 25-305-25</b>	<b>0.1</b>	<b>1</b>	<b>3</b>	
	<b>RD401-700</b>	0.30 s	0.38 s	-	
<b>RD403-900</b>	0.32 s	0.45 s	0.63 s		
<b>RD403-1300</b>	0.32 s	0.45 s	0.63 s		
<b>Version</b>	<b>Payload (kg) 90-400-90</b>	<b>0.1</b>	<b>1</b>	<b>3</b>	
	<b>RD401-700</b>	0.36 s	0.43 s	-	
<b>RD403-900</b>	0.47 s	0.58 s	0.75 s		
<b>RD403-1300</b>	0.47 s	0.58 s	0.75 s		

- ※ Cycle time is measured under the real condition, however, cycle time depends on the practical application, please inspect the actual cycle time in accordance with the real usage condition.
- ※ Measuring cycle 25-305-25, Moving path: vertical height 25mm, horizontal distance 305mm  
Measuring cycle 90-400-90, Moving path: vertical height 90mm, horizontal distance 400mm

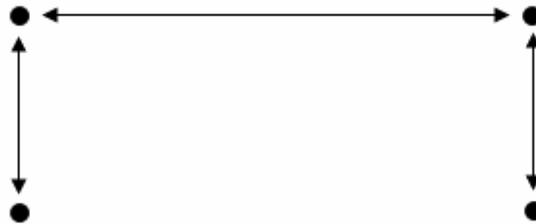


Fig. 1 Moving Path of Measuring Cycle time for Delta Robot

 <b>Caution</b>	❖ If the rated load of robot is exceeded, it may cause the damage to the robot or the robot to dislocate.
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## II. Conveyor Tracking Performance

<b>Conveyor Tracking</b> ✳				
<b>Speed (mm/s)</b>		<b>Repeatability (mm)</b>		
200		1.0		
250-500		2		
500-800		4.5		
<b>Electric Connection</b>				
<b>Version</b>	<b>Supply Voltage</b>	<b>Rated Power</b>	<b>Rated Output Current</b>	<b>Power Frequency</b>
<b>RD401-700</b>	Single Phase 200-240VAC	3.3kW	15 A	50-60Hz
<b>RD403-900</b>		4.4kW	20 A	
<b>RD403-1300</b>		4.4kw	20A	
<b>Safety</b>				
Safety & Emergency Stop Switch				
3-position Enabling Switch				

- ✳ Tracking performance is measured under real conditions. Real data depends on actual usage conditions and the maximum speed and acceleration during robot operation.
- ✳ The conveyor of test moves with constant speed.

### III. Definition of Motion Range

- **RD401-700 Motion Range**

Model No.	$\varphi D_1$	$\varphi D_2$	H <sub>1</sub>	H <sub>2</sub>
RD401-700	700	500	150	50

Unit: mm

- ※  $\varphi D_1$  Maximum Diameter of Motion Range.
- $\varphi D_2$  Minimum Diameter of Motion Range.
- H<sub>1</sub> Movable Height with Maximum Diameter.
- H<sub>2</sub> Movable Height in Trapezoid Zone of Maximum Diameter to Minimum Diameter.

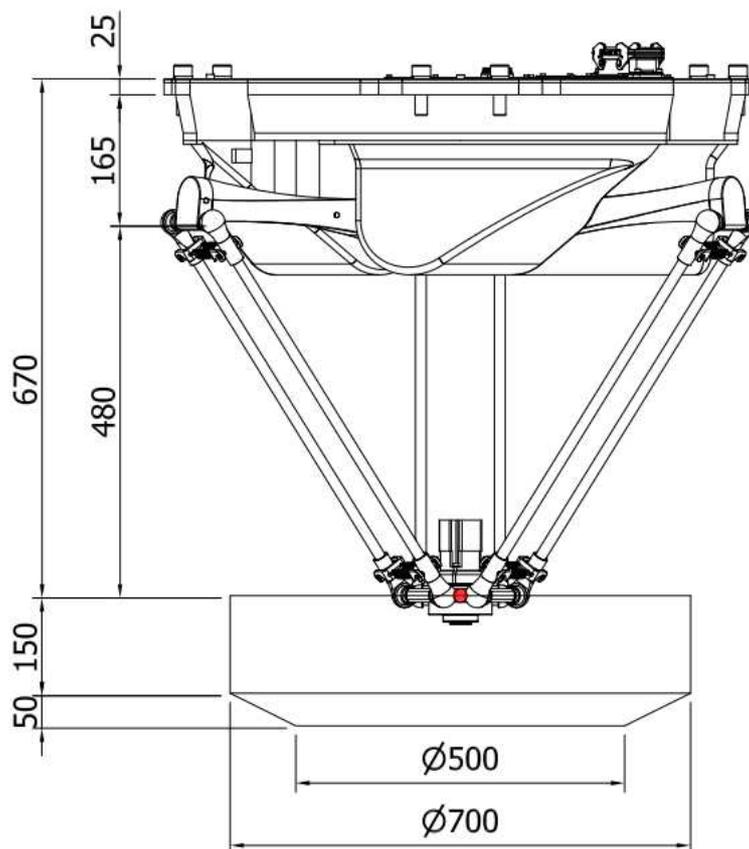


Fig. 2 Motion Range of RD401-700

 <p><b>Caution</b></p>	<ul style="list-style-type: none"> <li>❖ If the motion range of robot is exceeded, it may cause crash or other unpredictable risk.</li> <li>❖ Motion range will be different due to the end effector, assure there is no risk of crash prior to operation.</li> </ul>
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• **RD403-900 Motion Range**

Model No.	$\phi D_1$	$\phi D_2$	H <sub>1</sub>	H <sub>2</sub>
RD403-900	900	400	200	100

Unit: mm

- ※  $\phi D_1$  Maximum Diameter of Motion Range.
- $\phi D_2$  Minimum Diameter of Motion Range.
- H<sub>1</sub> Movable Height with Maximum Diameter.
- H<sub>2</sub> Movable Height in Trapezoid Zone of Maximum Diameter to Minimum Diameter.

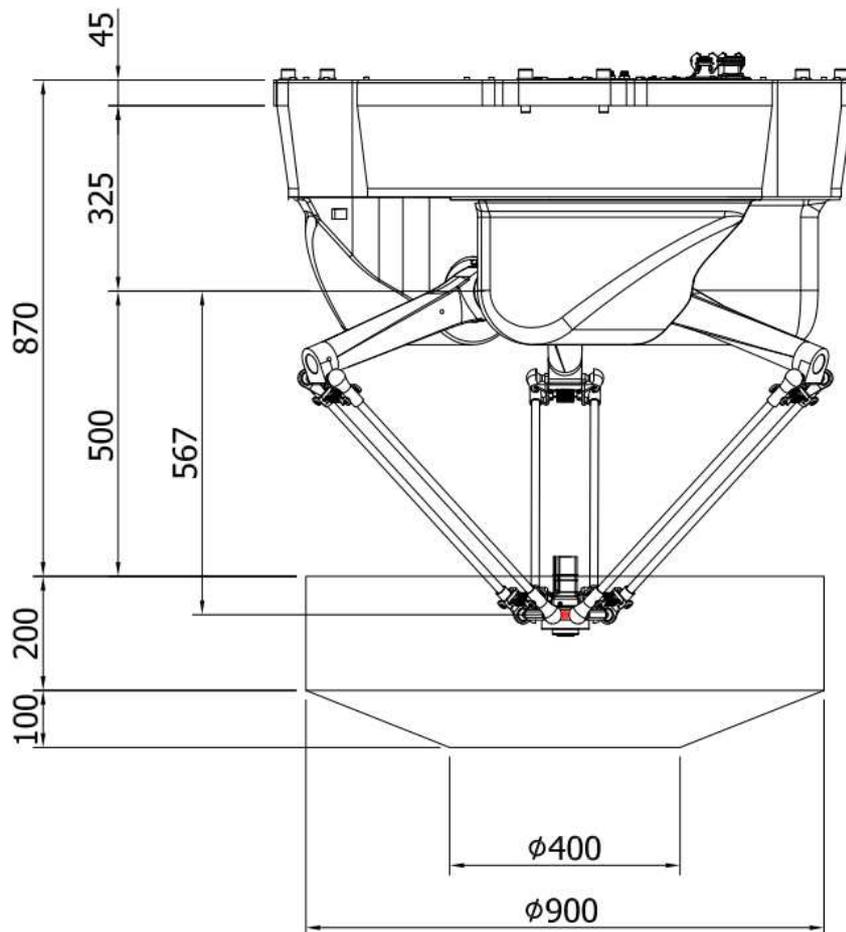


Fig. 3 Motion Range of RD403-900

 <p><b>Caution</b></p>	<ul style="list-style-type: none"> <li>❖ If the motion range of robot is exceeded, it may cause crash or other unpredictable risk.</li> <li>❖ Motion range will be different due to the end effector, assure there is no risk of crash prior to operation.</li> </ul>
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• **RD403-1300 Motion Range**

Model No.	$\phi D_1$	$\phi D_2$	H <sub>1</sub>	H <sub>2</sub>
RD403-1300	1300	750	300	200

Unit: mm

- ※  $\phi D_1$  Maximum Diameter of Motion Range.
- $\phi D_2$  Minimum Diameter of Motion Range.
- H<sub>1</sub> Movable Height with Maximum Diameter.
- H<sub>2</sub> Movable Height in Trapezoid Zone of Maximum Diameter to Minimum Diameter.

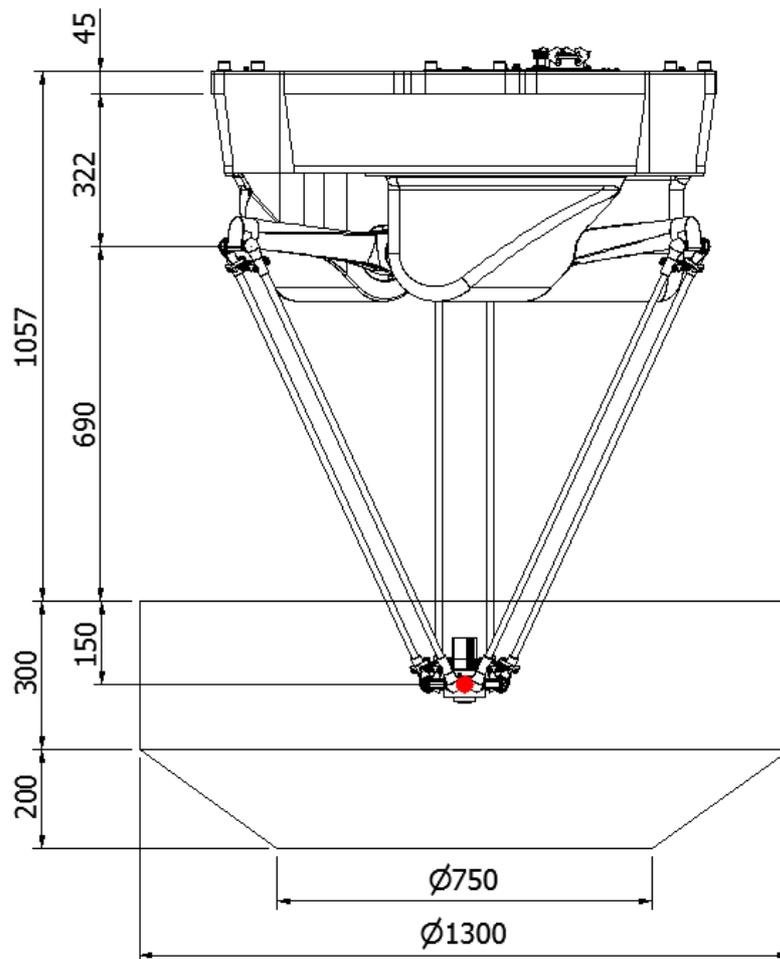


Fig. 4 Motion Range of RD403-1300



**Caution**

- ❖ If the motion range of robot is exceeded, it may cause crash or other unpredictable risk.
- ❖ Motion range will be different due to the end effector, assure there is no risk of crash prior to operation.

#### IV. Weight

- When necessary, use auxiliary lifting equipment to avoid the robot to fall accidents during installation, maintenance or repair.
- When use the lifting equipment for transporting the robot, be aware of the rated load of equipment.
- Weight Reference Table:

Unit: kg

<b>Item</b>	<b>RD401-700</b>	<b>RD403-900</b>	<b>RD403-1300</b>
<b>Net Weight of Robot</b>	60	165	165
<b>Controller</b>	30	30	30
<b>Gross Weight of Robot (Exclude the external packing case)</b>	90	195	195

**V. Allowable 4<sup>th</sup> Axis Load**

- The inertia coming from the size and weight of end effector and workpiece may result in poor product performance. Please refer to the following table when designing end effector or conducting application assessment.
- Allowable 4<sup>th</sup> Axis load table :

	Allowable Moment ( N-m )	Allowable Moment of Inertia (kg-m <sup>2</sup> )
4 <sup>th</sup> Axis	1.36	3kg : 8.46 x 10 <sup>-4</sup> 2kg : 9.66 x 10 <sup>-4</sup> 1kg : 1.11 x 10 <sup>-3</sup>

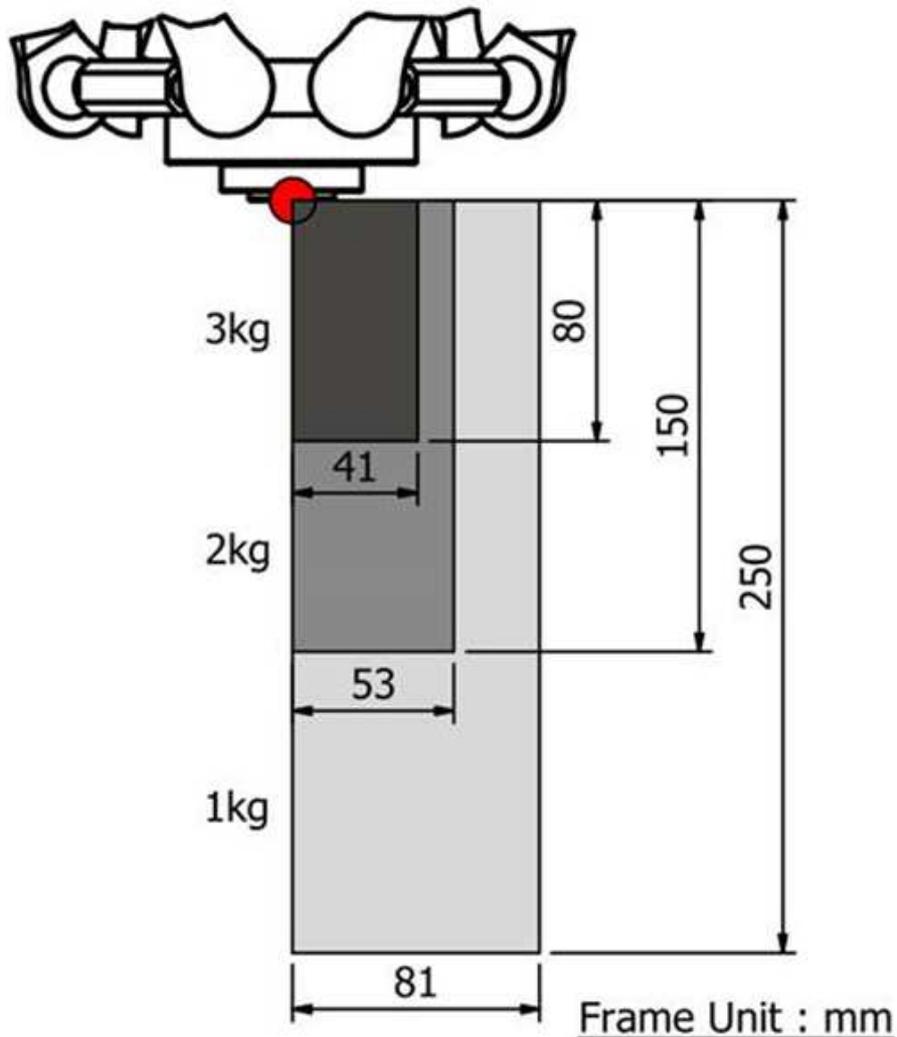


Fig. 5 Allowable 4<sup>th</sup> Axis load table drawing

## **VI. Transport**

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

- Please check safety mounting points prior to transport.
- During the transportation process, do not remove or reverse the external case.
- 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.

## VII. Confirm Procedures Prior to Installation

- **RD401-700 Parts Checklist**

Item No.	Name	Model/Specification	Qty
1	Manipulator	RD401-700	1
2	Controller	RCD401-700	1
3	Teach Pendant	TP-02	1
4	Motor Power Signal Cable	CN2-5	1
5	Connector of Emergency Stop Switch		1
6	Filtering Cotton Core of Controller		1
7	Door Lock Key of Controller		1
8	Connector of Functional Signal		1
9	Connector of Digital Signal		2
10	Stylus		1

- **RD403-900 、RD403-1300 Parts Checklist**

Item No.	Name	Model/Specification	Qty
1	Manipulator	RD403-900 RD403-1300	1
2	Controller	RCD403-900 RCD403-1300	1
3	Teach Pendant	TP-02	1
4	Motor Power Signal Cable	CN2-5	1
5	Connector of Emergency Stop		1
6	Filtering Cotton Core of Controller		1
7	Door Lock Key of Controller		1
8	Connector of Functional Signal		1
9	Connector of Digital Signal		2
10	Stylus		1

- **Options Parts Checklist**

Item No.	Name	Model/Specification
1	Encoder	E6B2-CWZ1X, 2000P/R, omron
2	Lithium Cell	TADIRAN 3.6V Lithium Cell BT-TL 5903

• **Confirmation Table of Installation Procedures**

Item No.	Item	Remark
1	Must be installed by qualified personnel.	
2	Visual inspection to check if the exterior parts of robot are loose.	
3	Confirm that the rated load of lifting equipment is able to withstand the weight of robot.	<a href="#">Please refer to page No.33</a>
4	Store robot under specified environmental conditions until put into service.	Please refer to page no.32
5	Confirm environmental operating conditions comply with recommended values.	<a href="#">Please refer to page no.15</a>
6	Please perform the aforementioned items prior to perform the installation.	

 <b>Warning</b>	❖ Make sure quantity of inventory parts and review procedures on the first time installation.
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- **Frame**
  - Robot does not include frame. Additional construction is required.
  - To avoid interfering with the dynamic performance of robot, it is recommended that the lowest nature frequency of frame be over 15Hz. The dynamic behavior can be optimized through adjustment of the motor parameters.
  - The manipulator has three mounting points. The rated load of each mounting point on the Z-axis of the RD401 is 260N. The rated load of each mounting point on the Z-axis of the RD403 is 540N..

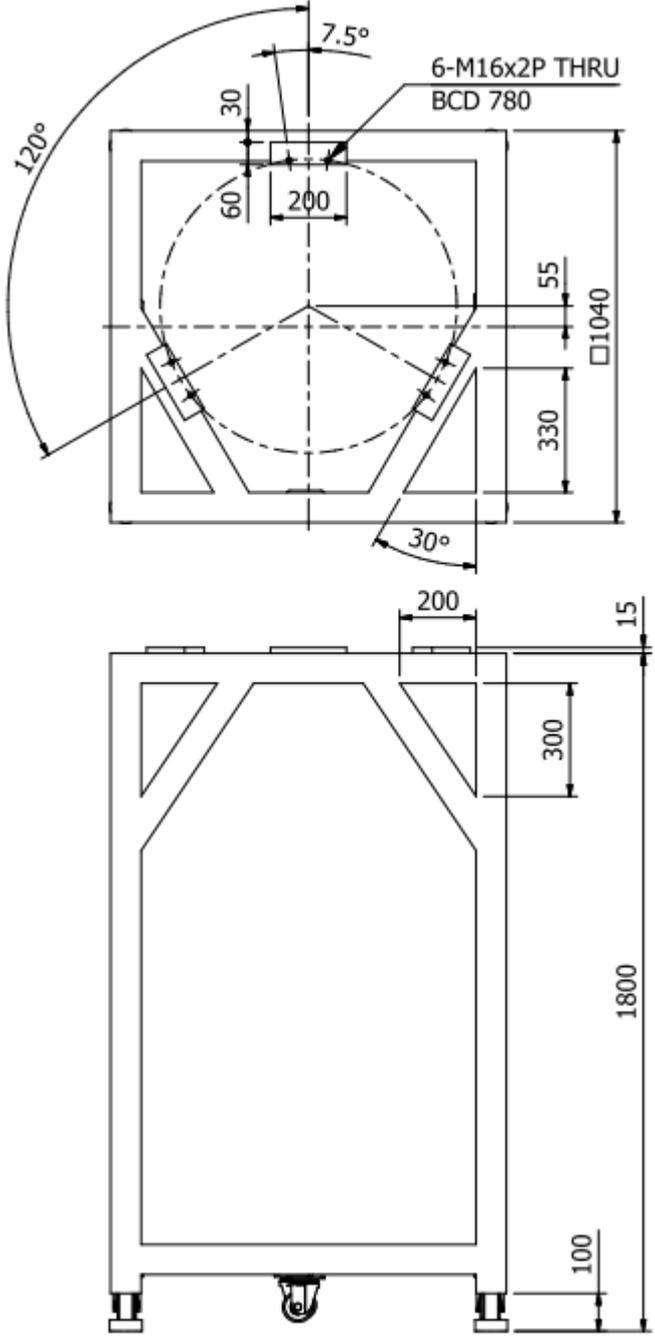


Fig. 6 Recommended Dimensional Drawing of RD401-700 Frame

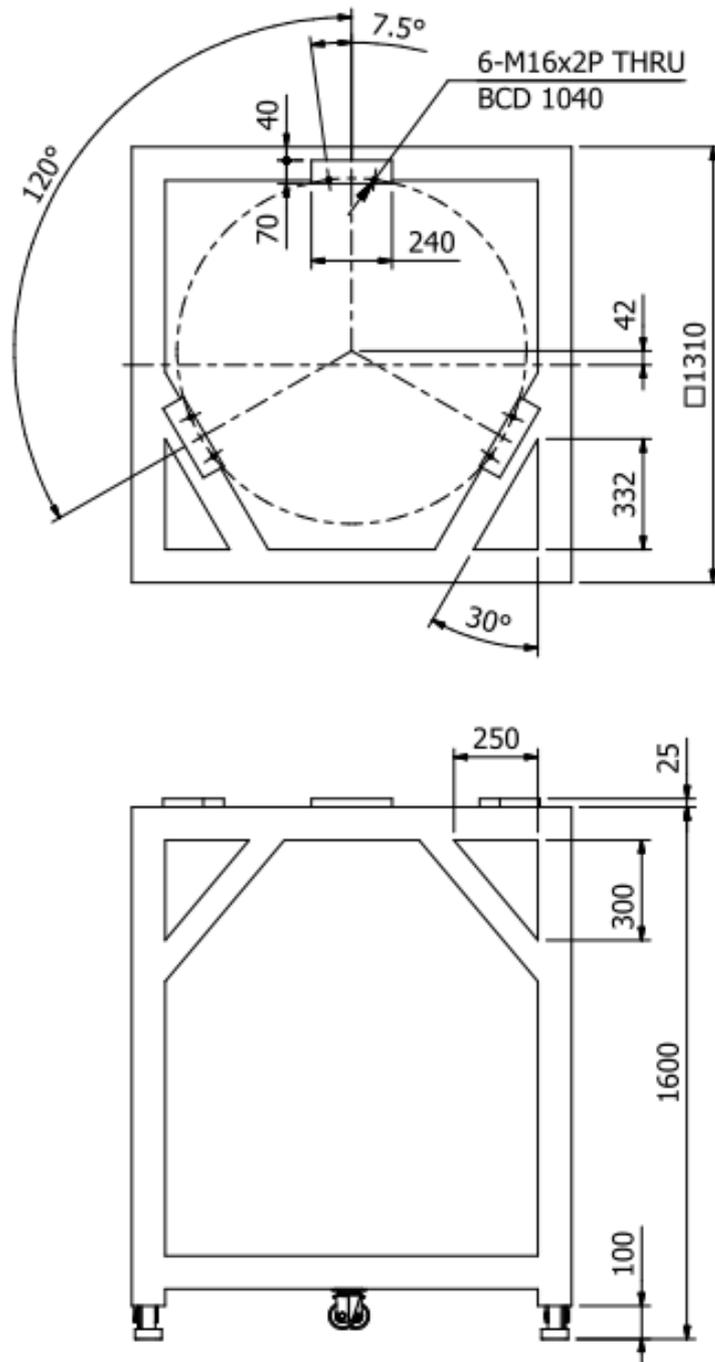
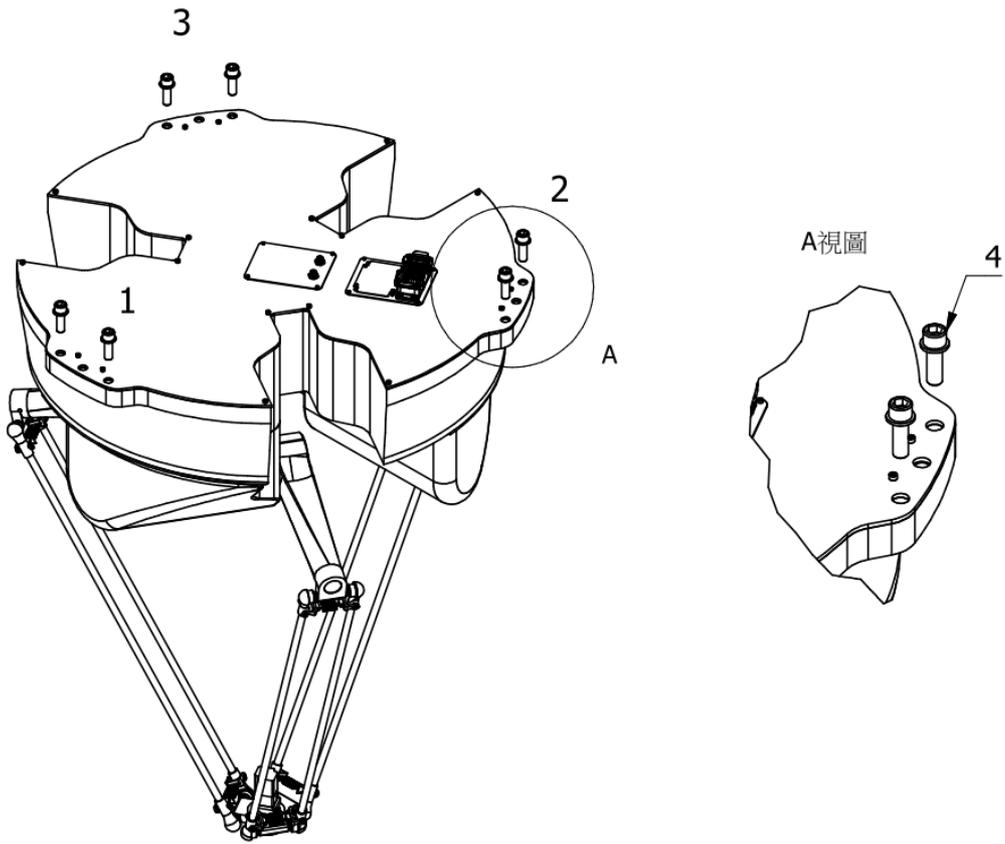


Fig. 7 Recommended Dimensional Drawing of RD403-900 Frame





Item No.	Description
1	1 <sup>st</sup> Fixing Point
2	2 <sup>nd</sup> Fixing Point
3	3 <sup>rd</sup> Fixing Point
4	M16 Bolt

Fig. 9 Installation Fixing Points Schematic Diagram of Manipulator

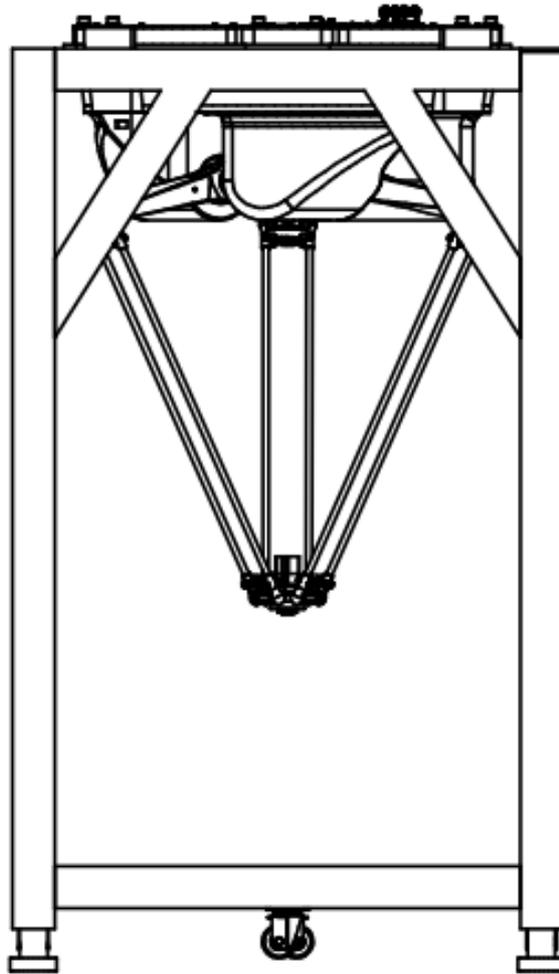


Fig. 10 Installation Frame Schematic Diagram of Manipulator



**Caution**

- ❖ The manipulator is mounted at 3 points. To ensure proper performance and avoid risk of dislocation, ensure arm is properly mounted.

- **Storage Conditions of Robot**

- Store robot under specified environmental conditions until put into service.

- Recommended Value of Storage Environment:

Relative Humidity	Below 80%
Temperature	-25°C~55°C

- **Operating Environmental Conditions:**

- Recommended Value of Operating Environment:

Relative Humidity	Below 95%
Temperature	5°C~50°C

- **Protection Class**

- The Manipulator has been tested and verified to protection class IP40.
- **IP40:** Equipment prevents entrance of objects with a diameter over 1mm, and provides no waterproof protection.

## 2.2 Installation Procedures of Robot

### I. Required Equipment

- **Lifting Equipment**

- The gross weight of RD401-700 (including the external packing case) is approximately 100 kg; the gross weight of RD403-900、RD403-1300 (including the external packing case) is approximately 200kg, the rated load of lifting equipment shall be greater than 200kg.
- When transporting the robot with a lifting equipment, ensure that robot is securely held.
- When hanging robot with an overhead crane, use hanging rings on robot and a safety sling and comply with related safety regulations.

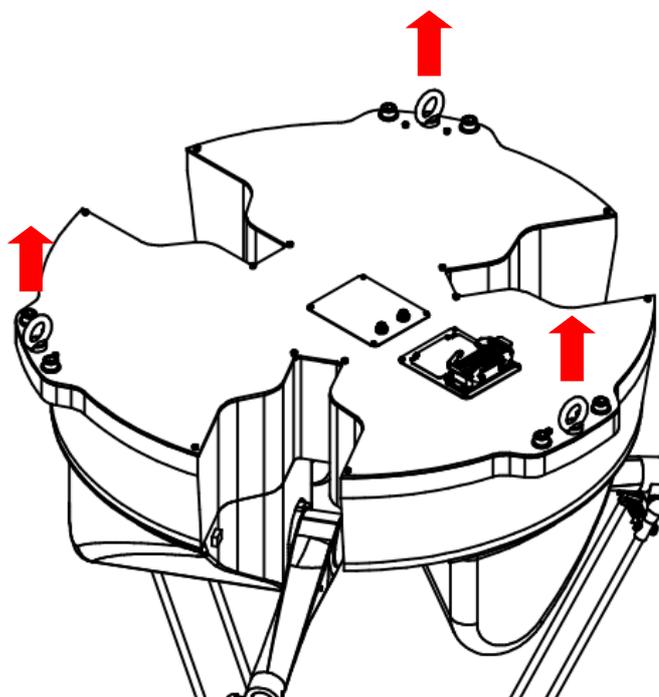


Fig. 11 Hanging Schematic Diagram of Manipulator

Item No.	Description
1	1 <sup>st</sup> Hanging Point
2	2 <sup>nd</sup> Hanging Point
3	3 <sup>rd</sup> Hanging Point

 <b>Caution</b>	❖ When installing robot, please avoid to use human power.
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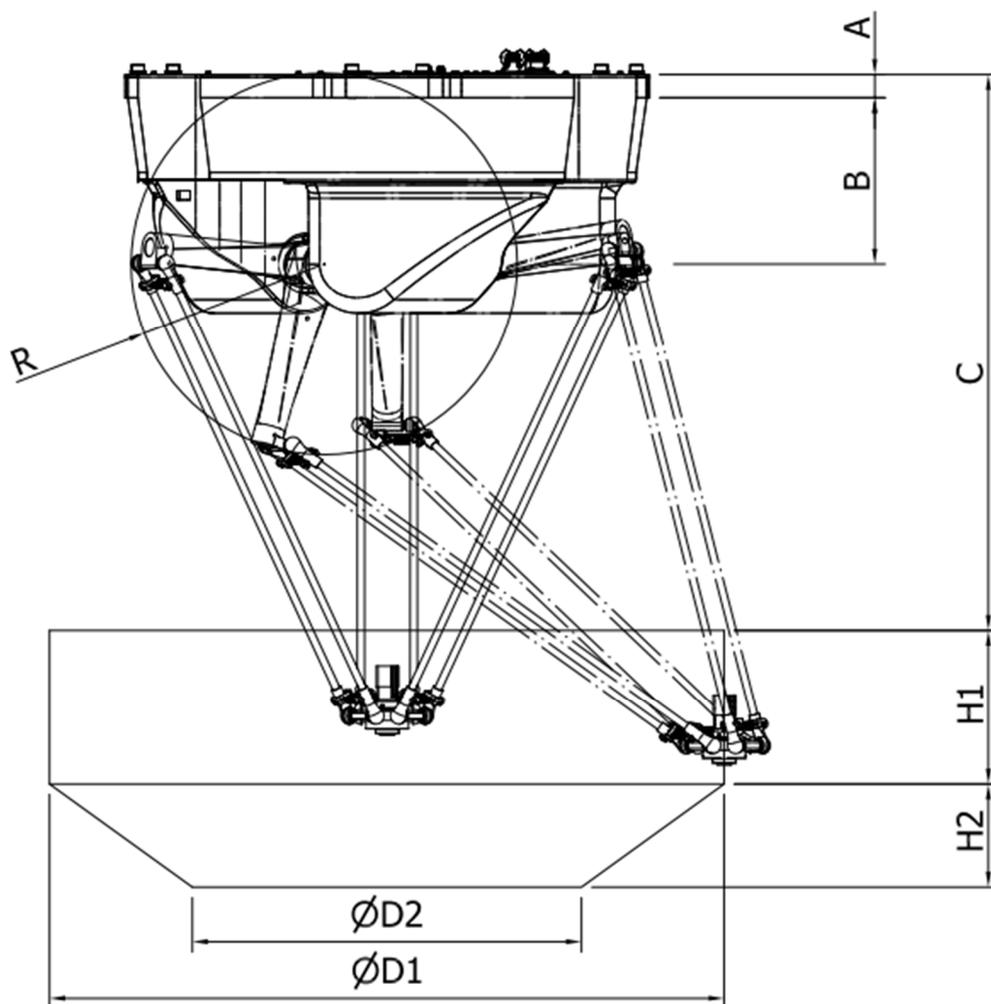
## II. Space Requirement

- **RD401 Motion Range**

Model	$\varphi D_1$	$\varphi D_2$	H <sub>1</sub>	H <sub>2</sub>	A	B	C	R
RD401-700	700	500	150	50	25	165	670	310

- **RD403 Motion Range**

Model	$\varphi D_1$	$\varphi D_2$	H <sub>1</sub>	H <sub>2</sub>	A	B	C	R
RD403-900	900	400	200	100	45	322	870	370
RD403-1300	1300	750	300	200	45	322	1057	370



- The swing angle of the upper arm and the overall motion range must be considered when establishing the installation space. Refer to the below schematic diagram for upper and lower limits of the arm.

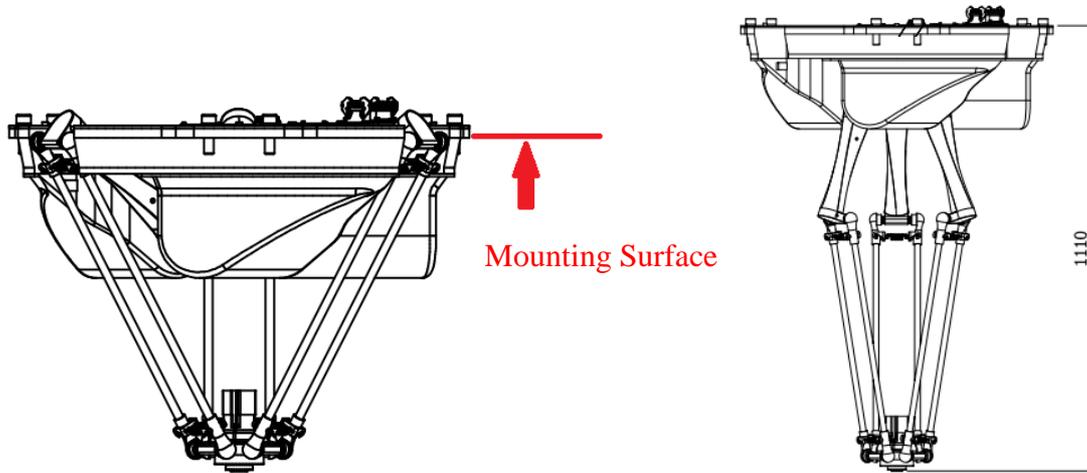


Fig. 12 Overall Angle Schematic Diagram between Upper, Lower Limit of RD401-700

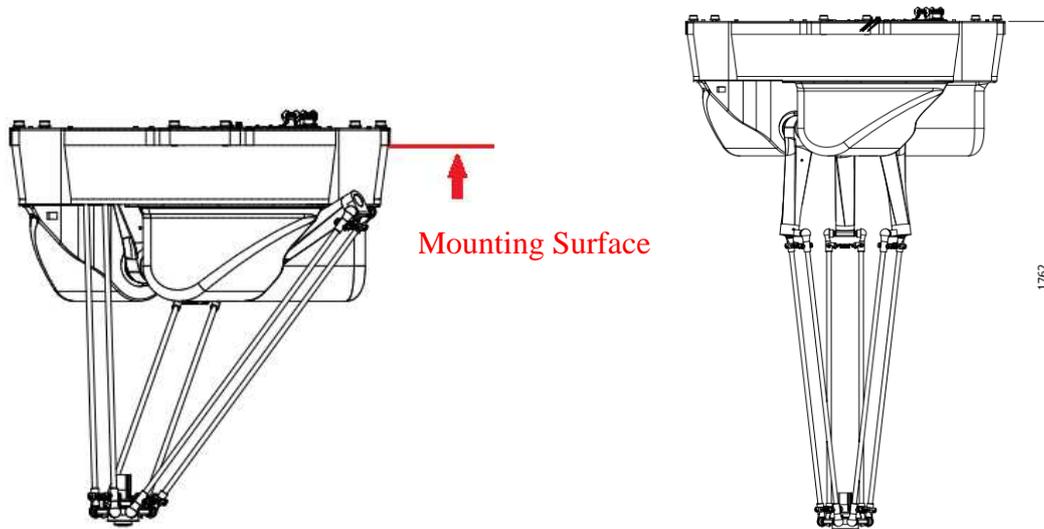


Fig.13 Overall Angle Schematic Diagram between Upper, Lower Limit of RD403-1300

	<p><b>Caution</b></p>	<p>❖ When operating the RD403-900, please do not use the upper limit for any operation.</p>
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### III. Positioning of Frame

- Please refer to page No. 26 for the related frame information.
- To ensure proper performance, the frame must be leveled in all direction after construction.
- To ensure strength, the frame can be mounted by anchor bolts.
- Prior to robot installation, it is required to confirm that the frame is secure.

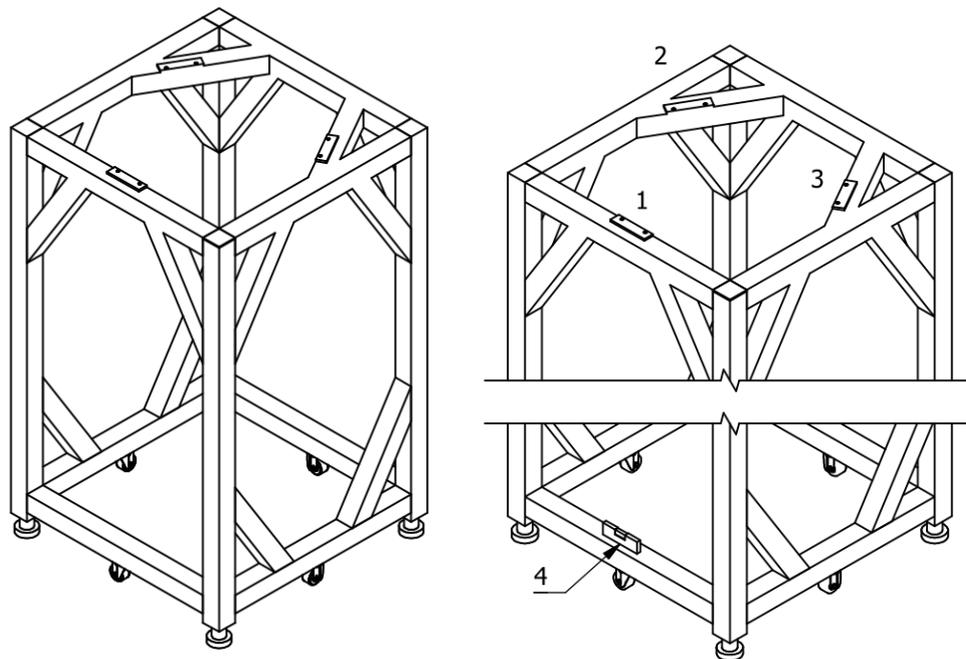


Fig.14 Schematic Diagram of Installing Points & Positioning for Frame

Item No.	Description
1	1 <sup>st</sup> Installing Point
2	2 <sup>nd</sup> Installing Point
3	3 <sup>rd</sup> Installing Point
4	Spirit Level

#### IV. Definition of Manipulator Mounting Holes

- There are three mounting points on the manipulator. The frame will have three corresponding leaning surfaces.

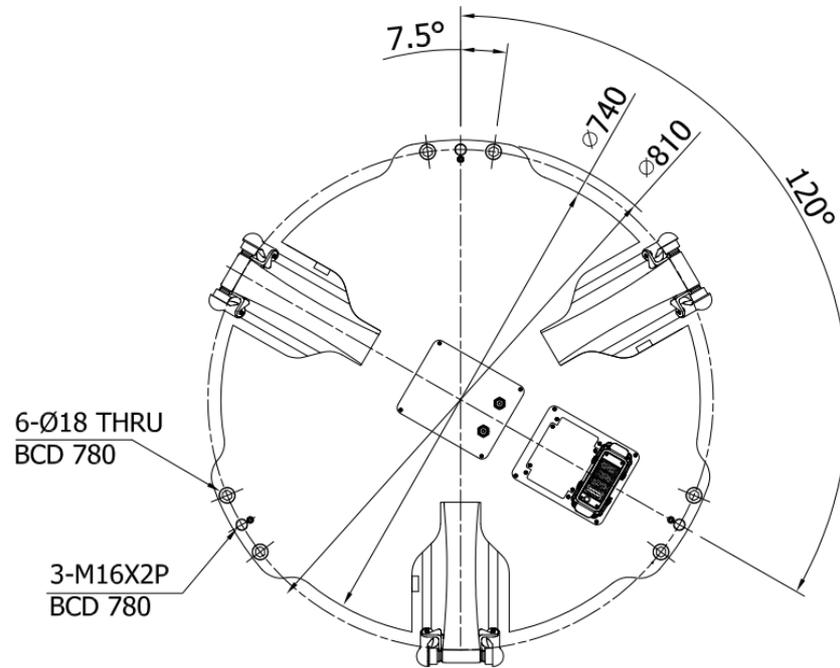


Fig. 15 Schematic Diagram of Mounting Holes for RD401-700

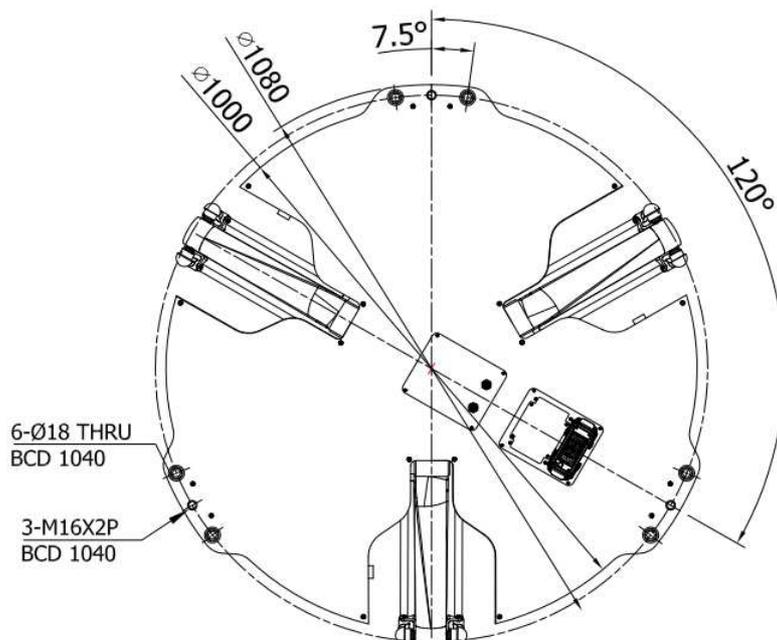


Fig.16 Schematic Diagram of Mounting Holes for RD403-900、RD403-1300

## V. Installation Process of Robot

- Please make sure to check and install the arm in accordance with the following process.

Item No.	Item	Remark
1	Confirm the robustness of frame.	
2	Prepare the parts and tools required for installation.	
3	Confirm if the arm posture will not interfere with the frame.	
4	Use the lifting equipment to lift the manipulator to the frame.	<a href="#">Please refer to page No.33</a>
5	The installation space required for the peripheral equipment shall be reserved.	
6	Lock the mounting bolts at six fixing places on the base.	M16×2P×40L*6pcs M16×2P×60L*6pcs Tightening Torque 103N-m
7	Assemble the parallel link set and movable plate.	<a href="#">Please refer to page No.52-56</a>
8	Fix 4th Axis Connecting Cable	<a href="#">Please refer to page No.57</a>
9	Place Controller.	
10	Connect Manipulator to Controller .	<a href="#">Please refer to page No.45</a>
11	Connect Teach Pendant to Controller.	<a href="#">Please refer to page No.46</a>

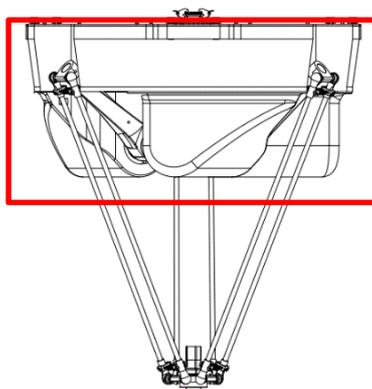


Fig.17 Schematic Diagram of Hanging Posture for Manipulator

 <p><b>Caution</b></p>	<ul style="list-style-type: none"> <li>❖ When installing robot, move upper and lower arm into base range (red frame shown in upper diagram) to avoid frame interference.</li> <li>❖ When installing robot, please avoid to use human power.</li> </ul> <p>Please refer to 2.2.1 for the required equipment to be used.</p>
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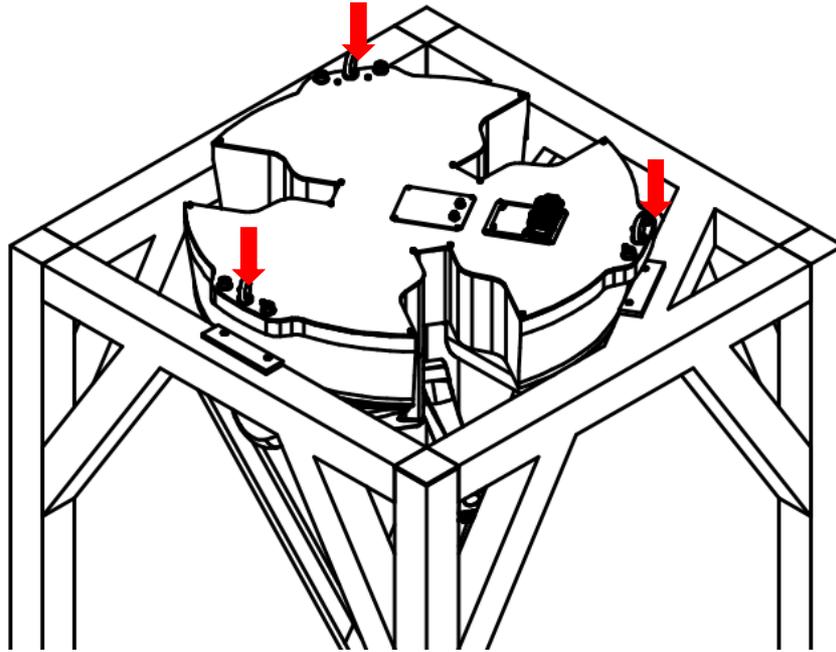


Fig.18 Schematic Diagram of Installation from Top to Underneath for Manipulator

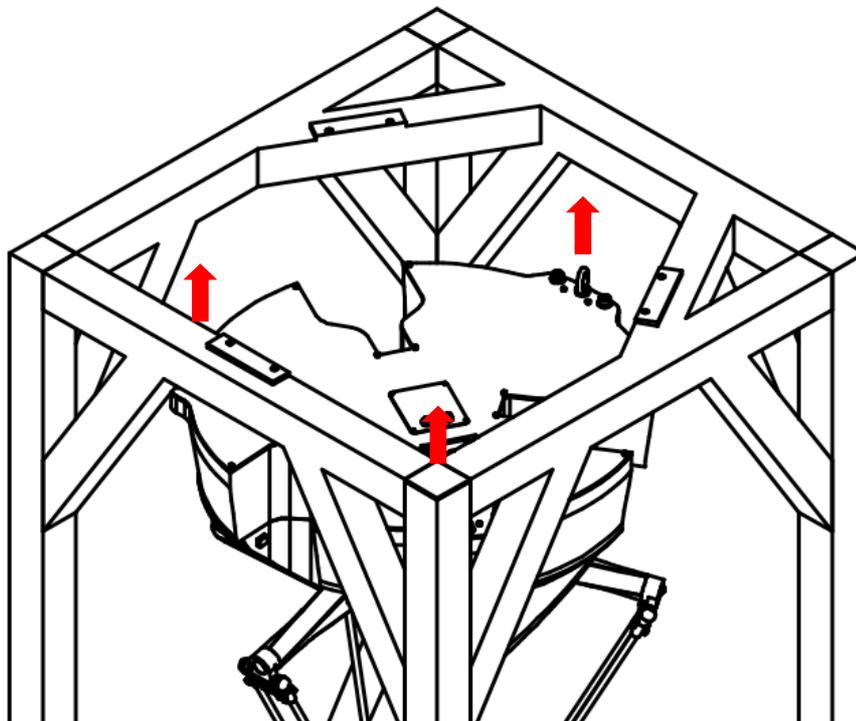


Fig. 19 Schematic Diagram of Installation from Underneath to Top for Manipulator

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

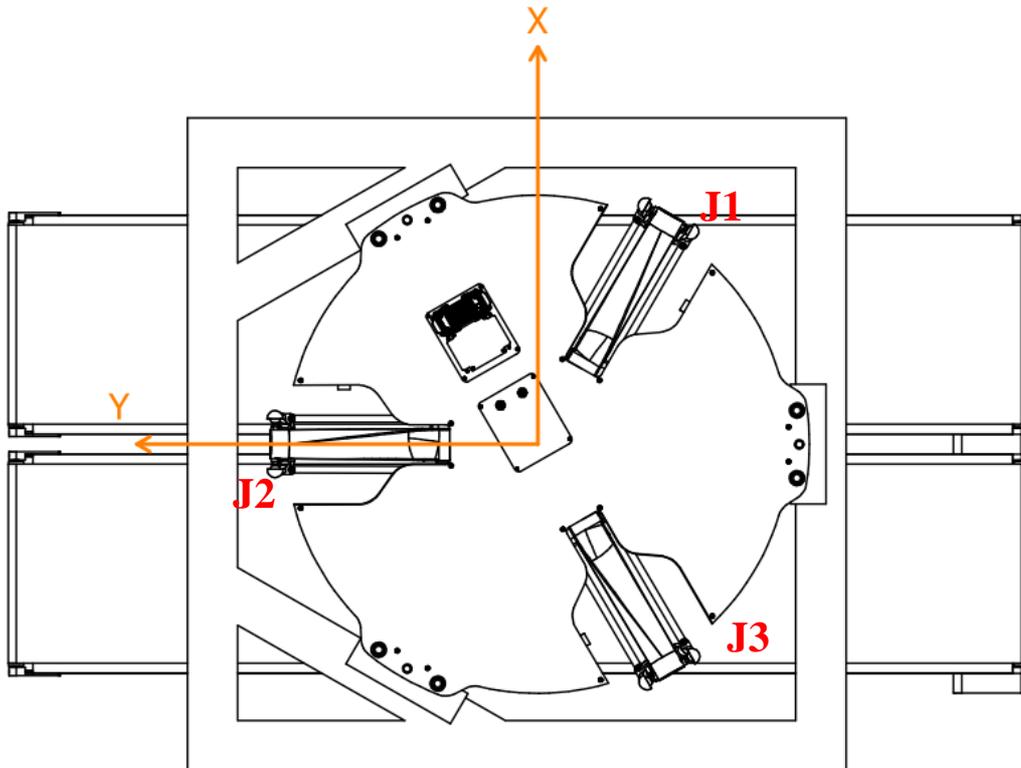


Fig. 20 Recommended Installation Mode for Arm Relative to Conveyor of Delta Robot

## VI. Calibration

- When performing the calibration, the servo motor break will need to be released manually.

 <b>Warning</b>	❖ Be aware that manual release of the break will allow the robot to move with gravity.
--	--

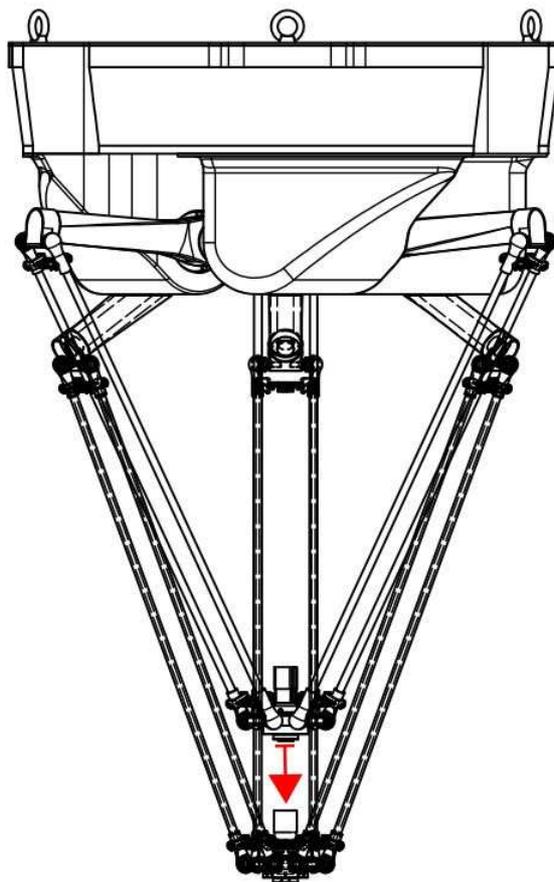


Fig.21 Fall Schematic Diagram of Robot Gravitational Pull

- [Please refer to page No.61](#) for the details of calibration procedures.

## 2.3 Electrical Connection

### I. Controller

- Name of Each Part & Function of Controller

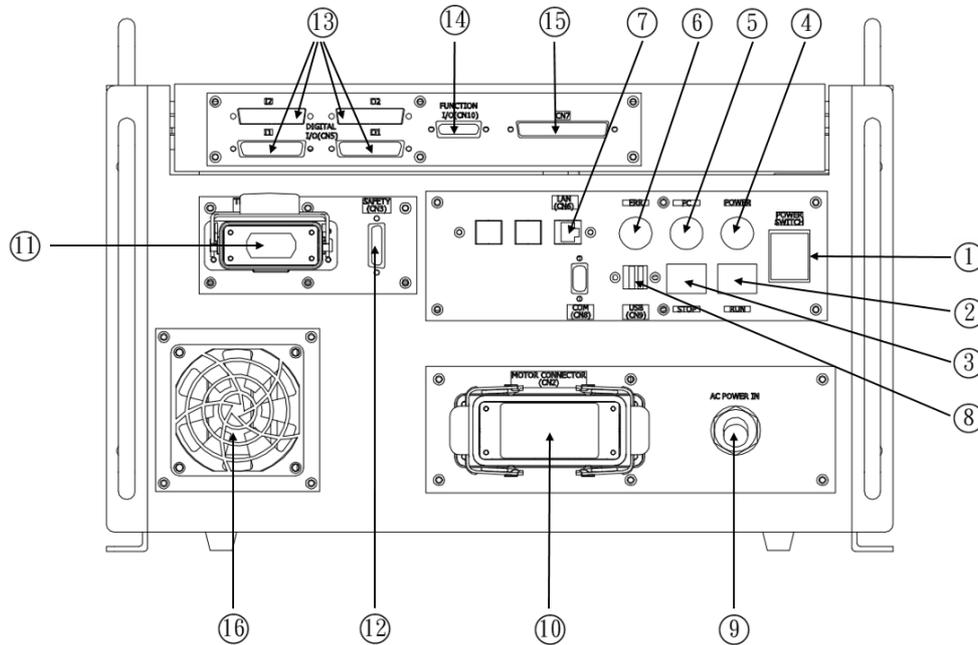


Fig.22 Connection Parts of Controller

Item No.	Name	Functional Description
1	Power Switch	Switching power ON/OFF
2	Start Button of Automatic Execution	Start program execution
3	Pause Button of Automatic Execution	Pause program execution
4	Power Indicator	Power input status of controller
5	PC Power Indicator	Display if control core of power ON/OFF is enabled
6	Error Indicator	Display if the controller is abnormal
7	LAN Connector (CN6)	Ethernet signal transmission
8	USB Connector (CN9)	USB signal transmission
9	Main Power Connector (CN1)	Power input of controller
10	Motor Connector (CN2)	Connector used to connect robot manipulator
11	Teach Pendant Connector (CN4)	Teach pendant signal transmission
12	Safety Connector (CN3)	Connector of external emergency stop button
13	Digital Input/Output Connector (CN5)	Connector of digital I/O signal transmission
14	Functional Input/Output Connector (CN10)	Connector of functional I/O signal transmission
15	Encoder Input (CN7)	Encoder extract input
16	Fan Air Inlet	Air inlet of controller fan

## II. Description of Robot Connecting Interface

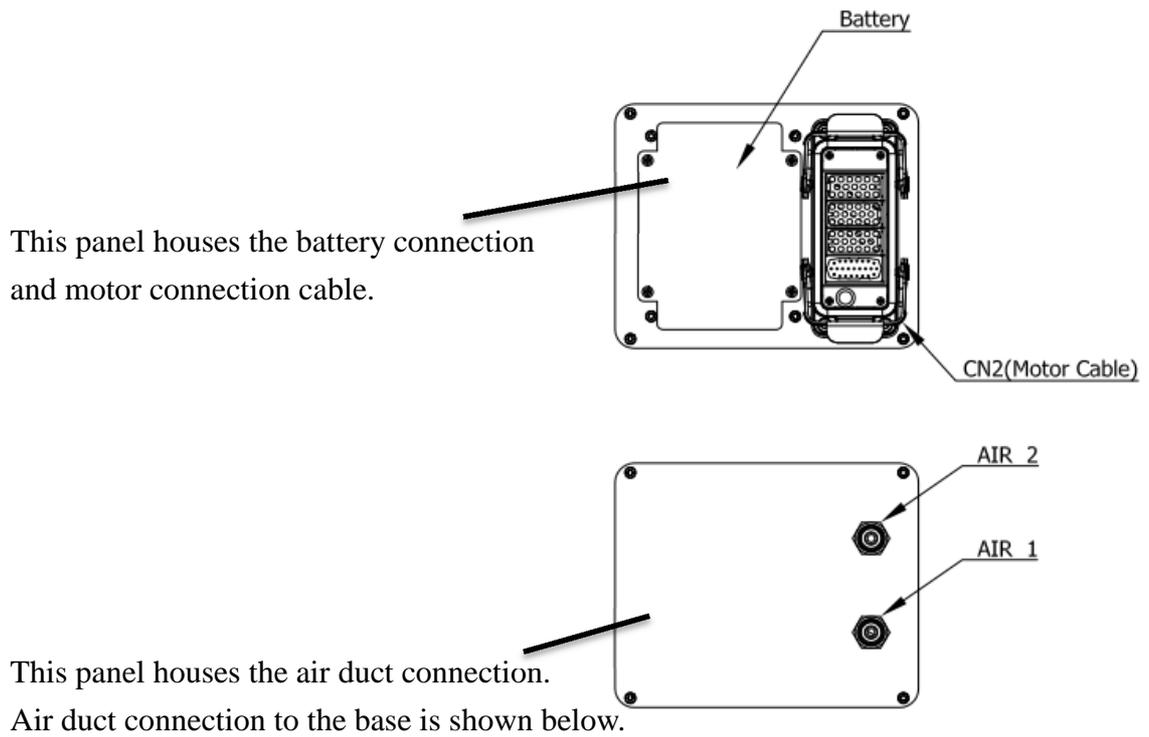


Fig. 23 Top Connection Parts of Manipulator

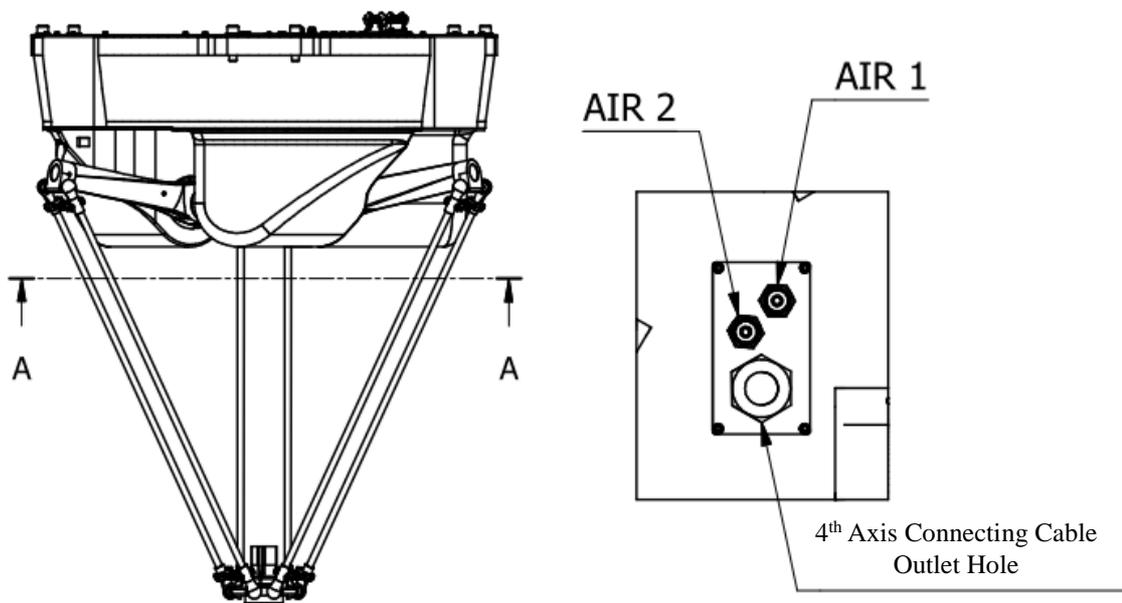


Fig.24 Underneath Connection Parts of Manipulator

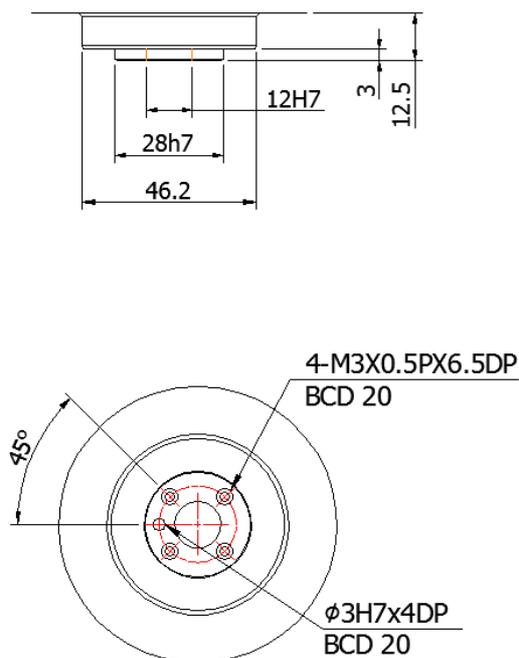


Fig.25 Hole Definition of Tool Mounting Flange

Tightening torque for Tool Mounting Flange :

Bolt strength	12.9	10.9	8.8
Tightening torque	1.7 N-m	1.5 N-m	1 N-m

 <p><b>Caution</b></p>	<ul style="list-style-type: none"> <li>❖ All connection parts are labeled. Prior to any electrical connection, confirm corresponding names.</li> <li>❖ Make sure to follow the hole definition of tool mounting flange when designing end-effector.</li> </ul>
---	--

### III. Connection of Manipulator & Controller

- **Motor power signal Cable (CN2)**
  - Installation Schematics of Manipulator Connecting Cable:

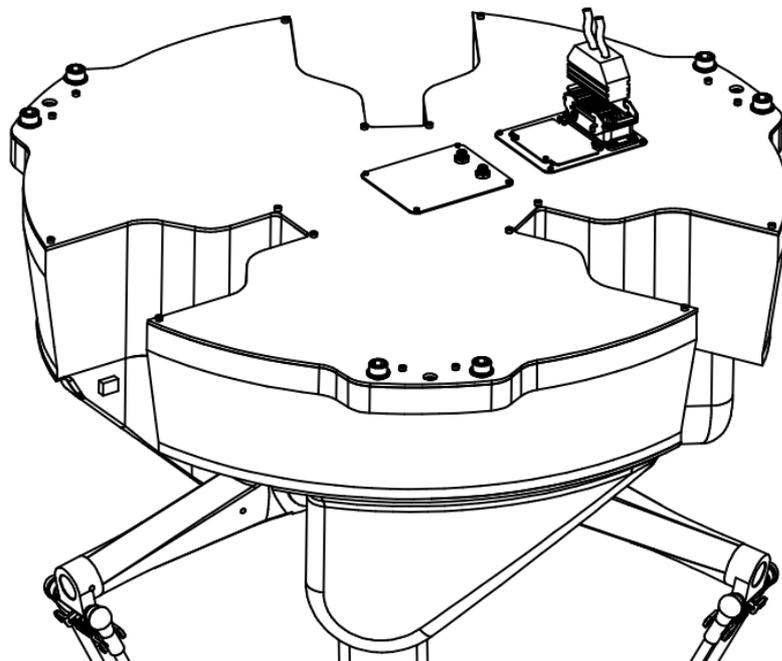


Fig. 26 Connection Schematic Diagram of Manipulator to Controller-1

- Installation Schematics of Controller Connecting Cable:



Fig.27 Connection Schematic Diagram of Manipulator to Controller-2

#### IV. Teach Pendant

- **Specification of Teach Pendant**



Fig.28 Teach Pendant

- **Specification Table of Teach Pendant:**

Item	Specification
Name	TP02
Size	318×245×107(mm)
Weight	1.4kg
Monitor	10.4 inches Touch Screen
Resolution	1024×768
Mode	Manual, Auto, Lock
Physical Button	20 Buttons, 3-position Enabling Switch (Note 1), Emergency Stop Switch
Cable Length	5 m

- Note1: 3-position Enabling Switch, under the manual mode, it can be categorized into three (3) states as follows:
  - Release Button: Robot is unable to move.
  - Tapping Switch: R1506obot is able to move and teach.
  - Firmly Press Button: Robot is unable to move.

Press one of the 3-position enabling switches on the left or right to operate the robot.

- **Name & Function of Teach Pendant**



Fig.29 Front View of Teach Pendant

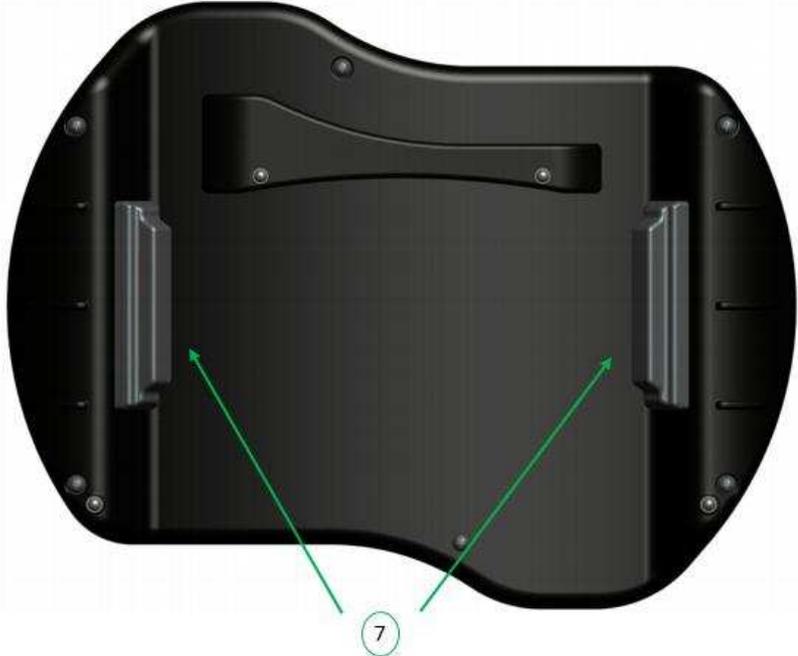


Fig.30 Rear View of Teach Pendant

➤ **Functional Key Definition of Teach Pendant:**

Item No.	Name	Function
1	Emergency Stop Switch	Perform the emergency stop, it will cut off the power of driver, stop all movement, and cut off the control system of robot.
2	Mode Changeover Switch	Switch the operating mode, there are manual, auto, & lock three (3) modes
3	Operation Key of X, Y Direction	Able to proceed the movement of X, Y direction
4	Operation Key of Z Direction	Able to proceed the movement of Z direction
5	Speed Operation Key	Change robot speed
6	Operation Key of Single Axis	Proceed the independent movement of single axis
7	3-stage Safety switch	Equip with 3-stage press switch, when release and firmly press, robot will stop directly, tap the switch will be able to operate the robot.

• **Installation Mode of Teach Pendant**



Fig.31 Schematic Diagram of Teach Pendant Installation Mode

※ Please refer to the operating manuals of multi-axis robot controller and robot system software for the detailed instruction of use.

### 3. Maintenance

#### 3.1 Maintenance Schedule

- **Foreword**
  - All the maintenance information and items shall be mainly based on the maintenance schedule table.
  - Please refer to the replacement schedule table for replacement information and consumables.
  - The maintenance schedule and consumable replacement schedule will vary based on the the actual usage situation and environment, please determine if the maintenance or repair is required in accordance with the reference data stated in the maintenance procedures.
  - Each maintenance procedure includes the required information and material.
- **Safety Information**

 <b>Caution</b>	<ul style="list-style-type: none"> <li>❖ Prior to maintenance, power system should be stopped and make sure if grounding is completed and all safety precautions should be taken.</li> </ul>
--	--

- **Routine Maintenance**
  - Routine maintenance ensure the working efficiency of the robot and reduces the possibility of unscheduled maintenance.
  - The maintenance schedule will vary due to the operating environment where the robot is located.
  - Regular Checks:

Item No.	Item	Remark
1	Check the wear degree of plastic washer, if there is damage, please replace.	
2	Check the wear degree of bushing, if there is damage, please replace.	
3	If the reducer has the oil leakage, please contact the technician.	
4	Check the wear degree of four axis circuit, if there is damage, please contact the technician.	
5	Check the connecting cable between the robot manipulator and controller if there is any wear.	

• **Maintenance Schedule Table**

Maintenance Item	Maintenance Procedure	Maintenance Hours (hr)				
		500	1500	3000	6000	15000
End Effector	Check	√				
Peripheral Equipment	Check		√			
Lower Arm	Check		√			
Upper Arm	Check			√		
Spring Unit	Check	√				
Movable Plate	Check				√	
4 <sup>th</sup> Axis Connecting Cable	Check				√	
Reducer	Check					√
Encoder Battery	Please replace at low voltage		√			

- The low voltage warning of encoder battery (6036~6039 encoder error) will be displayed on the tech pendant, please replace the battery when necessary.
- Lubricate the joint portion when necessary.

• **Replacement Schedule Table of Consumables**

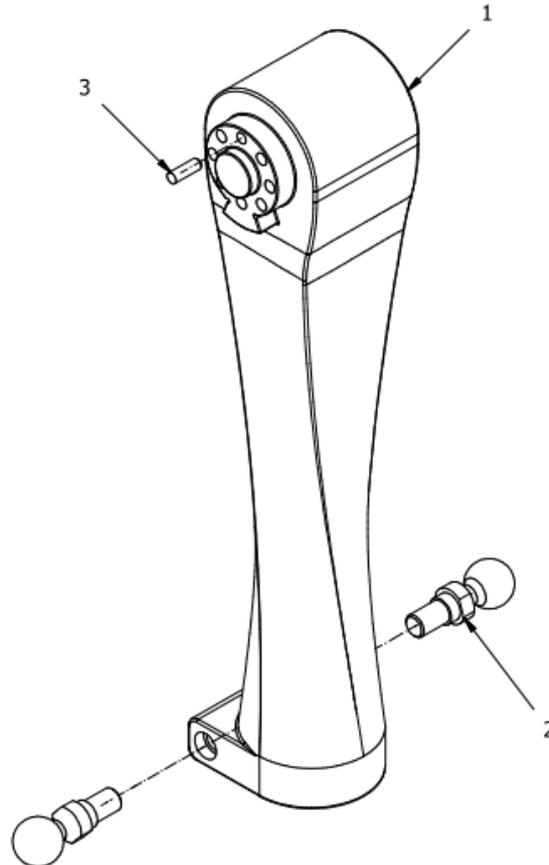
Item	Recommended Replacement Hours (hr)
Plastic Washer	3000
Bushing	3000
Spring	3000
Encoder Battery	6000

 <p><b>Caution</b></p>	<ul style="list-style-type: none"> <li>❖ The calculation of recommended replacement hours is the accumulated hours under continuous operation.</li> <li>❖ The calculation of recommended replacement hours is the accumulated hours under continuous operation.</li> </ul>
---	--

### 3.2 Maintenance

#### I. Upper Arm

- Please check the upper arm per 3000 hours.
- Exploded View of Upper Arm:



Item No.	Name	Qty
1	Upper Arm	1
2	Ball Joint	2
3	Pin	1

- Maintenance Procedures:

Item No.	Item	Remark
1	Check the outer surface of upper arm if there is any crack.	
2	Check the surface of ball joint if there is any crack.	

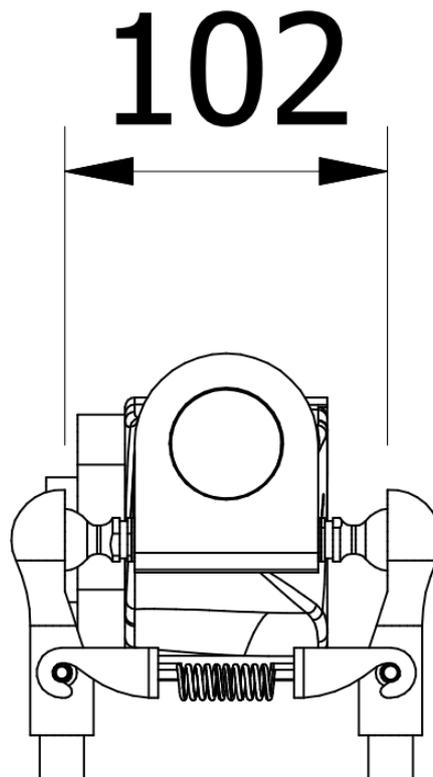


**Danger**

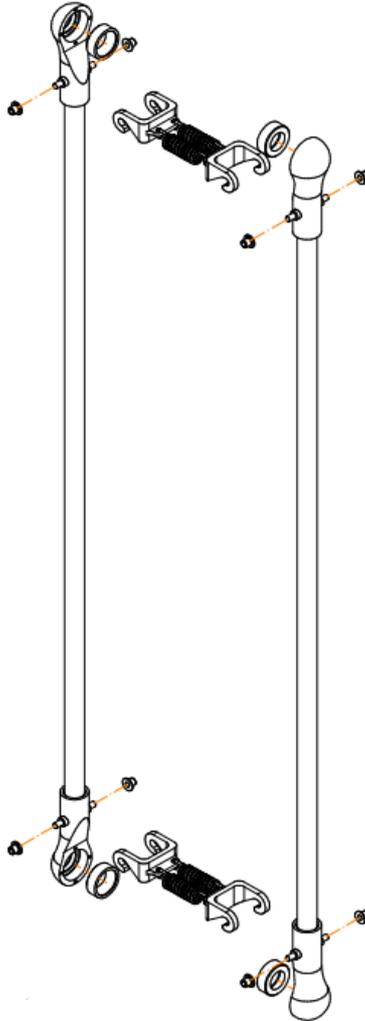
- ❖ Prior to maintenance, power, pneumatic and hydraulic systems should be stopped and all safety precautions should be taken.

## II. Lower Arm

- Please check the lower arm per 1500 hours. ◦
- The wear of plastic washer depends on the usage conditions and environment.
- The replacement condition of plastic washer depends on the distance between two ball joints, shown as the figure below. When the distance between two ball joints is less than 102mm, it is recommended to replace the plastic washer.

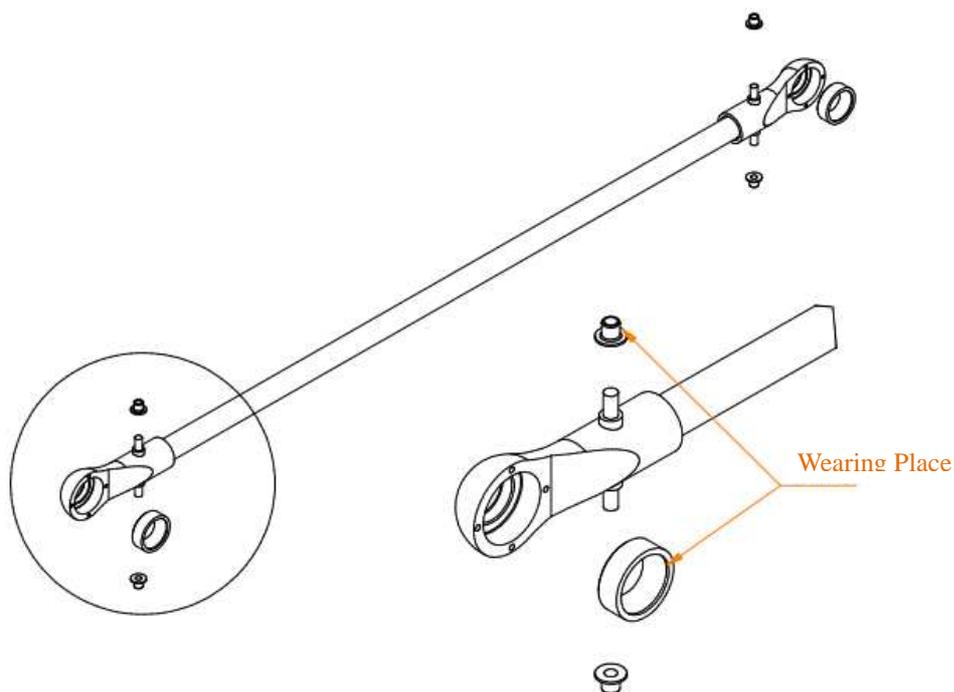


- Disassembly of lower arm shall follow the figure shown as below to avoid damaging parts.
- Exploded View of Lower Arm:



**Danger**

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



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

➤ Maintenance Procedures:

Item No.	Item	Remark
1	Check the wear degree of plastic washer, if there is any damage, please replace.	
2	Check the wear degree of bushing, if there is any damage, please replace.	
3	Check if the outer surface of lower arm if there is any crack.	

### III. Spring Unit

- Please check the spring unit per 500 hours.

 <b>Danger</b>	<ul style="list-style-type: none"> <li>❖ Prior to maintenance, power, pneumatic and hydraulic systems should be stopped and all safety precautions should be taken.</li> </ul>
---	--

- Schematic Diagram of Wearing Point for Spring Unit:



Item No.	Name	Qty
1	Hook	12
2	Spring	12

- Maintenance Procedures:

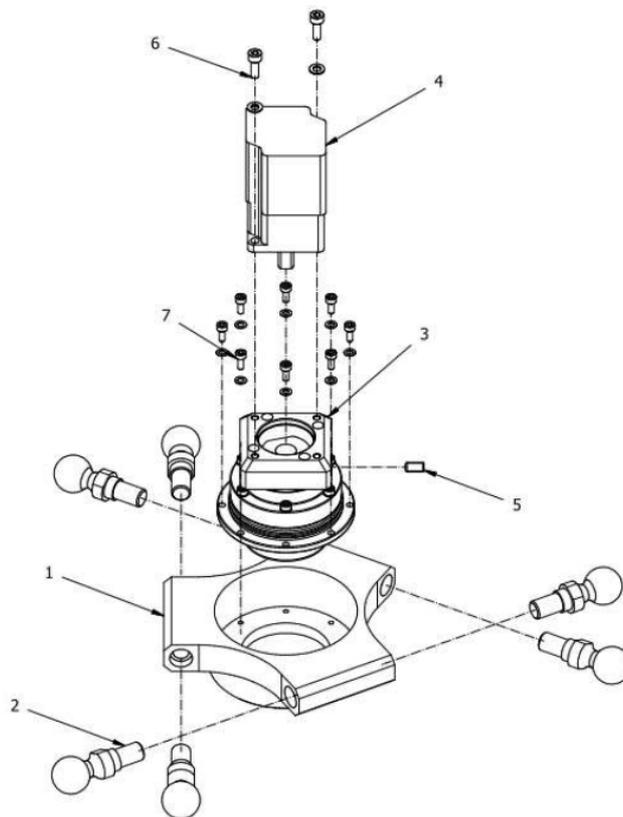
Item No.	Item	Remark
1	Check the wear degree of retaining ring.	
2	Check if the spring has any wear.	

**IV. Movable Plate**

➤ Please check the movable Platform per 6000 hours.

 <b>Danger</b>	<p>❖ Prior to maintenance, power, pneumatic and hydraulic systems should be taken and all safety should be taken.</p>
---	---

➤ Exploded View of Movable Platform:



Item No.	Name	Specification	Qty
1	Movable Platform		1
2	Ball Joint		6
3	Reducer		1
4	Motor		1
5	Set screw		1
6	Screw	M4X0.7PX12L	2
7	Screw	M3X0.5PX8L	8

➤ Maintenance Procedures:

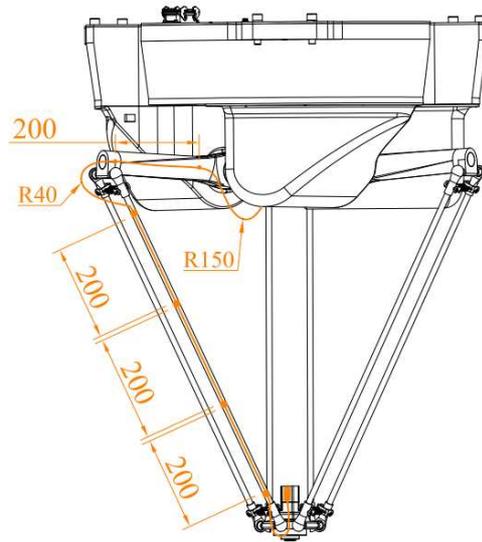
Item No.	Item	Remark
1	Check if the outer surface of movable plate has any crack.	
2	Check if the ball joint has any crack.	

**V. 4<sup>th</sup> Axis Connecting Cable**

- Please check the 4<sup>th</sup> axis connecting cable per 6000 hours.

 <b>Danger</b>	<ul style="list-style-type: none"> <li>❖ Prior to maintenance, power, pneumatic and hydraulic systems should be stopped and all safety precautions should be taken.</li> </ul>
---	--

- Wiring Schematic Diagram of 4<sup>th</sup> Axis Connecting Cable:



- Maintenance Procedures:

Item No.	Item	Remark
1	Check if the 4 <sup>th</sup> axis motor has any damage, if yes, please contact technician.	
2	Check the wear degree of 4 <sup>th</sup> connecting cable, if there is any damage, please contact technician.	
3	Check the sealability of waterproof connector.	

 <b>Caution</b>	<ul style="list-style-type: none"> <li>❖ The bending angle shall be reserved at the joint of 4<sup>th</sup> axis connecting cable, and shall fix the position of connecting cable.</li> <li>❖ When install the 4<sup>th</sup> axis connecting cable, the cable shall be closely fitted to the lower arm and fixed, please do not have the winding situation to avoid damaging the cable and reducing the lifetime.</li> <li>❖ When installing the 4<sup>th</sup> axis connecting cable, please operate manually at the lowest speed (T1 mode) to avoid winding 4<sup>th</sup> axis cable. For software instructions, please refer to HIWIN Robot System Software.</li> </ul>
--	--

## VI. End Effector

- Please check the end effector per 500 hours.

 <b>危險</b> Danger	❖ Prior to maintenance, power, pneumatic and hydraulic systems should be stopped and all safety precautions should be taken.
--	--

- Maintenance Procedures:

Item No.	Item	Remark
1	Check the end effector.	Please refer to the described documents of that end effector.
2	Check if the pneumatic pipe is damaged.	
3	Check the sensor connecting cable.	

## VII. Peripheral Equipment

- Please check the related peripheral equipment per 1500 hours.

 <b>Danger</b>	❖ Prior to maintenance, power, pneumatic and hydraulic systems should be stopped and all safety precautions should be taken.
--	--

- The degree of peripheral equipment wear depends on usage.

### 3.3 Replacement of Encoder Battery

- **Precautions**

- Since the encoder of servo motor is absolute type, therefore, it has the encoder battery, use to record the absolute encoded value.
- When turn off the power of driver, it will enable the encoder battery to record the absolute encoded value, the lifetime of battery depends on the actual usage situation, the average is 12 months.
- During the operation, the low voltage of encoder battery (A830) will be displayed on the driver.

 <b>Danger</b>	<ul style="list-style-type: none"> <li>❖ Prior to performing maintenance, power, pneumatic and hydraulic systems should be stopped and all safety precautions should be taken.</li> </ul>
---	---

- After replacing the encoder battery, please recalibrate the robot. [Please refer to page No.57](#) calibration.
- When replace the battery, please replace one single battery at a time, do not remove all batteries at once.
- Maintenance Procedures:

Item No.	Item	Remark
1	Replace encoder battery.	
2	Recalibrate robot.	

 <b>Caution</b>	<ul style="list-style-type: none"> <li>❖ When replacing encoder battery, do not remove all batteries at once. This will cause the encoder value to be forgotten due to power discontinuity.</li> </ul>
--	--

### **3.4 Cleaning**

- **General Precautions**
  - The protection of robot is defined in accordance with specification IEC529.
  - Prior to cleaning, power, pneumatic and hydraulic systems should be stopped and all safety precautions should be taken.
  - The cleaning mode is determined in accordance with the protection level of robot, the current protection level of robot is IP40.
- **IP40 Protection Degree**
  - Wipe down is recommended for cleaning. Water flushing is prohibited.
  - Corrosive cleaner will damage surface of parts and cables and should not be used.

## 4. Calibration

### 4.1 Definition of Calibration Point

- **Precautions**
  - When performing calibration, the servo motor brake should be released manually.

 <p style="font-size: 24pt; font-weight: bold; margin: 0;">Caution</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 release the brake manually, the robot will move due to the influence of gravity or external force, special attention shall be paid to the operation.</li> </ul>
---	--

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

The reasons of disappearing the absolute encoder value are listed as follows:

- A. Insufficient power of battery.
  - B. Encoder error.
  - C. Abnormal connection between the encoder and encoder battery.
- When crash occurs to the robot.

- **Definition of Calibration Point**

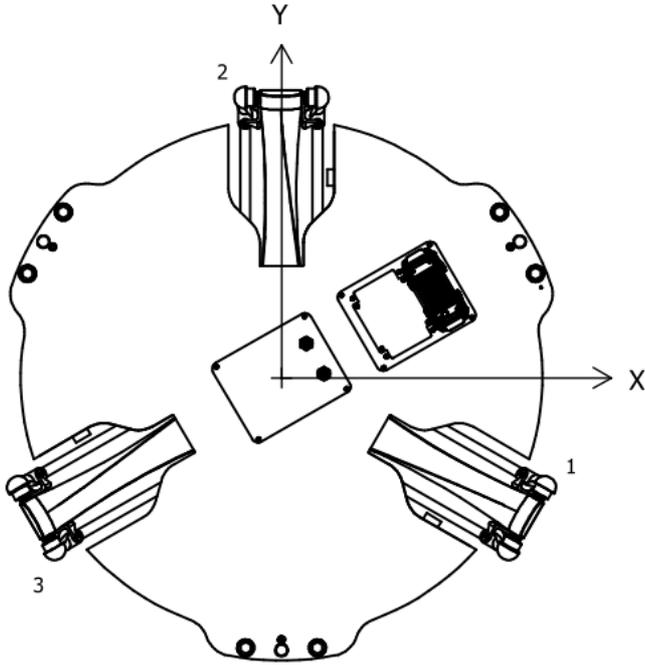


Fig.32 Schematic Diagram of Robot Coordinate Relation

Item No.	Item
1	Axis 1
2	Axis 2
3	Axis 3

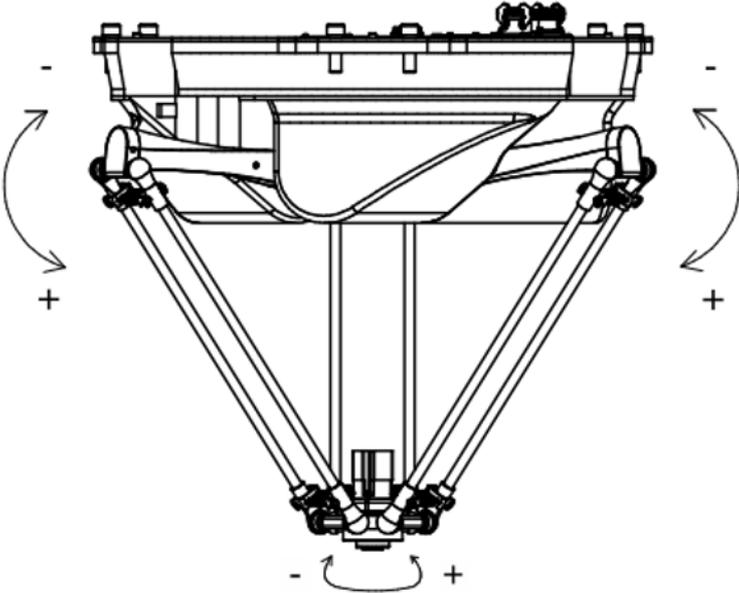


Fig. 33 Schematic Diagram of Robot Axial Direction

- **Calibration Method**
- Calibration of Delta Robot is performed through the mechanical limiting device.
- There are buttons on the three axis arm used for releasing brake which are labelled as BR1, BR2 and BR3.
- When the 1<sup>st</sup>, 2<sup>nd</sup> 3<sup>rd</sup> axis of RD401-700 locate at the upper limit calibration position, its angle is  $-31.79^\circ$ ; its angle is  $78.21^\circ$  at the lower limit calibration position.
- When the 1<sup>st</sup>, 2<sup>nd</sup> 3<sup>rd</sup> axis of RD403-1300 locate at the upper limit calibration position, its angle is  $-65.24^\circ$ ; its angle is  $87.76^\circ$  at the lower limit calibration position.
- When the 1<sup>st</sup>, 2<sup>nd</sup> 3<sup>rd</sup> axis of RD403-900 locate at the lower limit calibration position, its angle is  $87.76^\circ$ .

 <b>Caution</b>	❖ Please use the lower limit to calibration RD403-900 ◦
--	---

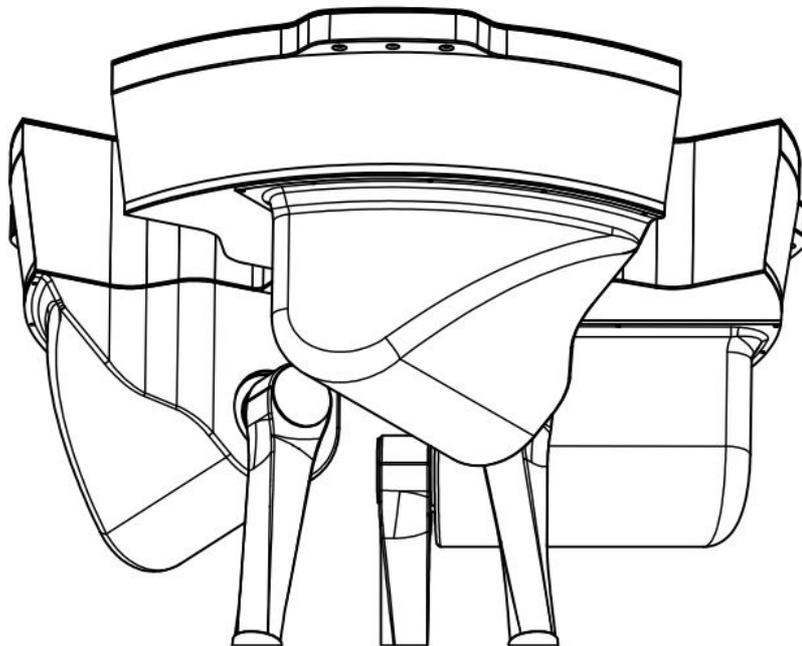


Fig. 34 Schematic Diagram of Calibration Position

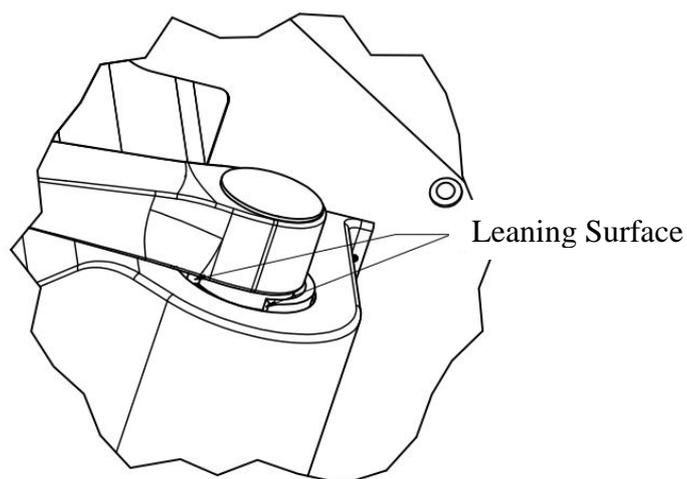


Fig. 35 Schematic Diagram of Calibration Leaning Surface

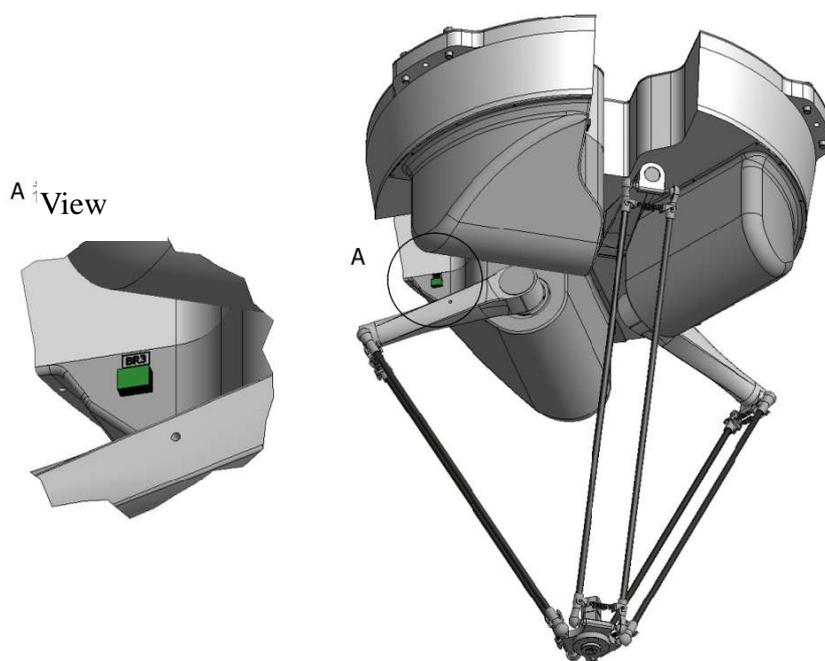


Fig. 36 Schematic Diagram of Single Axis Releasing Button



**Caution**

- ❖ When performing calibration, avoid moving all three arms simultaneously. Calibration should be performed on each arm separately.

## 4.2 Calibration Standard Procedures

- **Precautions**
  - The calibration personnel should have appropriate education/training and license.
- **Calibration Standard Procedures**

Item No.	Item	Remark
1	Press the emergency stop switch on the teach pendant.	
2	Continue pressing the brake release button of single axis to release the brake of that axis servo motor.	
3	Adjust that axis to the calibration position.	
4	Release the brake release button of single axis (arm restore the brake of servo motor immediately).	
5	Use the operating software of teach pendant to clear the encoder value.	
6	Restore that axis closing to the level state.	
7	Repeat step 2~6 in sequence for the other axis.	
8	Determine the angle position of each axis in the software (please refer to page No.58 Calibration for the angle value).	
9	Release the emergency stop switch on the teach pendant, and clear the software error on the teach pendant.	
10	Complete calibration	

- **Confirmation of Calibration**
  - After completing the calibration, check if the icon of arm posture on the teach pendant is same as the actual arm posture.
  - Please make sure to confirm the calibration position to avoid the crash.
  - Release the brake manually, place each axis to the calibration position, and confirm if the angle is the correct calibration angle.

 <b>Caution</b>	❖ This calibration portion only describes the operating steps of manipulator, please refer to the robot system software operating manual for the detailed operation.
--	--



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