Safety and Notice

1. Safety Information
   a. This safety information neither contains how to design, install and run a complete workstation or production line, nor ensure the whole system safety
   b. All machines must be designed and installed according to the industrial safety regulations to guarantee user safety
   c. HIWIN robot users have the responsibility to design and install safety devices that are in compliance with industrial safety regulations
   d. This manual can help prevent but not guarantee safety hazards
   e. Besides the built-in safety loop, the robot also provides an interface for an external safety device, which can receive external signals that provides additional control

2. Safety Symbol
   ![DANGER](image)
   These practices will prevent serious personal injury
   ![WARNING](image)
   These practices will prevent personal or property damage
   ![CAUTION](image)
   These practices ensure proper operation and technique

3. Safety Grade
   a. The following symbols are used frequently throughout this document as safety advisory. Please carefully read the following and always follow them before operating the robot.

   ![DANGER](image)
   ▲ Do not store the machine near flammable gas, flammable objects, or corrosive areas
   ▲ Do not operate the machine in heavy moisture, water or grease
   ▲ Do not operate the machine in an environment with strong vibrations or impacts
   ▲ Keep all electrical lines away from grease or water
   ▲ Do not connect or operate the machine with wet hands
   ▲ Make sure the controller is properly grounded
   ▲ Do not touch heat sink, power supply, or the controller during or shortly after operation due to high temperatures
   ▲ Disconnect power before moving, connecting, or checking/maintaining the controller
   ▲ Emergency stop switch must be installed in an appropriate location, which can easily be operated
   ▲ When the emergency stop is pressed, the robot must immediately stop moving
   ▲ Do not open the controller cover, any questions should be directed to our engineers
Do not stand or put heavy objects on the product
Do not block the outlet or put foreign objects on it
Ensure the robot is securely fixed onto the base
Do not pull or twist the electric wires
Do not repeatedly toggle any of the on/off switches
Ensure that the robot emergency stop switch and the controller are functioning properly before performing any work
Do not shut off the power during robot operation
Do not open, modify, disassemble or maintain the machine without consulting with HIWIN engineering
Turn the power off if the robot won’t be operating again soon

All operations must be executed by trained staff members
The controller must be kept away from high voltage or components that may generate electromagnetic fields, because this can lead to malfunction or damage
When doing test runs, keep the speed low and watch the operating conditions to prevent any unforeseen dangers
Do not turn the power off to the controller when modifying programs/parameters. This will damage the data stored in the controller or result in data loss

4. Safety Risks
   a. Installation
      i. Ordinary Risk
         1. Standard installation procedures demonstrated in this manual must be followed
         2. The emergency stop switch must be installed at an easily operable location
         3. The person who installs the robot must be trained and authorized
         4. Always follow the installation and safety requirements described in this manual to ensure personal safety
      ii. Risk Without Electric Shock
          1. A safety area must be set outside the working range of the robot, and a safety device must be used to prevent unauthorized entrance within the working range
          2. After the servo motor brake is released, the robot may move due to gravity
          3. When installing/disassembling any mechanical parts, be aware of falling parts which may hurt the operator
          4. Be aware of high temperatures produced by the controller
          5. Do not allow any climbing of the robot
   b. End Effector
      i. The end effector can be classified as two types:
         1. Gripper: Used to load and unload. These are typically pneumatic, hydraulic, electric, or vacuum.
         2. Tool: Used to compete a process. For example, welding, cutting, grinding, surface treatment, etc.
ii. The gripper-type end effector should prevent the workpiece from dropping or damaging when the robot encounters a power error or other errors (determined in the design phase)

iii. The end effector could be equipped with the control unit. The position must be noted to avoid robot interference

c. Pneumatic and Hydraulic Systems

**WARNING**

The tool-type end effector is usually equipped with high voltage, high temperature, or moving parts. Special attention should be paid during operation. Pressure in pneumatic and hydraulic systems may run several times higher than atmospheric pressure.

i. Be sure to relieve the pressure in pneumatic/hydraulic systems after the power is disconnected

ii. Internal pressure must be released before the pneumatic/hydraulic systems are maintained

iii. While pneumatic/hydraulic systems are operating, the clamped workpieces can be dropped due to insufficient working pressure

iv. Pneumatic/hydraulic systems must be equipped with a relief valve, for emergency situations

d. Working Environment Risks

i. The industrial robots can be modified for the different industrial environments

ii. All operating procedures must be specified under professional evaluation and according to the industrial safety regulations

iii. Maintenance must be conducted by trained personnel who clearly understand the procedures for the entire system and the risks associated

iv. When the operating procedures are interrupted, pay close attention during troubleshooting

e. Emergency Stop

i. When pressed, motor power is cut off

ii. When pressed, all actions are stopped and the control system disconnects

iii. To restart operating procedures, the emergency stop switch must be reset and the emergency error must be cleared on the pendant

iv. Emergency stop performs an immediate stop, by cutting all power to the motors

v. If the brakes are not applied on joints, the robot may fall by its own weight

vi. The emergency stop switch is used for emergency only

vii. Avoid using the emergency stop instead of the normal stop

viii. The HIWIN robot is equipped with two emergency stop switches; one is installed on the teach pendant, and the other is directly connected to the controller via the wires

ix. If other emergency stop switches are required, other connections can be installed for the same purpose

x. Based on the relevant industrial safety regulations, the emergency stop switch is directly connected to the controller of the robot via physical wires
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1. Introduction

1.1 Product Specifications

The product specifications are shown in Table 1-1.

<table>
<thead>
<tr>
<th>Model No.</th>
<th>Unit</th>
<th>RA605-710</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freedom</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Load capacity</td>
<td>kg</td>
<td>5</td>
</tr>
<tr>
<td>Maximum Motion Radius</td>
<td>mm</td>
<td>710</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Working Range</th>
<th>Degrees</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>J1*</td>
<td>±165</td>
<td></td>
</tr>
<tr>
<td>J2*</td>
<td>+85 ~ -125</td>
<td></td>
</tr>
<tr>
<td>J3*</td>
<td>+185 ~ -55</td>
<td></td>
</tr>
<tr>
<td>J4</td>
<td>±190</td>
<td></td>
</tr>
<tr>
<td>J5</td>
<td>±115</td>
<td></td>
</tr>
<tr>
<td>J6</td>
<td>±360</td>
<td></td>
</tr>
</tbody>
</table>

| Standard Cycle Time**    | sec      | 0.50      |
| Repeated Accuracy        | mm       | ±0.02     |

| Tolerant Torque          | N-m      |           |
| J4                       | 8.46     |           |
| J5                       | 8.46     |           |
| J6                       | 5.6      |           |

| Tolerant Rotation Inertia | kg-m²    |           |
| J4                       | 0.35     |           |
| J5                       | 0.35     |           |
| J6                       | 0.14     |           |

| Wrist Line               |          | 6 Input Point & 4 Output Point |
| Pneumatics              | φ4×2 (AIR IN & AIR OUT) |
| Connection Line         | m        | 3m (between robot and controller) |
| Controller              |          | RCA605 |
| Weight                  | kg       | 40 (not including controller) |

*Joint one, joint two, and joint three’s movement is limited by a mechanical stopper
**The cycle time is the time it takes the robot to move 25mm vertically, 300 mm horizontally, then -25 mm vertically, while holding 1 kg. The movement is shown in figure 1-1.

![Figure 1-1: Cycle Time Trajectory](image)
1.2 Appearance Dimension/Motion Range

The appearance dimensions and motion range are shown in Figure 1-2 and Figure 1-3.

**Figure 1-2: Appearance Dimensions**

**Figure 1-3: Motion Range**
1.3 Load Rating of Robot End
The load rating of the robot end not only limits the weight but also the position of gravity when the load’s center of gravity varies. Figure 1-4 shows the allowed position of gravity, when the load varies from 1kg to 5kg.

Figure 1-4: Illustration of Load Geometry

WARNING The transportable load weight is greatly related to the motion position and speed of the robot. This could produce a current overload even in the allowable range of the load. When this situation occurs, the position and speed will be changed.
1.4 Robot and Accessories

The RA605 package comes with a lot of accessories! Besides the physical robot, there are cables, calibration tools, emergency stop buttons, etc. A complete list of accessories is shown in table 1-2. Following that is an optional list of accessories, which are explained later in the catalog.

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Model No.</th>
<th>Quantity</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Calibration Set</td>
<td></td>
<td>1</td>
<td>Home calibration</td>
</tr>
<tr>
<td>2</td>
<td>Set of Fixing Plates</td>
<td></td>
<td>1</td>
<td>Fixing for robot</td>
</tr>
<tr>
<td>3</td>
<td>Stylus Pen</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>End I/O Connector</td>
<td>PLT-1112-PM</td>
<td>1</td>
<td>For end I/O</td>
</tr>
<tr>
<td>5</td>
<td>Main Power Line</td>
<td>CN1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Motor Signal Line</td>
<td>CN2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Signal Connection</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Controller Key</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Cotton Core</td>
<td></td>
<td>2</td>
<td>For controller inlet</td>
</tr>
<tr>
<td>10</td>
<td>Set of Emergency Stop Switch</td>
<td></td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Model No.</th>
<th>Quantity</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Suspension Plate for Transportation</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Base of Robot</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Lithium Battery</td>
<td></td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Set of Mechanical Stops for axis 1</td>
<td></td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
2. Unpack and Install

2.1 Unpack

The package of the robot that the customer receives is shown in Figure 2-1. The following procedures to unpack must be followed when the robot is unpacked:

**Figure 2-1: Package Diagram**

**Step 1:** Cut and remove the package strips
**Step 2:** Remove the box, as shown in Figure 2-2 (a)

**Figure 2-2 (a): Unpacking step 2**

**Figure 2-2 (b): Unpacking step 3**

**Step 3:** Take out the accessory kit (A), instruction device (B) and controller (C) from the cartons, as shown above in Figure 2-2(b)

**Step 4:** Remove the front plate that fixes the robot, as shown in Figure 2-2(c)

**Figure 2-2 (c): Unpacking step 4**

**Figure 2-2 (d): Unpacking step 5**

**Step 5:** Remove the back plate that fixes the robot, as shown in Figure 2-2(d). Unpacking is a success!
2.2 Transportation

If the robot is being transported after taking it out of the box, please follow these steps and list of materials to ensure safe handling.

**Table 2-1: Transportation Materials**

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Suspension Plates* (Appendix I)</td>
</tr>
<tr>
<td>4</td>
<td>Screws</td>
</tr>
<tr>
<td>4</td>
<td>Eye Bolts &amp; Nuts</td>
</tr>
</tbody>
</table>

*The suspension plates are optional components

**Steps:**

1. Fix the suspension plate to the robot with the provided screws, as shown in Figure 2-3

   ![Figure 2-3: Installation of the Suspension Plate](image)

2. Fasten the eye bolts to the suspension plate and hook a rope through each eye bolt

3. Lift the robot onto the installation surface, as shown in Figure 2-4

   ![Figure 2-4: Front (left) and Side (right) view of the robot being transported using the shipping and suspension plates](image)

**DANGER**

- After removing the plates, properly store them for future use
- Angle for suspended robot: A1 0°, A2 45°, A3 -55°, A4 0°, A5 -80°, A6 0°
- If the arm is directly suspended without using the specified suspension plate, it will cause damage due to a misaligned center of gravity
- Use safe practices while transporting, and avoid excessive vibration or shock during transportation
2.3 Installation

After the robot is placed on the installation surface, remove the suspension and fixing plate. Then fix the robot to the installation surface using M10 socket head cap screws, spring washers, and flat washers. The dimensions of the robot base are shown in Figure 2-4.

![Installation Diagram](image)

**Figure 2-5: Installation Diagram**

![Illustration of base dimensions](image)

**Figure 2-6: Illustration of base dimensions**

- Do not install the robot in areas of heat exposure (direct sunlight, excessive lighting, heaters, etc.)
- Make sure the installation surface has been leveled and has a roughness below 6.3a (if it is too rough the robot could shift position during an operation)
- Ensure the position of the installation surface is fixed
- Ensure the installation surface will not get damaged due to the robots movement
- If robot is installed on ceiling or wall, parameters must be changed
  Please contact engineering if this is the case
2.4 Ground Procedure

2.4.1 Grounding

There are three grounding types shown in Figure 2-7. All three are acceptable, however the best grounding system is to ground the robot and controller individually (shown in figure 2-7 (a)).

![Figure 2-7 (a): Grounding (excellent)](image1)
![Figure 2-7 (b): Common Grounding (Good)](image2)
![Figure 2-7 (c): Common Grounding (General)](image3)

**Grounding Components:**

A grounding wire over AWG#11 (4.2mm²) is used to connect the robot and the grounding area. The hardware needed for the connection consists of a screw, spring washer, and flat washer. The proper grounding is shown below in figure 2-8.

![Figure 2-8: Grounding Line Diagram](image4)

- **CAUTION**
  - Keep the length of the grounding wire as short as possible, by keeping the grounding point close to the robot
  - The grounding wire of the robot should be a separate wire than those from other equipment

2.5 Installation of Controller

The illustration of installing the controller and the robot is shown in Figure 2-9.

![Figure 2-9: The robot (left) is connected to the controller (right) via the cable](image5)
3. Teach Pendant Usage

3.1 Installation of Teach Pendant
The picture below is showing how to install the teach pendant to the controller.

![Teach Pendant Installation](image)

Figure 3-1: Teach Pendant (left) gets plugged directly into the controller (right)

3.2 Coordinate System
There are two coordinate systems for the robot, Articulated, and Cartesian.

The **Articulated Coordinate System** presents the robot's position by using the rotational angle of each axis (A1, A2, A3, A4, A5 and A6), as shown in Figure 3-2.

![Articulated Coordinate System](image)

Figure 3-2: Articulated Coordinate System
The **Cartesian Coordinate System** displays the robot’s position with X, Y, Z, RX, RY and RZ coordinates. There are the ROBOT, TOOL and BASE Coordinates in the Cartesian coordinate system, as shown in Figure 3-3. In the program, RX is represented as A, RY as B, and RZ as C.

![Figure 3-3: Cartesian Coordinate System](image)

ROBOT Coordinate is based on the robot as home  
TOOL Coordinate is the home at the sixth axis flange coordinate to define as the TOOL Coordinate system  
BASE Coordinate System is at the position of workpiece and based on the ROBOT Coordinate System

### 4. End Effector

Many types of tool and grippers can be attached via electrical interfaces, or with pneumatics through a double solenoid valve. Some examples are an electric clamp, burr removal module or welding tool. This tool that gets attached through the robot can then be accessed through the controller and teach pendant. There are six M5x0.8 I/O interface and electromagnetic valves at the end connector of the robot, as shown in Figure 4-1.

![Figure 4-1: Connector for the robot end (A is outlet, B is inlet)](image)
The pin assignment of the I/O pins is shown in figure 4-2. Before soldering I/O pins, separate the front-end of the I/O terminal from the housing. Users can connect corresponding pins based on the demand.

![Figure 4-2: I/O Pin Assignment](image)

If the wires attaching to the end effector are either getting tangled, wrapped or just unorganized, consider fixing them near the fifth axis joint (see figure 4-3).

![Figure 4-3: Securing wires using a fixed plate](image)

To do this, unscrew the desired screw that attaches to the Hiwin plate (using a torx wrench). Then tighten the fixed plate in between the screw and the face of the robot. This will limit how much the wire can wrap around the robot. The exact dimensions of the fixed plate can be seen in Appendix II.
5. Maintenance and Check

This chapter will introduce the methods and the steps for preventative maintenance. This will include cover removal and installation, internal maintenance, belt checks and replacements, lubrication, battery replacement, and home calibration.

5.1 Maintenance and Check Interval

The maintenance and check can be classified into two categories; daily checks and the periodic checks. The daily checks include the power on/off and operation, representing those before the power on/off and programming respectively, as shown in table 5-1. The periodic checks include those for the routine check A, B, C, D and E. The check contents are shown in table 5-2. The timetable can be worked out according to the periodical check, as shown in Figure 5-1. When these checks are done correctly, unnecessary troubles will be avoided and the robot can be operated for extended durations of time safely.

<table>
<thead>
<tr>
<th>Table 5-1: Daily Inspection Points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inspection Before Turning the Power ON</strong></td>
</tr>
<tr>
<td>1. Are any screws loose on the robot system?</td>
</tr>
<tr>
<td>2. Is the power supply cable securely connected?</td>
</tr>
<tr>
<td>3. Are the robot and controller connected?</td>
</tr>
<tr>
<td>4. Are there any cracks or foreign contamination?</td>
</tr>
<tr>
<td>5. Are there any air leaks, clogging or hose damage in the pneumatic system? Is the air source normal?</td>
</tr>
</tbody>
</table>

| **Inspection After Turning the Power ON** |
| 1. Is there any unusual motion or noise when the power is ON? | Refer to the troubleshooting manual |

| **Inspection During Operation** |
| 1. Do the fixed parts of robot move? | Refer to the troubleshooting manual |
| 2. Is there any unusual motion or sound? | Refer to the troubleshooting manual |

<table>
<thead>
<tr>
<th>Table 5-2: Periodic Inspection Points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Monthly Inspection Points (Item A)</strong></td>
</tr>
<tr>
<td>1. Are any of the screws on the manipulator loose?</td>
</tr>
<tr>
<td>2. Are any of the connector fixing screws or terminal block screws loose?</td>
</tr>
</tbody>
</table>

| **Quarterly Inspection Points (Item B)** |
| 1. Check if the tension of each axes timing belts is abnormal has changed | Refer to 5.2.3 |

| **Biannual Inspection Points (Item C)** |
| 1. Is the friction at the timing belt teeth severe? | Refer to 5.2.3 |

| **Annual Inspection Points (Item D)** |
| 1. Replace the backup battery in the manipulator | Refer to 5.2.5 |

| **3-Year Inspection Points (Item E)** |
| 1. Fill lubricant for axis decelerator | Refer to 5.2.4 |
5.2 Internal Maintenance and Inspection

This section will introduce the belt maintenance, lubrication and battery replacement. Please read the contents carefully, and follow the descriptions for all maintenance. The parts that customers check and maintain will be described in 5.3 Maintenance. If needed, please contact HIWIN engineers.

- Don’t remove any part not described in this manual without consulting HIWIN engineers
- After any of the following maintenance replacements/adjustments occur, the robot must be recalibrated because any of the axis may have moved and have lost their home position
5.2.1 Robot Structure

Figure 5-2 shows the robot structure. There is a brake installed on the first, second, and third axis motors. This brake prevents the robot from moving/falling without power. However, if the belt is taken off, then the brake will not work since the joint will not be attached to the motor.


(A6) The sixth axis motor [16] drives the umbrella gear [18] to rotate the sixth axis via the belt [17]
5.2.2 Install and Remove Robot Cover

Before removing/installing the robot cover, please return the robot to the home position. Figure 5-3 shows the exploded view of the robot, with covers removed. The screws are listed in Table 5-4.

![Exploded View of Robot](image)

**Figure 5-3: Exploded View of Robot**

**Table 5-4: List of cover screws**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Specification</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>[a]</td>
<td>Torx M3x12</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>M3 washer</td>
<td>10</td>
</tr>
<tr>
<td>[b]</td>
<td>Torx M3x12</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>M3 washer</td>
<td>10</td>
</tr>
<tr>
<td>[c]</td>
<td>Torx M3x8</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>M3 washer</td>
<td>9</td>
</tr>
<tr>
<td>[d]</td>
<td>Torx M3x8</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>M3 washer</td>
<td>9</td>
</tr>
<tr>
<td>[e]</td>
<td>Torx M3x8</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>M3 washer</td>
<td>4</td>
</tr>
<tr>
<td>[f]</td>
<td>Torx M3x6</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>M3 washer</td>
<td>4</td>
</tr>
<tr>
<td>[g]</td>
<td>Torx M3x8</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>M3 washer</td>
<td>5</td>
</tr>
</tbody>
</table>
5.2.3 Belt Maintenance

The purpose of the belt on the robot is to have a drive without lubrication that creates a low amount of noise. The belt tension has been adjusted prior to the robot being shipped. The belt will irregularly loosen or stretch due to operation conditions, the tension should be periodically checked, maintained and replaced.

5.2.3.1 Replace timing belt

Depending on robot conditions, the time to replace the belt will vary. If the following situations take place, the belt must be replaced:

- The belt teeth has severe cracks
- The belt has expanded
- The belt has significant wear (to approx. half of the tooth width)
- The belt has deviation or misalignment
- The belt has a large amount of friction

5.2.3.2 Belt Tension

When the belt is properly tensioned, it will drive as intended and improve durability. When the belt is adjusted to a certain extent, you can feel the flexibility with your finger. If the belt is too loose, it will vibrate; on the contrary, if it is too tight, you will hear a sharp sound, and the belt will excessively wear. The tension can be measured hand or tool. Fasten the belt to a certain extent and then release with a tension meter, as shown in Figure 5-4. The specifications of each axis belt are shown in Table 5-5.

---

**CAUTION**

- After the robot has operated for around 300 hours, some belt material may be seen on the cover. This doesn’t mean it will fail, but it should be wiped down, then replaced the next time the buildup is observed
- When the belt is replaced, the robot home could shift. In this situation the position data must be checked again. If it is shifted, recalibrate the robot

---

Figure 5-4: Belt Tension Diagram
Table 5-5: List of the tension of the timing belt

<table>
<thead>
<tr>
<th>Axis</th>
<th>Model No.</th>
<th>Pitch (mm)</th>
<th>Belt width (mm)</th>
<th>Mass (g)</th>
<th>Tension (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second axis</td>
<td>370-5GT-9</td>
<td>370</td>
<td>9</td>
<td>4</td>
<td>200-250</td>
</tr>
<tr>
<td>Third axis</td>
<td>440-5GT-9</td>
<td>440</td>
<td>9</td>
<td>4</td>
<td>200-250</td>
</tr>
<tr>
<td>Fifth axis</td>
<td>285-3GT-6</td>
<td>285</td>
<td>6</td>
<td>2.5</td>
<td>50-70</td>
</tr>
<tr>
<td>Sixth axis</td>
<td>285-3GT-6</td>
<td>285</td>
<td>6</td>
<td>2.5</td>
<td>50-70</td>
</tr>
</tbody>
</table>

**CAUTION**

- If the first axis and the fourth axis need to replace the belt, contact HIWIN Engineers

5.2.3.3 Second Axis Belt Maintenance

Figure 5-5 shows the illustration of the second axis structure.

Check second axis belt:
1. Disconnect the power
2. See 5.2.2 to remove the second axis cover (first arm)
3. Check the belt for significant wear or markings
4. If the belt needs replacing, please see the following to adjust the second axis belt

Adjusting second axis belt tension:
1. Lightly loosen the three screws for the motor plate [1]
2. Loosen the tension nut [6], and then adjust the tension screw [3]
3. After the tension is adjusted, tighten the tension nut [6]
4. Tighten the three screws for the motor plate [1]
   a. The belt could shift and loosen if they are not tightened after adjustment

Replace second axis belt:
1. Lightly loosen the three screws for the motor plate [1], then remove
2. Loosen the tension nut [6] and the screws [3], and remove the old belt
3. Install the new belt, and see Adjust Second axis Belt to adjust the belt
4. The home position needs to be recalibrated, since the motor and brake were disconnected from the axis (See 5.4 to recalibrate the home)
5.2.3.4 Third axis Belt Maintenance

Figure 5-6 shows the illustration of the third axis structure.

![Figure 5-6: Third axis belt structure](image)

Check third axis belt:
1. Disconnect the power
2. See 5.2.2 to remove the third axis cover (first arm)
3. Check the belt for significant wear or markings
4. If the belt needs replacing, please see the following to adjust the third axis belt

Adjusting third axis belt tension:
1. Remove the screw plate (connects the third and second axis motor plate to tension the second axis)
2. Lightly loosen the three screws for the motor plate [1]
3. Loosen the tension nut [6], and then adjust the tension screw [3]
4. After the tension is adjusted, tighten the tension nut [6]
5. Tighten the three screws for the motor plate [1]
   a. The belt could shift and loosen if they are not tightened after adjustment

Replace third axis belt:
1. Lightly loosen the three screws for the motor plate [1]
2. Loosen the tension nut [6] and the screws [3], then remove the old belt
3. Install the new belt, and see Adjust third axis Belt tension to adjust the belt
4. The home position needs to be recalibrated, since the motor and brake were disconnected from the axis (See 5.4 to recalibrate the home)
5.2.3.5 Fifth axis Belt Maintenance

Figure 5-7 shows the illustration of the fifth axis structure.

![Fifth axis belt structure](image)

**Figure 5-7: Fifth axis belt structure**

**Check fifth axis belt:**
1. Disconnect the power
2. See 5.2.2 to remove the fifth axis cover (right case of the second cover, even though the left case is shown)
3. Check the belt for significant wear or markings
4. If the belt needs replacing, please see the following to adjust the third axis belt

**Adjusting fifth axis belt tension:**
1. Lightly loosen the two screws for the motor plate [1]
2. Loosen the tension nut [6], and then adjust the tension screw [3]
3. After the tension is adjusted, tighten the tension nut [6]
4. Tighten the two screws for the motor plate [1]
   a. The belt could shift and loosen if they are not tightened

**Replace fifth axis belt:**
1. Lightly loosen the two screws for the motor plate [1]
2. Loosen the tension nut [6] and the screws [3], then remove the old belt
3. Install the new belt, and see Adjust fifth axis Belt tension to adjust the belt
4. The home position needs to be recalibrated, since the motor was disconnected from the axis (See 5.4 to recalibrate the home)
5.2.3.6 Sixth axis Belt Maintenance

Figure 5-8 shows the illustration of the sixth axis structure.

![Sixth axis belt structure](image)

**Figure 5-8: Sixth axis belt structure**

**Check sixth axis belt:**
1. Disconnect the power
2. See 5.2.2 to remove the sixth axis cover (left case of the second arm)
3. Check the belt for significant wear or markings
4. If the belt needs replacing, please see the following to adjust the sixth axis belt

**Adjusting sixth axis belt tension:**
1. Lightly loosen the two screws for the motor plate [1]
2. Loosen the tension nut [6], and then adjust the tension screw [3]
3. After the tension is adjusted, tighten the tension nut [6]
4. Tighten the two screws for the motor plate [1]
   a. The belt could shift and loosen if they are not tightened after adjustment

**Replace sixth axis belt:**
1. Lightly loosen the two screws for the motor plate [1]
2. Loosen the tension nut [6] and the screws [3], then remove the old belt
3. Install the new belt, and see Adjust sixth axis Belt tension to adjust the belt
4. The home position needs to be recalibrated, since the motor was disconnected from the axis (See 5.4 to recalibrate the home)
5.2.4 Lubrication

5.2.4.1 Inlet and Outlet Positions and Lubrication Specification

Figure 5-9 shows the inlets and outlets. The lubrication specifications are shown in Table 5-6. See 5.2.2 before installing/removing any covers.

![Figure 5-9: Lubrication Position](image)

<table>
<thead>
<tr>
<th>Lubrication</th>
<th>Nozzle Dimensions</th>
<th>Lubricant</th>
<th>Weight [g]</th>
<th>Time [hr]</th>
<th>Use [g]</th>
<th>Remove cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>First axis deceleration gear</td>
<td>M5x0.8*6</td>
<td>HRG-01</td>
<td>52.5</td>
<td>24000</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Second axis deceleration gear</td>
<td>M5x0.8*6</td>
<td>HRG-01</td>
<td>45</td>
<td>8</td>
<td>Remove J1 axis cover</td>
<td></td>
</tr>
<tr>
<td>Third axis deceleration gear</td>
<td>M5x0.8*6</td>
<td>HRG-01</td>
<td>24</td>
<td>4</td>
<td>Remove J1 axis cover</td>
<td></td>
</tr>
<tr>
<td>Fourth axis deceleration gear</td>
<td>M5x0.8*6</td>
<td>HRG-01</td>
<td>19.5</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fifth axis deceleration gear</td>
<td>M5x0.8*6</td>
<td>HRG-01</td>
<td>13.5</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sixth axis deceleration gear</td>
<td>M5x0.8*6</td>
<td>HRG-01</td>
<td>9.15</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5.2.4.2 Notice for Lubricant Supply

- The lubrication time is the overall time the robot spends traveling at the maximum speed
  - If the robot holds or operates at the slow speed, the lubrication time can be linearly extended
- Do not allow the robot to run without lubrication
- Re-lubrication interval is typically around 3 years
- If the full lubrication is required, please contact us to avoid excessive lubrication leakage
5.2.4.3 Lubrication Method

**CAUTION**

- Lubricant is filled at 0.03MPa when manually operating the filler
- Don’t use the factory filler to avoid excessive pressure

1. Figure 5-9 (page 25) shows the position to lubricate the robot
2. See 5.2.2 to remove the cover
3. Cover the belt to prevent any contact with the lubrication
4. Loosen the lubrication screws, and connect the nozzle
5. Tighten the nozzle between 3N-m to 4.4N-m
6. Remove the outlet lubrication screws
7. Fill lubricant from lubrication nozzle with the filler
8. After lubricant is filled, reinstall the outlet screws
9. Disconnect the nozzle and reinstall the lubrication screws
10. See 5.2.2 to install the cover

5.2.5 Replacing Backup Battery

Absolute encoders are used to record the position. When the power is disconnected, the power from the backup battery will be active to record the current position of the encoders. Depending on the operating conditions, the back-up battery should be replaced every year to maintain functionality. When the battery is low, the customer should replace the batteries immediately. Figure 5-10 shows the method to replace the battery. The procedures to replace the battery are described as below:

**Figure 5-10:** Battery replacement

1. Make sure the robot and controller are fully connected
2. Before new batteries are installed, press the emergency stop switch to kill all power leading to the robot
3. Unscrew the battery cover [1] and take the old batteries out
4. Replace each battery one at a time with new batteries
5. All batteries must be replaced in one sitting, and an old/new batteries combination will cause excess heat
6. After the batteries are replaced, reinstall the battery cover onto the battery box

**CAUTION**

- If all batteries are removed at once, the data stored in the encoders will be lost and the robot will have to be recalibrated
5.3 Maintenance

Table 5-7 shows the parts which will be periodically replaced. These accessories are available through Hiwin.

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Specification</th>
<th>Location</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Belt</td>
<td>270-5GT-9</td>
<td>J1 axis</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>370-5GT-9</td>
<td>J2 axis</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>440-5GT-9</td>
<td>J3 axis</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>216-3GT-6</td>
<td>J4 axis</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>285-3GT-6</td>
<td>J5 axis</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>285-3GT-6</td>
<td>J6 axis</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>Lubricant</td>
<td>EK3</td>
<td>Deceleration gear for each axis</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>Lithium battery</td>
<td>No. 3, 3.6V One-time lithium battery 2.4A</td>
<td>In battery box</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 5-7: Parts list

5.4 Calibrating Home Position

Fixture Home Method: There is a fixture for home calibration in the accessory kit, which is used for the calibration of the first to fifth axis. The robot is adjusted to the minimum speed during the calibration. There are different pinholes and keyway seats for each individual axis, which must be lined up. The calibration tools are shown below in figure 5-11.

Figure 5-11: Calibration Kit (requires 2.5mm and 3mm Allen wrenches)

The following are the illustrations to calibrate the first 5 axis. To successfully calibrate the sixth axis, a combination of a level and a flat tool or mounting plate must be used. The plate would be mounted to the robot end effector.
5.4.1 Set first axis home
To calibrate the first axis, the calibration plate must be installed to the base of the robot, seen in figure 5-12. The first axis is adjusted with the minimum speed until the tab is flush with the fastened calibration plate.

![Figure 5-12: First axis home calibration](image)

5.4.2 Set second axis home
The second axis calibration is accomplished by rotating the second axis at minimum speed until the pinhole on the first arm is concentric with the pinhole of the robot base. The calibration rod can then be set to the origin position. Then the second axis is calibrated, as shown in Figure 5-13.

![Figure 5-13: Second axis home calibration](image)
5.4.3 Set third axis home
The third axis calibration is accomplished by rotating the third axis at minimum speed until the pinhole on the second arm is concentric with the pinhole of the first arm. The calibration rod can then be set to the origin position. Then the third axis is calibrated, as shown in Figure 5-14.

![Figure 5-14: Third axis home calibration](image)

5.4.4 Set fourth axis home
The fourth axis calibration is accomplished by rotating the fourth axis at minimum speed until the calibration groove on the second arm is aligned with the calibration groove of the twisting arm. The calibration key can be placed and into the calibration groove, or origin position. Then the fourth axis is calibrated, as shown in Figure 5-15.

![Figure 5-15: Fourth axis home calibration](image)
5.4.5 Set fifth axis home

The fifth axis calibration is accomplished by rotating the fifth axis at minimum speed until the pinhole on the second arm is concentric with the pinhole of the fifth axis and the calibration rod can be set to the origin position. Then the fifth axis is calibrated, as shown in Figure 5-16.

Figure 5-16: Fifth axis home calibration
6. Appendix

6.1 Appendix I

Suspension Plates for transporting the robot (refer to 2.2)
6.2 Appendix II

The fixed plate used to control the directions and orientations of wires connecting to the end effector.