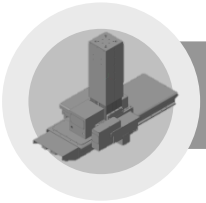
Warning

INSTALLATION SHOULD ONLY BE PERFORMED BY QUALIFIED INSTALLATION PERSONNEL AND MUST CONFORM TO ALL NATIONAL AND LOCAL CODES

Hyundai Robot



Manipulator Maintenance Manual

HJ Series

HYUNDAI ROBOTICS

HYUNDAI ROBOTICS

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Safety

1.1. Introduction

The main purpose of this chapter is to describe the matters regarding the safety of those who use, maintain, and operate the robot.

This manual complies with the safety regulations both of the Machinery Directive 98/37/EC (2006/42/EC) by the UC and of the OSHA of the USA, and describes matters regarding safety related to the use of the manipulator and controller. The manipulator and controller are manufactured in compliance with the safety standards of EN ISO 10218-1:2006 and ANSI/RIA R15.06-1999.

Every worker who installs, replaces, adjusts, operates, preserves, and maintains the robot system must carefully read and fully understand both the operation and maintenance manuals. In particular, it is required to pay special attention to sections marked with the ⚠ symbol, which is considered the most critical marking related to safety.

Installation, replacement, adjustment, operation, preservation, and maintenance of the robot system should be performed, according to the instructed order, by personnel trained for this purpose.

Our company plans and provides the preservation, maintenance and operation trainings for those works, so the person using the robot should ensure that the workers working in the robot system should receive the relevant trainings. It must be ensured that only those who have completed this course can handle the robot.

The user of the robot is responsible for understanding and complying with safety laws related to robots applicable in the relevant country, and for designing, installing, and operating safety devices to protect all workers working with the robot system.

The dangerous area of the robot system, i.e., areas where the robot, tools, and peripheral devices are operating, should be equipped with safety devices in accordance with ANSI/RIA R15.06-1999 to prevent an object, other than the workers and the workpiece, from entering the dangerous area. The robot system should be configured in a way in which it can be stopped immediately by an emergency stop device when a worker or object needs to enter the dangerous area in spite of the risk. Workers are responsible for installing, checking, and operating these safety devices.

1.2. Related Safety Regulations

The robot is designed according to ISO 10218-1:2006 safety specifications for industrial robots and complies with ANSI/RIA 15.06-1999 regulations.

1.3. Safety Training

Any worker who wants to teach or inspect the robot should complete the training related to the use of the robot and safety. The safety training program includes:

- Purpose and functions of safety devices
- Safety procedures in robot handling
- Performance of the robot or the robot system, and possible related danger
- Works associated with any specific application of the robot
- Concept of safety, etc.

1.4. Safety-Related Plates

1.4.1. Safety Symbols

In this manual, the following safety symbols are used for work instructions.

Table 1-1 Safety Symbols

Symbols		Descriptions
Warning		Indicates a highly dangerous situation, meaning that improper operation or handling could result in death or serious injury to people or damage to equipment; utmost attention should be paid to the operation and handling
Mandatory		Indicates actions that must be taken
Prohibited		Indicates actions that should never be done

1.4.2. Safety Plates for Caution

Safety plates for caution, warning markings, and safety symbols are attached on the inside and outside of the robot and control panel. Name markings are provided for the wire harnesses between the robot and the control panel and also for the cables inside and outside the robot and the controller. The appropriate wire markings are also provided.

All types of safety plates for caution should be attached to apparent positions on the manipulator and control panel to ensure safety and relevant functions.

The paint markings for the robot area and dangerous areas, which are to be marked on the floor where the robot is installed, should be clearly distinguished in form, color, and style from other marks in the facility or machinery where the robot system is installed.

It is prohibited to damage the safety plates for caution, warning markings, safety symbols, name markings, cable markings, etc., which are clearly visible on the manipulator and controller, by moving, placing a cover on, or painting them.

1.5. Definitions of Safety Functions

Emergency Stop Function - IEC 204-1,10,7

The controller and teach pendant have one emergency stop button each. It should be made possible to connect, if necessary, an additional emergency button to the safety chain circuit of the robot. The emergency stop function is to be applied with higher priority over all other control functions of the robot. It stops the power supply to the motors of individual axes of the robot, stops the operation of relevant parts, and removes the power of other dangerous functions controlled by the robot to prevent them from being used.

Safety Stop Function - EN ISO 10218-1:2006

A safety stop circuit should be configured, and, through this circuit, each robot should be connected to safety devices and interlocks. The robot should have several electrical input signals, allowing itself to be used in connection with external safety devices such as safety doors, safety pads, safety lights, etc. Through these signals, the safety functions by all the facilities, including the robot itself and its peripheral devices, will be performed.

Speed Limit Function - EN ISO 10218-1:2006

In manual mode, the speed of the robot is limited to a maximum of 250 mm/s. The speed limit applies not only to the Tool Center Point (TCP) but also to all other parts of the robot that are to be operated in manual mode. It should also be made possible to monitor the speed of the equipment mounted on the robot.

Operation Area Limit - ANSI/RIA R15.06-1999

The soft limit restricts the operation area of each axis. In the case of Axes 1, 2, and 3, the operation area is also limited by a mechanical stopper.

Operation Mode Selection - ANSI/RIA R15.06-1999

The robot can be operated in manual mode or auto mode. In manual mode, the robot can only be operated using the teach pendant.

1.6. Installation

1.6.1. Safety fence

Because the robot may collide with workers during operation, install a safety fence to prevent workers from making contact with the robot.

Because of workers' possible collision with the robot during operation, it is required to install a safety fence to prevent the worker from making contact with the robot. Accidents can result from entry by workers or others, whether intentional or unintentional. Configure the system to ensure that the robot stops when a worker opens the door of the fence and approaches the facility, during robot operation, to inspect the robot or welding jigs and fixtures or to perform tip dressing or tip changing.

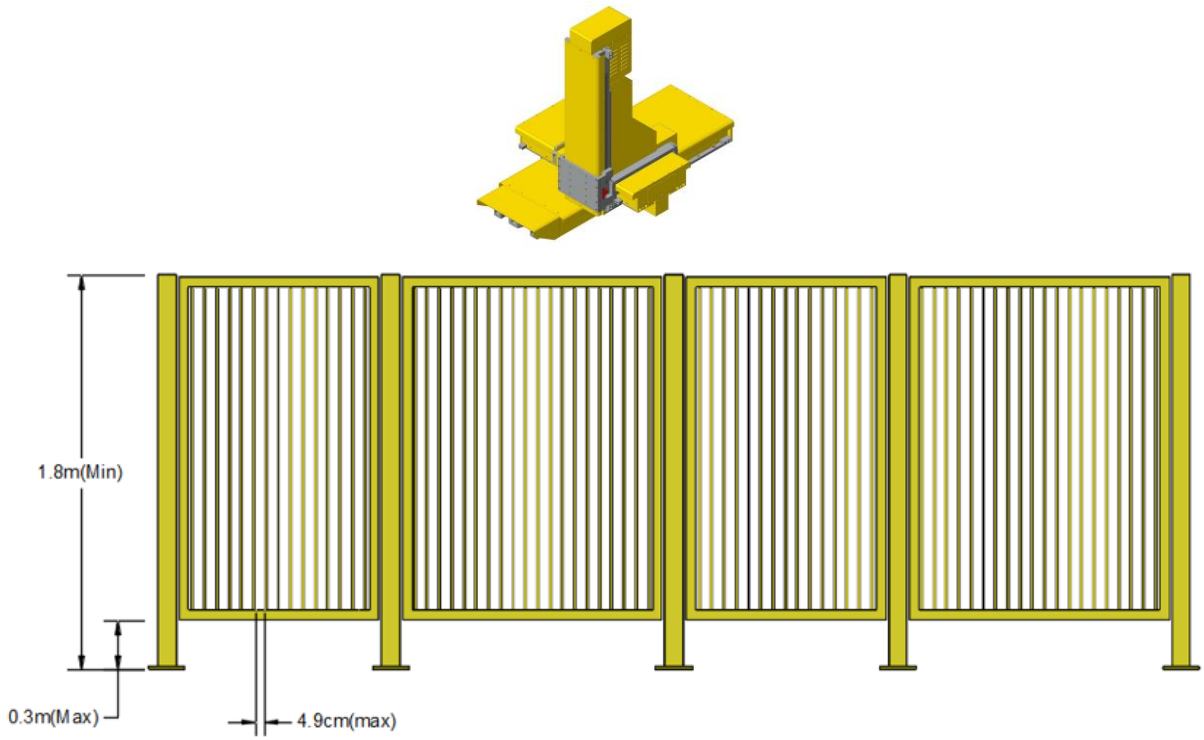


Figure 1.1 Recommended Fence Size and Opening Size (Slot-Type Opening)

(1) The safety fence should cover the robot operation area and provide sufficient space so that the workers will not face interference with their teaching and maintenance works. In addition, the safety fence should be constructed in a way in which it cannot be easily moved and built in a structure that will not allow people to go over it easily.

(2) In principle, the safety fence should be installed in a fixed type, and it is required to use a type of fence that will not have features such as an uneven structure or pointed corners that will pose a danger.

(3) Install an entrance door to enter the safety net. A safety plug must be attached to the entrance door to prevent it from being opened unless the plug is removed. Wiring should be performed in interlock mode that the robot should be in the operation ready off mode and motor off mode if the safety plug is removed or the safety fence is opened.

(4) Wiring should be performed in a way in which the robot will be in slow playback mode if you want to operate the robot with the safety plug removed.

(5) Install the emergency stop button of the robot at a location where the worker can press it immediately.

(6) If a safety fence is not to be installed, install a photoelectric switch, a mat switch, etc. for the entire area within the robot operation range, instead of a safety plug, so that the robot can automatically stop when a person enters the area.

(7) Ensure that the robot operation area (danger area) can be identified using some methods such as painting the floor.

1.6.2. Allocation of the Robot and Peripheral Devices

The following methods must be applied in allocating the robots and peripheral devices.

(1) In case of connecting the primary power of the controller or peripheral devices, perform the connection after checking whether the power at the supply side is off. Since high voltage, such as 220 V or 440 V, is used as the primary power supply, there is a danger of electric shock.

(2) Put a sign “No entry while operating” at the entrance of the safety fence and inform the worker of the intents.

(3) Allocate the controller, interlock panels, and other control panels in a way in which they can be operated from outside the safety fence.

(4) When installing the operation stand, attach an emergency stop button to it also. Wherever you operate the robot, you should stop the robot in an emergency.

(5) Do not let the workers’ feet get caught on or the forklift directly step on the wiring or piping of the manipulator, controller, interlock panel, timer, etc. An accident could occur because of the worker falling over and wiring being disconnected.

(6) Allocate the controller, interlock panel, and operation stand at a location where the operation of the manipulator can be seen sufficiently. If the robot is operating abnormally or the worker is working on something in an area from which the robot operation cannot be seen, there is a danger of major accidents during operation.

(7) If the area required for the robot operation is narrower than the operation area that is currently maintained, you should limit the current robot operation area. It can be restricted by soft limit, mechanical stopper, etc. If the robot operates outside the normal operation area caused by abnormality, it can be stopped in advance (Please refer to the Manipulator Maintenance Manual).

(8) During welding, spatter may fall on or fall near the worker and cause a burn or fire. Install a light shield plate, cover, etc. in the range where the manipulator can be seen sufficiently.

(9) When it comes to a device that shows the auto and manual operation mode of the robot, an easily visible device should be installed to ensure that the status can be recognized from a distance. In case of starting the operation in auto mode, alarms using a buzzer or an alarm light can also be valid.

(10) Make sure there is no protruding part on the peripheral devices of the robot. If necessary, place a cover on them. Otherwise, an accident could occur when the worker comes into contact with a protruding part during normal operation, and a major accident could occur when a worker surprised over a sudden movement of the robot could fall over.

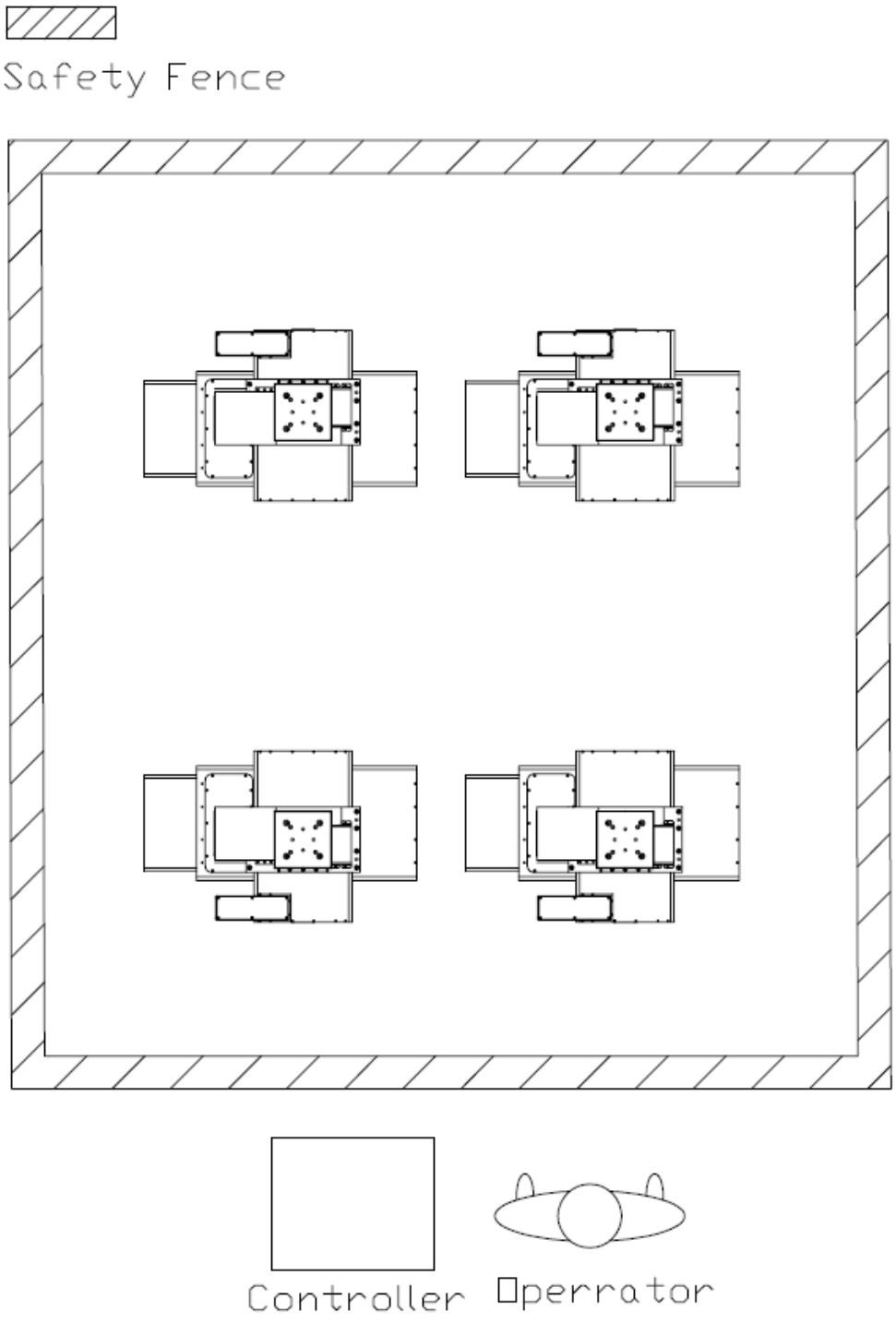


Figure 1.2 Allocation of the Peripheral Devices of the JIG Robot, and the Operator

1.6.3. Robot Installation

The following methods must be applied in allocating the robots and peripheral devices.

The robot should be installed according to the pre-reviewed and planned foundation and allocation for its functions to be fully utilized. If the robot is installed poorly, it may cause errors in the relative position between the robot and the workpiece during operation, and it may cause vibration degrading the quality of the work by the robot, shortening the service life of the robot and creating dangerous situations. Therefore, pay attention to the following items during robot installation.

General Matters regarding Safety

(1) To protect the workers, the robot system must be completely designed and installed according to the safety requirements regulated by the laws and specifications of the country where the robot is installed.

(2) The worker who uses the robot should fully understand the contents described in the application and auxiliary manuals, and operate and handle the industrial robot skillfully.

(3) The worker installing the robot should apply the safety instructions during the installation if there is a problem.

(4) The system supplier should guarantee that all circuits used for safety functions perform their functions.

(5) The main power supply to the robot should be installed in a way in which it can be cut off from outside the robot operation area.

(6) The system supplier should guarantee that all circuits used for the emergency stop function safely perform their functions.

(7) The emergency stop button should be positioned at a location where the operator can easily approach it when required to stop the robot in a matter of urgency.

Technical Matters regarding Safety

(1) By taking into consideration the dimensions of the manipulator and the operation range, make sure that that there is no interference with peripheral devices.

(2) Avoid installing the robot in a location that is exposed to direct sunlight, has a high level of humidity, has oil or chemicals around, and has large amounts of metal powder or explosive gas in the air.

(3) Install the robot in the place where the ambient temperature is 0℃–45℃.

(4) Secure enough space for disassembling and inspecting the robot.

(5) Install the safety fence, and prevent people from entering the robot operation range.

(6) Make sure there is no obstacle in the robot operation area.

(7) When installing the robot in a location exposed to direct sunlight or near a heating element, you should take measures in consideration of the thermodynamic state of the controller.

(8) Take special measures when installing the robot in a location that is exposed to large amounts of dust, such as metal powder in the air.

(9) Because the grounding is important for preventing a malfunction caused by noise and an electric shock, you should install the robot, as shown below.

① Install the dedicated grounding terminal while setting it as Type 3 Ground or higher. (If the input voltage of the robot controller is 400 V or higher, set it as Special Type 3 Ground or higher).

② Connect the ground wire to the ground bus bar inside the control panel.

③ When the manipulator is installed, if it is directly grounded to the floor by an anchor, etc., the controller side and the manipulator side will make a two-point ground, forming a closed circuit, which conversely may cause malfunctioning caused by factors such as noise. In this case, connect the ground wire to the base part of the manipulator, but not to the controller side. In addition, if there is shaking when the robot stops, there is a high possibility that the grounding is incomplete or there is a closed circuit. It is required to check on the grounding again.

1.6.4. Space for Robot Installation

Install the robot after securing enough space required to perform the preservation of the manipulator, controller, and other peripheral devices. To install the manipulator and controller, secure the installation area as described above. Install the controller at a location outside the safety fence where the operator can see the manipulator easily and perform works safely.
Install the robot in a way in which the maintenance can be performed easily when the controller door is opened. Secure a preservation area that can be used. The controller specification may vary depending on the controller type. (Please refer to the relevant maintenance manual for details.)

1.7. Safety works during Robot Operation

Safety work procedures must be observed to prevent safety accidents. Do not change or ignore safety devices or circuits under any circumstances. Take precautions against accidents caused by electric shocks. In auto mode, all normal works should be performed outside the safety fence. Before starting the work, make sure that no one is inside the robot operation area.

1.7.1. Safety Measures during Robot Operation

Observe the following measures considering that safety is critical during robot operation.

(1) The worker who operates the robot or the worker who may operate it, and the supervisor should take specific training. Except for those who are recognized to be fully aware of the safety and functions of the robot and designated accordingly, any unqualified person should not operate the robot.

(2) A safety hat, protective glasses, and safety footwear must be worn.

(3) Work must be done with two people working together wherein one person should be teaching, and the other should be monitoring from the operation panel. One of the two should be ready to press the emergency stop switch at any time, and the other should perform the work quickly with sufficient care in the operation area. In addition, the evacuation route should be checked before starting the work.

(4) Supply the power after confirming that there is no worker in the robot operation area.

(5) Works such as teaching should be performed outside the robot operation range in principle. However, when stopping the system and working within the operation range, it is required to bring the key switch required to switch to the auto mode, or bring the safety plug. Such action is necessary to make sure that no other operator accidentally switch the robot to auto mode. Also, in case of emergency, pay special attention to the direction of the operation of the robot in preparation for the robot malfunctioning or in wrong conditions.

(6) The supervisor should observe the following.
① The supervisor should be positioned at a location where she or he can see the robot entirely and should be dedicated to the duties of supervision.
② If there is any problem, press the emergency stop button immediately.
③ Other people except for the persons involved in the work should not be allowed to stay within the operation range.

(7) In manual mode, the speed should be limited to a maximum of 250 mm/sec.

(8) In the case of teaching, post the sign [Teaching in progress].

(9) When entering the safety fence, the worker must pull the safety plug out and bring it with himself or herself.

(10) Do not use equipment that could be a source of noise near the teaching place or its surroundings.

(11) Do not operate the robot operation buttons on the teach pendant without looking at the buttons. Full attention should be given for this process.

(12) Be cautious about the movement of the robot, and keep your eyes on it at all times.

(13) Make sure to check under your feet when teaching. In particular, make sure to secure a safe area on which you can move safely when performing teaching at a higher location (2 m or higher).

(14) Take the following measures when an abnormality occurs.

① If an abnormal operation is found, immediately press the emergency stop button.
② If an abnormality is to be checked following emergency stop, the stop status of related facilities must be checked.
③ If the robot stops automatically because of power abnormality, check first that the robot is stopped completely. Afterward, investigate the cause and take measures.
④ If the emergency stop device does not function properly, immediately shut off the main power. Afterward, investigate the cause and take measures.
⑤ Investigation of the abnormality should not be performed by anyone other than those qualified. After the emergency stop, you should restart the system after identifying the cause of the abnormality and taking measures accordingly.

(15) Prepare proper work regulations, considering the installation location and work details, concerning the robot operation and manipulation methods, and actions to take when an abnormality occurs. In addition, work should be carried out according to the work regulations.

(16) Precautions to take when the robot is stopped.
The robot should be approached only when it has fully stopped, as it may make sudden movements that can cause accidents when still operational. The robot will be in the stopped state in the following cases.

Table 1-2 State of the Robot

No.	State of the Robot	Driving Source	Entry
1	In temporary stop mode (minor abnormality, temporary stop button)	ON	X
2	In emergency stop mode (major abnormality, emergency stop button and safety door)	OFF	O
3	Waiting for input signal from peripheral device (start interlock)	ON	X

4	Playback being completed	ON	X
5	Waiting in progress	ON	X

You should not be negligent in paying attention to sudden movements even when entry is made possible. Approaching the robot without proper preparation for possible emergencies should not be done under any circumstances.

- **If the entrance door needs to be opened to take measures for minor abnormalities during a temporary stop, the same measures as taken for opening the door for normal works should be taken.**

(17) After completing the robot operation, clean the inside of the safety fence to make sure that no tools, oil, or foreign substances remain. If the operation area is soiled with oil, or if tools are left in the operation area, it could cause an accident such as falling over. Make sure that arranging and organizing are always performed.

1.7.2. Safety Measures When Trial Operating the Robot

Observe the following measures considering that safety is critical when trial operating the robot.

In the case of trial operation, there may be a design error, a teaching error, or a defect in manufacturing concerning the entire system, including the teaching program, jigs, and sequencing. For this reason, you must work with elevated safety awareness in trial operation. Multiple factors can contribute to safety accidents.

(1) Before operating the robot, check the functions of buttons such as the emergency stop button and the stop button, as well as the functions of relevant signals. After that, check the operation related to the detection of abnormality. First of all, it is essential to check all the signals that stop the robot. When an accident is expected, the most important action to take is to stop the robot.

(2) When trial operating the robot, operate it at low speed (about 20%–30%) using the speed variable function and repeat the operation for more than one cycle to check the operation. If a problem is identified, correct it immediately. After that, increase the speed in order (50% → 75% → 100%), and repeat the operation more than one cycle to check the operation. Operating the robot at high speed from the start could lead to a major accident.

(3) It is not possible to predict what kind of problem will occur during trial operation. Never enter the safety fence during trial operation. As reliability is low, unexpected accidents could likely occur.

1.7.3. Safety Measures for Auto Operation

Observe the following measures considering that safety is critical when operating the robot in auto mode.

(1) Post a sign [No entry while operating] on the safety fence entrance, and instruct workers to refrain from entering during operation. If the robot is stopped, you may enter the safety fence after a proper judgment of the situation.

(2) When starting the auto operation, you must check whether there is any worker inside the safety fence as negligence on this may lead to human accidents.

(3) When starting the auto operation, check first that the program number, step number, mode, start selection, etc. are in a proper state for auto operation. If you start the robot while an irrelevant program or step is selected, the robot may behave unexpectedly, causing an accident.

(4) When starting the auto operation, check that the robot is in the position where the robot can start the auto operation. Check also whether the program number or step number matches with the robot position. Even when the program or step is correct, if the robot is in a different position, an accident may occur because of an operation different from normal operation.

(5) Be prepared to press the emergency stop button immediately at the start of auto operation. If an unexpected robot operation or situation occurs, immediately press the emergency stop button.

(6) Check the operation path, operation status, operation sound, etc. of the robot to judge whether there is an abnormal state. The robot may suddenly cause an abnormality such as a failure, but it may display some symptoms before the failure occurs. To predict this in advance, it is required to have a thorough understanding of the normal operating status of the robot.

(7) If any abnormality is found, immediately make an emergency stop and take proper measures for it. Using the robot without proper measures could lead to a severe failure that may cause the stopping of production and significant human accidents.

(8) While completing measures and checking the operation after an abnormality occurs, do not operate the robot while a worker is still inside the safety fence. Unexpected accidents such as other abnormalities may occur as reliability is low.

1.8. Safety Measures When Entering Inside the Safety Fence

Observe the following measures considering that safety is critical when entering the safety net.

Even at a slow speed, the robot is heavy, and its force is very strong. When entering the safety area of the robot, you must comply with the safety regulations of the relevant country.
Operators should always be aware that the robot may operate unexpectedly. While in temporary stop mode, it is possible for the robot to make sudden movements at high speed. The operator should be aware that the robot can change paths because of an external signal without warning. If you want to stop the robot during teaching or trial operation, you should stop it immediately with the teach pendant or the control panel of the controller.
When entering the safety door in the robot operation area, bring the teach pendant to prevent others from operating the robot. You must post on the control panel of the controller a sign indicating that the robot is currently operating.

If you enter the robot operation area, you must understand the following.

(1) No one except the teaching person should enter the robot operation area.

(2) The operation setting mode of the controller should be in manual mode on the control panel.

(3) Always wear certified work clothes. (Any arbitrary loose clothing is not allowed.)

(4) Do not wear gloves when operating the controller.

(5) Ensure that there is no loose article of clothing (underwear, shirt, tie, etc.) coming out of work clothes.

(6) Do not wear sizable jewelry such as earrings, rings, or necklaces.

(7) Safety shoes, safety helmet, and protective glasses, as well as safety gear such as safety gloves, must be worn.

(8) Before operating the robot, check if the emergency stop circuit is functioning well to turn off the motor when the emergency stop button on the control panel and teach pendant is pressed.

(9) Work in a position facing the manipulator.

(10) Follow predetermined work procedures.

(11) Always prepare an evacuation plan in case the robot rushes toward a worker unexpectedly.

1.9. Safety Measures When Maintaining and Inspecting

1.9.1. Safety Measures When Maintaining and Inspecting the Controller

Observe the following safety measures when maintaining and inspecting the robot controller.

(1) Maintenance and inspection works should be performed only by those who have received special maintenance training and understood the related contents thoroughly.

(2) Progress the work according to the controller maintenance and inspection procedures.

(3) For the maintenance and inspection works, you must check the surroundings for safety, and secure a passage or a place to avoid danger before performing the works.

(4) Power must be turned off before performing daily inspection or maintenance of the robot or replacement of parts. In addition, to prevent other workers from inadvertently turning on the power, put a warning mark such as [No Power] on the primary power supply.

(5) Always use the designated replacement parts.

(6) When opening the controller door, you must turn off the power and wait for about three minutes before starting the work.

(7) Do not touch the heat sink and regenerative resistor of the servo amplifier as they generate excessive heat.

(8) After maintenance, check whether tools, foreign substances, etc. are left behind inside the controller first. Afterward, make sure that the door is shut tight.

1.9.2. Safety Measures When Maintaining and Inspecting the Robot System and the Manipulator

Observe the following safety measures when maintaining and inspecting the robot system and the manipulator.

(1) Refer to safety measures for the maintenance and inspection of the controller.

(2) When maintaining and inspecting the robot system and the manipulator, proceed with the work according to the instructed procedures.

(3) The main power of the controller must be cut off. To prevent other workers from powering it up again, put a warning mark such as [No Power] on the primary power supply.

(4) During maintenance and inspection of the manipulator, the robot arm may fall, or there could be a danger if the robot moves. Thus, be sure to fix the arm before performing the work. (Please refer to the Robot Manipulator Manual.)

1.9.3. Actions to Take after Maintenance and Inspection

Observe the following actions after maintenance and inspection

(1) Check if the wires or parts inside the controller are connected normally.

(2) After maintenance, check whether any tool is left behind inside and around the controller, manipulator, or the robot system, and keep them arranged and organized. Every door should be closed.

(3) If any problem or fatal defect is found, do not turn on the robot.

(4) Before turning on the power, check that there is no worker inside the robot operation area and that the relevant area is safe.

(5) Turn on the main power breaker in the control panel.

(6) Check the current position and status of the robot.

(7) Operate the robot at low speed.

1.10. Safety Functions

1.10.1. Operation of the Safety Electric Circuit

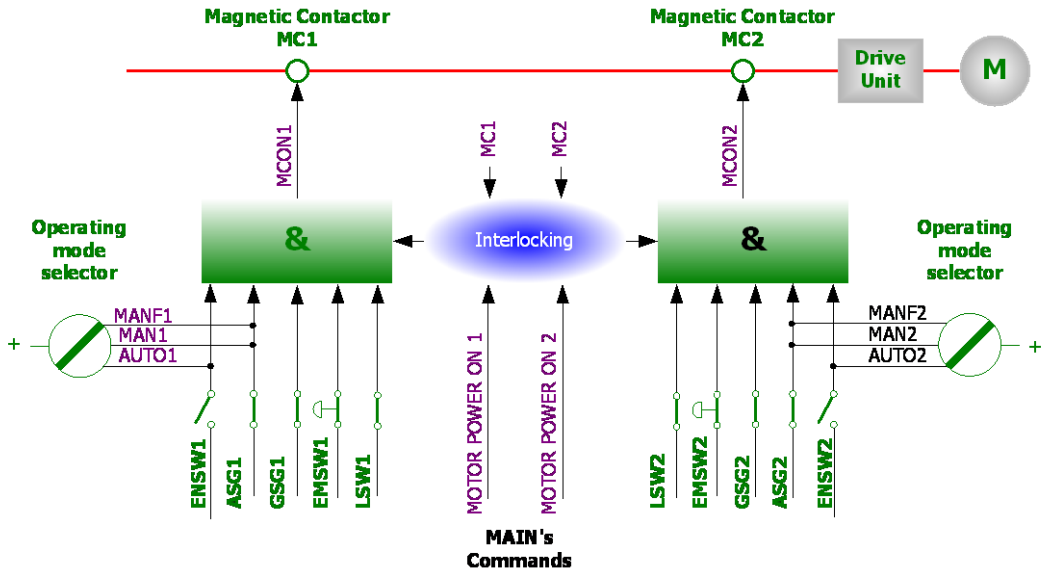


Figure 1.3 Safety Chain Configuration Drawings

The safety system of the robot consists of a double safety electric circuit that constantly monitors the status of the robot. If an error is detected, the power of the motor will be cut off immediately, and the motor brake will be activated. To return the motor to the “on” state, all switches of the double electric circuit should be connected. If any of the double switches in the safety electric circuit is shorted, the contactor of the motor will be disconnected, and the brake will be activated to stop the robot. In addition, as soon as the safety electric circuit is disconnected, an interrupt call will be sent to the controller to check the cause of the interruption.

During operation, the safety control circuit is based on a dual safety electrical circuit in which the controller and the motor on mode interact with each other. For the robot to be in motor-on mode, all of the safety electric circuits, configured by connecting multiple switches, should be connected. The motor on mode means that the drive current is supplied to the motor. If any contact point of the safety electric circuit is disconnected, the robot will always return to the motor off mode.

The motor off mode means that the drive current is not supplied to the motor of the robot, and the motor brake is activated. The state of the switches will be displayed in the teach pendant. (Refer to the “I/O Monitoring” screen in the Operation Manual.)

Safety Electric Circuits

The emergency stop buttons on the control panel and teach pendant and the emergency stop buttons installed on the external facilities are all included in the safety electric circuit. The safety devices (safety plugs, safety area entry stop devices, etc.) that operate in auto mode can be installed by the user. In manual operation mode, the safety device signals will not be acknowledged. The user in all operation modes can apply the stop operation by safety devices (by overall safety stop devices) by connecting the devices. In other words, in auto mode, all safety devices (doors, safety mats, safety plugs, etc.) will be activated so that no one can enter the safety area of the robot. These signals are also generated in manual mode, but the controller ignores them to teach the robot and allows the robot to continue operation. In this case, the maximum speed of the robot will be limited to 250 mm/s. In other words, the purpose of the functions of the safety stop devices is to provide a safety area around the manipulator while a person approaches the robot to preserve and teach the robot.

When the robot is stopped by the limit switch, it is possible to change the position of the robot by jogging it, in the constant setting mode, with the operation key of the teach pendant (integer setting mode means the state of entering “『[F2]: System』” → “『3. Robot Parameter』” → “『2. Axis Constant』” / “『3. Soft Limit』” / “『4. Encoder Compensation』”).

Never ignore, modify, or change the safety electric circuit in any way.

1.10.2. Emergency Stop

The emergency stop function should be activated when people or equipment are in dangerous areas. All safety control devices, such as the emergency stop button on the operation panel of the controller, should be easily accessible from outside the safety area.

Emergency Stop State

When the emergency stop button is pressed, the robot should operate as follows.
In any case, the robot must stop immediately.

- The servo system power of the robot will be turned off.
- The motor brake of the robot will be activated.
- An emergency stop message will be displayed on the screen of the teach pendant.

Emergency stop can be implemented in the following two methods.

(1) Emergency stop through the operation panel or teach pendant (basic)

A button is located on the top of the controller operation panel and teach pendant.

(2) Emergency stop through an external system

External emergency stop devices (button, etc.) can be connected to the safety electrical circuit according to the application standards of the emergency stop circuit (refer to the system board section of the “Basic Configuration” of the Controller). In this case, connect the wire in a way in which the emergency stop can be set to the “Normal ON” mode, and check its activation during the trial operation.

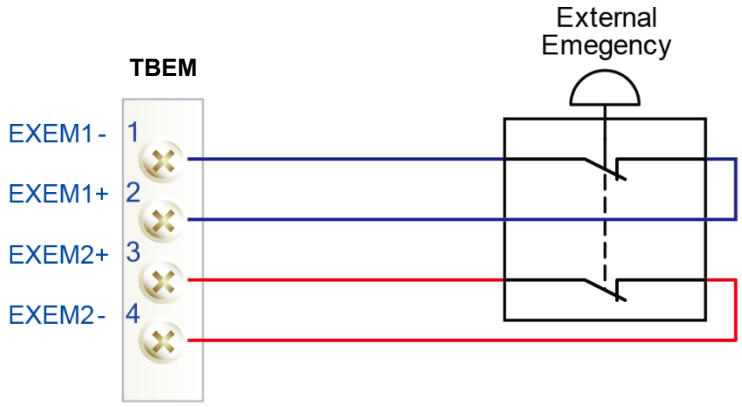


Figure 1.4 Connection of the External Emergency Stop Button through the System Board Terminal Block

1.10.3. Operation Speed

To teach the robot, the operation mode switch must be set to manual. In this case, the maximum speed of the robot will be limited to 250 mm/s.

1.10.4. Connection of Safety Devices

The external safety devices are used to interlock the controller by connecting safety lights, safety curtains, safety plugs, and safety mats, which are used externally by the system designer, to the safety electrical circuit of the controller. These devices are used as safety devices in the process of executing normal programs in automatic mode.

1.10.5. Limit of the Operation Area

If some operations are deemed unnecessary in the process of applying the robot, the operation range of the robot can be limited to secure a sufficient safety area. When the robot collides with an external safety device such as the safety fence, this function will help minimize possible damage. Axes 1, 2, and 3 of the robot are controlled by a mechanical stopper or an electrical limit switch. If the operation range is changed by a mechanical stopper or electrical limit switch, the operation area limit parameter should also be changed in software. If necessary, the movement of the three axes of the wrist may also be limited. The user can change the limit of the operation area of each axis. When shipped, the robot is set for the maximum operation area.

- **Manual mode: The maximum speed is 250 mm/s.**
  In manual mode, the operator can choose to enter the safety area of the robot.

- **Auto mode: Can operate the robot using a remote operation device**
  Safety devices, such as doors and safety mats, will be activated.
  No one should enter the safety area of the robot.

1.10.6. Monitoring Function

(1) Motor monitoring function
The motor is protected from overloading by a sensor inside the motor.

(2) Voltage monitoring function
The servo amplifier module will turn off the switch of the power to be inputted to the servo amplifier when overvoltage or undervoltage occurs to protect the amplifying element.

1.11. Liabilities

The robot system is manufactured according to the latest technical standards and approved safety specifications. Nevertheless, the robot system and the surrounding facilities may collide with each other, resulting in a threat to the operator's life or injuries to the arms and legs of the operator.

The robot system should be used in a technically perfect condition that is appropriate for design, and should also be used by an operator who can pay full attention to safety by fully recognizing the dangers involved in the operation. Use the robot system according to the operation instructions and the manual supplied together with the robot system. Using the safety-related functions for other purposes in the robotic system is not permitted in any case.

To use the robot system for other purposes or additional purposes other than the purpose for which the robot is designed, you should review whether the purposes comply with the purpose of the design. The manufacturer shall not be held liable for any damages or accidents caused by such misuse. The user will be solely responsible for any misuse. When operating the robot system within the scope of the designed usage, you must understand the operation manual thoroughly, which is the reference document for the robot operation.

Do not use the robotic system until the machines or systems, included and used in the robot system, can comply with the EU machinery reference documents as directed by 98/37 / EC (2006/42 / EC) and US OSHA.

The standards documents outlined below are related to the safety of the robot systems.

- ANSI/RIA R15.06-1999
  Industrial Robots and Robot Systems - Safety Requirements
- ANSI/RIA/ISO 10218-1-2007
  Robots for Industrial Environment - Safety Requirements - Part 1 - Robot
- ISO 11161:2007
  Safety of machinery - Integrated manufacturing systems - Basic requirements
- EN ISO 13849-1:2008
  Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design (ISO 13849-1:2006)
- EN 60204-1:2006
  Safety of machinery - Electrical equipment of machines - Part 1: General requirements (IEC 60204-1:2005 (Modified))
- EN ISO 10218-1:2006
  Robots for industrial environments - Safety requirements - Part 1: Robot (ISO 10218-1:2006)

The user shall be responsible for the accidents caused by neglecting these instructions. In addition, the manufacturer shall not be liable for any damage caused by the equipment supplied by the user, or by the equipment not included in the contract with the manufacturer, or by the equipment arbitrarily configured by the user around the robot system. The user shall be solely responsible for all risks associated with such equipment.

2 Specification

2.1. Instrument part type of the robot

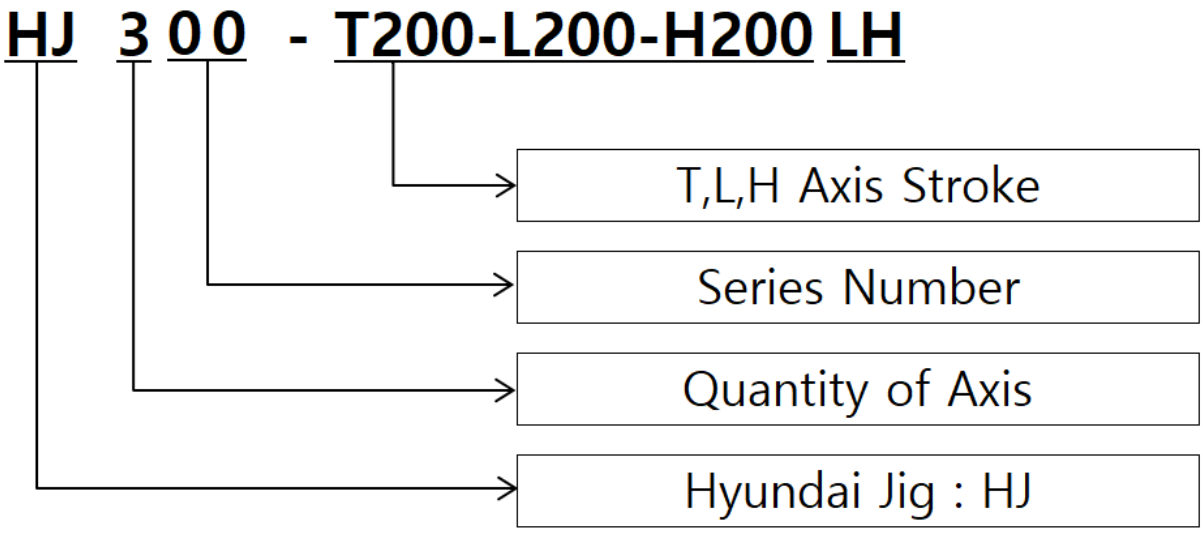


Figure 2.1 Instrument Part Type of the Robot

2.2. Basic Specification

Table 2-1 Basic Specification for Each Model (HJ Series)

Item		Specifications
Operation range	X[T]-axis	100~600 mm
	Y[L]-axis	100~600 mm
	Z[H]-axis	100~600 mm
Maximum speed	X[T]-axis	250 mm/sec
	Y[L]-axis	250 mm/sec
	Z[H]-axis	50~250 mm/sec
Accuracy of repeatability	±0.2mm	
Maximum payload	200 kg	
Manupulator weight (kg) (with no base)	200~300 Kg	
Installation environment	Temp.	0 ~ 40℃
	Humidity	20 ~ 80 %RH

2.3. External Dimensions and Operation Area of the manipulator

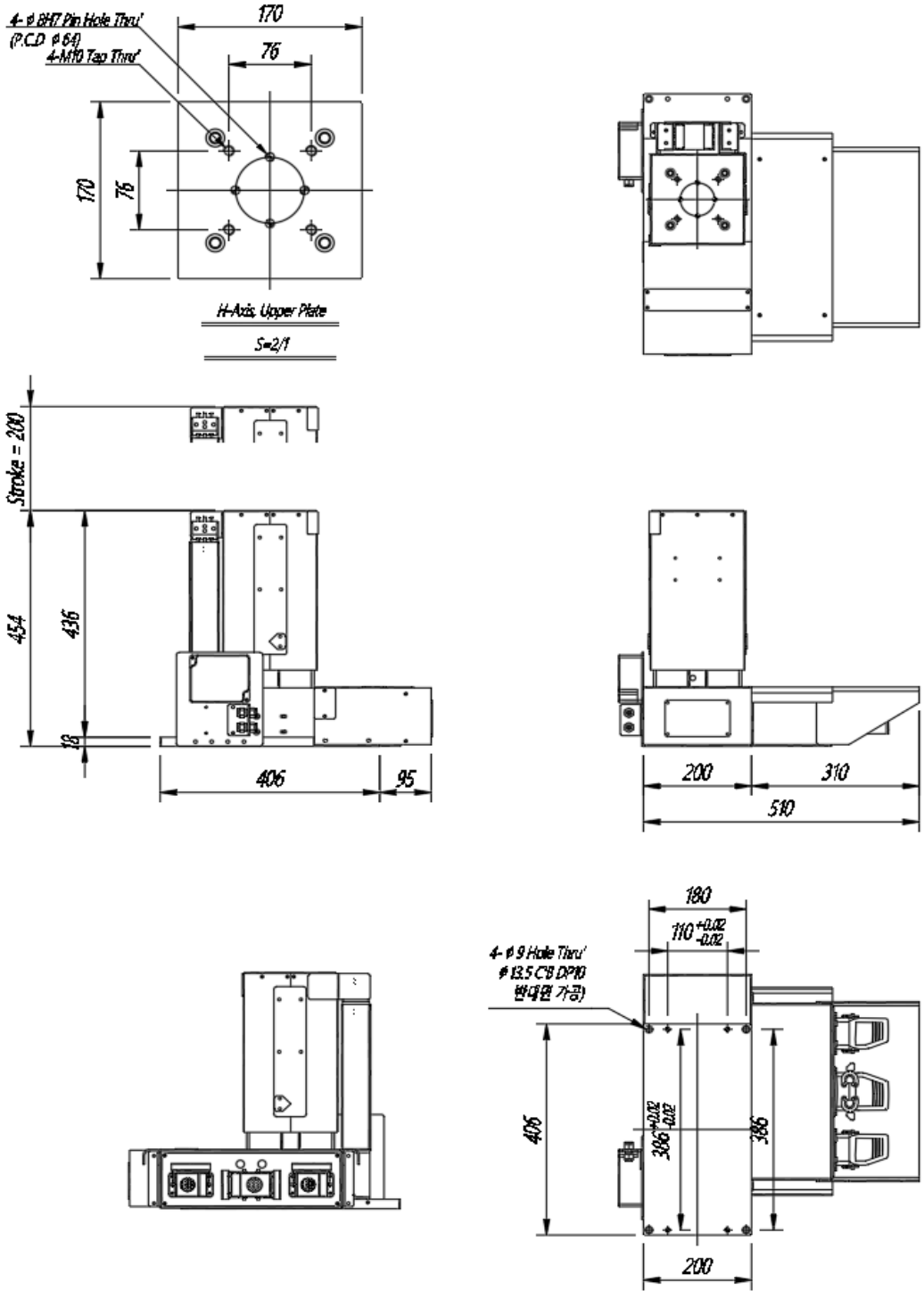


Figure 2.2 External Dimensions and Operation Area of the Manipulator
[HJ10, HJ115 Series]

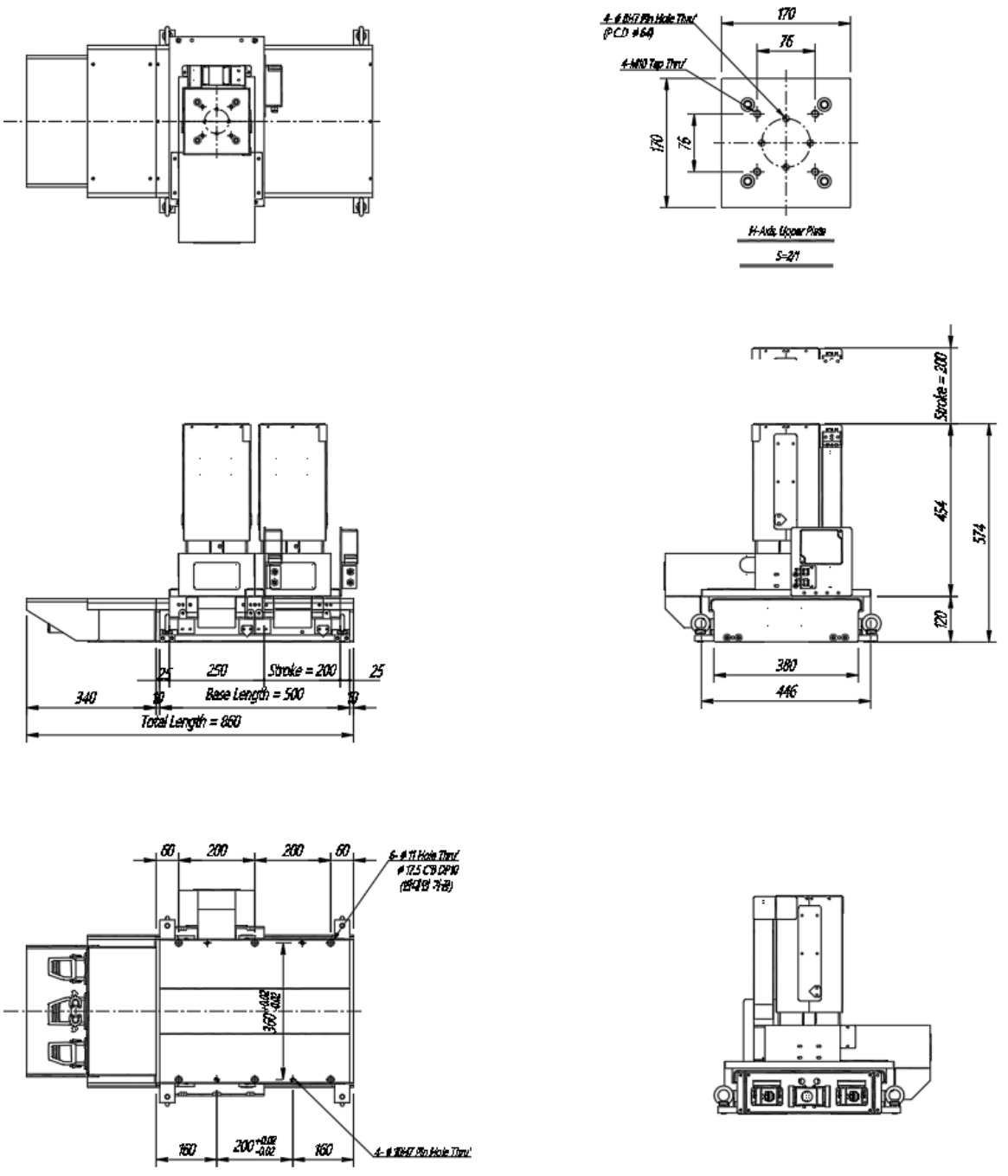


Figure 2.3 External Dimensions and Operation Area of the Manipulator
[HJ210, HJ215, HJ225 Series]

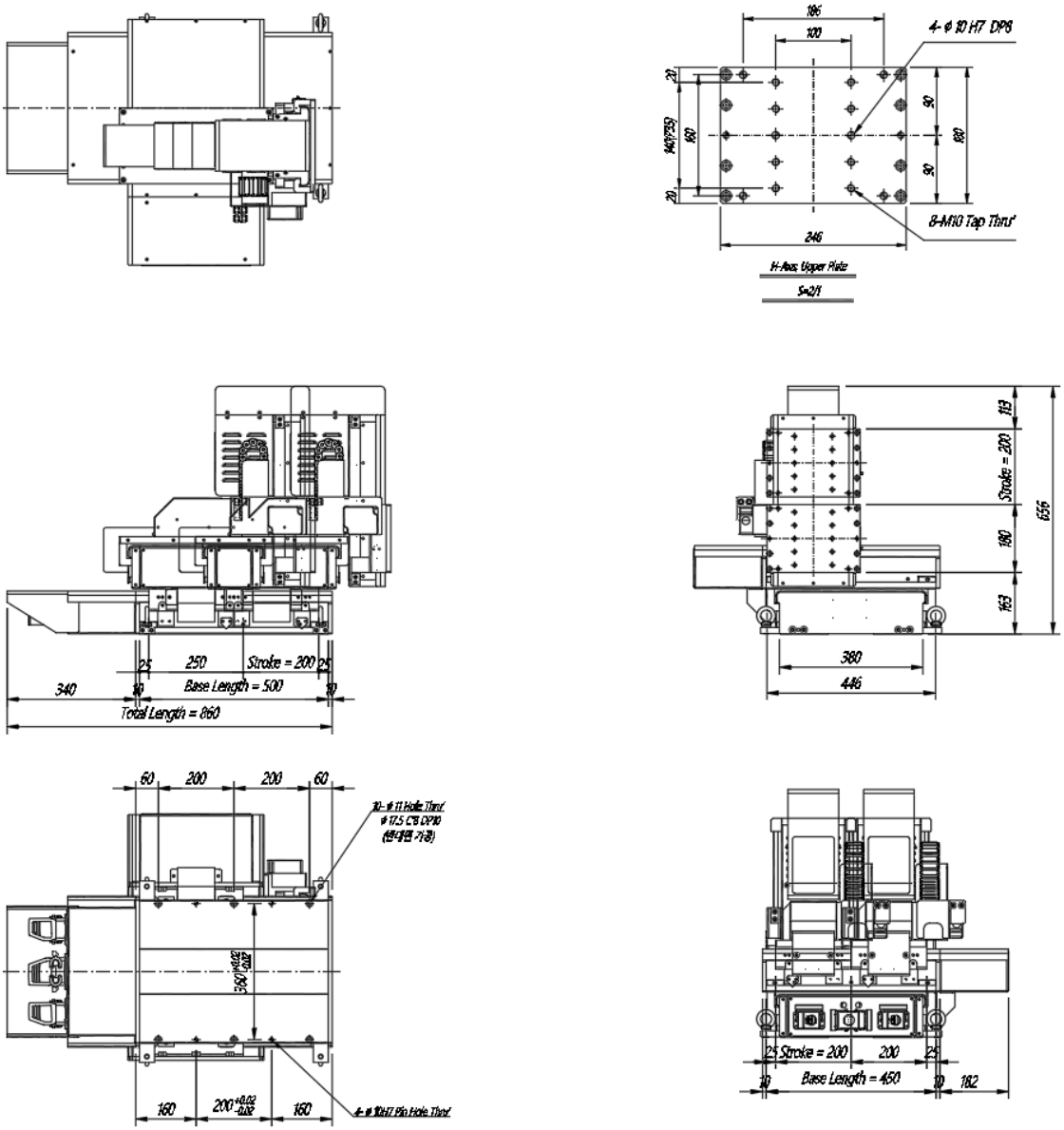


Figure 2.4 External Dimensions and Operation Area of the Manipulator
[HJ300, HJ320, HJ325 Series]

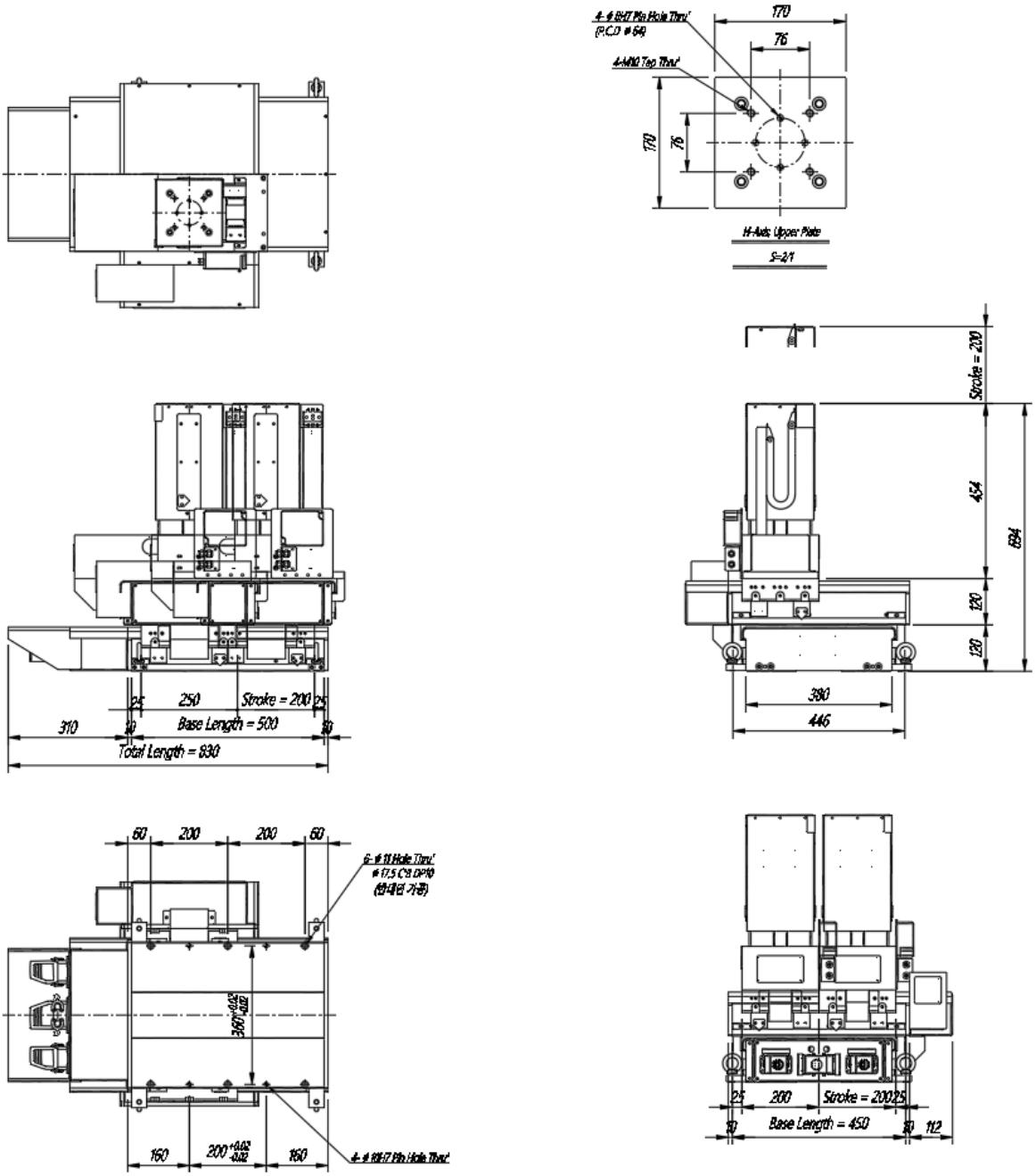


Figure 2.5 External Dimensions and Operation Area of the Manipulator
[HJ310, HJ315, HJ330 Series]

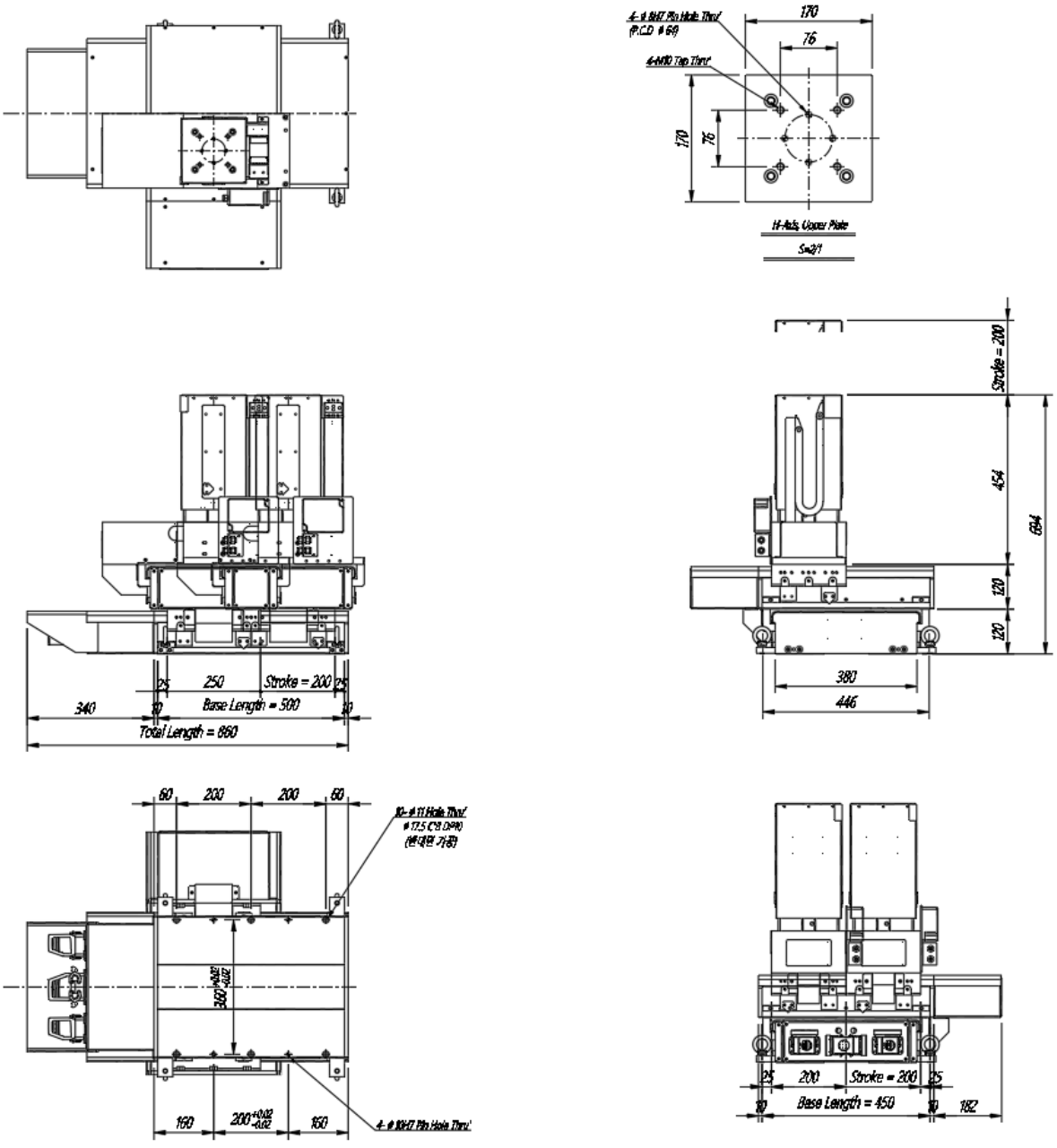


Figure 2.6 External Dimensions and Operation Area of the Manipulator
[HJ335, HJ340 Series]

2.4. Names of Operation Axes

Table 2-2 Direction of Rotation of Each Axis

Name of Axis	Operation	Buttons on Teach Pendant
X[T]	Travel	X
Y[L]	Travel	Y
Z[H]	Travel	Z

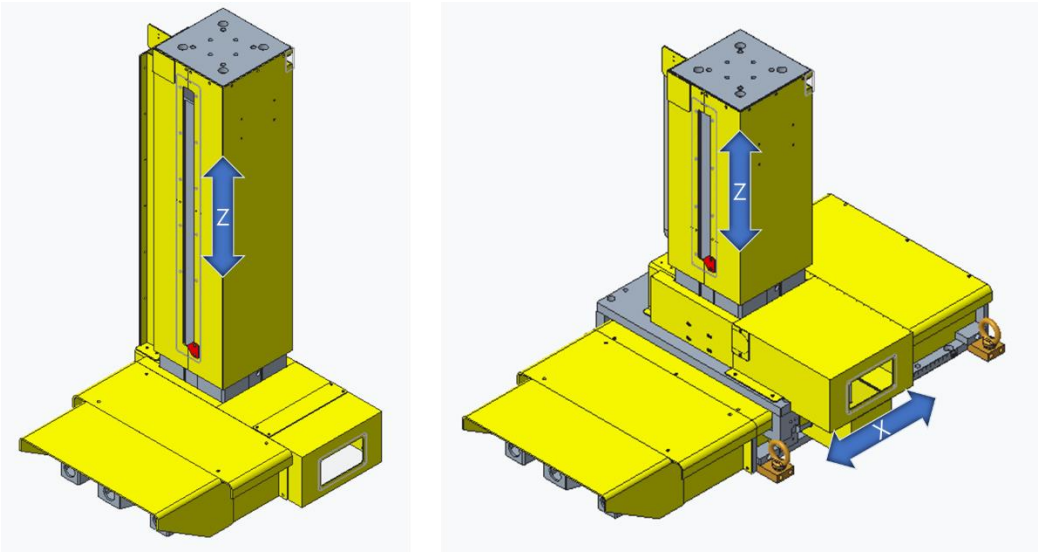


Figure 2.7 Exterior and Operation Axes of the Manipulator [HJ1, 2 Series]

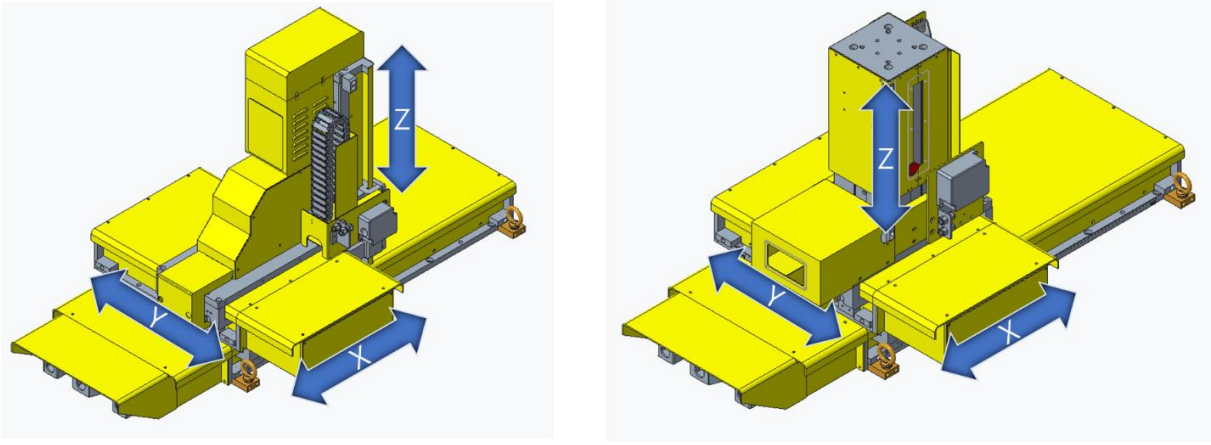


Figure 2.8 Exterior and Operation Axes of the Manipulator [HJ3 Series]

3

Precautions in Handling

3.1. Precautions in transportation

First, you must secure a location where you can perform the work before transporting the manipulator. When lifting the manipulator using a crane, take precautions not to put your hand or go under it for safety.

3.2. Transportation Method

3.2.1. Using a Crane

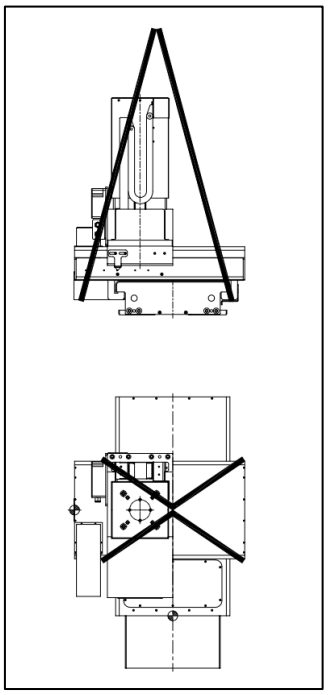


Figure 3.1 Transportation Method: Using a Crane

Precautions must be observed for the lifting work when transporting the robot using a crane. If the center of gravity is changed, it will make lifting difficult. Full attention should be given.

- Never walk under the manipulator.
- Set the robot in the posture, as shown in the figure.
- Fasten wire ropes at the both frames of the Y axis.
- Comply with safety regulations when performing the lifting work.
- Take precautions not to apply an impact on any part of the robot when transporting it.
- Weight of the manipulator: 200~300 kg
- Minimum crane capacity: 1 tons

※ Insert the wire rope into a protective hose to prevent damage to the painted parts of the robot at the contact area between the manipulator and the wire rope.

3.2.2. Using a Lift(Forklift)

When transporting the robot using a lift (forklift), perform transportation by considering the center of gravity of the robot as follows.

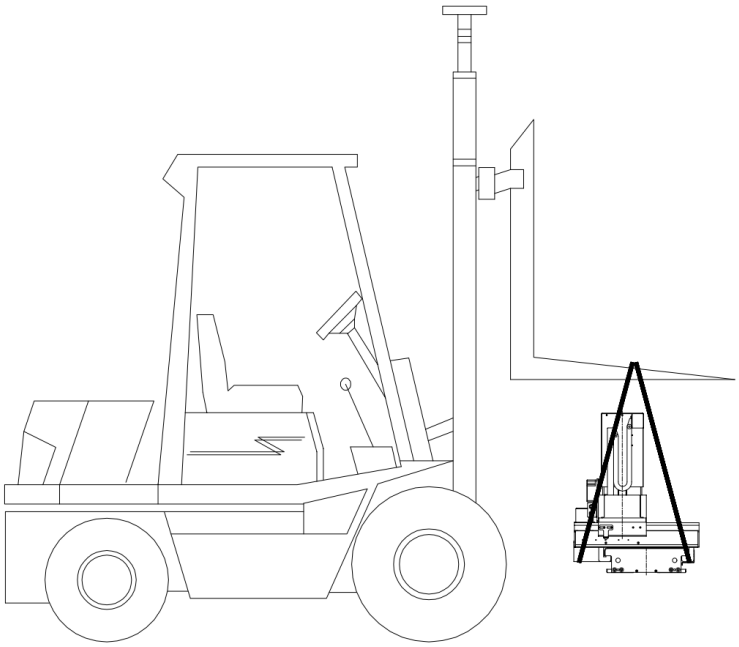


Figure 3.2 Transportation Method: Using a Forklift

3.3. Installation Method

Caution:
Before unpacking and installing the robot, you must read the safety regulations or related instructions carefully.

Warning:
Installation must be carried out by an installation specialist in compliance with the relevant regulations in the concerned country or region.

When unpacking the robot, you should check whether the robot is damaged while being transported or unpacked. In addition, considering that not only the method of installing the manipulator, but also the foundation of the robot, is essential for maintaining the robot functions, you should observe the following.

3.3.1 Precautions in Robot Installation

The robot should be installed according to the pre-reviewed and planned foundation and allocation for its functions to be fully utilized. If the robot is installed poorly, it may cause errors in the relative position between the robot and the workpiece during operation, and it may cause vibration degrading the quality of the work by the robot, shortening the service life of the robot and creating dangerous situations. Therefore, pay attention to the following points during robot installation.

General Matters regarding Safety

(1) To protect the worker, the robot system must be completely designed and installed according to the safety requirements regulated by the laws and specifications of the country where the robot is installed.

(2) The operator who uses the robot should fully understand the contents described in the application and auxiliary manuals, and operate and handle the robot skillfully.

(3) The worker installing the robot should apply the safety instructions during the installation if there is a problem.

(4) The system supplier should guarantee that all circuits used for safety functions perform their functions.

(5) The main power supply to the robot should be installed in a way in which it can be cut off from outside the robot operation area.

(6) The system supplier should guarantee that all circuits used for the emergency stop function safely perform their functions.

Technical Matters regarding Safety

(1) By taking into consideration the dimensions of the manipulator and the operation range, make sure that that there is no interference with peripheral devices.

(2) Secure enough space for disassembling and inspecting the robot.

(3) Make sure there is no obstacle in the robot operation area.

3.3.2. Conditions of Use

(1) The ambient temperature should be 0℃–45℃.

(2) The surrounding humidity should be 20%–80% RH, and there should be no condensation.

(3) If the robot is not to be installed immediately, keep it in a dry place where the temperature is -15℃ to 40℃.

3.3.3. Installation Position of the Manipulator

After installing the manipulator, fix the hand at a position where it will not touch the sidewall, safety cover, or the controller. You must secure a space for inspecting the manipulator. The standard cable length between the manipulator and the controller is 5 m.

3.3.4. Fixing of the Manipulator Frame

The fixing of the frame may vary depending on the installation position, floor conditions, etc. Fixing the frame is essential for the stable operation of the robot. Please contact our engineers for any inquiries about the details.

3.3.5. Method of Setting the Origin of the Manipulator

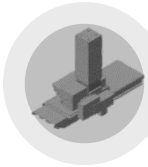
After the robot is installed, batteries will be installed, in principle, to prevent the loss of the encoder value. Thus, there is no possibility of losing the origin position. However, if you want to replace the motor or change the origin position, you should reset the origin.
The basic position and axis setting values for setting the origin are as follows.
.

Axis Name	HJ3/4 Series
X[T]	0 mm
Y[L]	0 mm
Z[H]	0 mm

Table 3-1 Value for Each Axis for Setting the Origin of the Robot

4

Inspection



4. Inspection

This section describes the periodic inspection, overhaul, adjustment, etc., which are necessary to maintain the performance of the positioner for a long time.

4.1. Inspection Plan

Inspection must be performed to maintain high performance when the robot is to be operated for a long duration.
Inspections are divided into daily inspections and regular inspections, and the personnel responsible for inspections must carry out inspections according to the basic inspection cycles shown in [Table 4-1].
Overhaul should be carried out every 40,000 operating hours or every 5 years.

If the inspection and adjustment methods are difficult to understand, please contact our after-sales service center (customer support department) for inquiries.

Table 4-1 Inspection Plan

Inspection Cycle	Maintenance work	Manager
Daily	Checking for damage to the exterior of the unit Remove dust and contaminants when necessary	Operator
Every month	Check the mounting condition of parts and options and modify them if necessary Check connection for tight fixation	Qualified person
Every year	Check the condition of labels and warnings and replace them if necessary	Qualified person
6 month	Qualified person to check the exterior damage of the option	Qualified person

4.2. Inspection Items and Cycle

Table 4-2 Inspection Items and Cycle

No.	Inspection Cycle			Inspection Items	Inspection Method	Reference	Remarks
	Daily	3 Months	1 Year				
Common for the manipulator and individual axes							
1	○			Cleaning of the manipulator	Visually checking for impurities		
2		○		Inspection of the wiring	Visually checking for damage to cables Visually checking the paint marking of the cable fixing bracket fastening bolts.		
3		○		Main bolts	Visually checking the paint marking		
4			○	Timing belt	Checking the timing belt tension	Refer to p. 5-15	
5	○			Motor	Checking for generation of abnormal heat Checking for generation of abnormal sound		
6	○			Reducer	Checking for generation of abnormal sound Checking for generation of vibration		
7		○		LM guide	Checking for generation of abnormal sound Checking for generation of vibration occrrence		
8		○		Ball screw	Checking the correct amont of grease Visually checking for foreign substances		
9		○		Coupling	Checking the correct amont of grease Visually checking for foreign substances		

10		○		Tool part fastening bolts	Visually checking the paint marking		

- Inspect all visible cables, and replace any damaged cables.
- Check the fastening torque of the main bolts.
- To check the power transmission devices (motor, reducer, etc.) for abnormalities, check them in auto or teach mode whether there is any abnormal sound. Check for abnormal sound in the auto or teaching mode to check the power transmission system (the motor, the reducer, etc.) for abnormalities.

4.3. Inspection of the Wiring in the Manipulator

The internal wiring of the manipulator is designed to withstand flexibility. However, if disconnection or short-circuiting occurs because of damage to or breakage of the wires, there could be a problem with robot operation, which requires the user to perform a daily inspection effectively. In addition, the user must carry out a prior inspection when you plan to perform works within the operation range according to the conditions for a safety inspection.

4.3.1. Conditions for Safety Inspection

When planning to carry out works such as teaching of the robot within the robot operation range (except for cutting off the driving source of the robot), the user should check the following items before starting the works. If any abnormality is confirmed, the user should correct it immediately and take other necessary measures.

- Check for damage to the cover and cable of the external power supply.
- Check for abnormality with the operation of the main body of the positioner.
- Check the functions of the emergency stop function.

5 Maintenance

5.1. Replenishment/Relacement of the Grease

If the grease is determined to be insufficient at the time of inspection, grease should be replenished. It is required to inject grease into the robot instrument part regularly.

Caution

If the grease is not properly injected, the internal pressure at the injection part may increase suddenly, possibly causing damage to the oil seal, leakage, and abnormal operation. Therefore, you must comply with the following items when injecting the grease.

(1) Use a grease gun when injecting grease. A grease gun with a nozzle diameter of Φ 6 mm or less should be used.

(2) Use only the designated grease. Otherwise, damage to the reducer and other problems could occur.

(3) Be careful not to inject grease more than the recommended amount, as it may cause problems such as grease leakage or defective robot trajectory.

(4) After injecting the grease, check whether the grease outlet is leaking and whether there is no pressure at the inlet before fastening the plug.

(5) When using the robot at an ambient temperature of 40° C or higher, reduce the grease replenishment and replacement cycles in half.

(6) It is not necessary to perform injection for parts other than those designated.

■ Grease Replenishment/Replacement Cycle

Table 5-1 Lubrication Position and Injection Cycle

No.	Position	Grease specification	Cycle	Injection amount	Remarks
1	Z axis of HJ110, 115				Oilless
2	X axis of HJ210, 215, 225	LGEP 2	10,000km	1.4cm^3	replenishment
3	Z axis of HJ210, 215, 225				Oilless
4	X axis of HJ300, 320, 325	LGEP 2	10,000km	1.4cm^3	replenishment
5	Y axis of HJ300, 320, 325	LGEP 2	10,000km	1.4cm^3	replenishment
6	Z axis of HJ300, 320, 325	LGEP 2	10,000km	1.4cm^3	replenishment
7	X axis of HJ310, 315 330	LGEP 2	10,000km	1.4cm^3	replenishment
8	Y axis of HJ310, 315 330	LGEP 2	10,000km	1.4cm^3	replenishment
9	Z axis of HJ310, 315 330				Oilless
10	X axis of HJ335, 340	LGEP 2	10,000km	1.4cm^3	replenishment
11	Y axis of HJ335, 340	LGEP 2	10,000km	1.4cm^3	replenishment
12	Z axis of HJ335, 340				Oilless

5.1.1 Z axis of HJ110, HJ115

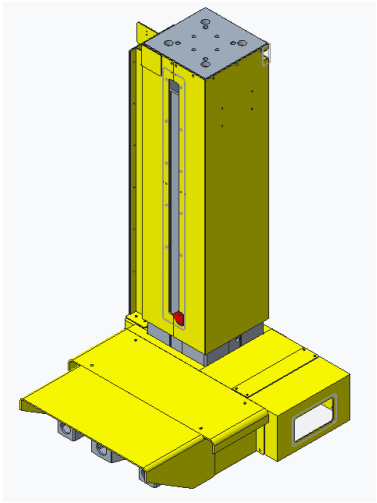


Figure 5.1 Z axis of HJ110, HJ115

(1) Oilless.

5.1.2 X, Y, Z axis of HJ215, HJ225

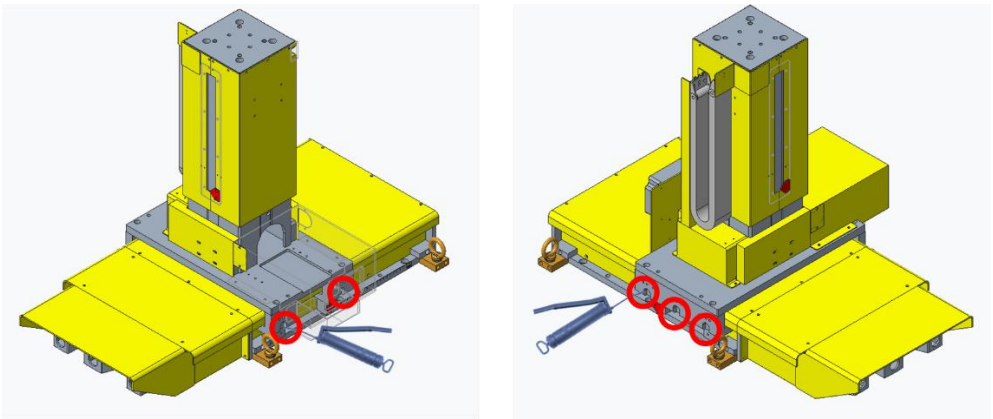


Figure 5.2 X axis of HJ210, HJ215, HJ225

(1) Apply grease evenly to the teeth of the rack gear of the X axis.

Grease type : LGEP2
Grease injection amount : 1.4cm³ / 10000km

(2) After grease is applied, you should move the X axis back and forth in full stroke several times.

(3) Wipe off grease on parts other than the rack gear.

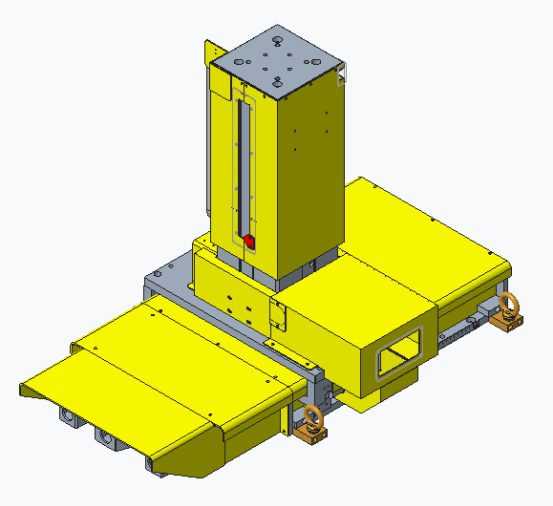


Figure 5.3 Z axis of HJ210, HJ215, HJ225

(1) Oilless

5.1.3 X, Y, Z axis of HJ300, HJ320, HJ325

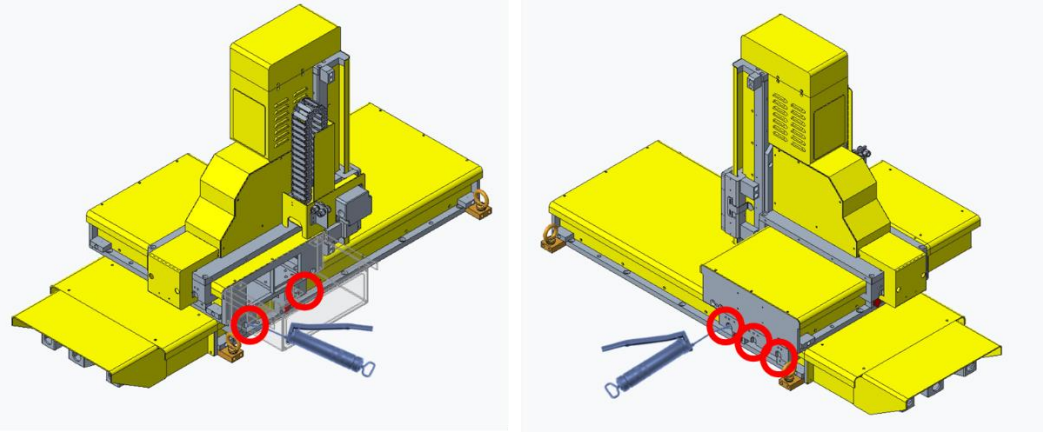


Figure 5.4 X axis of HJ300, HJ320, HJ325

(1) Apply grease evenly to the teeth of the rack gear of the X axis.

Grease type : LGEP2 **Grease injection amount : 1.4cm³ / 10000km**

(2) After grease is applied, you should move the X axis back and forth in full stroke several times.

(3) Wipe off grease on parts other than the rack gear.

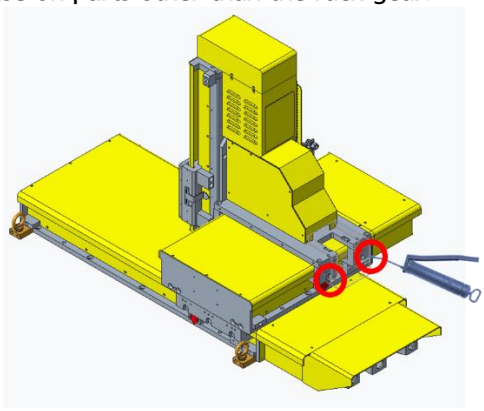


Figure 5.5 Y axis of HJ300, HJ320, HJ325

(1) Apply grease evenly to the teeth of the rack gear of the Y axis.

Grease type : LGEP2
Grease injection amount : 1.4cm³ / 10000km

(2) After grease is applied, you should move the Y axis back and forth in full stroke several times.

(3) Wipe off grease on parts other than the rack gear.

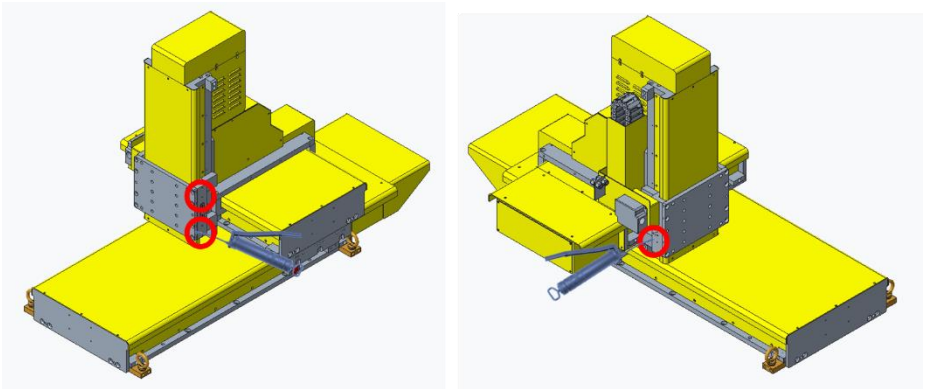


Figure 5.6 Z axis of HJ300, HJ320, HJ325

(1) Apply grease evenly to the teeth of the rack gear of the Y axis.

Grease type : LGEP2
Grease injection amount : 1.4cm³ / 10000km

(2) After grease is applied, you should move the Y axis back and forth in full stroke several times.

(3) Wipe off grease on parts other than the rack gear.

5.1.4. X, Y, Z axis of HJ310, HJ315, HJ330

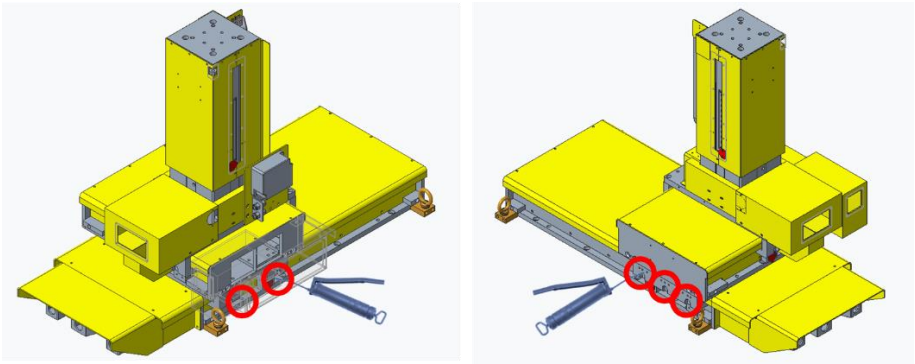


Figure 5.7 X axis of HJ310, HJ315, HJ330

(1) Apply grease evenly to the teeth of the rack gear of the X axis.

Grease type : LGEP2
Grease injection amount : 1.4cm^3 / 10000km

(2) After grease is applied, you should move the X axis back and forth in full stroke several times.

(3) Wipe off grease on parts other than the rack gear.

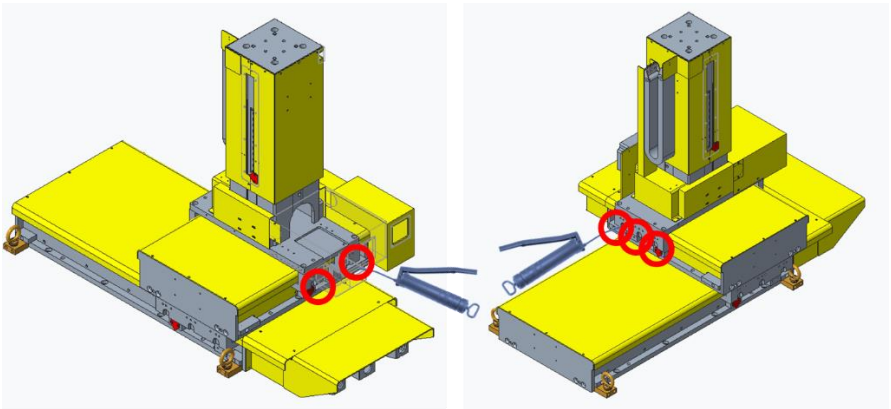


Figure 5.8 Y axis of HJ310, HJ315, HJ330

(1) Apply grease evenly to the teeth of the rack gear of the Y axis.

Grease type : LGEP2
Grease injection amount : 1.4cm^3 / 10000km

(2) After grease is applied, you should move the Y axis back and forth in full stroke several times.

(3) Wipe off grease on parts other than the rack gear.

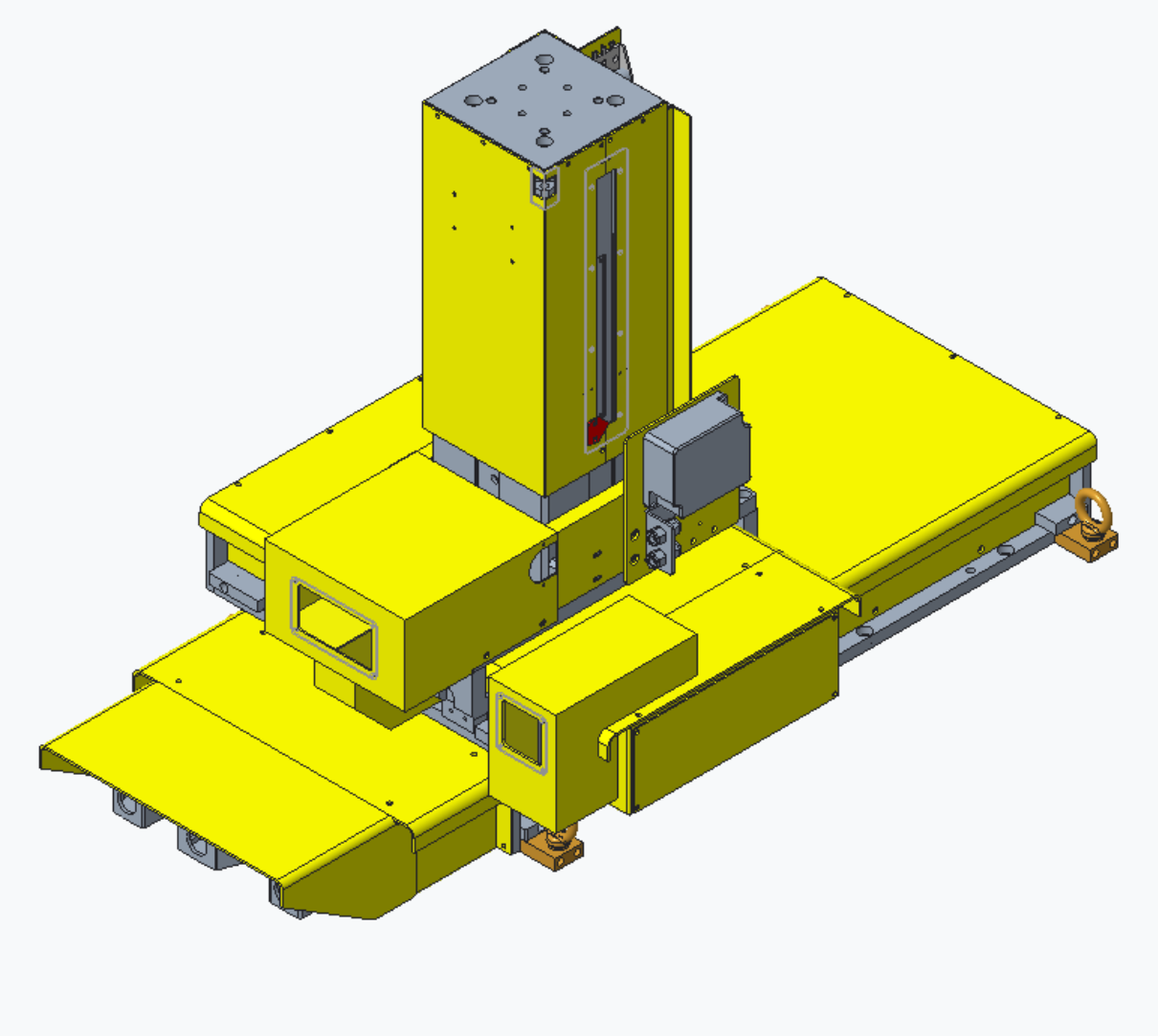


Figure 5.9 Y axis of HJ310, HJ315, HJ330

(1) Oilless

5.1.5. X, Y, Z axis of HJ335, HJ340

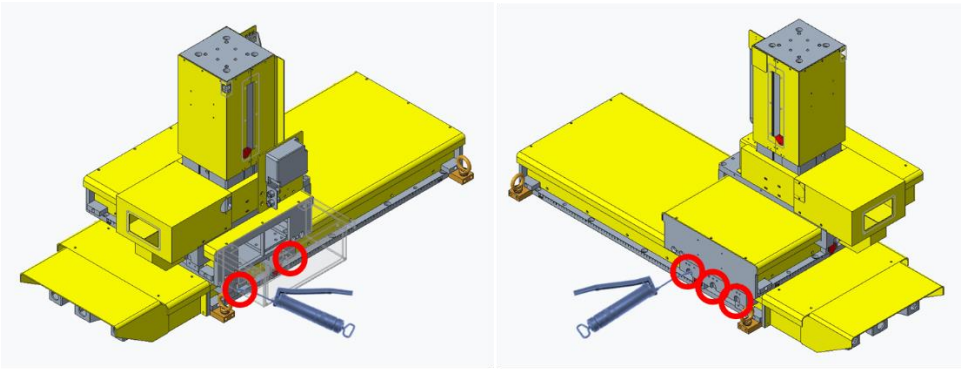


Figure 5.10 X axis of HJ335, HJ340

(1) Apply grease evenly to the teeth of the rack gear of the X axis.

Grease type : LGEP2
Grease injection amount : 1.4cm³ / 10000km

(2) After grease is applied, you should move the X axis back and forth in full stroke several times.

(3) Wipe off grease on parts other than the rack gear.

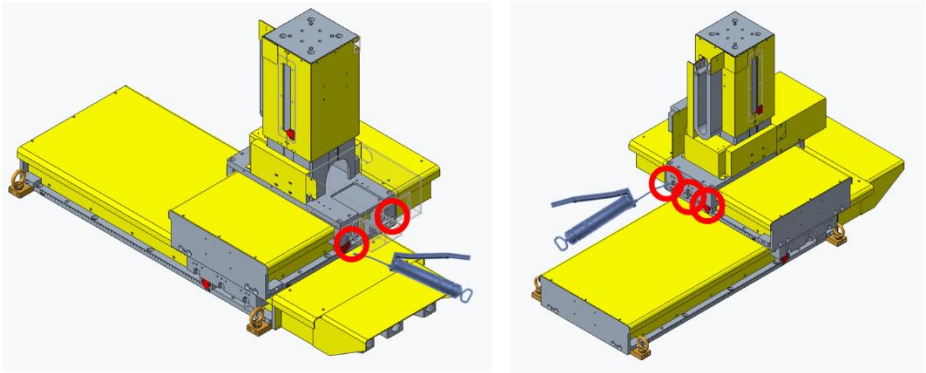


Figure 5.11 Y axis of HJ335, HJ340

(1) Apply grease evenly to the teeth of the rack gear of the Y axis.

Grease type : LGEP2
Grease injection amount : 1.4cm³ / 10000km

(2) After grease is applied, you should move the Y axis back and forth in full stroke several times.

(3) Wipe off grease on parts other than the rack gear.

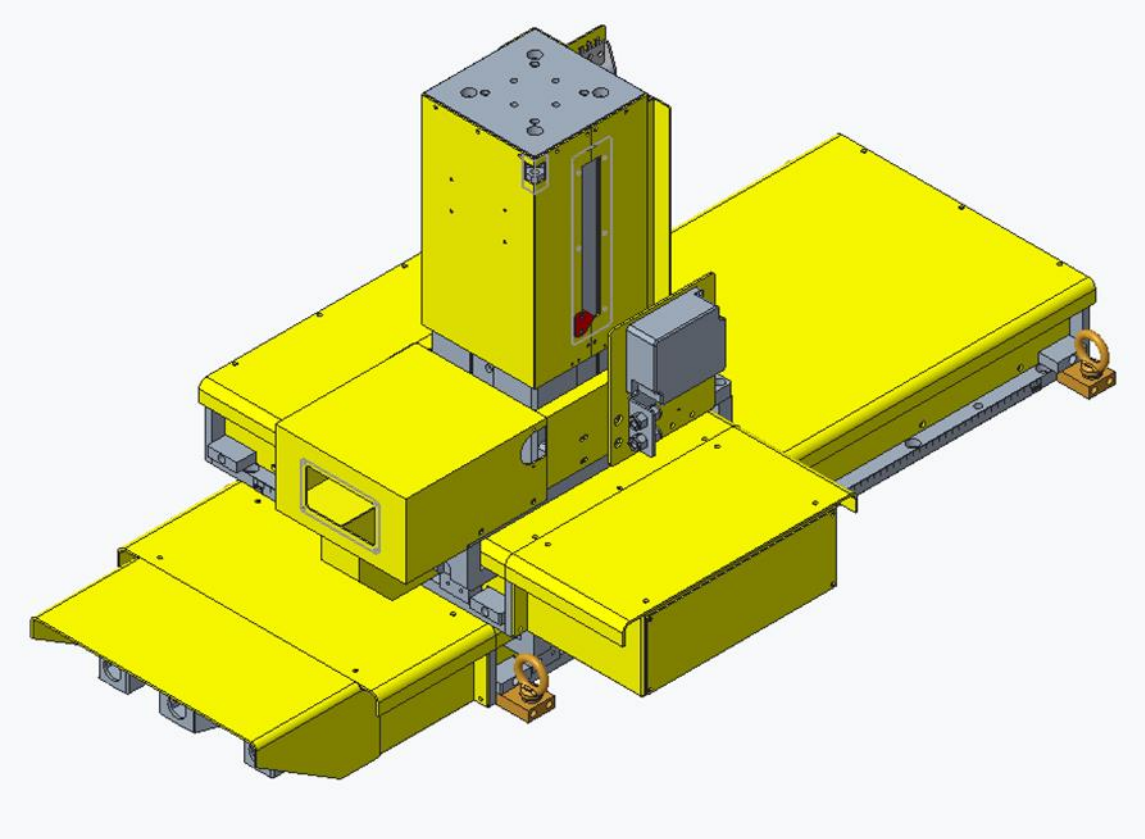


Figure 5.12 Z axis of HJ335, HJ340

(1) Oilless

5.2. Battery Replacement

The position data of each axis is to be preserved using the backup batteries. Lithium batteries are used. If the voltage of the battery drops, data cannot be maintained normally.
The batteries should be replaced every two years. In addition, if the batteries' voltage drop does not stay within a specific limit, a voltage drop error will be indicated on the controller and then the batteries must be replaced. It is required to comply with the following procedures in replacing the batteries.

Caution

If you turn off the power and replace the batteries, all current position data will be lost. Therefore, the origin should be reset.

- ✓ **Battery specification : ER6C(AA) 3.6V**
- ✓ **Battery manufacturer : Maxell**

(1) Press the emergency button while the controller power is ON.

(2) Remove the battery cover of each axis of the robot body.
(Refer to 〈5.4 Motor Replacement〉 for the detailed location of the motor by model)

(3) Remove the batteries. If the batteries are left unattended for 6 hours after being removed, an abnormality will occur to the encoder data. You must be careful about it.

(4) Replace the batteries with new ones.

(5) Attach the battery cover.

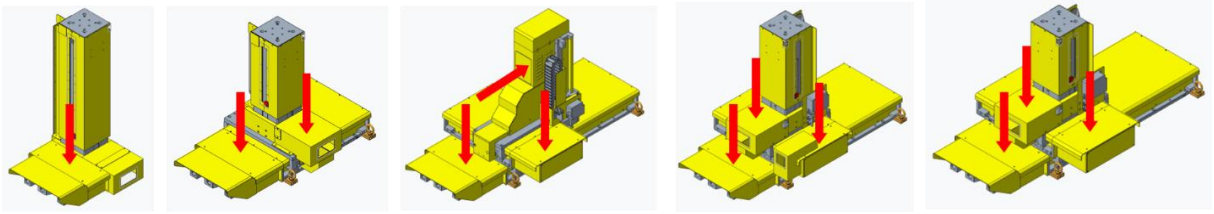


Figure 5.13 Area Where Batteries Are to Be Replaced

Table 5-2 Battery Type and Connector Name

Battery	Axis Name	Connector name	Battery type
Battery - 1	X	CNLBX	ER6C(AA) 3.6V
Battery - 2	Y1	CNLBT	ER6C(AA) 3.6V
Battery - 3	Y2	CNLBZ	ER6C(AA) 3.6V
Battery - 4	Z	CNLBC	ER6C(AA) 3.6V

Caution

- ✓ **Do not discard the battery. Handle it as industrial waste in accordance with the laws and codes.**
- ✓ **Do not charge the battery. Otherwise, an explosion or overheating could occur.**
- ✓ **Do not use a battery that is not designated.**
- ✓ **Replace the battery only with the designated one.**
- ✓ **Do not short the negative/positive sides of the battery.**
- ✓ **Do not expose the battery to a flame or high temperatures.**

5.2.1 Precautions in Battery Storage

(1) Do not store the batteries in a location with high temperature or high humidity, and store them in a well-ventilated area to avoid condensation.

(2) Store the batteries in a location where the temperature stays at the room temperature (20±15℃), the variation of temperature is low, and the relative humidity can be kept at 70% or less.

(3) The reference period for battery storage should be six months, and they should be managed based on the first-in and first-out method.

5.3. Tension adjustment of the Timing Belt

In the robots of the HC1853K series, timing belts are used to drive the L/R axes.
Check the tension of the timing belt drive part after 2,000 hours, when vibration/noise occurs, or when the hand position is misaligned. Improper tension on the timing belt can cause a significant adverse impact on the performance of the robot.

Caution

- ✓ **Never use a timing belt that is not designated.**
- ✓ **Power must be turned off before replacing the timing belt or adjusting its tension. Otherwise, injury could occur if the robot operates.**
- ✓ **Do not use belts or pulleys that suffered a damage to the external surface or are damaged. Otherwise, troubles could occur.**
- ✓ **If foreign objects get caught in the belt, it may cause serious trouble.**
- ✓ **Maintain a proper tension of the belt. Otherwise, the motor may be overloaded or the instrument may malfunction.**

It is recommended to use a sonic belt tension meter to measure the tension of the timing belt.

- ✓ **Manufacturer : Unita**
- ✓ **Type : U-507 Series**

Table 5-3 Belt Position and the Set Tension

No.	Position/Name	Regulated Belt Tension Value
1	Z axis drive Timing belt / HJ300, HJ320, HJ325	197 ±10Hz

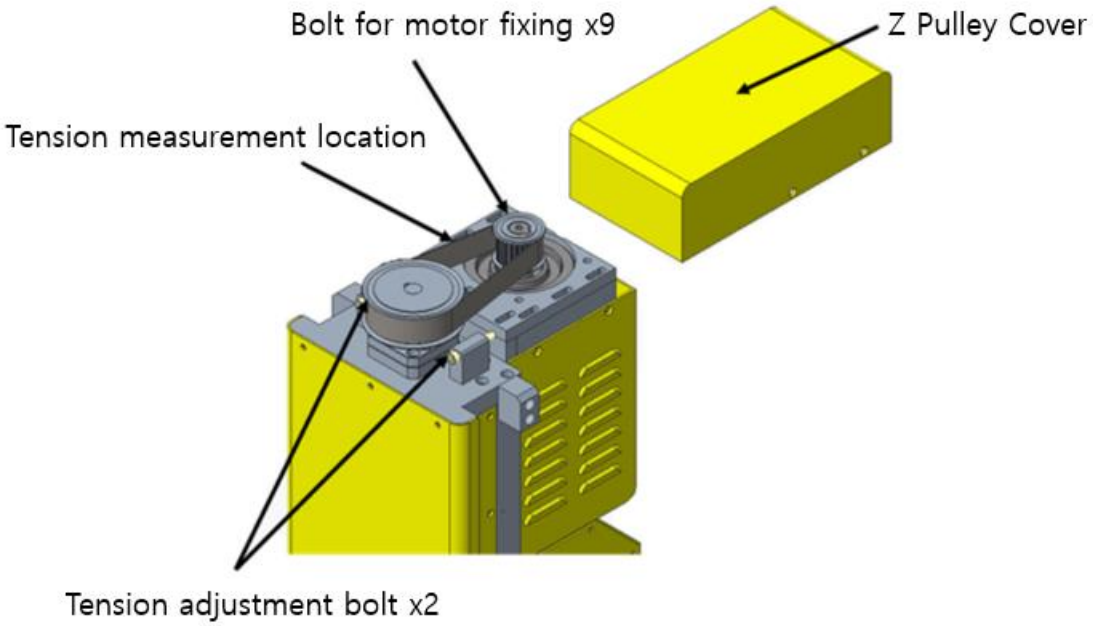


Figure 5.14 HJ300, HJ320, HJ325 location

5.3.1. Tension adjustment of the HJ300, HJ320, HJ325 Timing Belt

(1) Turn off the power and remove the Z pulley cover.

(2) After measuring the tension three times or more using a sound wave tension meter, calculate the average value. Compare the average value with the appropriate belt tension value. If it does not match the proper tension, adjust the tension as follows.

(3) Loosen all bolts for fixing the motor, and tighten the tension adjustment bolt until the belt tension reaches an appropriate level using the tension adjustment bolt.

(4) After adjusting the static tension, tighten the motor fixing bolt firmly to fix it. Install the Z pulley cover.

(5) Standard belt tension :197 ±10Hz

5.4. Motor Replacement

Caution

- ✓ **Since this robot has a built-in brake for posture maintenance in the motor, the Z-axis body and workpieces fall when the motor is removed. Therefore, in order to prevent falling, safety measures must be taken so that there is no risk of falling by making the Z-axis body close downward.**

(1) Set the controller to teaching mode and set it to operation ready [ON]. If the operation preparation [ON] does not work, make sure that the Z-axis does not fall and check if it is sufficiently fixed.

(2) The shaft for exchanging the motor takes the basic posture.

(3) Turn the controller power [OFF] and the primary power [OFF].

(4) Disconnect the motor wiring.

(5) After that, replace it according to the X, Y, Z motor replacement method.

(6) Connect the motor wiring.

(7) Motor resets the encoder of the exchanged shaft.

Caution

Before performing encoder correction, first set the operation preparation [ON] and check whether the power is turned on while pressing the enable switch of the teach pendant for 2 to 3 seconds.

(8) Correct the encoder of the shaft where the motor was replaced by referring to [Encoder Compensation] in the controller operation manual.

(9) Check if there is any problem with the robot operation.

5.4.1. Motor Replacement of X axis

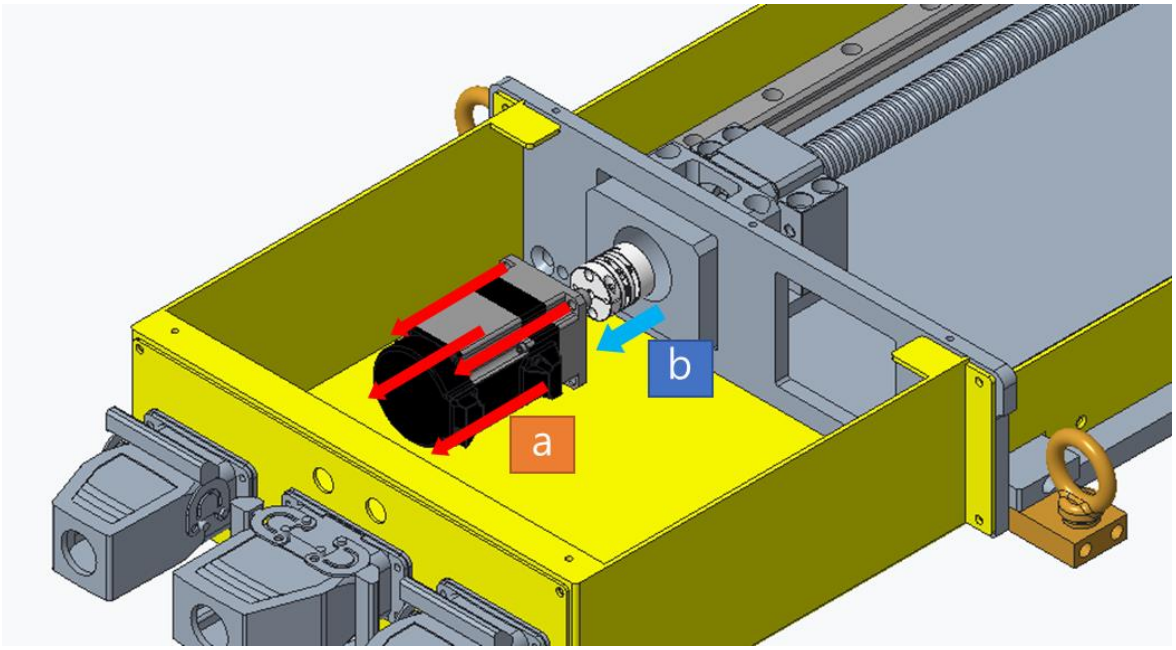


Figure 5.15 X axis of HJ2, HJ3 Series

(1) Disconnect the AMR, AER, and USER I/O connectors.

(2) Separate the X-axis motor power and the encoder connector.

(3) Loosen the 4 motor bolts and separate the motor from the bracket. (a)

(4) Separate the coupling and hub and separate the motor from the shaft.

(5) Replace new motor.

(6) Assembly is done in reverse order of disassembly.

5.4.2. Motor Replacemnet of Y axis

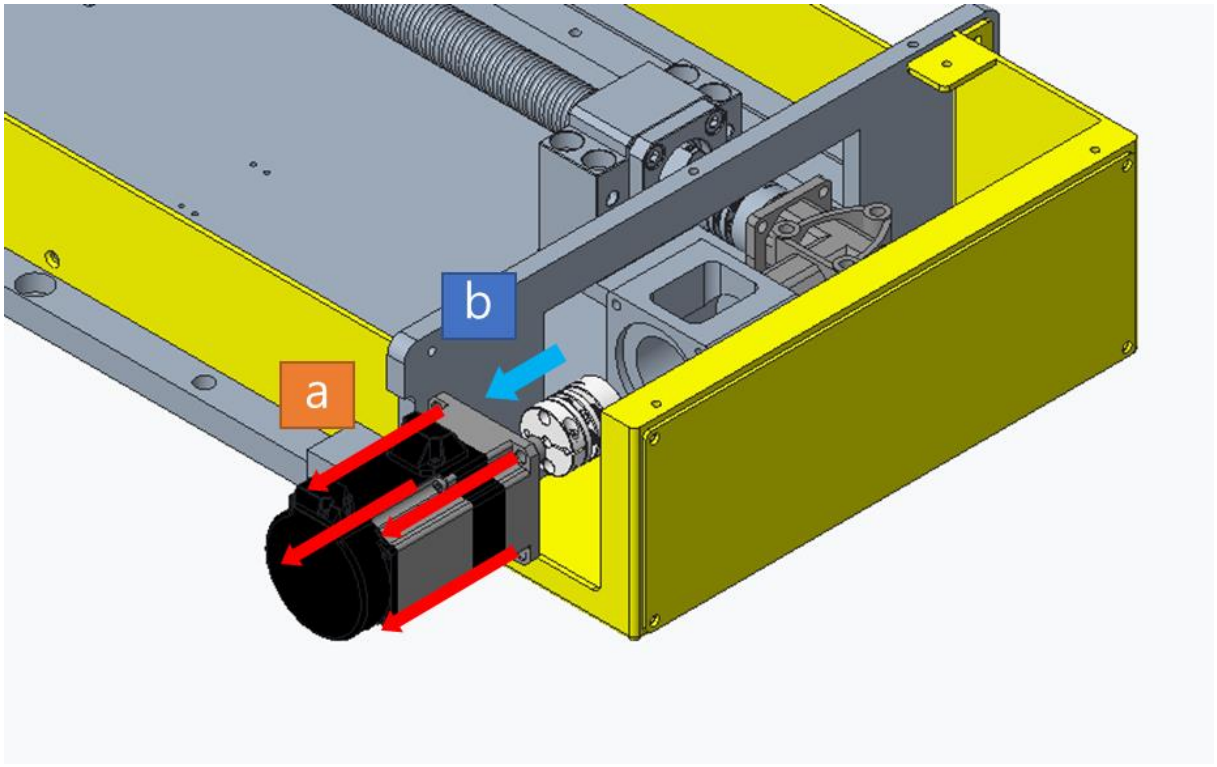


Figure 5.166 Y axis of HJ310,315,330

(1) Disconnect the AMR, AER, and User I/O connectors.

(2) Remove the Y-axis window. (a)

(3) Remove the connector cover from the Y-axis base. (b)

(4) Disconnect the Y-axis motor connector.

(5) Loosen 4 bolts to remove the motor from the motor bracket. (c)

(6) Remove the coupling hub and carefully remove the motor. (d)

(7) Replace with a new motor.

(8) Assembly is done in reverse order of disassembly.

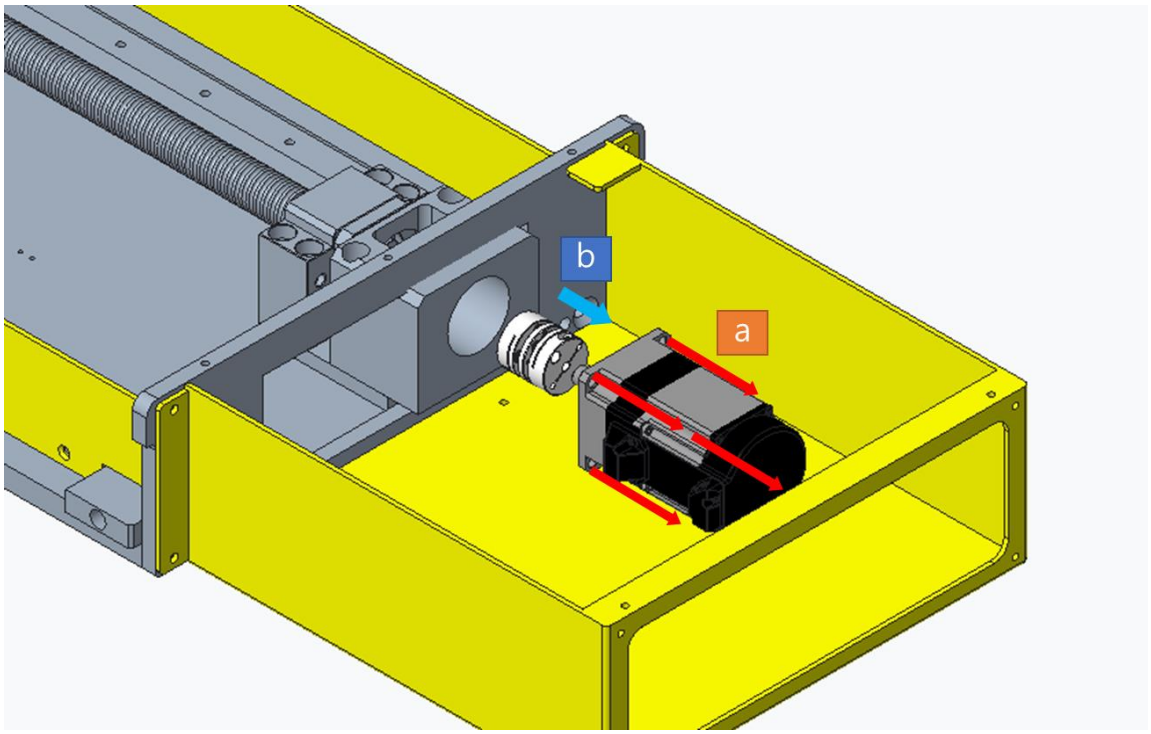


Figure 5.17 Y axis of HJ300,320,325,335340

(1) Disconnect the AMR, AER, and User I/O connectors.

(2) Separate the upper cover and motor cover.

(3) Separate the Y-axis motor power from the encoder connector.

(4) Loosen 4 bolts to remove the motor from the motor bracket. (a)

(5) Remove the coupling hub and carefully remove the motor. (b)

(6) Replace with a new motor.

(7) Assembly is done in reverse order of disassembly.

5.4.3. Motor Replacement of Z axis

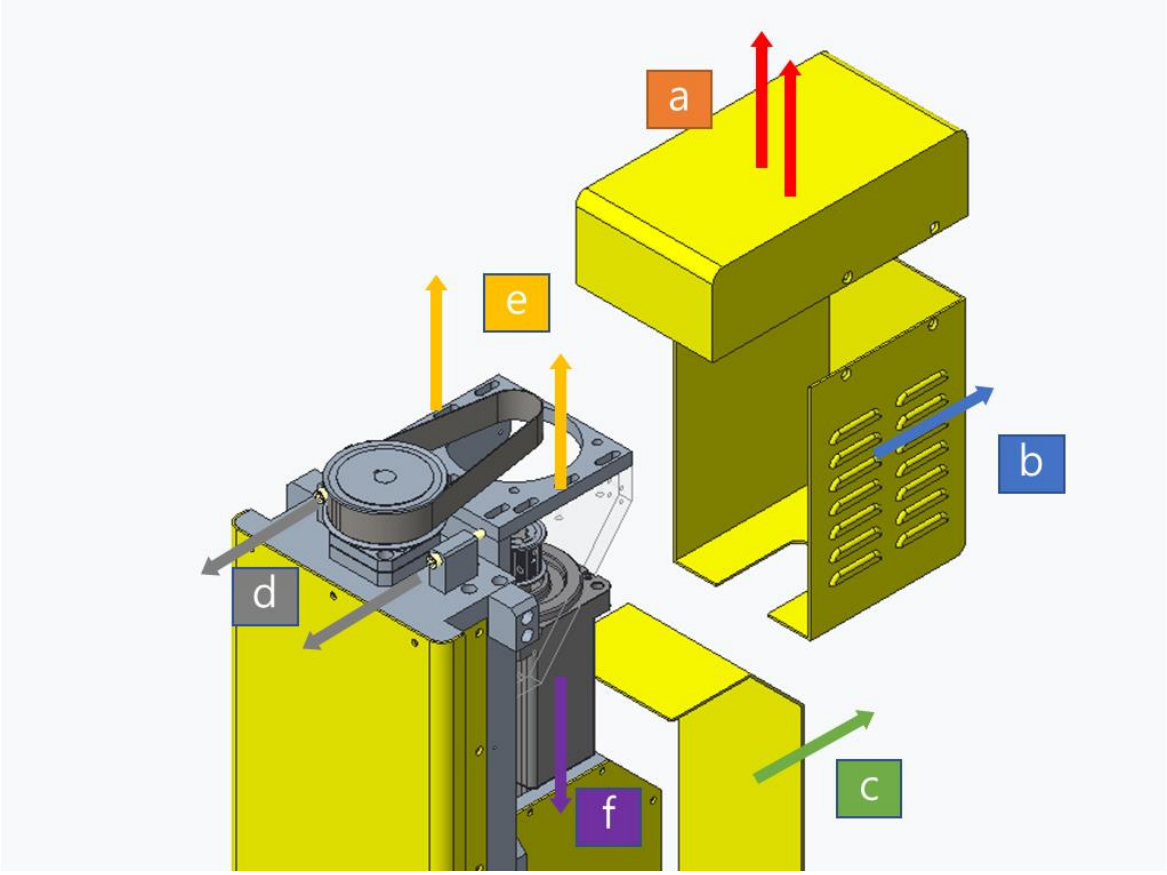


Figure 5.18 Z axis of HJ300,320, 325

(1) Disconnect the AMR, AER, and User I/O connectors.

(2) Remove the Z-axis motor cover. (a), (b), (c)

(3) Loosen the two tension adjustment bolts. (d)

(4) Loosen the 9 motor bracket bolts. (e)

(5) Loosen the 4 motor bolts and separate the motor from the bracket. (f)

(6) Replace with a new motor and join the pulley.
(The pulley can be removed by loosening the 4 headless bolts.)

(7) Align the motor bracket and check the tension adjustment bolt.
(Refer to the marking mark on the tension adjustment bolt.)

(8) Assembly is done in reverse order of disassembly.

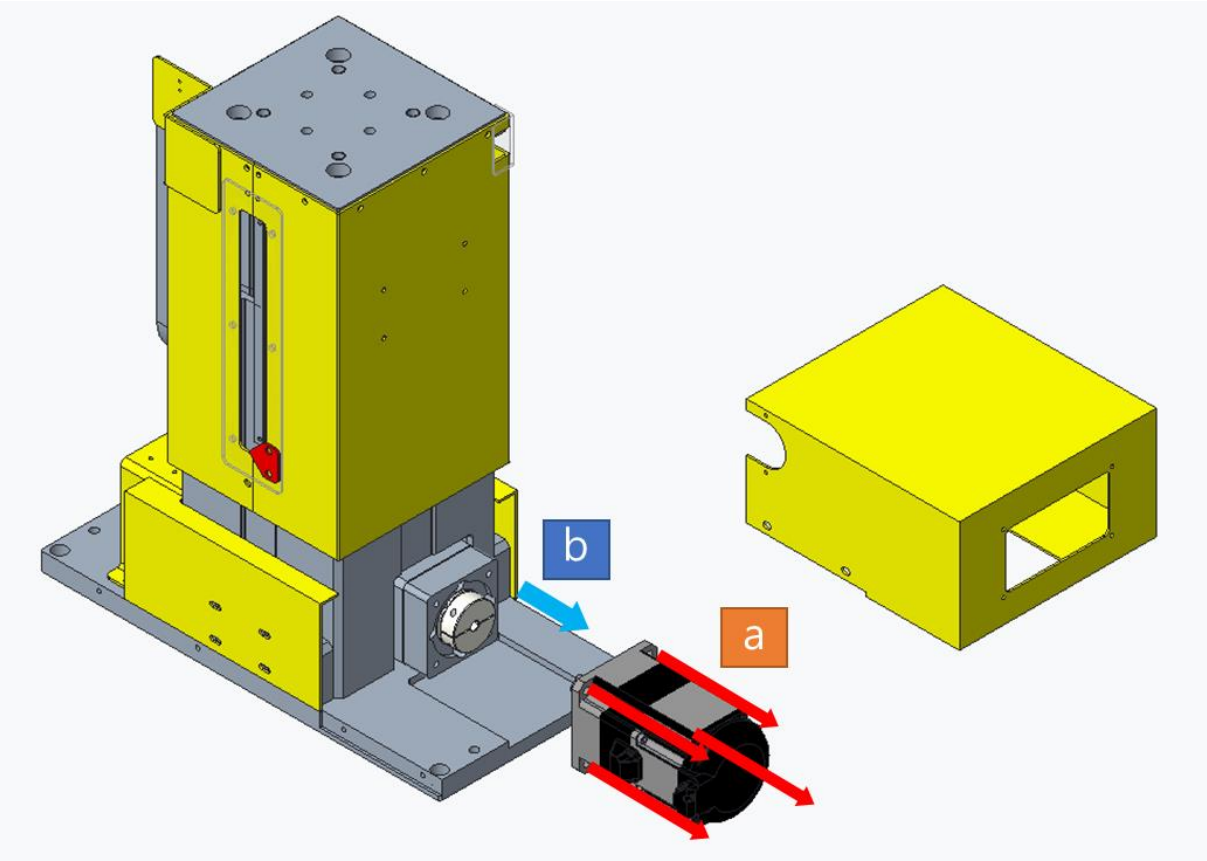


Figure 5.19 Z axis of HJ110, 210, 215, 225, 310, 315, 330, 335, 340

(1) Disconnect the AMR, AER, and User I/O connectors.

(2) Remove the Z-axis motor cover.

(3) Loosen the 4 motor bolts and separate them from the bracket. (a)

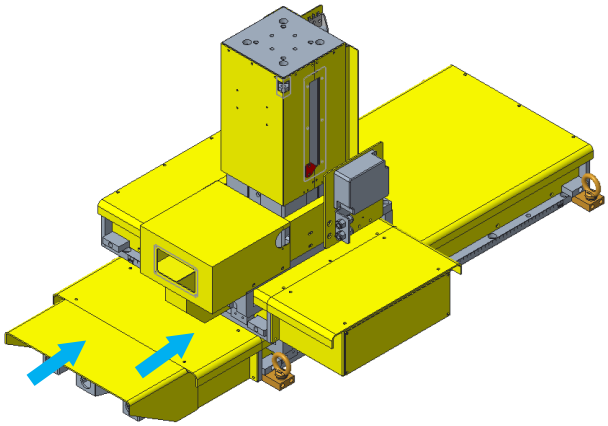
(4) Remove the coupling hub and separate the motor from the shaft. (b)

(5) Replace with a new motor.

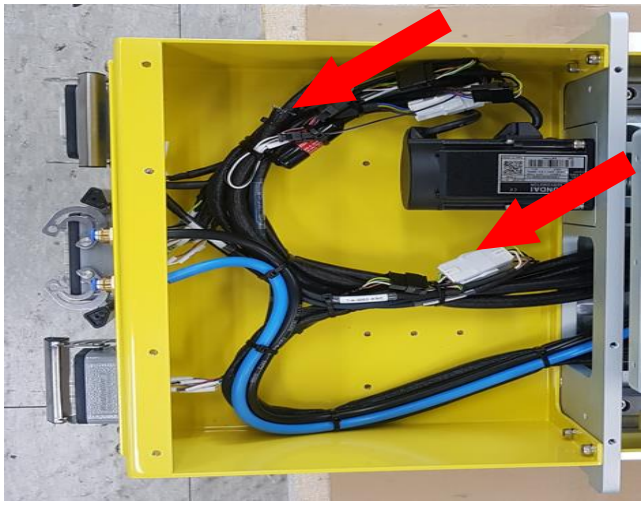
(6) Assembly is done in reverse order of disassembly.

5.5. Body wiring replacement

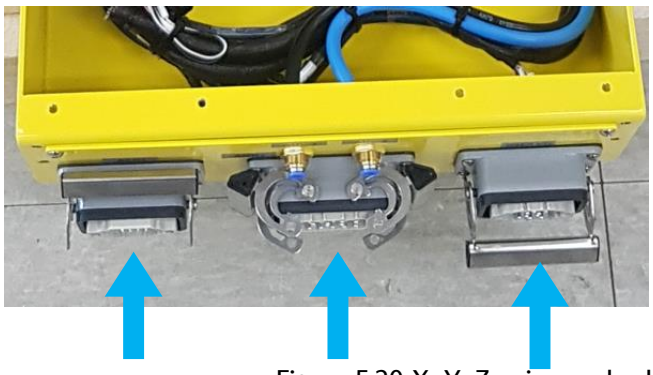
5.5.1. X, Y, Z axis panel cable exchange (all models)



(1) Remove the x-axis motor cover.



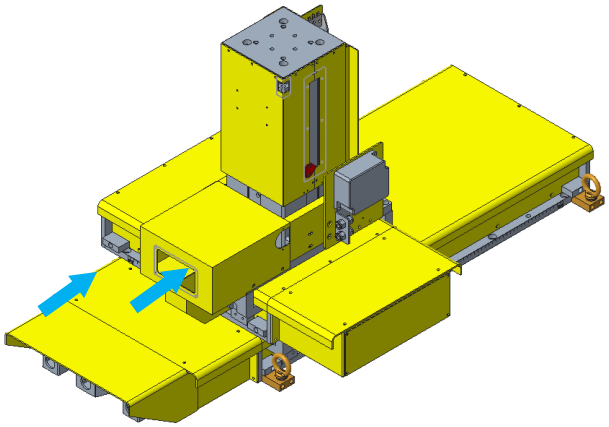
(2) Inside the x-axis motor cover, separate the panel cabel to be replaced and the motor connection cable.



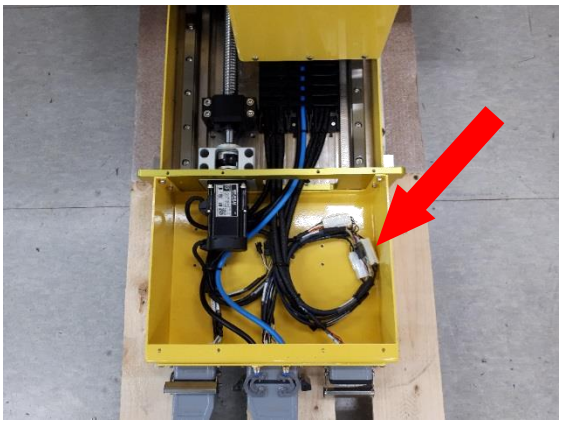
(3) Remove the panel connector cable to be replaced from the connector retaining plate.

Figure 5.20 X, Y, Z axis panel cable exchange (all models)

5.5.2. X-axis wiring replace (all models)



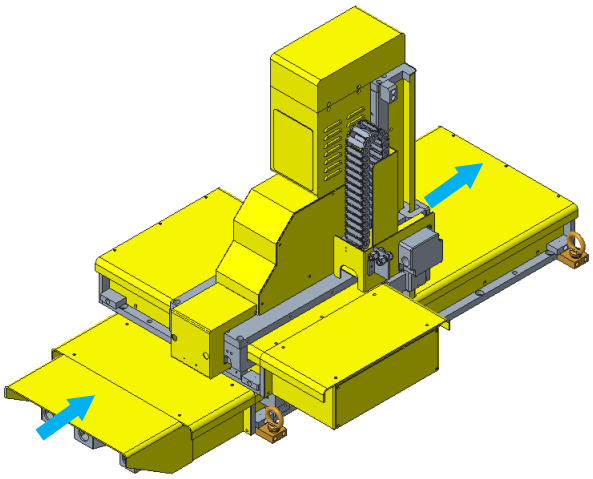
(1) Remove the x-axis motor cover.



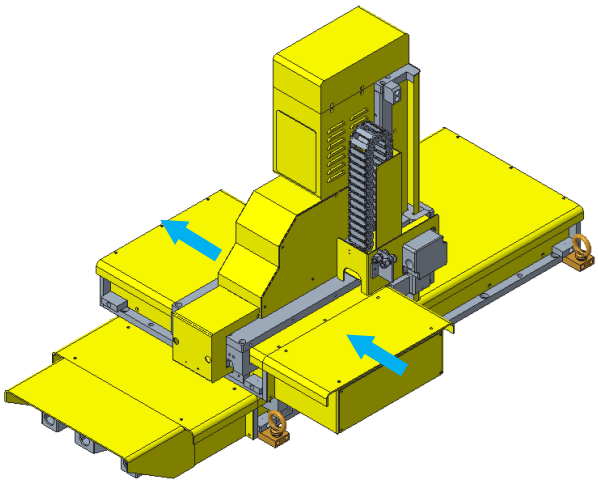
(2) Disconnect the motor and encoder connectors and replace the motor or encoder cables.
(3) Since the X-axis motor cable is directly connected to the panel cable, refer to the X,T,Z-axis panel cable replacemnet item for replacement.

Figure 5.21 X-axis wiring replace (all models)

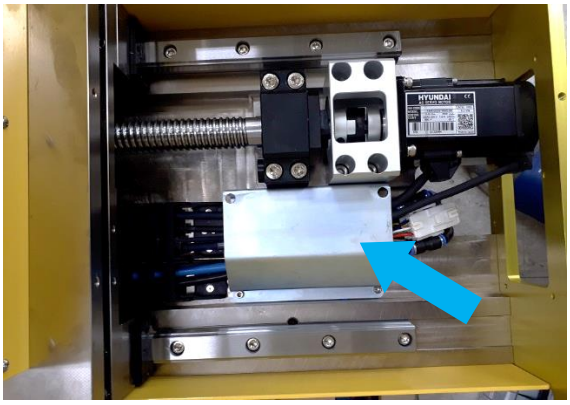
5.5.3. Y-axis wiring replace (HJ300, HJ320, HJ325, HJ335, HJ340)



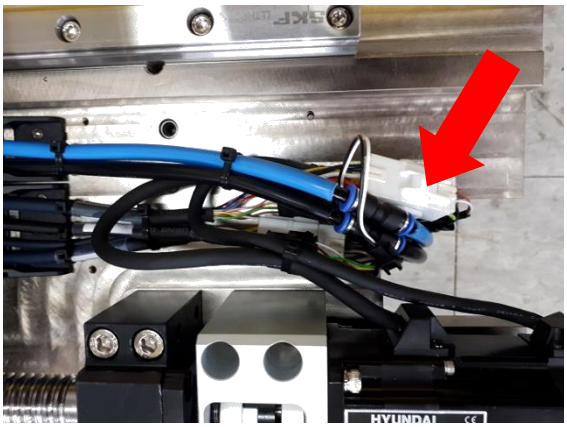
(1) Remove the X-axis cover.



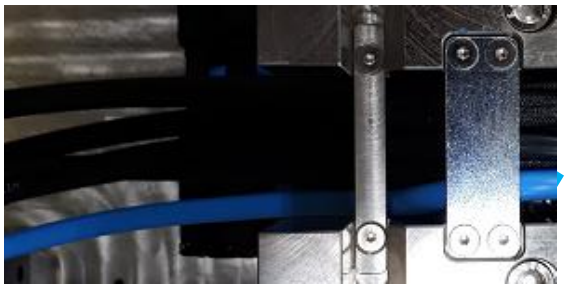
(2) Remove the Y-axis cover.



(3) Remove the connector cover from the Y-axis base.



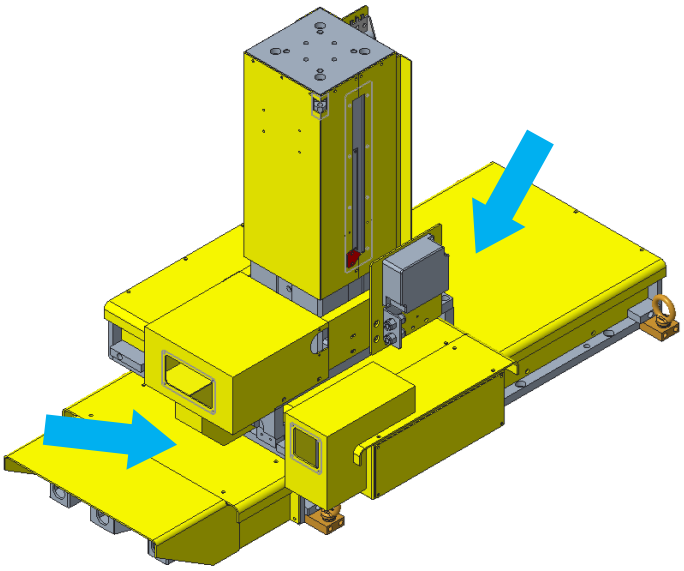
(4) Disconnect the Y-axis connector cable.
(5) Separate the Y-axis from the X-axis carriage.



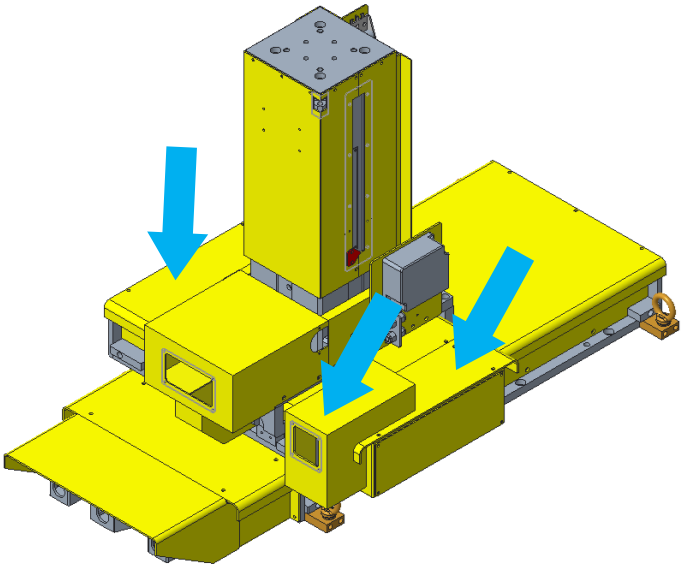
(6) Remvoe the cable fixing plate from the x-axis carriage and remove the cable and cableveyor from the x-axis base.

Figure 5.22 Y-axis wiring replace (HJ300, HJ320, HJ325, HJ335, HJ340)

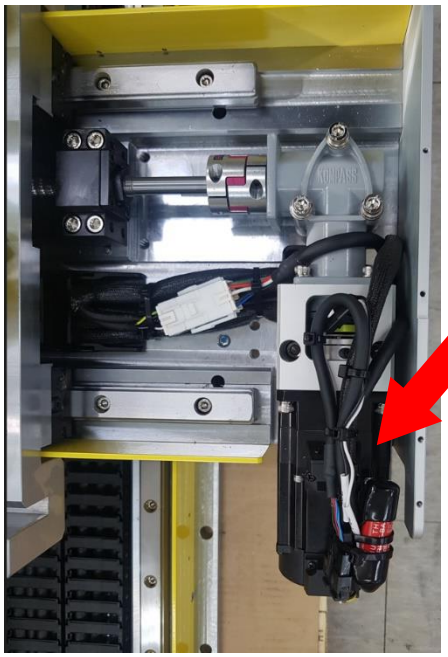
5.5.4. Y-axis wriring replace (HJ310,HJ315,HJ330)



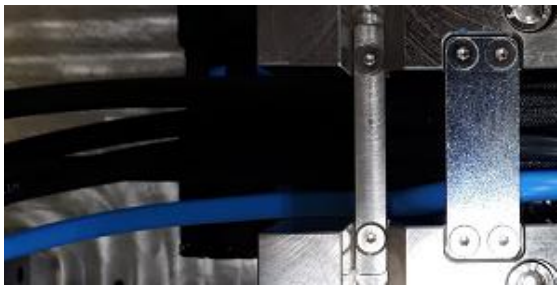
(1) Remove the X-axis cover.



(2) Remove the Y-axis cover



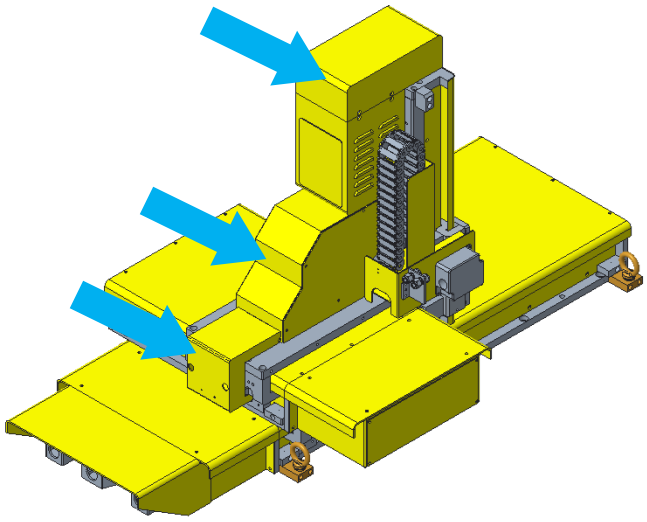
(3) Disconnect the Y-axis connector and cable.
(4) Remove the Y-axis from the X-axis carriage.



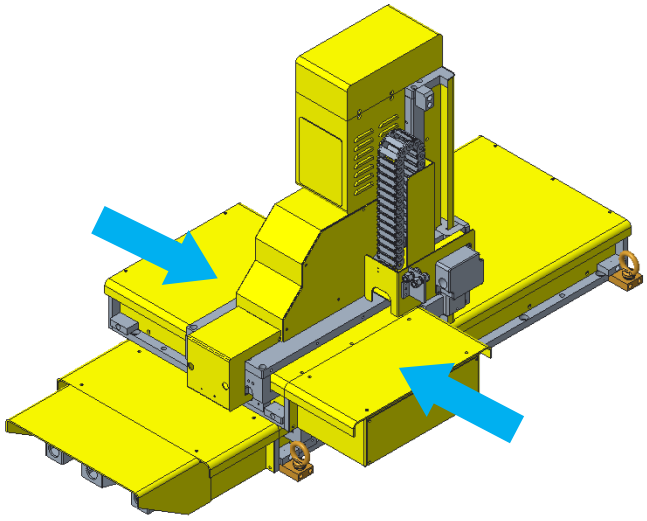
(5) Remove the cable fixing plate from the X-axis carriage and remove the cable and cableveyor the X-axis base.

Figure 5.23 Y-axis wriring replace (HJ310,HJ315,HJ330)

5.5.5. Z-axis wiring replace (HJ300,HJ320,HJ325,HJ335,HJ340)

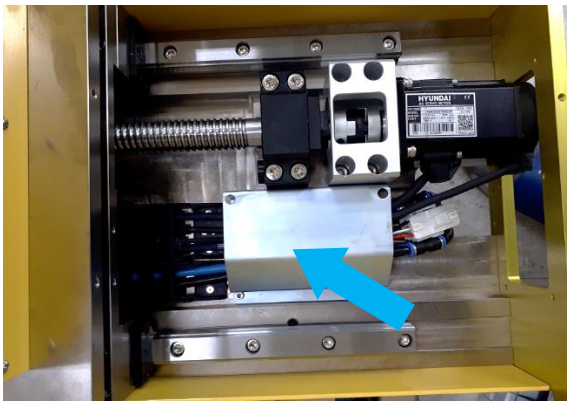


(1) Remove the Z-axis motor cover.

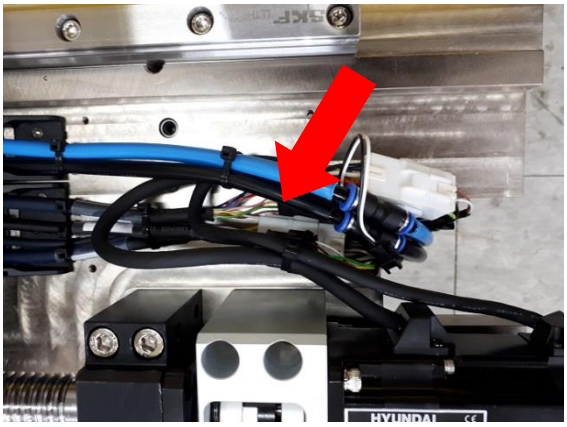


(2) Remove the Y-axis cover and motor cover.

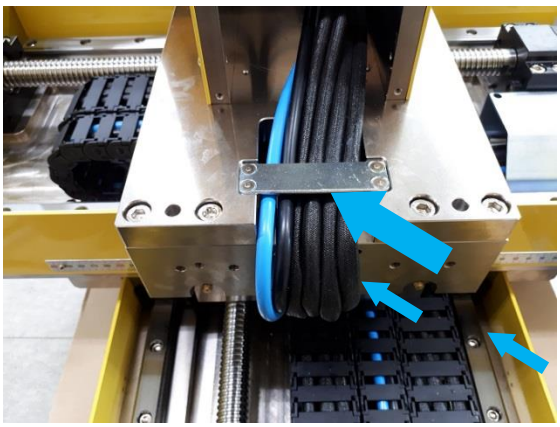
(3) Disconnect the Z-axis connector and cable.



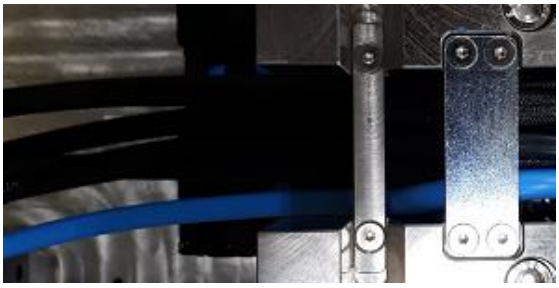
(4) Remove the connector cover from the Y-axis base.



(5) Disconnect the Z-axis cable.
(6) Remove the Z-axis from the Y-axis carriage.



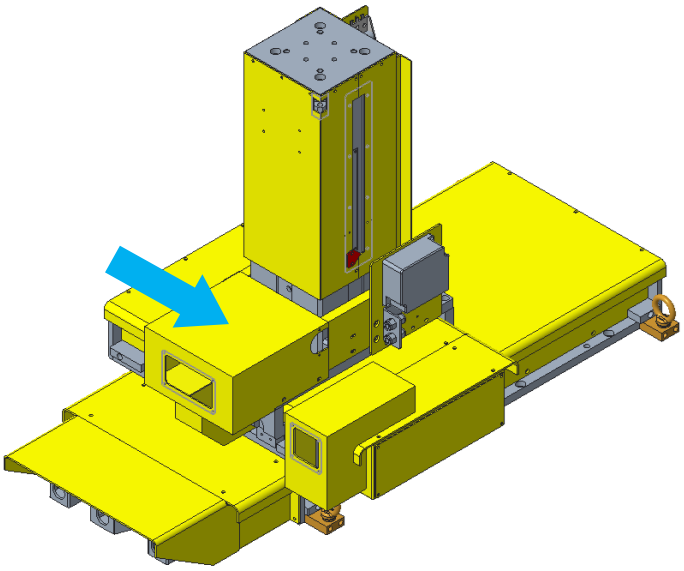
(7) Remove the cable fixing plate.



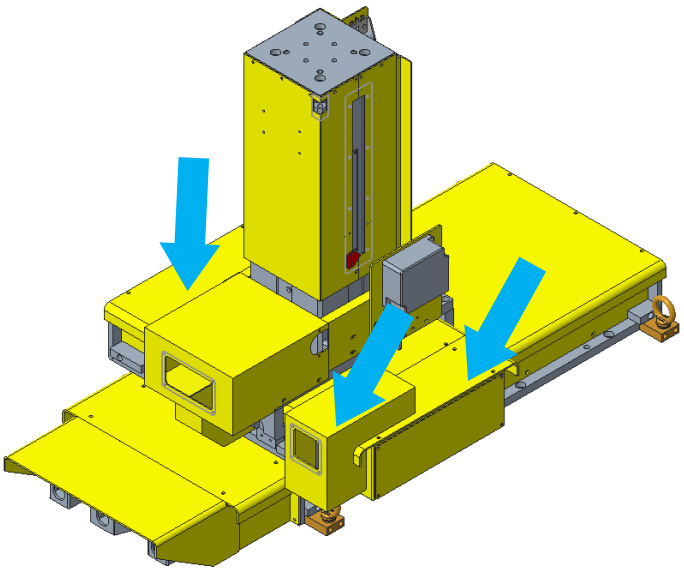
(8) Remove the cable fixing plate from the Y-axis carriage and remove the cable and cable

Figure 5.24 Z-axis wiring replace (HJ300,HJ320,HJ325,HJ335,HJ340)

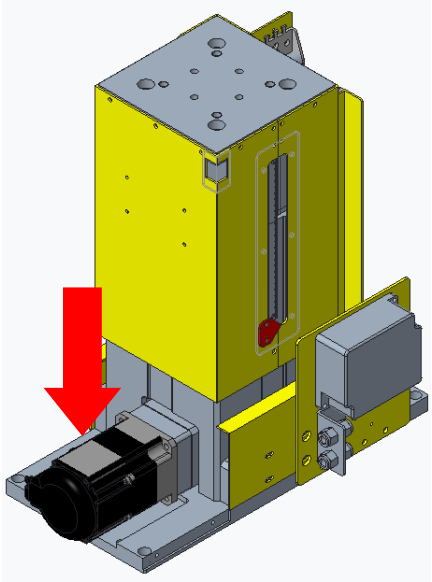
5.5.6. Z-axis wiring replace (HJ300,HJ320,HJ325,HJ335,HJ340)



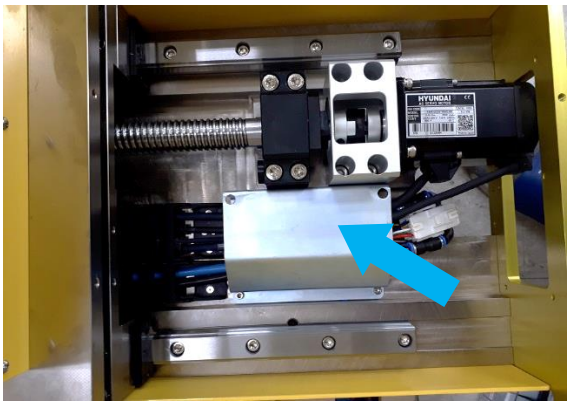
(1) Remove the Z-axis motor cover.



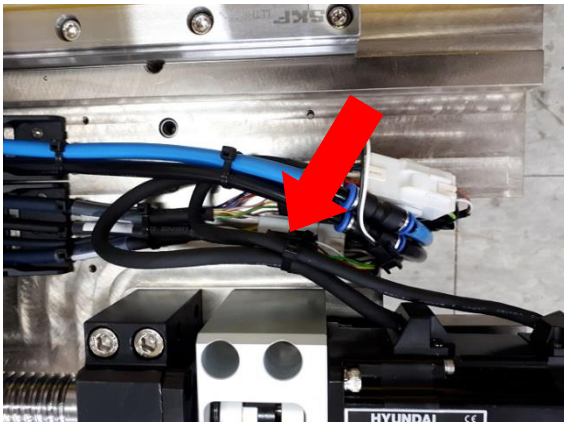
(2) Remove the Y-axis motor cover



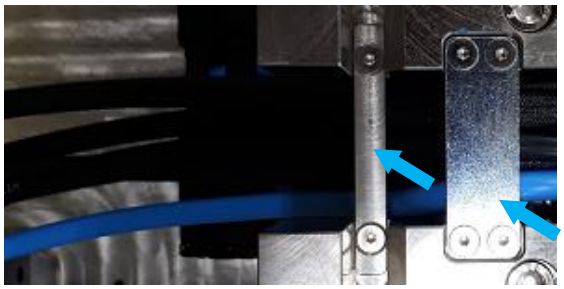
(3) Disconnect the Z-axis connector and cable.



(4) Remove the connector cover from the Y-axis base.



(5) Disconnect the Z-axis cable.
(6) Remove the Z-axis from the Y-axis carriage.



(7) Remove the cable fixing plate from the Y-axis carriage and remove the cable and cableveyor from the Y-axis base.

Figure 5.25 Z-axis wiring replace (HJ300,HJ320,HJ325,HJ335,HJ340)

6

Wiring System Drawings

6.1. Wiring System Drawings

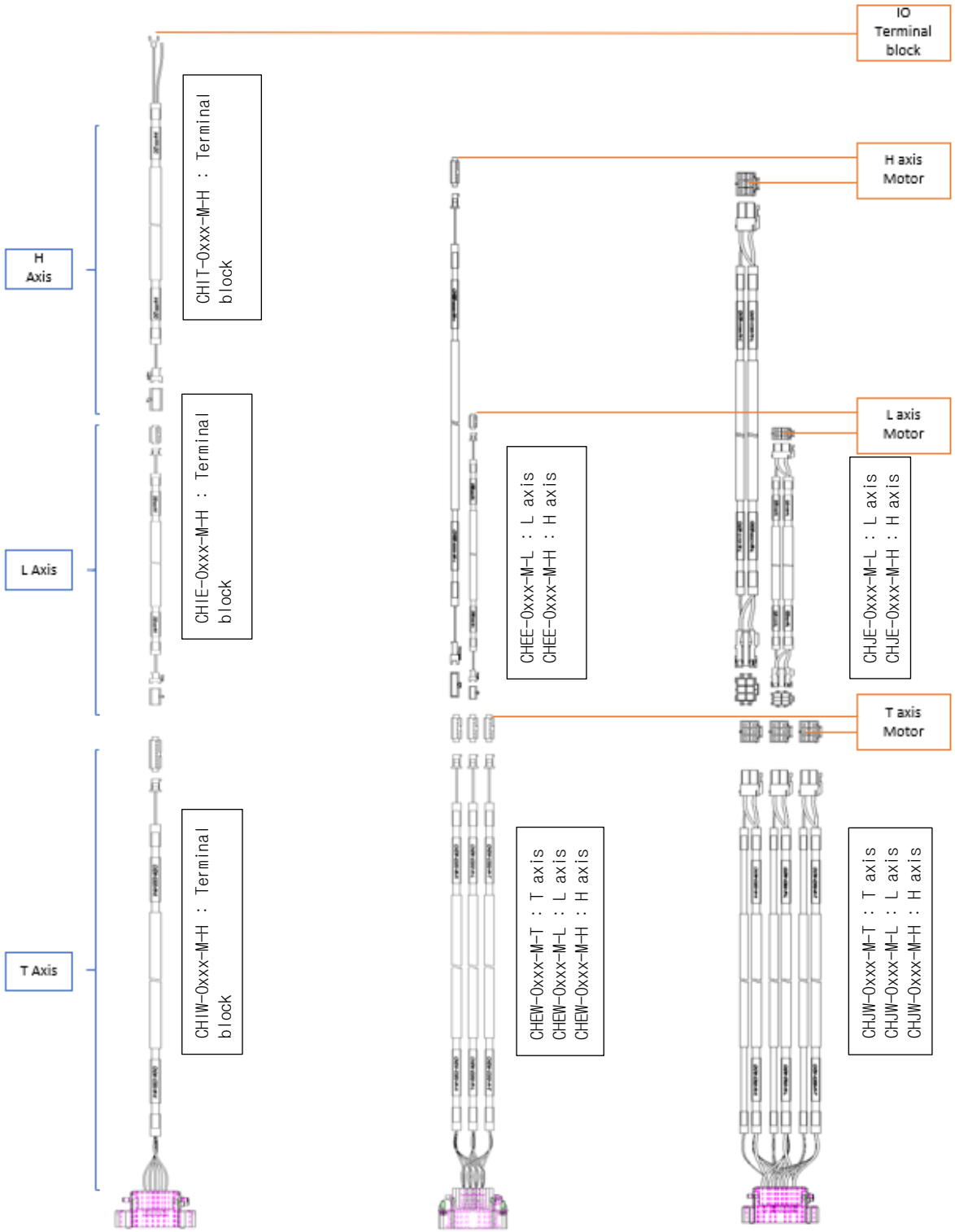


Figure 6.1 Wiring System Drawing of HJ1~3 series

7

Troubleshooting

7.1. Method of Progressing an Investigation of the Causes of Problems

When an abnormality occurs during the operation of the robot, and it is not attributable to an abnormality with the controller, it will be a problem because of damages to the mechanical parts. To solve the problem quickly and easily, it is necessary first to identify the phenomenon correctly and determine which part is defective.

(1) First step: Which axis has an abnormality?
First of all, check which axis shows the abnormal phenomenon. When it is difficult to make a judgment because the abnormality does not appear during the operation, it is required to investigate as follows.

- Is there any part generating an abnormal sound?
- Is there any part generating an abnormal heat?
- Is there any part that has clearance?

(2) Second step: Are there any damaged parts?
If an axis is determined to have an abnormality, it is required to investigate which part is causing the abnormality. There can be several causes of one phenomenon. Refer to the [Table 7-1] Phenomena and Caused of Troubles.

(3) Third step: Handling of defective parts
Parts that are determined to be defective should be handled according to the methods described in 『Section 7.3 Methods for Investigating and Handling Individual Parts』. Please contact our service department for items that your company cannot handle.

7.2. Phenomena and Causes of the Troubles

There may be multiple parts that may be the cause of one phenomenon, as shown in [Table 7-1]. Please refer to the following table to determine which parts are damaged.

Table 7-1 Phenomena and Causes of the Troubles

Parts with Abnormality / Phenomena of Troubles	Gearbox	Motor	Encoder	Drive part
Overload [Note 1]	○	○		○
Position deviation	○	○	○	
Generation of abnormal sound	○	○		○
Vibration during operation [Note 2]		○		○
Shaking when stopping [Note 3]		○	○	○
Irregular cycle (pulsation) [Note 4]		○	○	○
Abnormality in deviation		○	○	
Free fall of the axis	○			
Abnormal heat generation	○	○	○	
Malfunction, runaway		○	○	

[Note 1] Overload—A phenomenon that occurs when a load exceeding the rated specification of the motor is applied; specifically, the temperature relay or the circuit breaker will be cut off.
The phenomenon that occurs when a load exceeding the rated specification of the motor is applied; specifically, the temperature relay or the circuit breaker will be cut off.
[Note 2] Vibration during operation—A phenomenon of vibration during the operation
[Note 3] Shaking when stopping—A phenomenon of shaking several times around the position of the stopping when the robot stops
[Note 4] Irregular cycles (pulsation)—A phenomenon of vibrating without maintaining a fixed cycle while in the holding posture

7.3. Method for Investigating and Handling Individual parts

7.3.1 Drive part

Damage to the driving part (ball screw/belt and LM guide) of each shaft itself may cause vibration, noise and overload. Since a problem may occur in the case of external shock or the end of the life of the driving part, it is necessary to obtain an accurate diagnosis from the manufacturer and replace the product.

- **Investigation method**

  ① Investigate whether loud noise or vibration occurs during driving.
  ② During normal operation, check if the motor overload alarm occurs periodically.
  ③ Before an abnormality occurs, check whether the robot has any object that generates external force or is not in contact with peripheral devices.

- **Handling method**

  Replace it with a spare HJ series, and request AS handling from the manufacturer. If you have any difficulties, please contact our service department.

7.3.2 MOTOR

If an abnormality occurs to the motor, abnormal operation such as shaking when stopping, irregular cycle (pulsation), and vibration during operation will occur. In addition, abnormal heat and abnormal sound may occur.

As the phenomena similar to the ones caused by damages to the reducer may occur, investigate the reducer and the bearing part at the same time to determine where the abnormality is caused.

- **Investigation method**

  Investigate whether there is any abnormal sound or heat generated.

- **Handling method**

  Replace the motor.

7.3.3 ENCODER

If there is an abnormality with the encoder, it may cause position deviation, malfunction, runaway, etc., and it may cause shaking during stop and irregular cycles (pulsation). Those troubles are not related to the phenomenon of abnormal mechanical sound, heat generation, vibration, etc.

- **Investigation method**

  ① Investigate whether there is an abnormality with the encoder data.
  ② Set the customized scale to the reference position, and then investigate whether there is an error with the position data.
  ③ Move each axis of the robot, and investigate whether there is an axis whose data changes irregularly.
  ④ Replace the servo amplifier circuit board BD542 and then investigate whether an error occurs.

- **Handling method**

  ① Check the wiring and replace the encoder if the wiring is not disconnected.
  ② If the error does not occur when the servo amplifier circuit board BD542 is replaced, it should be replaced.

8

Recommended spare Parts

The parts recommended as the spare parts for the robot are as follows. When purchasing them, it is required to check the serial number and manufacture date on the manipulator and contact our service department.

Table 8-1 Spare Parts list of HJ110, HJ115

Spare parts list of HJ110, HJ115			
Manufacturer	Name	Description	1 Set Qt'y
Z Axis Assy			
EWELLIX	Pillar Actuator	CPSM	1
HANSHIN CHAIN	Cableveyor	HSP0180-4BN-28R	1
EWELLIX	CHJW-0300-M-H	300mm	1
EWELLIX	CHEW-0300-M-H	300mm	1
HRC	SERVO MOTOR	TSM3303 N7048	1

Table 8-2 Spare parts list of HJ210, HJ215, HJ225

Spare parts list of HJ210, HJ215, HJ225			
Manufacturer	Name	Description	Qt'y
X Axis Assy			
HANSHIN CHAIN	Cableveyor	HSP0180-2BN-28R	1
HANSHIN CHAIN	Cabkeveyor	HSP0180-4BN-28R	1
EWELLIX	CHJW-0300-M-T	300mm	1
EWELLIX	CHEW-0300-M-T	300mm	1
HRC	SERVO MOTOR	TSM3202 N7060(HJ210,215)	1
HRC	SERVO MOTOR	TSM3303 N7048 (HJ225)	1
Z Axis Assy			
EWELLIX	Pillar Actuator	CPSM	1
HANSHIN CHAIN	Cableveyor	HSP0180-4BN-28R	1
EWELLIX	CHJW-0300-M-H	300mm	1
EWELLIX	CHEW-0300-M-H	300mm	1
EWELLIX	CHJE-xxxx-M-H	T_stroke+1000	1
EWELLIX	CHEE-xxxx-M-H	T_stroke+1000	1

HRC	SERVO MOTOR	TSM3303 N7048	1
Sensor Cable			
EWELLIX	CHIW-0300-M-H	300mm	1
EWELLIX	CHIE-xxxx-M-H	T_stroke+1000	1
EWELLIX	CHIT-xxxx-M-H	L_stroke+1400	1

Table 8-3 Spare parts list of HJ300, HJ320, HJ325

Spare parts list of HJ300, HJ320, HJ325			
Manufacturer	Name	Description	1Set Qt'y
X Axis Assy			
HANSHIN CHAIN	Cableveyor	HSP0180-2BN-28R	1
HANSHIN CHAIN	Cableveyor	HSP0180-4BN-28R	2
EWELLIX	CHJW-0300-M-T	300mm	1
EWELLIX	CHEW-0300-M-T	300mm	1
HRC	SERVO MOTOR	TSM3202 N7060 (HJ300)	1
HRC	SERVO MOTOR	TSM3303 N7048 (HJ320,325)	1
Y Axis Assy			
HANSHIN CHAIN	Cableveyor	HSP0180-4BN-28R	2
EWELLIX	CHJW-0300-M-L	300mm	1
EWELLIX	CHEW-0300-M-L	300mm	1
EWELLIX	CHJE-xxxx-M-L	T_stroke+1000	1
EWELLIX	CHEE-xxxx-M-L	T_stroke+1000	1
HRC	SERVO MOTOR	TSM3202 N7060 (HJ300)	1
HRC	SERVO MOTOR	TSM3303 N7048 (HJ320,325)	1
Z Axis Assy			
HANSHIN CHAIN	Cableveyor	HSP0180-4BN-28R	1
MISUMI	Timing Belt	440 S5M 250	1
EWELLIX	CHJW-0300-M-H	300mm	1
EWELLIX	CHEW-0300-M-H	300mm	1
EWELLIX	CHJE-xxxx-M-H	L_stroke+1400	1
EWELLIX	CHEE-xxxx-M-H	L_stroke+1400	1
HRC	SERVO MOTOR	TSM3406 N7021 (HJ300,320,325)	
Sensor Cable			
EWELLIX	CHIW-0300-M-H	300mm	1

EWELLIX	CHIE-xxxx-M-H	T_stroke+1000	1
EWELLIX	CHIT-xxxx-M-H	L_stroke+2300	1

Table 8-4 Spare parts list of HJ310, HJ315, HJ330

Spare parts list of HJ310, HJ315, HJ330			
Manufacturer	Name	Description	1Set Qt'y
X Axis Assy			
HANSHIN CHAIN	Cableveyor	HSP0180-2BN-28R	1
HANSHIN CHAIN	Cableveyor	HSP0180-4BN-28R	2
EWELLIX	CHJW-0300-M-T	300mm	1
EWELLIX	CHEW-0300-M-T	300mm	1
HRC	SERVO MOTOR	TSM3202 N7060	1
Y Axis Assy			
HANSHIN CHAIN	Cableveyor	HSP0180-4BN-28R	2
TOHO KOREA	Gearbox	KHK-KBX-101L	1
EWELLIX	CHJW-0300-M-L	300mm	1
EWELLIX	CHEW-0300-M-L	300mm	1
EWELLIX	CHJE-xxxx-M-L	T_stroke+1000	1
EWELLIX	CHEE-xxxx-M-L	T_stroke+1000	1
HRC	SERVO MOTOR	TSM3202 N7060	1
Z Axis Assy			
EWELLIX	Pillar Actuator	CPSM	1
HANSHIN CHAIN	Cableveyor	HSP0180-4BN-28R	1
EWELLIX	CHJW-0300-M-H	300mm	1
EWELLIX	CHEW-0300-M-H	300mm	1
EWELLIX	CHJE-xxxx-M-H	L_stroke+900	1
EWELLIX	CHEE-xxxx-M-H	L_stroke+900	1
HRC	SERVO MOTOR	TSM3202 N7060 (HJ310)	1
HRC	SERVO MOTOR	TSM3303 N7048 (HJ315,330)	1
Sensor Cable			
EWELLIX	CHIW-0300-M-H	300	1
EWELLIX	CHIE-xxxx-M-H	T_stroke+1000	1
EWELLIX	CHIT-xxxx-M-H	L_stroke+1400	1

Table 8-5 Spare parts list of HJ335, HJ340

Spare parts list of HJ335, HJ340			
Manufacturer	Name	Description	1Set Qt'y
X Axis Assy			
HANSHIN CHAIN	Cableveyor	HSP0180-2BN-28R	1
HANSHIN CHAIN	Cableveyor	HSP0180-4BN-28R	2
EWELLIX	CHJW-0300-M-T	300mm	1
EWELLIX	CHEW-0300-M-T	300mm	1
HRC	SERVO MOTOR	TSM3303 N7048	1
Y Axis Assy			
HANSHIN CHAIN	Cableveyor	HSP0180-2BN-28R	1
HANSHIN CHAIN	Cableveyor	HSP0180-4BN-28R	2
EWELLIX	CHJW-0300-M-T	300mm	1
EWELLIX	CHEW-0300-M-T	300mm	1
HRC	SERVO MOTOR	TSM3303 N7048	1
Z Axis Assy			
EWELLIX	Pillar Actuator	CPSM	1
HANSHIN CHAIN	Cableveyor	HSP0180-4BN-28R	1
EWELLIX	CHJW-0300-M-H	300mm	1
EWELLIX	CHEW-0300-M-H	300mm	1
EWELLIX	CHJE-xxxx-M-H	L_stroke+900	1
EWELLIX	CHEE-xxxx-M-H	L_stroke+900	1
HRC	SERVO MOTOR	TSM3303 N7048	1
Sensor Cable			
EWELLIX	CHIW-0300-M-H	300	1
EWELLIX	CHIE-xxxx-M-H	T_stroke+1000	1
EWELLIX	CHIT-xxxx-M-H	L_stroke+1400	1

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