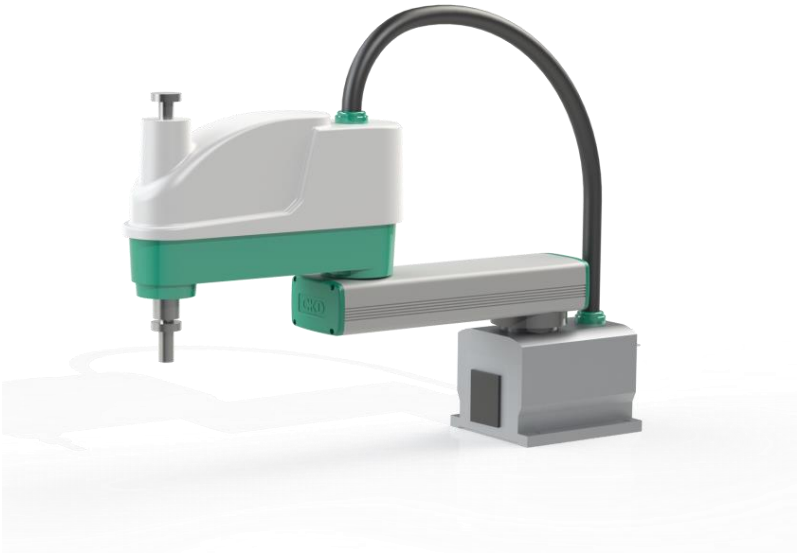
CKD

SCARA Robot

KHL Maintenance Manual

INSTRUCTION MANUAL

SM-A20061-A



- Read this Instruction Manual before using the product.
- Read the safety notes carefully.
- Keep this Instruction Manual in a safe and convenient place for future reference.

CKD Corporation

WARRANTY

This product is delivered to each customer only after it is inspected very carefully to make sure that it satisfies the CKD's standard. Should it cause an inconvenience, we will guarantee as described below.

1. Warranty period
   CKD agrees to repair or replace as necessary all defective material or workmanship up to the period shown below, whichever comes first.
   1) Eighteen (18) months from the date of dispatch from our plant.
   2) Twelve (12) months from the date of machine installation at customer's job site.
   3) 2,400 running hours from the date of initial machine operation.

2. Contents of warranty
   1) Only the product is subject to CKD's Guarantee. Such Guarantee covers the specifications and functions as defined in the product specifications manual, catalog, instruction manual, etc. In no event does the Guarantee cover any secondary or associated damage caused by malfunction of the product.
   2) CKD repairs the product free of charge only when it malfunctioned after handling or use according to the instruction manual attached to the product within the specified warranty period.

3. Exemption from responsibility
   CKD's Guarantee shall not cover the following cases.
   1) Incorrect use not described in the instruction manual, and trouble or damage caused by negligent use.
   2) Inconvenience caused by aged deterioration or long-term usage (natural fading of coating or painting, deterioration of consumable parts (*1), etc.).
   3) Inconvenience caused by sensuous phenomena (noise generation, etc. which will not affect the function).
   4) Remodeling or disassembly which CKD will not permit.
   5) Trouble and damage caused by insufficient maintenance/inspection or improper repair.

6) Trouble and damage caused by disaster, fire or other external factor.

7) Internal data such as program and point which were created by the customer.

8) When the product purchased in Japan was shipped overseas.

4. Precautions

1) Unless the product was used pursuant to its specifications, CKD will not guarantee the basic performance of the product.

2) If the customer did not observe the warnings and cautions described in this manual, CKD will not assume the responsibility for any consequential accident resulting in injury or death, damage or trouble.

3) Please note that the warnings, cautions and other descriptions stipulated in this manual are only those which can be assumed by CKD as of now.

(*1) The consumable parts signify the replacement parts for maintenance as listed in Section 8 of this manual.

INTRODUCTION

This manual describes the maintenance of this product, KHL series, and the KSL3000, controllers.

The maintenance and inspection are essential to maintain the product performance for long years to prevent a trouble and improve the safe work.
Before starting an actual operation, it is strongly recommended to read through this manual and draw up a maintenance schedule.

CAUTIONS ON SAFETY

This manual contains the important information on the robot and controller to prevent injury to the operators and persons nearby, to prevent damage to assets and to assure correct use.
Make sure that the following details (indications and symbols) are well understood before reading this manual. Always observe the information that is noted.

[Explanation of indications]

Indication	Meaning of indication
 **DANGER**	This means that “incorrect handling will imminently lead to fatalities or serious injuries.”
 **WARNING**	This means that “incorrect handling may lead to fatalities or serious injuries.”
 **CAUTION**	This means that “incorrect handling may lead to personal injuries*1) or physical damage*2).”

*1) Injuries refer to injuries, burns and electric shocks, etc., which do not require hospitalization or long-term medical treatment.

*2) Physical damage refers to damages due to destruction of assets or resources.

[Explanation of symbols]

Symbol	Meaning of symbol
	This means that the action is prohibited (must not be done). Details of the actions actually prohibited are indicated with pictures or words in or near the symbol.
	This means that the action is mandatory (must be done). Details of the actions that must be done are indicated with pictures or words in or near the symbol.

	This means danger and caution. The details of the actual caution are indicated with pictures or words in or near the symbol.

[Maintenance and inspection]

Be sure to observe the following items to use this product safely.

 **DANGER**	
 Prohibited	• DO NOT incinerate, disassemble or charge the batteries. Otherwise, they may rupture.
 Mandatory	• Be sure to remove the power plug of the controller from the power source before starting inspection or maintenance. • Batteries should be disposed of according to the user's in-house regulations.

 **CAUTION**	
 Disassembly prohibited	• The user must NEVER replace or modify parts other than those described in the instruction manual. Otherwise, the performance may deteriorate or faults or accidents will be caused.
 Mandatory	• Always use the CKD's designated spare parts when replacing the parts. • Maintenance and inspection should be performed regularly. Otherwise, the system may malfunction or accidents will be caused.
 Caution	• The axis 4 motor of the KHL series robots is not provided with a brake. With the servo off, therefore, Axis 4 may rotate due to the dead weight of the tool and hand, offset condition or touch by hand. Once Axis 4 rotates, Axis 3 will move up or down. Take careful precautions not to have your hand and leg caught in it. • A brake release switch is provided at the back of the base (KHL-300, KHL-400) and at the upper part of the axis 2 arm cover (KHL-500 – KHL-700). If the brake release switch is pressed while a heavy load such as a hand or workpiece is mounted on arm 3, arm 3 will drop. Take careful precautions not to have your hand or leg caught in it.

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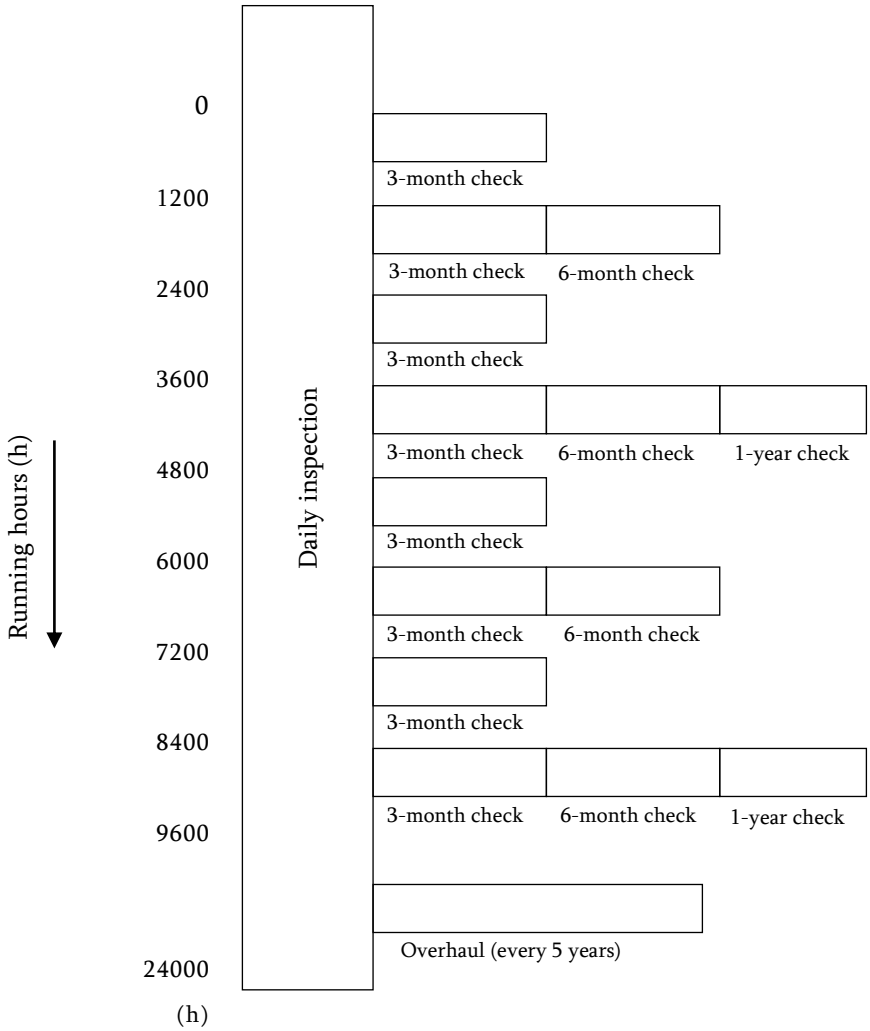
1. Maintenance

1.1 Maintenance Schedule

Please do maintenance by a qualified person according to laws and regulations of each country. Maintenance comes in the two (2) types; daily inspection, and regular inspection and maintenance. For the regular inspection and maintenance, inspection items are added every 1,200 running hours.



Inspection schedule

- When the system is operated for 16 hours per day:
  1,200hours × 16 hours x 25 days = 3 months
- When the system is operated for 24 hours per day:
  1,200hours × 24 hours x 25 days = 2 months

If the system is operated for 16 hours per day, it should be inspected every three (3) months. If the number of hours of system operation per day becomes longer, the regular inspection on the system must be done at shorter intervals.

Fig. 1.1 Maintenance Schedule

1.2 Items for Maintenance and Inspection

This section describes the items for maintenance and inspection.
For the executing procedures, see the relevant paragraph listed in the table below.

1.2.1 Inspection at Power OFF (at Non-Operation)

D: Daily inspection　　Q: Quarterly inspection
S: Semi-annual inspection　　A: Annual inspection

Table 1.1 Inspection at Power OFF

<Robot>

Description	Check position	D	Q	S	A	Refer to	
						KHL-300 KHL-400	KHL-500 KHL-600 KHL-700
Make sure that all bolts are completely tightened and secured. Otherwise, tighten the bolts completely.	Tool set bolts	○	○	○	○	Para. 2.1.1	Para. 3.1.1
	Robot installation bolts	○	○	○	○		
	Motor set bolts				○		
Make sure that the cable clamps are tightened.	Arm 2, upper base				○	Para. 2.1.3	Para. 3.1.3
Make sure that no cut or scratch is found. Clean the contaminant, if any.	Entire robot	○	○	○	○		
	Arm 2 interior			○	○		
Make sure that anti-corrosive is properly applied. If not, apply anti-corrosive.	Ball spline nut section, end face of Ball screw shaft	○	○	○	○	Para. 2.6.3	Para. 3.6.3
Make sure that each timing belt is not worn off or cracked. Check each timing belt for tension.	Arm 2 interior			○	○	Para. 2.5.5	Para. 3.5.5
Make sure that the cables and air tubing are not worn out.	Cables and air tubing of each unit	○	○	○	○	Para. 2.1.2	Para. 3.1.2
Make sure that each axis can be operated properly by moving the axis by hand.	Entire robot			○	○	Para. 2.1.4	Para. 3.1.4

<Controller>

Description	Check position	D	Q	S	A	Refer to
						KSL3000
Check of controller air vent holes.	Controller air vent holes	○	○	○	○	Para. 5.3.1

1.2.2 Inspection at Power ON (at Operation)

D: Daily inspection Q: Quarterly inspection
S: Semi-annual inspection A: Annual inspection

Table 1.2 Inspection at Power ON

Description	Check position	D	Q	S	A	Refer to	
						KHL-300 KHL-400	KHL-500 KHL-600 KHL-700
Make sure that enough volume of grease is filled. Otherwise, fill the grease.	Ball screw shaft	○	○	○	○	Para. 2.6.3	Para. 3.6.3
Push each arm by hand in the servo ON condition to make sure that the arm is secured.	Each joint				○		
Make sure that no abnormal vibration or noise is caused.	Entire robot	○	○	○	○		
Check for teaching position	Tip of robot		○	○	○		
Replace the batteries for position detection with new ones.	Battery box				○	Para. 8.3	
Check of safety devices for function	Safety devices for function	○	○	○	○	Para. 5.3.2/ Para. 6.3.2/ Para. 7.3.2	

1.2.3 Overhaul

Table 1.3 Overhaul

<Robot>

Description	Maintenance parts	Every 5 years	Refer to	
			KHL-300 KHL-400	KHL-500 KHL-600 KHL-700
Check for the consumable parts and replace as necessary.	Motors, belts, ball screws, reduction gears ,Harness	○	Para. 2.3 to 2.7	Para. 3.3 to 3.7

<Controller>

Description	Maintenance parts	Every 5 years	Refer to
			KSL3000
Replace the battery with a new one.	Backup battery in the controller	○	Para. 4.3.3
Replace the switching power supply unit with a	In the controller	○	Para. 4.3.4

new one.			

1.3 Cautions on Maintenance and Inspection

Please do maintenance by a qualified person according to laws and regulations of each country. When performing inspection or maintenance of the robot, strictly observe the following precautions to protect yourself and coworkers.

! DANGER

- Be sure to remove the power plug of the controller from the power source before approaching the robot for maintenance and inspection.
- When moving the robot by hand while the power is connected, be sure to assure the safe work and effect an emergency stop beforehand.
- In the above situation, if the work is to be done while the axis 3 motor brake release switch is pressed, be sure to perform the work by two (2) persons.
  One person should carry out the work while the other is monitoring the work outside the hazardous zone. The latter person should watch the work and be ready to turn off the controller switch if any abnormality occurs. Once the controller power is turned off, the motor brake actuates even if the axis 3 motor brake release switch is kept pressed.
- If the axis 3 motor brake release switch is pressed while the robot is carrying a heavy workpiece, Axis 3 may drop suddenly. To avoid this, the customer should take all necessary measures by themselves.

1.4 Maintenance Tools

We recommend using the following tools for maintaining the robot and controller.

- Screwdrivers (Phillips head screwdrivers, flat head screwdrivers)
- Hexagonal wrench keys, nominal size 2.5 mm to 14 mm ・Torque wrenches, nominal size 3 mm to 12 mm
- Torque driver ・Wrenches, nominal size 5.5 mm, 7 mm, 46 mm, 50 mm
- Box wrench, nominal size 5.5 mm ・Nippers ・Needle-nose pliers ・Pliers
- Torque wrench extension bar ・Plastic hammer ・Scale

Recommended provisions other than the tools:

- Alcohol (for cleaning) ・Waste cloth ・Vise (fixture) ・Spatula (for grease application)
- Loctite adhesive (242: mid to heavy-duty adhesive force) ・Loctite adhesive (221: low adhesive force)

- Belt tension meter ・Anti-corrosive: KLUBER A20
- TSPC program creation/teaching support software (option)
- Liquid gasket(THREEBOND1221H)

1.5 Clamping Hexagon Socket Head Cap Screws and Set screws

This robot uses hexagon socket head cap screws at places requiring mechanical strength. At the time of factory-assembly, Loctite is applied and each screw is tightened with the following clamping torque.
When these screws and set screws are tightened again according to the inspection and maintenance as stipulated in this manual, use a torque wrench or torque driver, and Loctite (medium strength) to assure the appropriate clamping torque.
The places which do not fall under the table below are detailed in the paragraph of the replacement procedures.

Table 1.4 Clamping Torque

Hexagon socket head cap screw	–	–	M3	M4	M5	M6	M8	M10	M12
Set screws	M3	M4	M5	M6	M8	M10	M12	M16	M20
Clamping torque	1.5N·m	1.8N·m	2.0 N·m	4.7 N·m	9.0 N·m	15 N·m	37 N·m	75 N·m	128 N·m

For the screws arranged on a circle for mounting the reduction gear, etc., tighten them in the diagonal order, as shown below.

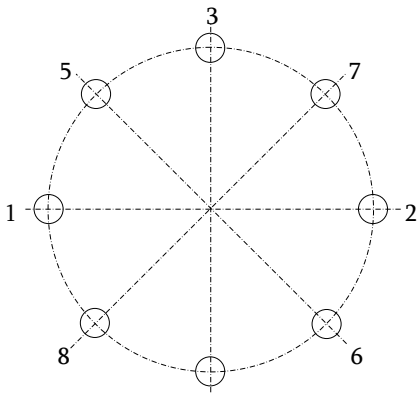


Fig.1.2 Tool set bolts

DO NOT tighten one (1) screw at a time. Tighten each screw in multiple steps, using a hexagonal wrench key, and secure with appropriate clamping torque by means of a torque wrench.

1.6 Maintenance Contract and Repair

1.6.1 Maintenance Contract

For the inspection items for maintenance and inspection to be done semi-annually and after, it is rather difficult for the user to execute, except for greasing and lubrication. We recommend that the user contact CKD Service Department and conclude an after-sale service contract with us.

1.6.2 Repair

If a fault has occurred or if repair is necessary, turn off the controller power and contact the CKD Service Department. At this time, advise us of the details of the fault and the following information stated on the robot and controller.
(For the contact information of the CKD Service Department, please refer to Service Network.)

- Robot model
- Manufacture number
- Manufacture number of controller
- Date of manufacture of robot
- Running hours

For the manufacture number and date of manufacture, see the following labels attached to main base of the robot.

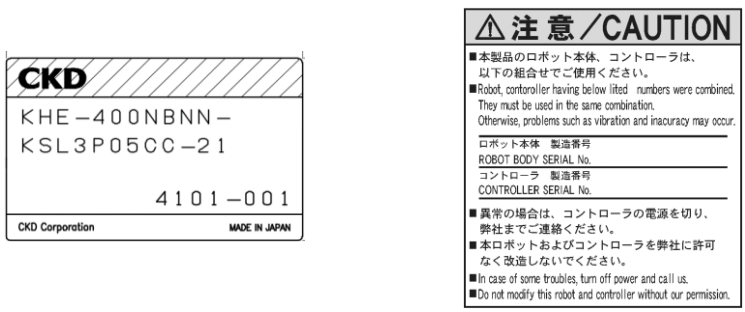


Fig.1.3 Label

1.6.3 Modification

The robot and controller MUST NOT be modified or disassembled without a prior consent from CKD.

! CAUTION

- The user must NEVER replace or modify parts other than those described in the instruction manual. Otherwise, the performance may deteriorate or faults or accidents will be caused.

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2. Maintenance of the Main Robot (KHL-300, KHL-400)

2.1 Details of Inspection

2.1.1 Check of Each Bolt (or Screw) for Clamping

1) Tool Set Bolts

Using the hexagonal wrench key, make sure that the clamping bolts (M4 x 4 pcs.) of the tool set flange (option), which are clamped to the tool shaft, are tightened completely. If loose, tighten them completely.

Using the hexagonal wrench key, make sure that the mounting bolts (M4 x 4 pcs.), which secure the tool to the tool flange, are tightened completely. If loose, tighten them completely. (Loctite not necessary)

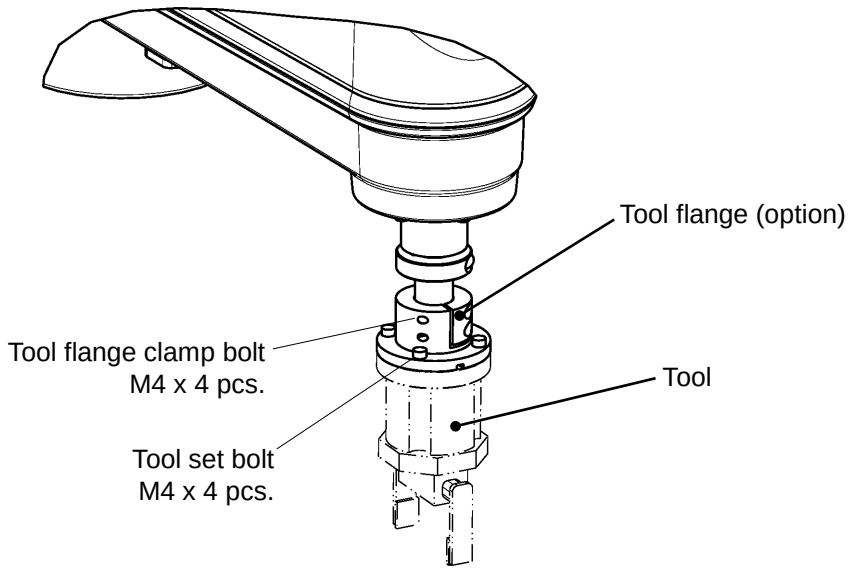


Fig. 2.1 Tool set bolts

2) Robot Installation Bolts

Make sure, using the hexagonal wrench key, that the installation bolts of the main robot base are tightened completely. If loosened, tighten them completely. (Loctite is not necessary)

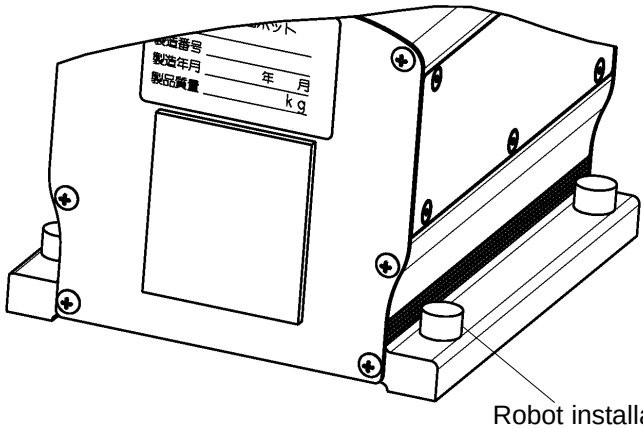


Fig. 2.2 Robot installation bolts (KHL-300, KHL-400)

3) Motor Set Bolts

Make sure, using the hexagonal wrench key, that the bolts for securing each axis drive motor are tightened completely. If loosened, tighten them completely. Also make sure that the motor and motor plate bolts are tightened completely. For the places where the following bolts are used, see “Para. 2.4, Replacing Motor.”

Table 2.1 Motor and motor plate set bolt (KHL-300, KHL-400)

Location of bolt	Type	Bolts used	Reference Para.
Axis 1 drive motor set bolt	M4 x 12	4 pcs.	2.4.4 Mounting Axis 1 Motor
Axis 2 drive motor set bolt	M4 x 12	4 pcs.	2.4.6 Mounting Axis 2 Motor
Axis 3 drive motor set bolt	M3 x 10	4 pcs.	2.4.8 Mounting Axis 3 Motor
Axis 3 motor plate set bolt	Flange head bolt M4 x 8	4 pcs.	2.4.8 Mounting Axis 3 Motor
Axis 4 drive motor set bolt	M4 x 12	4 pcs.	2.4.10 Mounting Axis 4 Motor
Axis 4 reduction gear set bolt	M5 x 16	4 pcs.	2.7.7 Replacing Axis 4 Reduction Gear
Axis 4 motor plate set bolt	Flange head bolt M4 x 8	4 pcs.	2.5.4 Replacing Axis 4 Timing Belt

* For the recommended clamping torque, see Para. “1.5 Clamping Hexagon Socket Head Cap Screws and Set screws”
* It is not necessary to apply Loctite to the flange head bolts of Axes 3 and 4 motor plate set bolts.

2.1.2 Check of Each Cable and Air Tube for Abrasion

Disassemble the arm 2 cover and the base rear cover, and make sure that each cable is not worn out, broken or cracked. Especially, carefully inspect the vicinity of the cable outlets.

For how to dismount the covers, see “Para. 2.3, Dismounting and Mounting Each Cover.”

The figure below shows an example of air tube installation.

Also inspect the wear and disorder of the air tube as well as the pipe connection. Make sure that the air tube is not worn out and is installed properly, and pipe connection is correct. Otherwise, correct them.

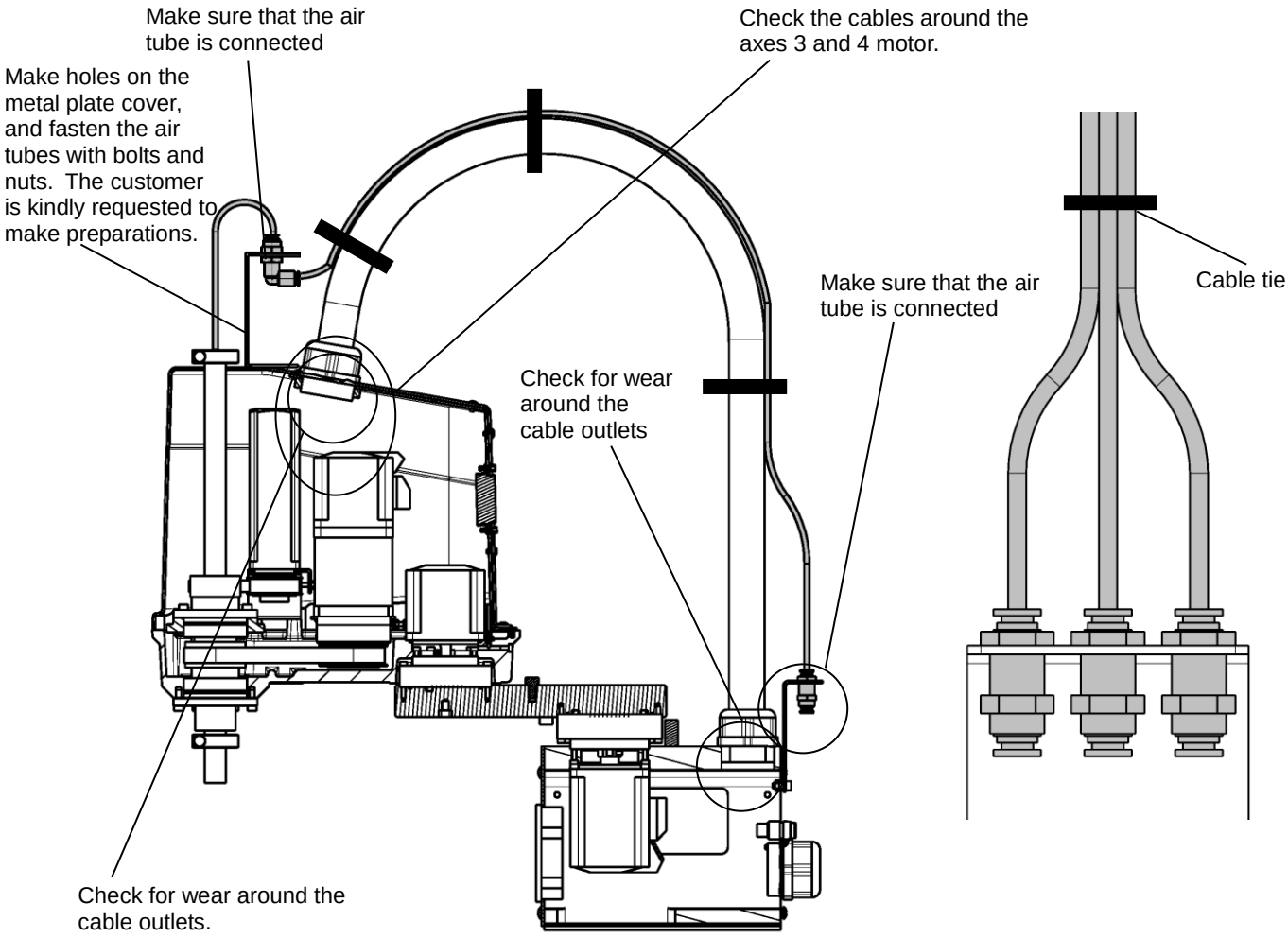


Fig. 2.3 Cable inspection locations (KHL-300, KHL-400)

CAUTION

- The air tube is a consumable item. Check the condition during periodic inspection. If any damage is found, replace it.
- Please note that Fig. 2.3 shows a piping example and does not warrant damage to the air tube and its accessories.

2.1.3 Check of Cable Clamp Tightening

Using a wrench, make sure that the clamps securing the cable are not loose. There are two clamps, one on the arm 2 side and the other on the base side. If they are loose, apply Loctite (low adhesive force) and tighten them. When checking the tightened clamps, check the one on the base side first. By checking the tightness of the clamp on the base side first, the twist of the cable can be adjusted slightly on the arm 2 side. Make sure to tighten the clamps in the posture as shown in the figure below. If the clamps are tightened while the arm is bent, the cable cannot be installed correctly.

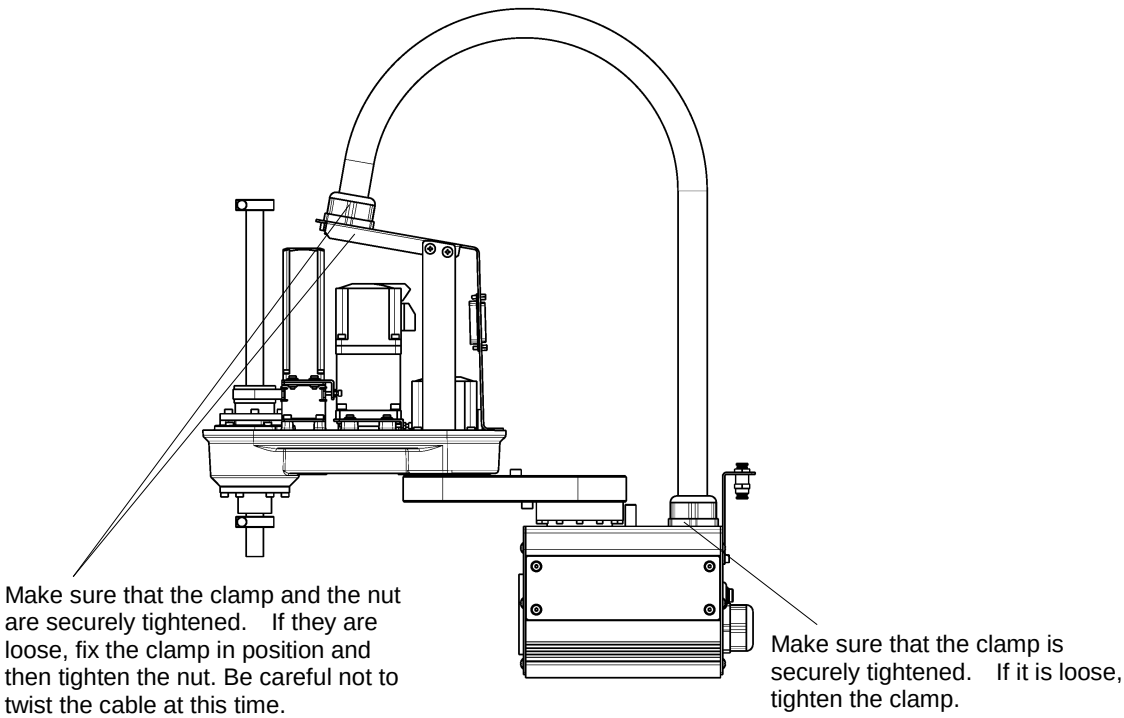


Fig. 2.4 Cable clamp inspection locations (KHL-300, KHL-400)

2.1.4 Check of Each Axis for Operation

Connect the power plug of the controller to the power source, then keep the EMERGENCY pushbutton switch in the depressed condition. Move each axis by hand and make sure that it can move smoothly.
For Axis 3, when the brake release switch is pressed, the brake is released. Take careful precautions at this time as the tool shaft may drop according to the weight of the hand and tool.

CAUTION

- If Axes 1 and 2 are moved to the vicinity of the operation range limit and then your hands are released, Axes 1 and 2 may move by the counterforce of the cables.

2.2 Layout of Robot Components and Drive Mechanism

The layout of the robot mechanical components is shown in Fig. 2.5.

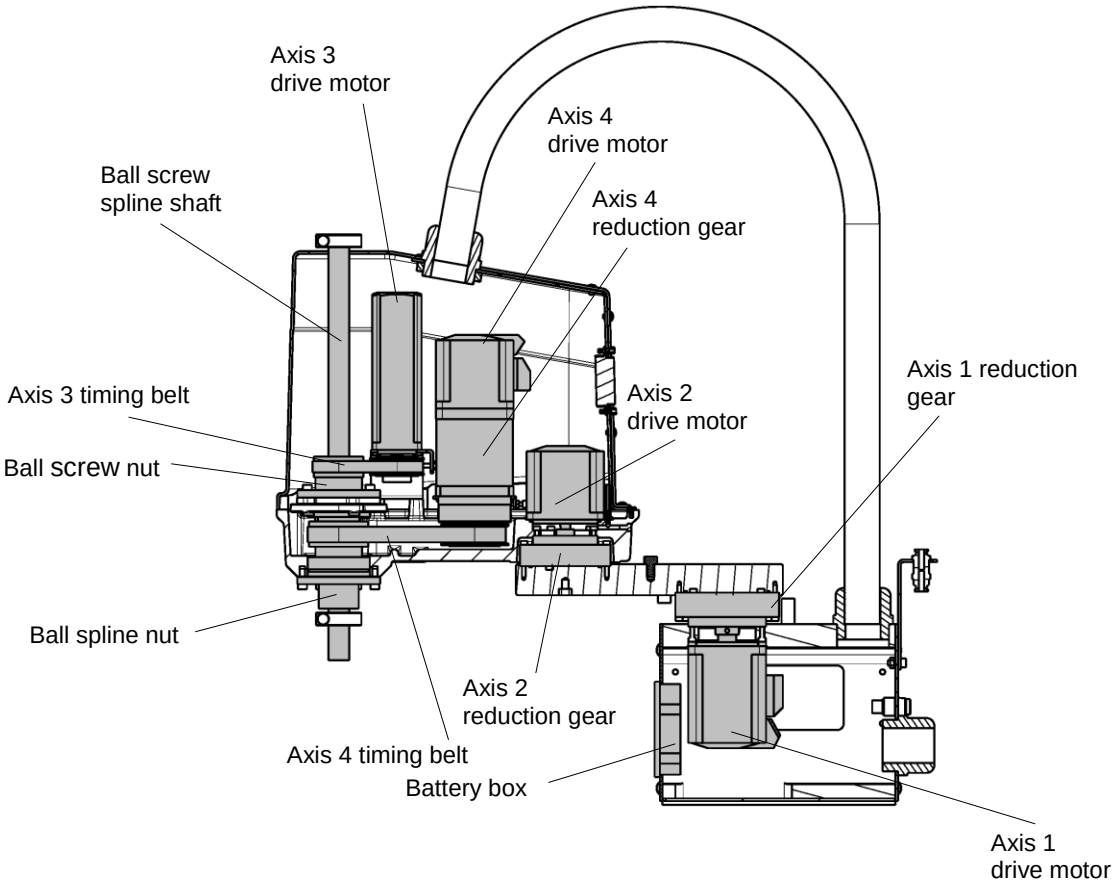


Fig. 2.5 Layout of robot mechanical components (KHL-300, KHL-400)

2.3 Dismounting and Mounting Each Cover

This paragraph describes the dismounting and mounting of the covers, which are common to the maintenance and replacement of each unit.

DANGER

- When opening the cover, take careful precautions not to allow entry of moisture or contaminant into the robot. If the power is turned on while moisture or contaminant is left, you may get an electric shock or the robot may malfunction, which is very dangerous.

CAUTION

- When mounting the arm 2 cover and base cover, take careful precautions not to catch any cable in it. If the cable is bent and pushed by force, it will be broken. Each cable is secured to the plate, etc. with cable ties. After the cover is disconnected, make sure of the cable layout and return the cables to natural wiring state.

2.3.1 Arm 2 Cover

The arm 2 cover is secured to Arm 2 and the harness guide with 4 hexagon socket head cap screws (M3 x 16) and to cross truss head screws (M3 x 10 x 2 pcs., M3 x 6 x 8 pcs.) (It is not necessary to apply Loctite when installing.)

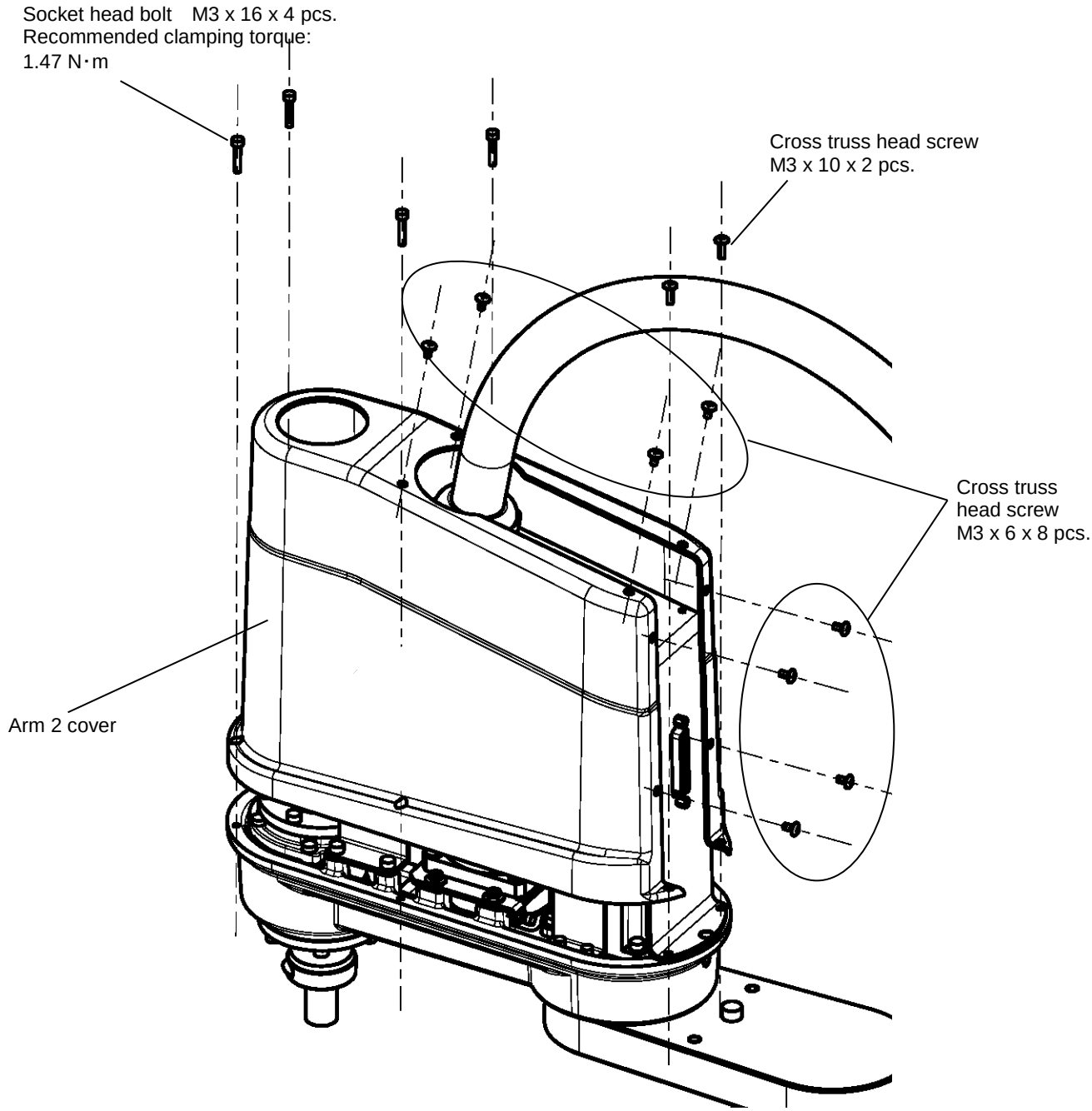


Fig. 2.6 Arm 2 cover (KHL-300, KHL-400)

After the cover is mounted, manually move up and down the ball screw spline shaft while pressing the brake release switch, and make sure that the ball screw hole for the arm 2 cover will not interfere with the ball screw stopper.

2.3.2 Base Covers

There are four (4) types of base covers: base front cover, base rear cover, base side cover and base cover. (It is not necessary to apply Loctite to all the covers when installing.)
Each of the base front cover and the base rear cover is secured to the base with six (6) cross truss head screws (M4 x 8). They can be dismounted from the base when these fastening screws are removed, but do not pull them with force as they are connected with the connectors inside.
Each of the left and right base side covers is secured to the base with four (4) hex countersunk screws (M4 x 12).
The base cover is secured to the base with four (4) hex countersunk screws (M4 x 8).

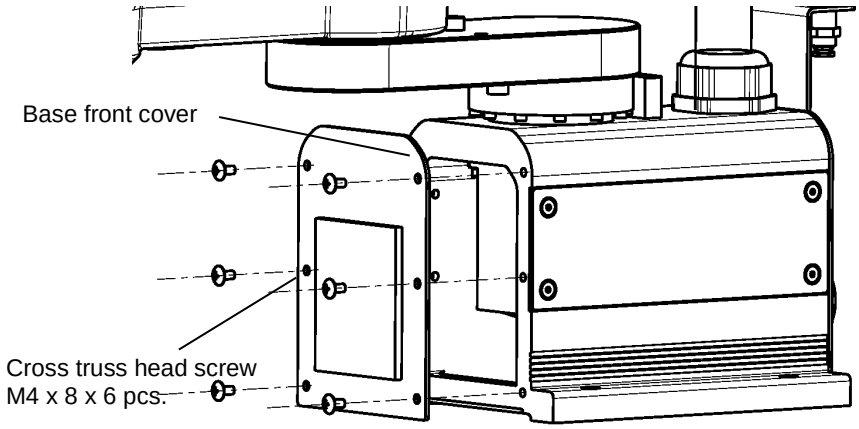


Fig. 2.7 Base front cover (KHL-300, KHL-400)

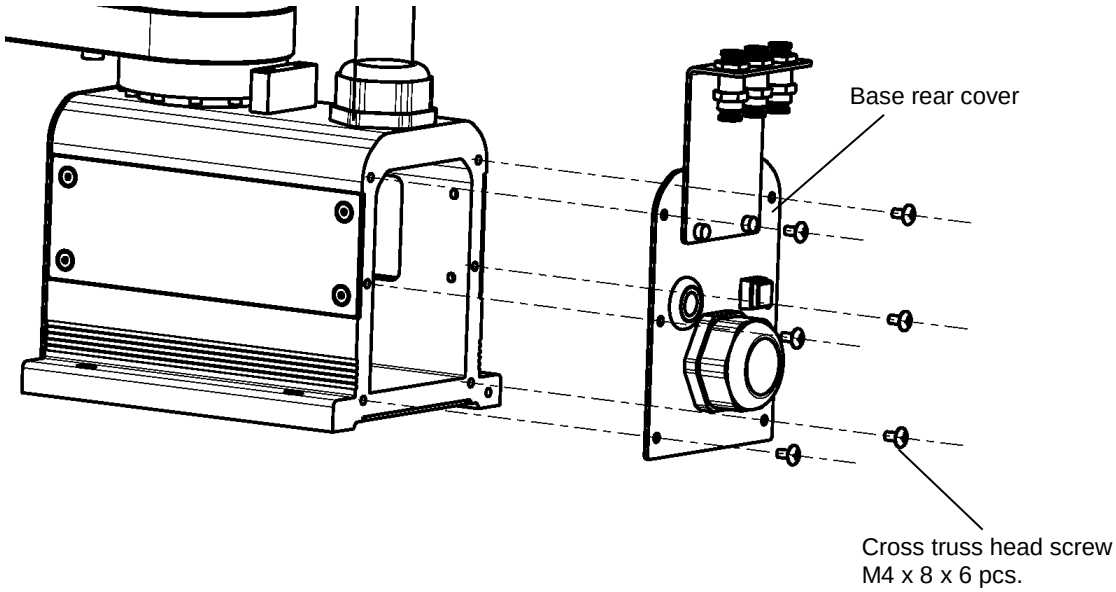


Fig. 2.8 Base rear cover (KHL-300, KHL-400)

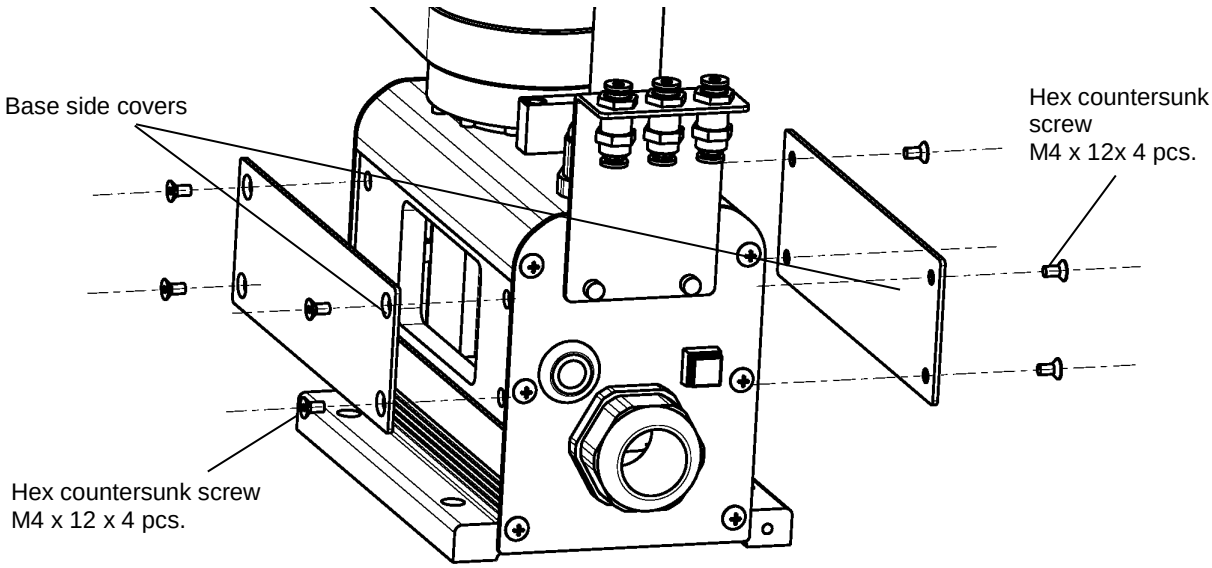


Fig. 2.9 Base side covers (KHL-300, KHL-400)

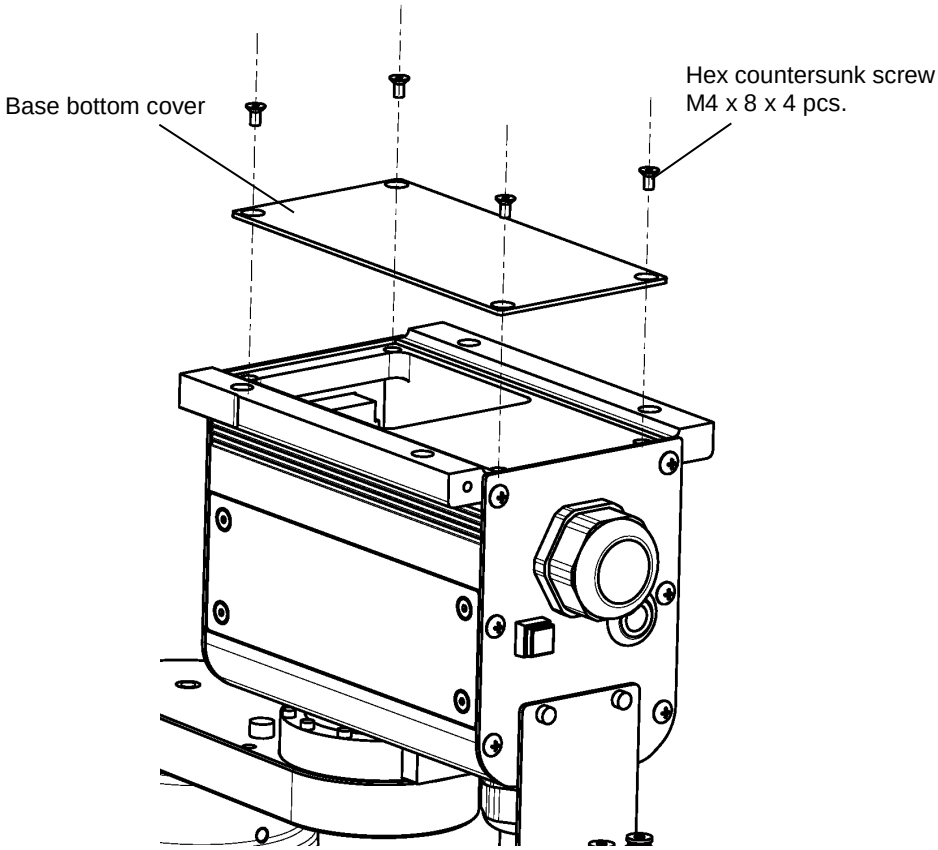


Fig. 2.10 Base bottom cover (KHL-300, KHL-400)

2.4 Replacing Motor

The motor is to be replaced by our service engineer. If it is replaced by the customer, we will not guarantee any consequential trouble or accident.

DANGER

- The motor should be replaced with a new one only after the controller power supply plug is removed. If the work is done while the power is connected, you may get an electric shock or the robot may malfunction, which is very dangerous.

CAUTION

- When replacing the motor, take careful precautions not to exert a heavy impact on the motor shaft. Otherwise, the motor and encoder may be damaged.
- NEVER disassemble the motor and encoder. Otherwise, they cannot be used due to positional shift, etc.
- Once the motor has been changed, the mechanical home point origin (or origin) will shift and precise control will not be possible. To avoid this, home return operation is necessary after motor replacement.
  For the home return procedures, see “Section 8. Robot Home Point and Position Detector Error.”

2.4.1 Type of Motor

The motors employed in this robot are shown below. When you place an order for a replacement motor, make sure of the robot model (KHL-300 and KHL-400), the serial number, the axis name, and our drawing number according to the following table.
For the location where the serial number plate is attached, see the “Safety Manual.”

Table 2.2 Type of Motor (KHL-300, KHL-400)

Description	Axis name	Type	Our drawing No.	Unit code
AC servo motor	Axis 1		S890967	Y610A3NL0
	Axis 2, 4		S890968	Y610A3NM0
	Axis 3		S777296	Y610A37A0

2.4.2 Motor Locations

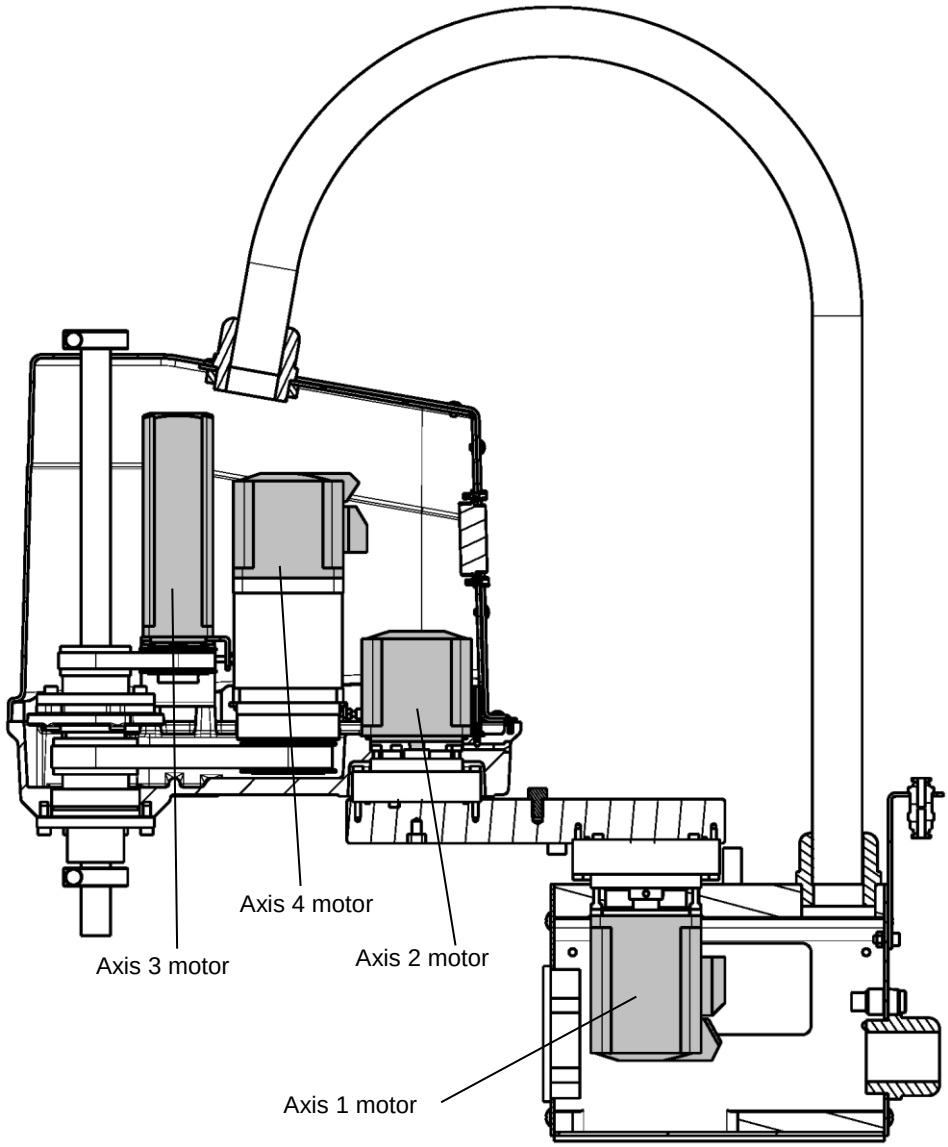


Fig. 2.11 Motor locations (KHL-300, KHL-400)

2.4.3 Dismounting Axis 1 Motor

1) Remove the base front cover and both of the base side covers. (See “Para. 2.3.2, Base Covers.”) The battery for position detection is connected to the base front cover, so do not forcibly pull it or unplug the connector.

2) Remove the four hexagon socket head cap screws (M4 x 12 x 4 pcs.) and the washers that secure the axis 1 motor, pull the axis 1 motor assembly in the axis direction and then pull it out. Have a waste cloth handy as grease may drip from the motor mounted section when pulling out the motor assembly. At this time, remove the O-ring (CO0534A) being mounted on the base groove side surface. Also, when pulling out the motor assembly, do not pull it with force as the motor connector is connected.

3) Remove the connectors of the axis 1 motor, i.e., J1AS and J1AP (power drive cable), and J1BS and J1BP (encoder cables).

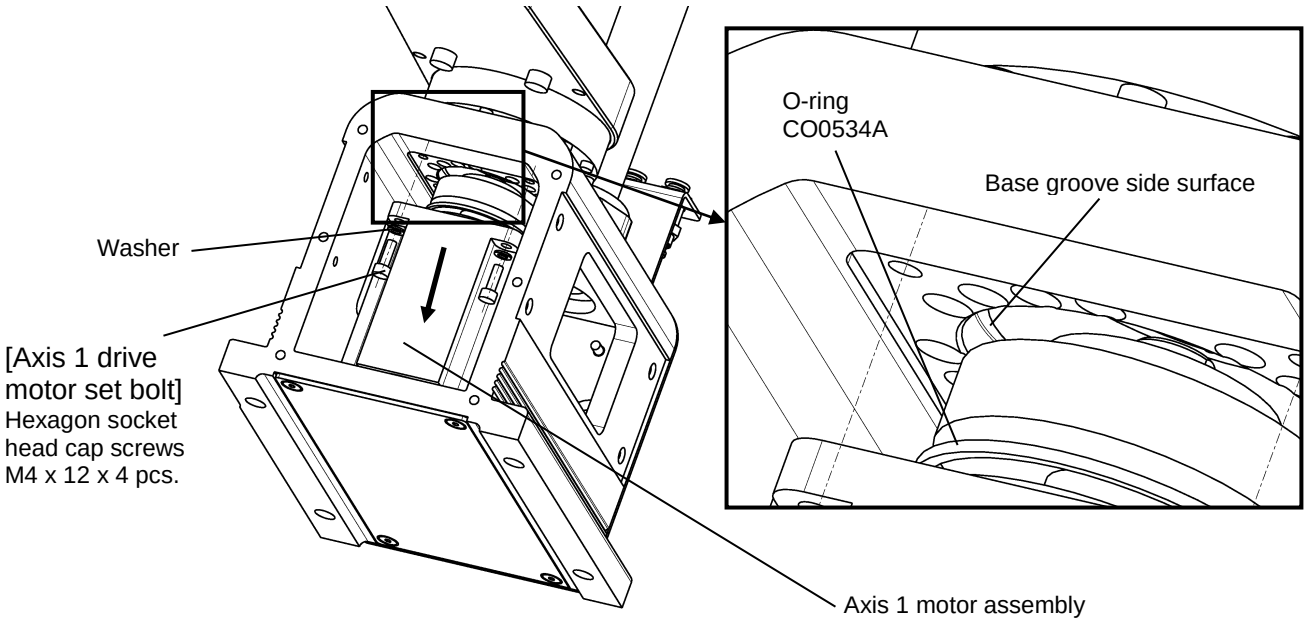


Fig. 2.12 Dismounting axis 1 motor assembly (KHL-300, KHL-400)

4) Remove the set screws (2 pcs.) securing the wave generator to the axis 1 motor and pull out the wave generator.

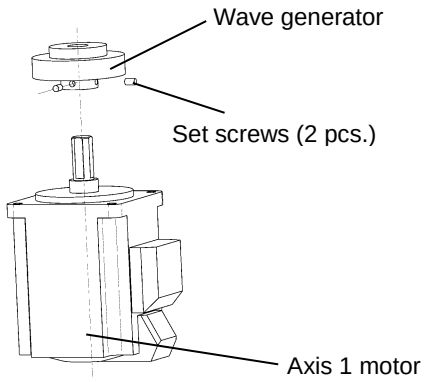


Fig. 2.13 Dismounting axis 1 wave generator (KHL-300, KHL-400)

2.4.4 Mounting Axis 1 Motor

1) When inserting the wave generator into the axis 1 motor, be sure to fasten it using the two jigs for fastening Axis 1. If fastened without using these jigs, vibrations may occur when the robot is used. Install the set screws (2 pcs.) to the wave generator. Align the holes of the set screws with the phases of the D cuts of the axis 1 motor and insert the wave generator. Mount the fastening jigs as shown in the figure below. While pushing down each part to make tight contact and paying attention to the D cuts and the phases of the set screws, tighten the set screws to fasten the wave generator. Then, pull out the fastening jigs. In case the fastening jigs come out too easily, remount them in such a way that some force is required to pull them out.

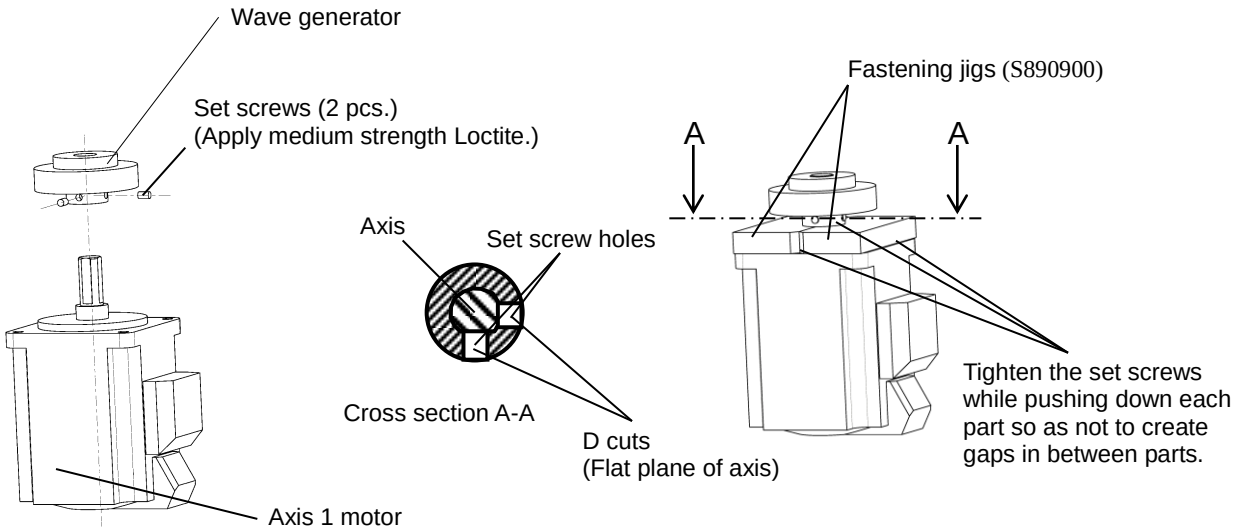


Fig. 2.14 Mounting axis 1 wave generator (KHL-300, KHL-400)

2) Apply grease to the O-ring (CO0534A) and mount it to touch the base groove side surface. Be careful not to drop the O-ring while doing so.

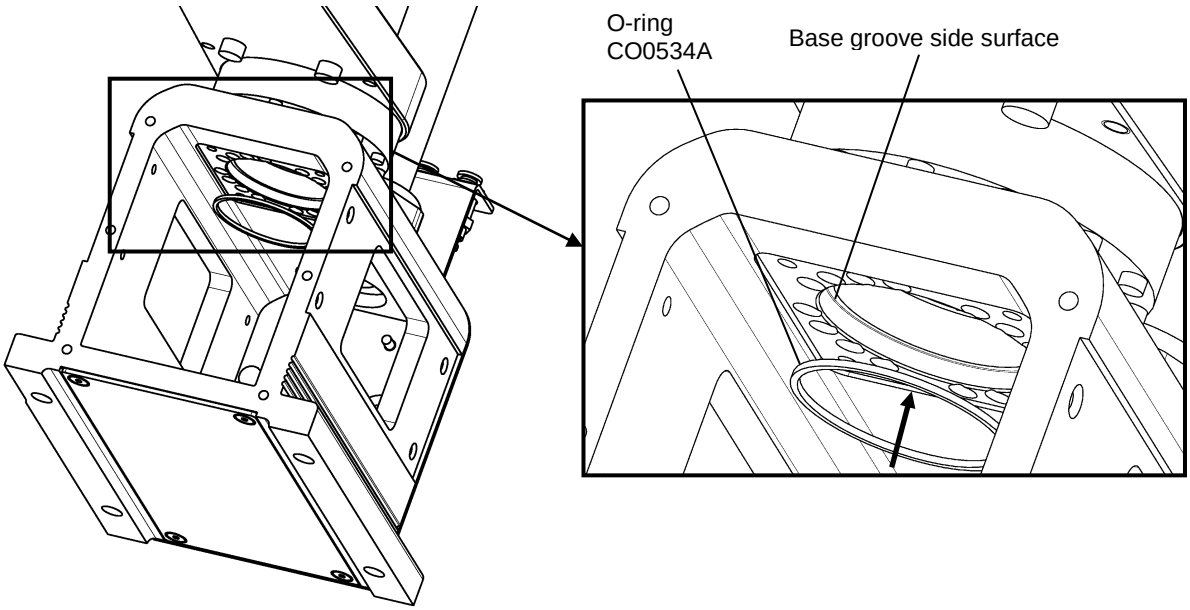


Fig. 2.15 Mounting axis 1 base side O-ring (KHL-300, KHL-400)

3) Apply an appropriate amount of grease onto the all surfaces of the wave generator mounted to the axis 1 motor.

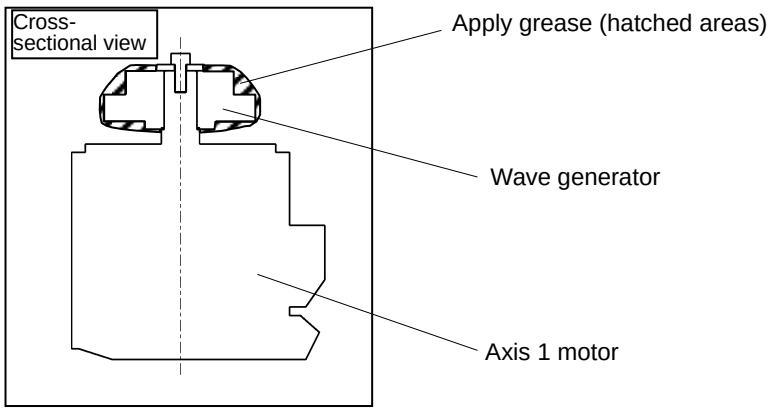


Fig. 2.16 Apply grease onto wave generator (KHL-300, KHL-400)

4) Connect the connectors of the axis 1 motor, i.e., J1AS and J1AP (power drive cable), and J1BS and J1BP (encoder cables).

5) Insert the axis 1 motor assembly into the base while paying attention to the motor's mounting phases, the orientations of the reduction gear's main body and wave generator when the motor is inserted (align the long sides of the ovals of the reduction gear and the wave generator), and the position of the O-ring (it should not move). Do not forcibly push in the motor.

6) Secure the axis 1 motor assembly with four (4) hexagon socket head cap screws (M4 x 12) and washers.

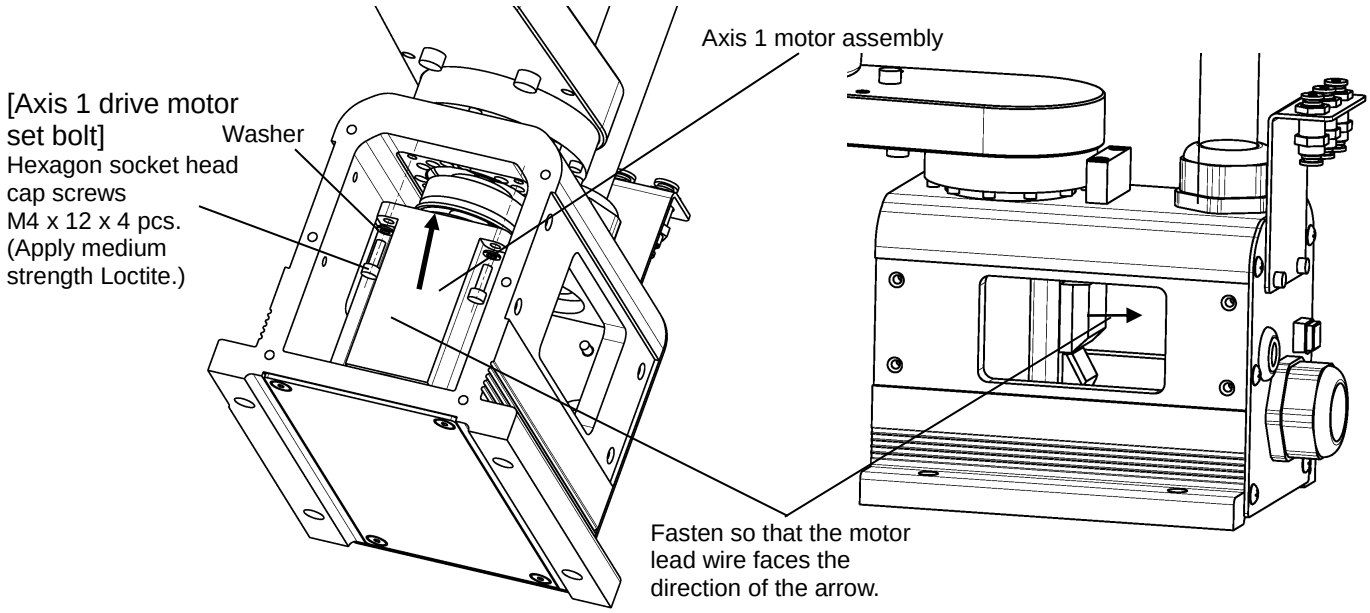


Fig. 2.17 Mounting axis 1 motor assembly (KHL-300, KHL-400)

7) After changing Axis 1 motor, move Arm 1 by hand and check that there is no abnormal sound before turning on the power.

8) Mount the base front cover and the base side covers. (See “Para. 2.3.2, Base Covers.”)

9) Turn on the power and set up the axis 1 home position to complete axis 1 motor replacement.
(Check the coordinates of Axes 2 to 4 and set up the home position if necessary. See “Section 8, Robot Home Point and Position Detector Error”.)

! CAUTION

- Do not forget to mount the O-ring.
  If the O-ring is not mounted, grease will leak from the motor mounted surface.

2.4.5 Dismounting Axis 2 Motor

1) Disconnect the arm 2 cover. (See “Para. 2.3.1, Arm 2 Cover.”)
2) Cut the cable ties of the cables with nippers or the like, and remove J2AS and J2AP (axis 2 power drive cables), J2BS and J2BP (axis 2 encoder cables). It is recommended to take photos of the cable installation positions and the locations where cable ties are used so that these locations can be restored when needed.
3) Remove the harness guide being secured with one (1) cross countersunk screw (M3 x 6) and the support plate being secured with two (2) hexagon socket head cap screws (M3 x 6).

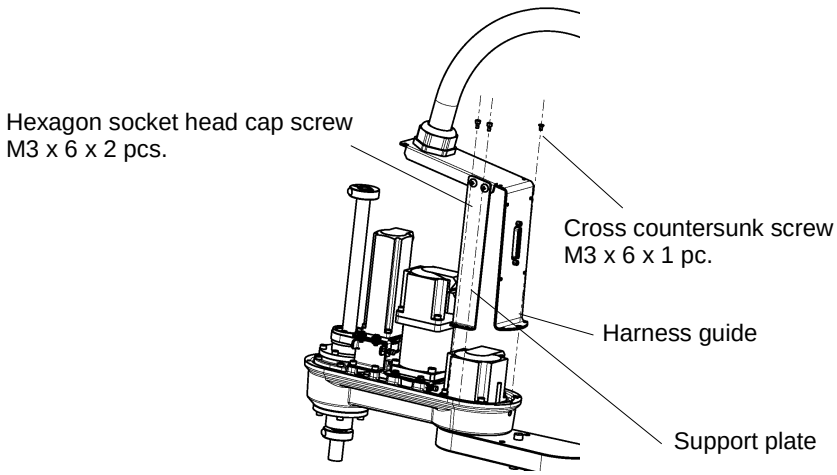


Fig. 2.18 Dismounting harness guide and support plate (KHL-300, KHL-400)

4) Remove four (4) hexagon socket head cap screws (M4 x 12) and washers that secure the axis 2 motor. Pull out the axis 2 motor assembly. Also remove the O-ring (CO0538A).

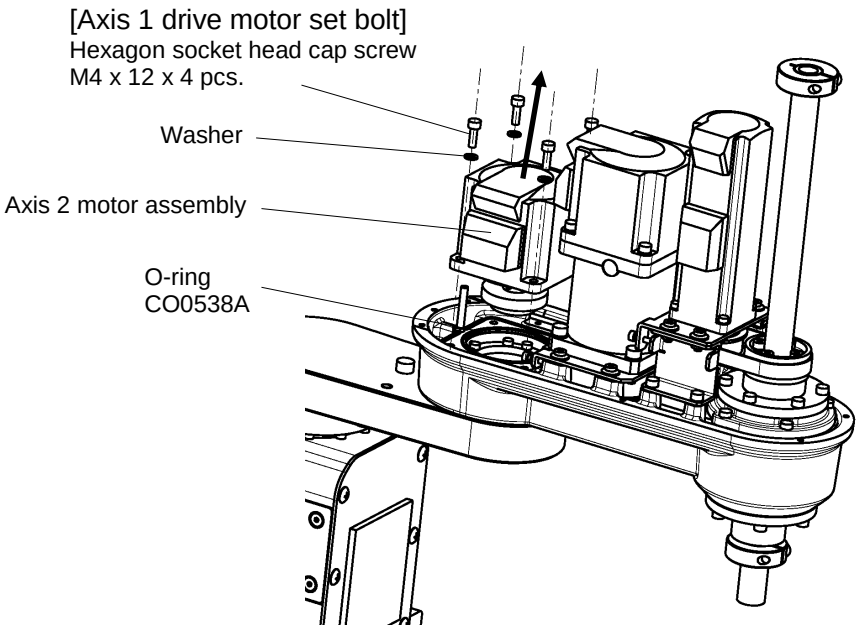
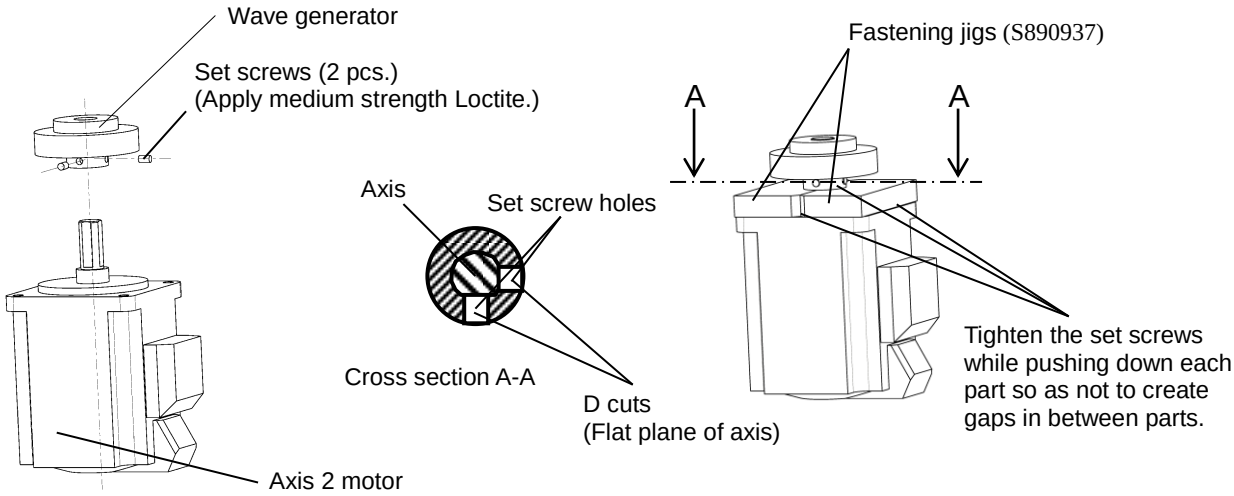


Fig. 2.19 Dismounting axis 2 motor assembly (KHL-300, KHL-400)

5) Remove the wave generator from the axis 2 motor assembly. (Same as Step 4 in “Para. 2.4.3, Dismounting Axis 1 Motor.”)

2.4.6 Mounting Axis 2 Motor

1) Mount the wave generator to the axis 2 motor. (Same as Step 1 in “Para. 2.4.4, Mounting Axis 1 Motor.”) When inserting the wave generator into the axis 2 motor, be sure to use the two jigs for fastening Axis 2.



2) Apply grease to the O-ring (CO0538A) and mount it to the inlaid part of the axis 2 motor.

3) Apply an appropriate amount of grease onto the all surfaces of the wave generator mounted to the axis 2 motor. (Same as Step 3 in “Para. 2.4.4, Mounting Axis 1 Motor.”)

4) Insert the axis 2 motor assembly into Arm 2 while paying attention to the motor's mounting phase, the orientations of the decelerator main body and the wave generator when the motor is inserted (align the long sides of the ovals of the reduction gear and wave generator), and the position of the O-ring (it should not move).

5) Secure the axis 2 motor with four (4) hexagon socket head cap screws (M4 x 12) and washers.

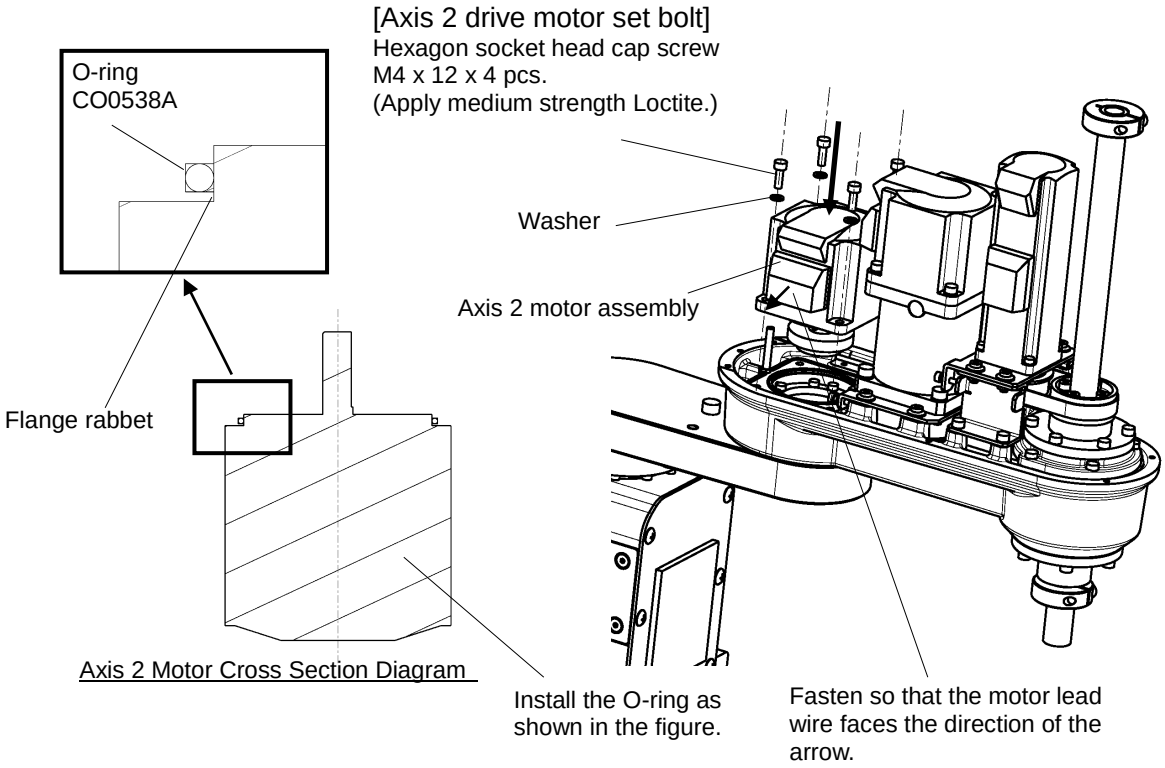


Fig. 2.20 Mounting axis 2 motor assembly (KHL-300, KHL-400)

! CAUTION

- Do not forget to mount the O-ring.
  If the O-ring is not mounted, grease will leak from the motor mounted surface.

6) Secure the harness guide and the support plate with one (1) hex countersunk screw (M3 x 8, application of Loctite not necessary) and two (2) Cross countersunk screw (M3 x 6).

7) After changing the axis 2 motor, move Arm 2 by hand and check that there is no abnormal sound.

8) Connect J2AS and J2AP (axis 2 power drive cables) and J2BS and J2BP (axis 2 encoder cables).

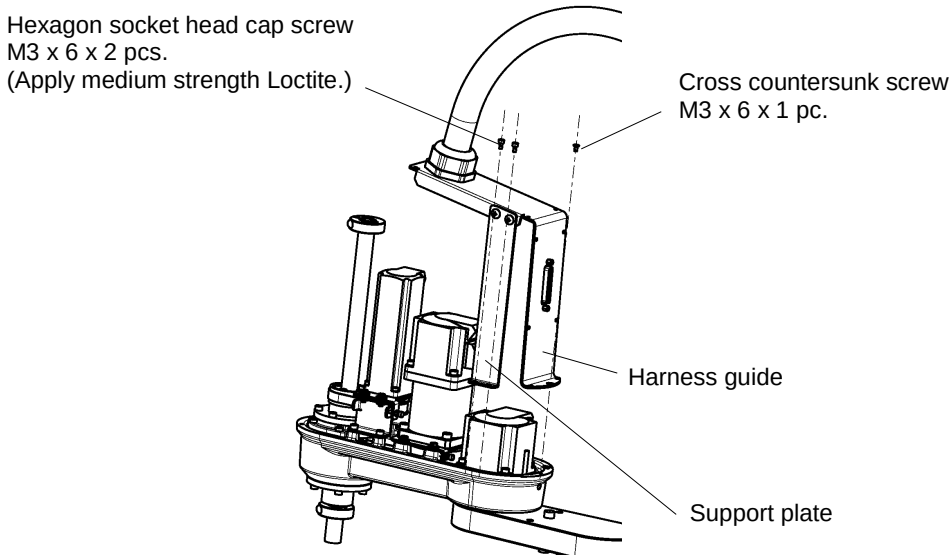


Fig. 2.21 Mounting harness guide and support plate (KHL-300, KHL-400)

9) Restore the cables in Arm 2 to the original conditions.

10) Mount arm 2 cover.

11) Turn on the power and set up the home positions of axes 2 to complete axis 2 motor replacement (see “Section 8, Robot Home Point and Position Detector Error”).

2.4.7 Dismounting Axis 3 Motor

! CAUTION

- The axis 3 motor is provided with a brake. At replacement of the axis 3 motor, this brake becomes inoperative. Before starting the work, therefore, move down the ball screw spline to the lower limit. Otherwise, the shaft will drop due to the dead weight of the shaft or workpiece, and your hand or finger may be caught.

1) Remove the arm 2 cover. (See “Para. 2.3.1, Arm 2 Cover.”)

2) Cut the cable ties of the cables with nippers.
It is recommended to take photos of the cable installation positions and the locations where cable ties are used so that these locations can be restored when needed.

3) Disconnect connectors J3AS and J3AP (power drive cables), connectors J3BS and J3BP (encoder cables) and connectors J3DS and J3DP (brake cables) for Axis 3, which are connected to the connector panel.

4) Loosen the axis 3 tension adjustment bolt (M3 x 12 x 2 and hexagonal nuts) and remove the flange head bolts (M4 x 8 x 4) securing the axis 3 motor plate to cancel the axis 3 timing belt tension. Next, pull out the axis 3 motor assembly upward while making sure that it does not touch the sheet metal and the ball screw spline.

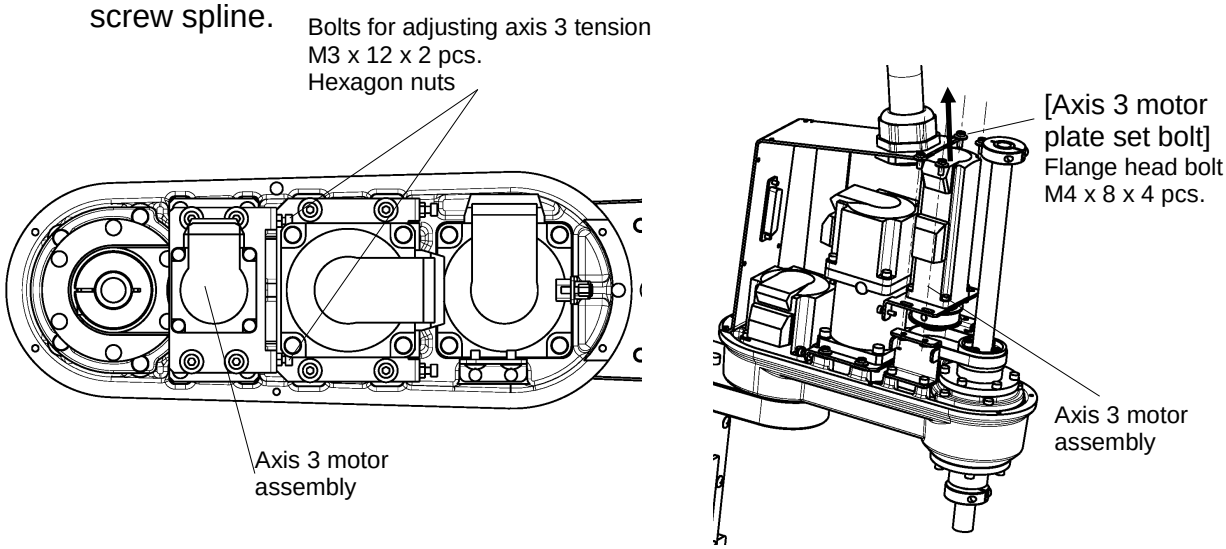


Fig. 2.22 Dismounting axis 3 motor assembly (KHL-300, KHL-400)

5) Remove the set screws (4 x 5 x 2 pcs. and 3 x 5 x 2 pcs.). Then, pull out the pulley.
6) Remove four (4) hexagon socket head cap screws (M3 x 10) and washers that secure the axis 3 motor and then disassemble the axis 3 motor plate and the axis 3 motor.

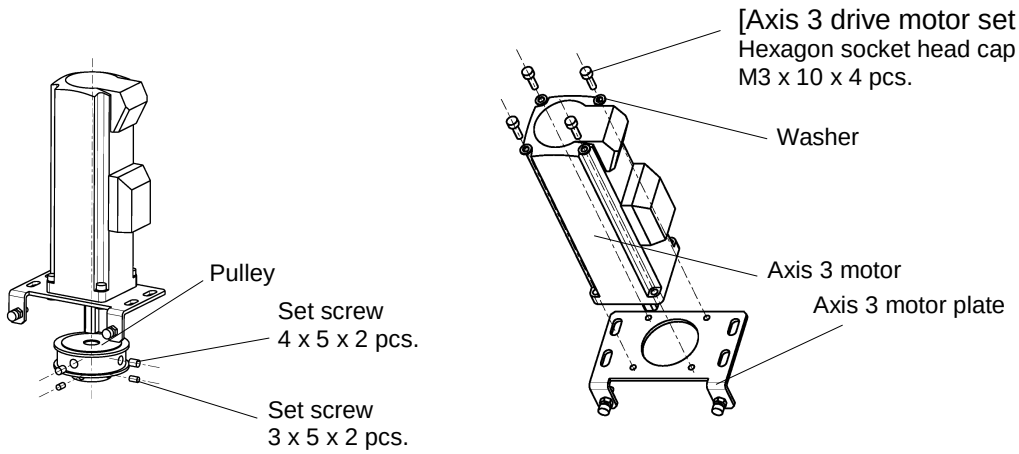


Fig. 2.23 Dismounting axis 3 motor pulley and plate (KHL-300, KHL-400)

2.4.8 Mounting Axis 3 Motor

1) Fasten the axis 3 motor to the axis 3 motor plate with the hexagon socket head cap screws (M3 x 10 x 4 pcs.) and the washers. At this time, be careful with the installation phases of the axis 3 motor and axis 3 motor plate.
2) Mount the pulley for the axis 3 motor and fasten it with the set screws (4 x 5 x 2 pcs. and 3 x 5 x 2 pcs.). Fasten the pulley while aligning the holes of the set screws of the pulley with the phases of the D cuts as shown in Cross Section Diagram B-B.

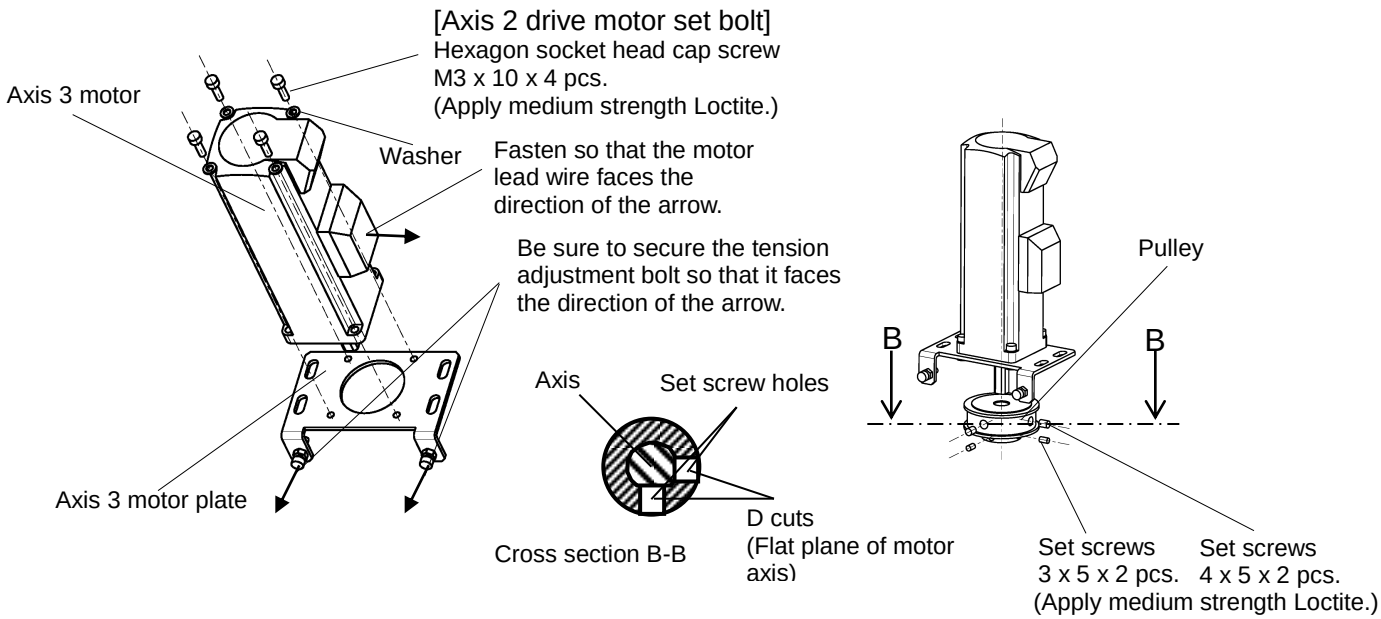


Fig. 2.24 Mounting axis 3 pulley and plate (KHL-300, KHL-400)

3) Hang the axis 3 motor timing belt to the arm 3 motor pulley, and temporarily secure the axis 3 motor plate to Arm 2 with four (4) flange head bolts (M4 x 8, application of Loctite not necessary). Be careful with the motor mounting phase at this time. Apply tension using two (2) axis 3 tension adjustment bolts (M3 x 12, application of Loctite not necessary). (For the belt replacement procedures and tension adjustment values, see “Para. 2.5.3, Replacing Axis 3 Timing Belt.”) Then, tighten the temporarily tightened flange head bolts. Next, tighten the tension adjustment bolts and fasten with the hexagon nuts.

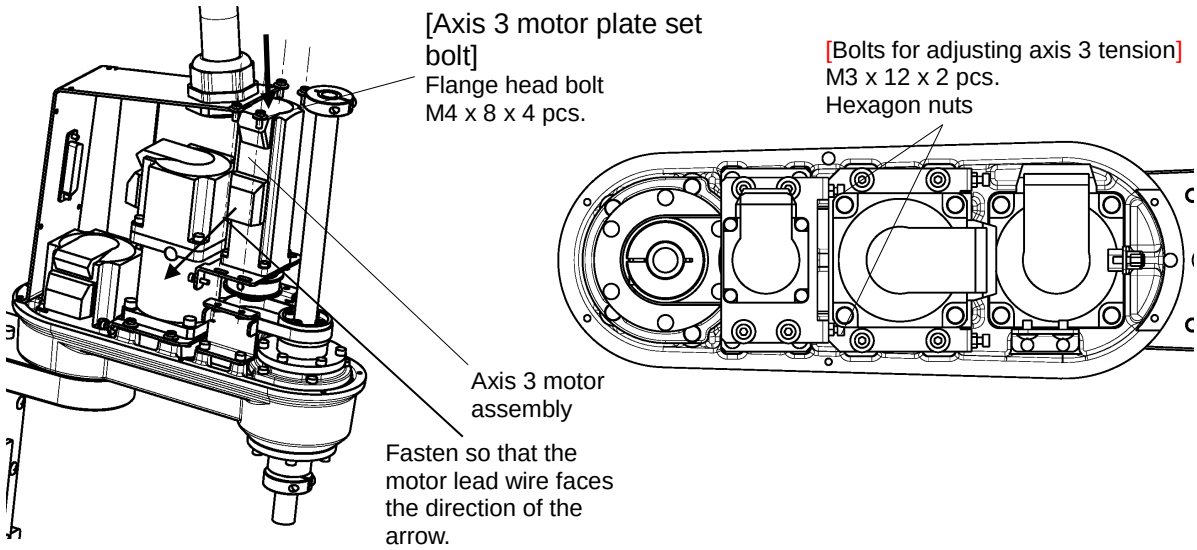


Fig. 2.25 Mounting axis 3 motor assembly (KHL-300, KHL-400)

4) Connect the connectors and restore the cables. (See the pictures taken in Section 2.4.7 Dismounting Axis 3 Motor Step 2)

5) Mount the arm 2 cover and perform home setting for Axes 3 and 4. Now, the axis 3 motor replacement is complete. Need perform home setting for Axes 4 at this time.

6) Turn on the power. While pressing the brake release switch in the servo off mode, move the ball screw in the vertical direction. Make sure of the smooth operation of the ball screw.

7) Carry out a test operation of Axes 3 and 4 and make sure that each part operates properly.

2.4.9 Dismounting Axis 4 Motor

1) Remove the arm 2 cover. (See “Para. 2.3.1, Arm 2 Cover.”)

2) Cut the cable ties of the cables with nippers.
It is recommended to take photos of the cable installation positions and the locations where cable ties are used so that these locations can be restored when needed.

3) Disconnect connectors J4AS and J4AP (power drive cables) and connectors J4BS and J4BP (encoder cables) of the axis 4 motor.

4) Remove the cross recessed flat head screw (M3 x 6 x 1 pc.) and the hexagon socket head cap screws (M3 x 6 x 2 pcs.) which are fastening the harness guide and the support plate, and then remove the harness guide and the support plate.

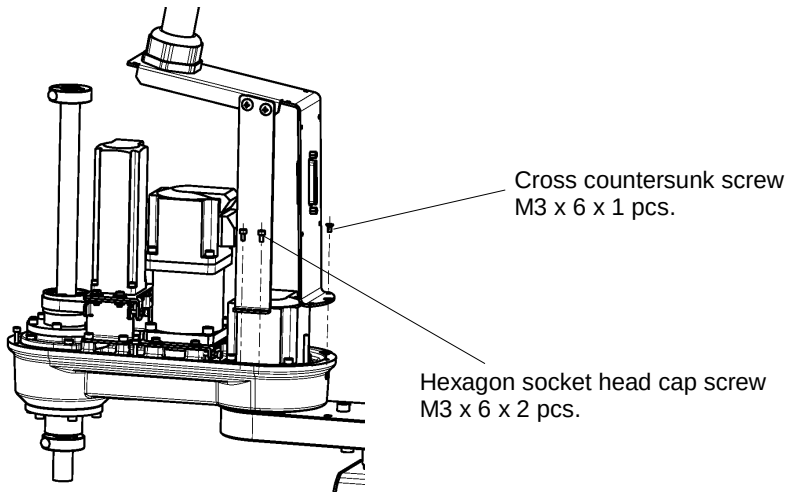


Fig. 2.26 Dismounting harness guide and support plate (KHL-300, KHL-400)

5) Remove the cap on the side panel of the axis 4 reduction gear and loosen the bolt (M3) of the coupling which is fastening the input axis of the axis 4 reduction gear. If the phases of the hexagonal holes of the bolt cannot be aligned, manually rotate the ball screw spline shaft and align the phases.

6) Remove four (4) hexagon socket head cap screws (M4 x 12) and washers that secure the axis 4 motor, and then pull the axis 4 motor upward.

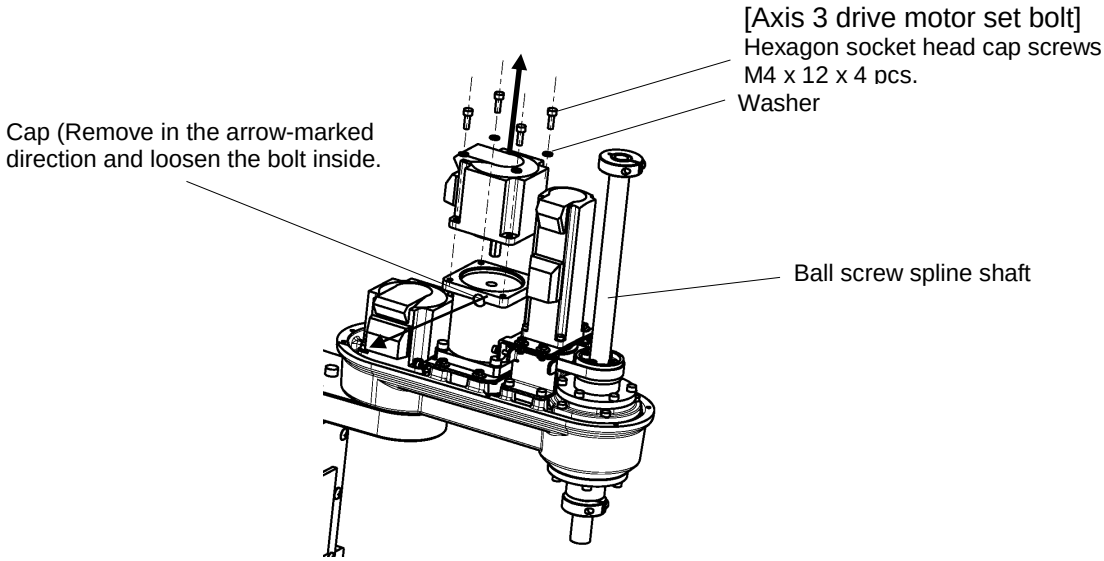


Fig. 2.27 Dismounting axis 4 motor (KHL-300, KHL-400)

2.4.10 Mounting Axis 4 Motor

1) Mount the new motor to the reduction gear with four (4) hexagon socket head cap screws (M4 x 12) and washers. Be careful with the phase when mounting the motor. (Recommended clamping torque: 2.3 N·m)

2) Tighten the coupling of the axis 4 reduction gear by means of the attached bolt (M3) to mount the cap. (Recommended clamping torque: 1.8 N·m)

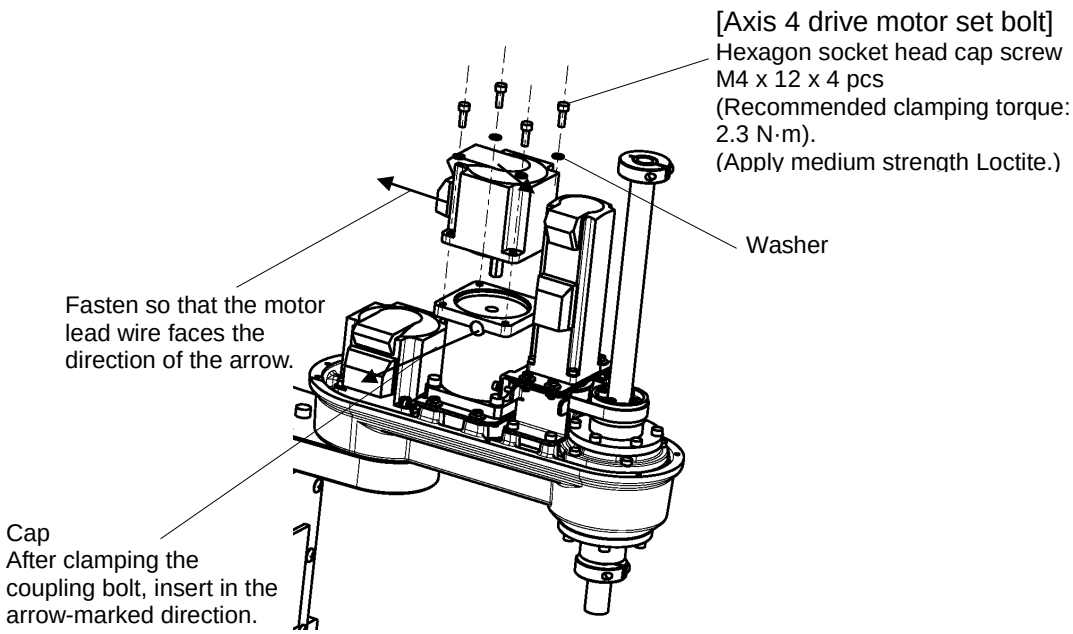


Fig. 2.28 Mounting axis 4 motor (KHL-300, KHL-400)

3) Connect the connectors of the axis 4 motor, i.e., J4AS and J4AP (power drive cables), and J4BS and J4BP (encoder cables).

4) Restore the cables to the original conditions and then mount the arm 2 cover.

5) Set up the home positions of Axes 3 and 4 to complete motor replacement. During the replacement of the axis 4 motor, it is necessary to set up the home position of Axis 3.

6) Carry out a test operation of Axes 3 and 4 and make sure that each part operates properly.

2.5 Adjusting and Replacing Timing Belt

The timing belt is to be replaced by our service engineer. If it is replaced by the customer, we will not guarantee any consequential trouble or accident.

DANGER

- The timing belt should be replaced with a new one only after the controller power supply plug is removed. If the work is done while the power is connected, you may get an electric shock or the robot may malfunction, which is very dangerous.

CAUTION

- The axis 3 motor is provided with a brake. At replacement of the axis 3 timing belt, this brake becomes inoperative. Before starting the work, therefore, move down the shaft to the lower limit. Otherwise, the shaft will drop due to the dead weight of the shaft or workpiece, and your hand or finger may be caught.
- Because the timing belt is disconnected, the mechanical home point shifts and proper control cannot be done. To avoid this, home return operation is necessary after replacement of the timing belt. For the home return procedures, see “Section 8, Robot Home Point and Position Detector Error.”

2.5.1 Type of Timing Belt

The timing belts used in this robot are shown below.
When you place an order for a replacement belt, specify the robot model (KHL-300, KHL-400), the serial number, the axis name, and our drawing number.
For the location where the serial number plate is attached, see the “Safety Manual.”

Table 2.3 Type of timing belt (KHL-300, KHL-400)

Description	Axis name	Width	Our drawing No.
Timing belt	Axis 3	9mm	S890882
	Axis 4	12mm	S890883

2.5.2 Timing Belt Locations

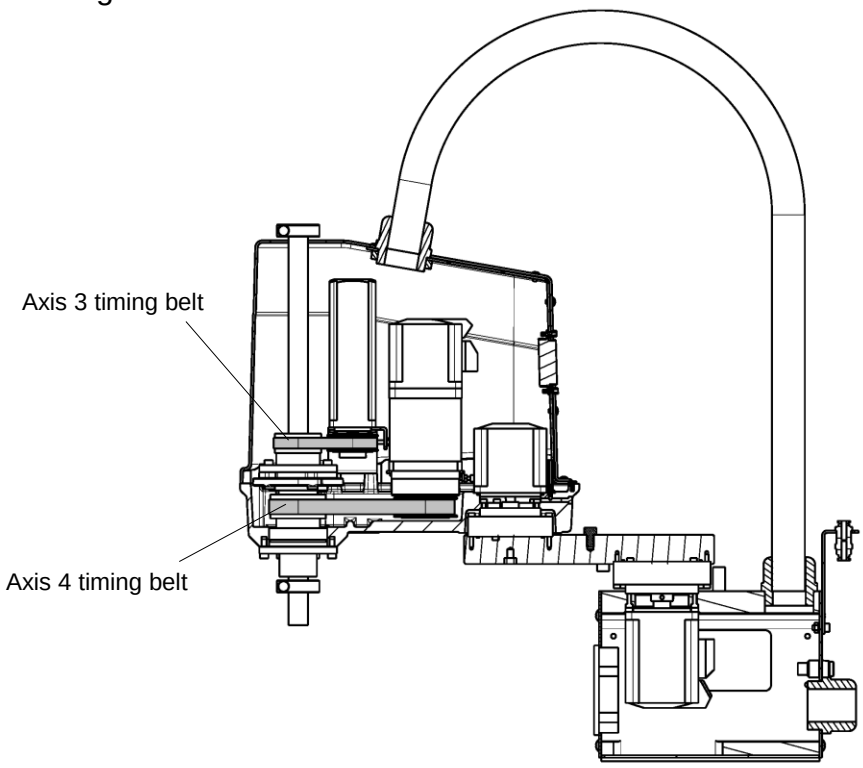


Fig. 2.29 Timing belt locations (KHL-300, KHL-400)

2.5.3 Replacing Axis 3 Timing Belt

1) Remove the arm 2 cover. (See “Para. 2.3.1, Arm 2 Cover.”)

2) Cut the cable ties of the cables with nippers. It is recommended to take photos of the cable installation positions and the locations where cable ties are used so that these locations can be restored when needed.

3) Disconnect the axis 3 motor assembly. For the disconnecting procedures, see Steps 1) through 4) of “Para. 2.4.7, Dismounting Axis 3 Motor.”

! CAUTION

- The axis 3 motor is provided with a brake. At replacement of the axis 3 timing belt, this brake becomes inoperative. Before starting the work, therefore, move down the shaft to the lower limit. Otherwise, the shaft will drop due to the dead weight of the shaft or workpiece, and your hand or finger may be caught.

4) Disconnect the axis 3 timing belt.

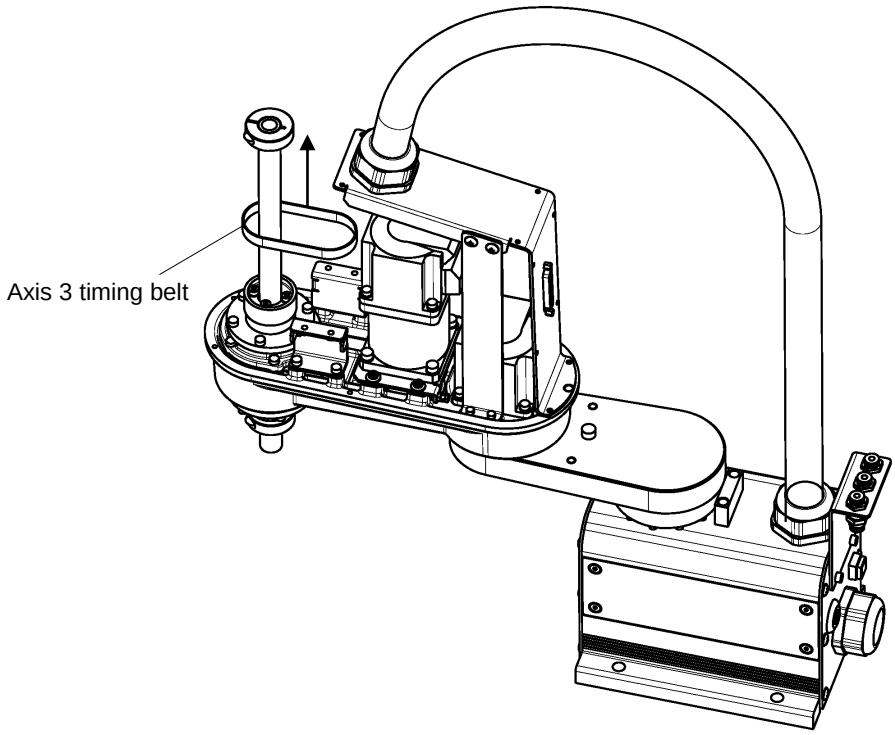


Fig. 2.30 Replacing axis 3 timing belt (KHL-300, KHL-400)

5) Mount the new timing belt.

6) Hang the timing belt to the axis 3 motor assembly which was previously removed in 3), and temporarily secure it to Arm 2 with four (4) flange head bolts (M4 x 8, application of Loctite not necessary). Move the ball screw spline unit up and down to make it fit in. Apply tension using two (2) axis 3 tension adjustment bolts (M3 x 12, application of Loctite not necessary).
While pulling the axis 3 motor plate with the axis 3 tension adjustment bolts, measure the tension with a tension meter. Tighten the flange head bolt at the location where the tension reaches a value slightly smaller than 48 N (because the tension gets larger by retightening of the flange head bolt). Adjust so that the tensile value becomes between 48 and 64 N when the flange head bolt is retightened. If the bolt is not tightened any further, the bolt will come out while the robot is in operation. Next, fasten with the hexagon nuts.
The values to be used for the tension meter are as shown in the table below.

Table 2.4 Value of tension of axis 3 timing belt (KHL-300, KHL-400)

Value of tension [N]	Unit mass [g/m]	Belt width [mm]	Span [mm]
48 to 64	2.2	9	45

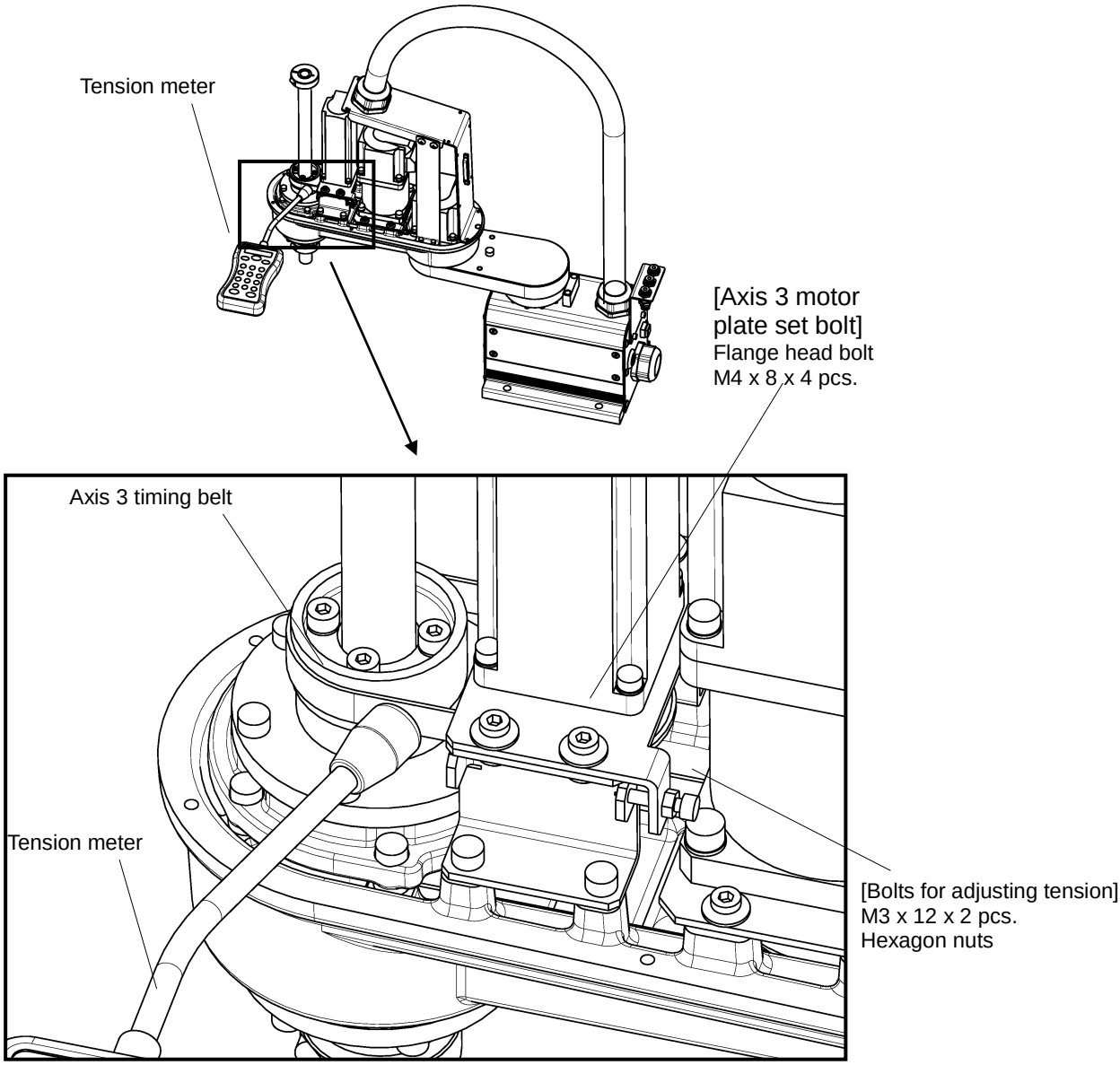


Fig. 2.31 Adjusting axis 3 tension (KHL-300, KHL-400)

7) Connect the connectors and return them to their original location, mount the arm 2 cover, and perform home setting for Axes 3 and 4. This completes the replacement of the timing belt. When replacing the 3rd-axis timing belt, be sure to set the 4th-axis home position.

8) Turn on the power. While pressing the brake release switch in the servo off mode, move the ball screw in the vertical direction. Make sure of the smooth

operation of the ball screw.

9) Carry out a test operation of Axes 3 and 4 and make sure that each part operates properly.

2.5.4 Replacing Axis 4 Timing Belt

! CAUTION

- When the axis 4 timing belt is replaced with a new one, Axis 3 should be disassembled also due to the structure. Therefore, strictly observe the cautions on replacement of the axis 3 timing belt and motor also.
- When the ball screw nut integrated with the ball screw spline shaft is disconnected, take utmost care not to cause the ball screw spline shaft to come off. Otherwise, the ball in the ball screw nut will drop and the ball screw nut integrated with the ball screw spline shaft cannot function any further.

1) Remove the arm 2 cover.

2) Cut off the cable ties with nippers. It is recommended to take photos of the routing of the cables and the locations where cable ties are used in advance in case they become necessary for restore.

3) Remove the cross recessed flat head screw (M3 x 6 x 1 pc.) and the hexagon socket head cap screws (M3 x 6 x 2 pcs.), and then remove the harness guide and the support plate.

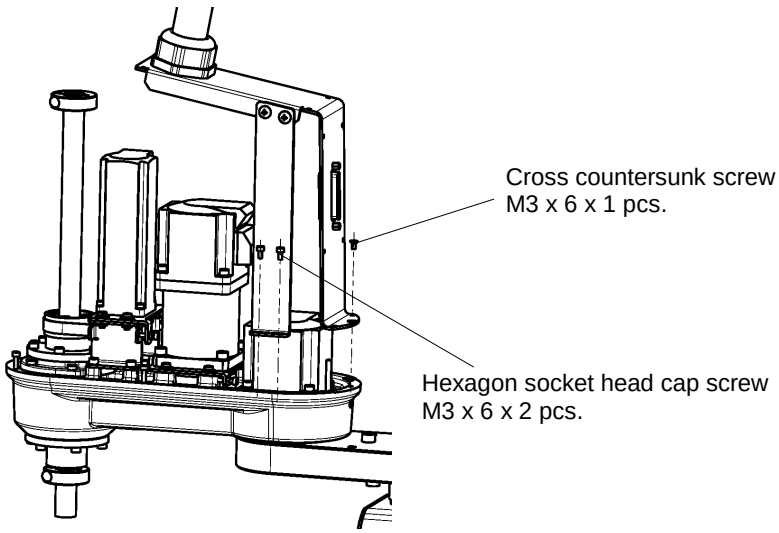


Fig. 2.32 Dismounting harness guide and support plate (KHL-300, KHL-400)

4) Remove the axis 3 motor assembly and the axis 3 timing belt. For more information about removal, see items 3) and 4) in "2.5.3, Replacing Axis 3 Timing Belt."

5) Remove the hexagon socket head cap screws (M4 x 8 x 4 pcs.) which are fastening the axis 3 brackets (sheet metal, 2 pcs.), and then remove the axis 3 brackets (sheet metal, 2 pcs.).

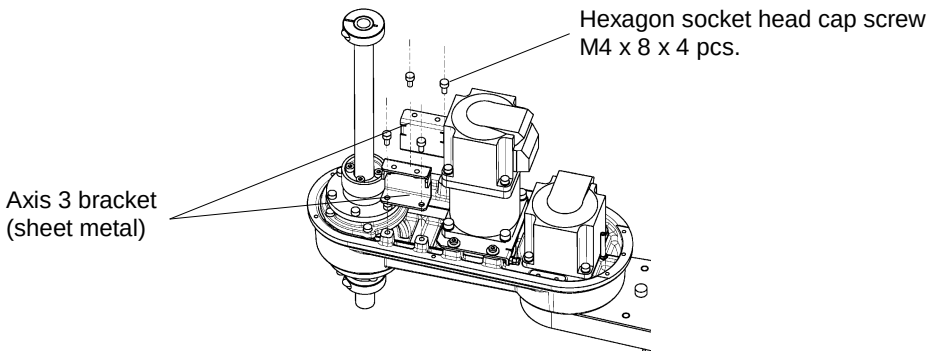


Fig. 2.33 Dismounting axis 3 bracket (sheet metal) (KHL-300, KHL-400)

6) Remove the stoppers, the ball screw spline shaft, the ball screw nuts and the axis 3 bracket (casting). For more information about removal, see item 5) in "2.6.4, Dismounting Ball Screw Spline Unit."

7) Remove the flange head bolts (M4 x 8 x 4 pcs.), and then remove the axis 4 motor assembly and the axis 4 timing belt.

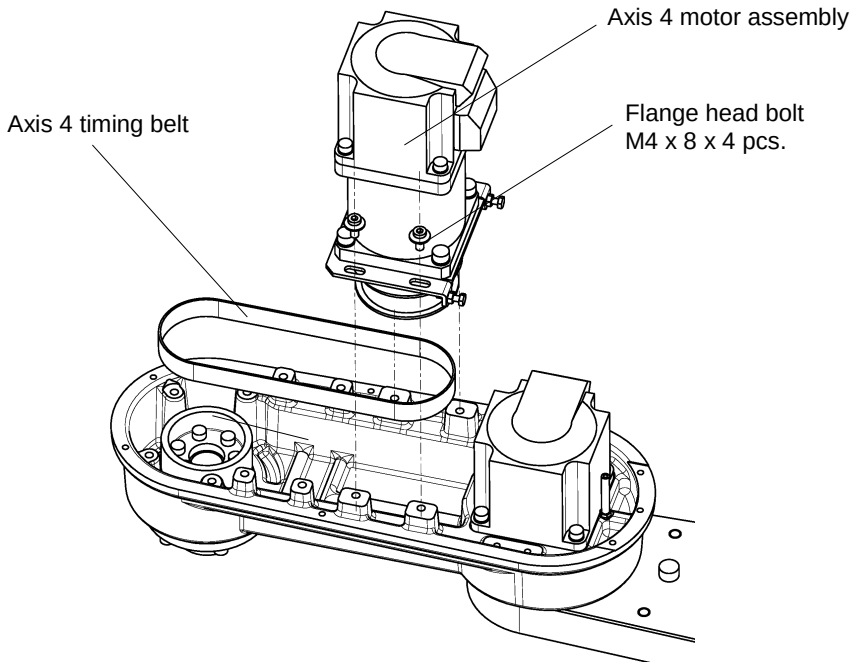


Fig. 2.34 Dismounting axis 4 belt and motor assembly (KHL-300, KHL-400)

8) Temporarily fasten the axis 3 bracket (casting) to Arm 2 with the hexagon socket head cap screws (M4 x 16 x 4 pcs.).
At this time, hang a new axis 4 timing belt on the pulley.

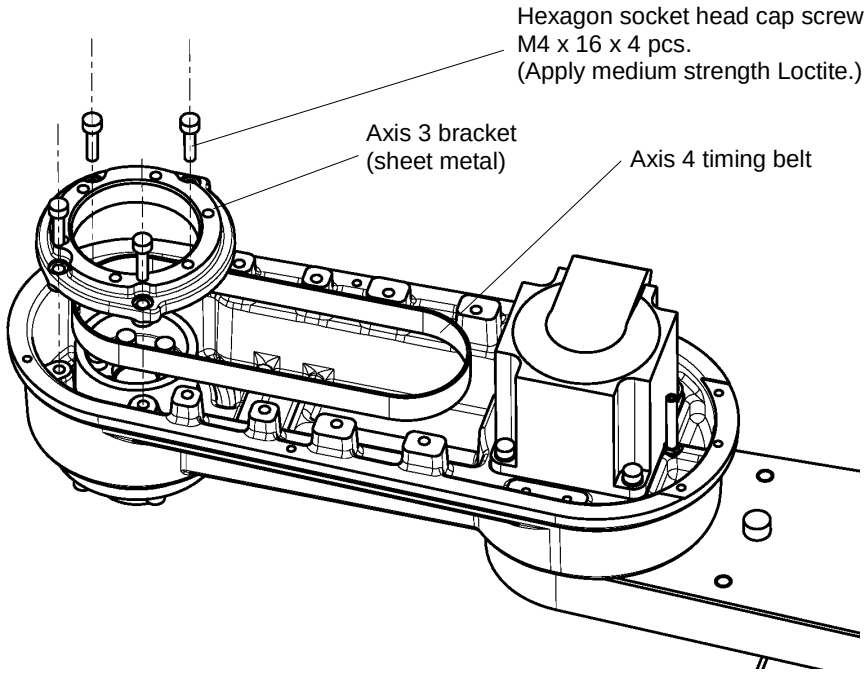


Fig. 2.35 Mounting axis 3 bracket (casting) and axis 4 timing belt (KHL-300, KHL-400)

9) Fasten the ball screw nuts, the ball screw spline shaft and the stoppers which were removed in step 6) above to Arm 2. For more information about mounting of the ball screw spline unit and the stoppers, see "2.6.5, Mounting Ball Screw Spline Unit."

10) Temporarily fasten the axis 4 motor assembly to Arm 2 with the flange head bolts (M4 x 8 x 4 pcs.).

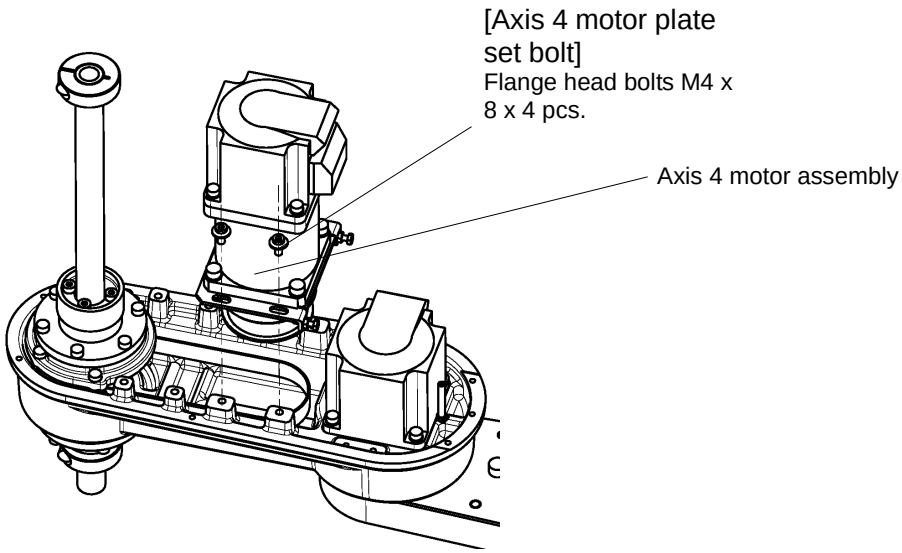


Fig. 2.36 Mounting axis 4 motor assembly (KHL-300, KHL-400)

11) While pulling the axis 4 motor plate with the axis 4 tension adjustment bolts, measure the tension with a tension meter. Tighten the flange head bolt at the location where the tension reaches a value slightly smaller than 66 N (because the tension gets larger by retightening of the flange head bolt). Adjust so that the tensile value becomes between 66 and 88 N when the flange head bolt is retightened. Next, tighten the tension adjustment bolts and fasten with the hexagon nuts. If the bolt is not tightened any further, the bolt can come out while the robot is in operation. The values to be used for the tension meter are as shown in the table below.

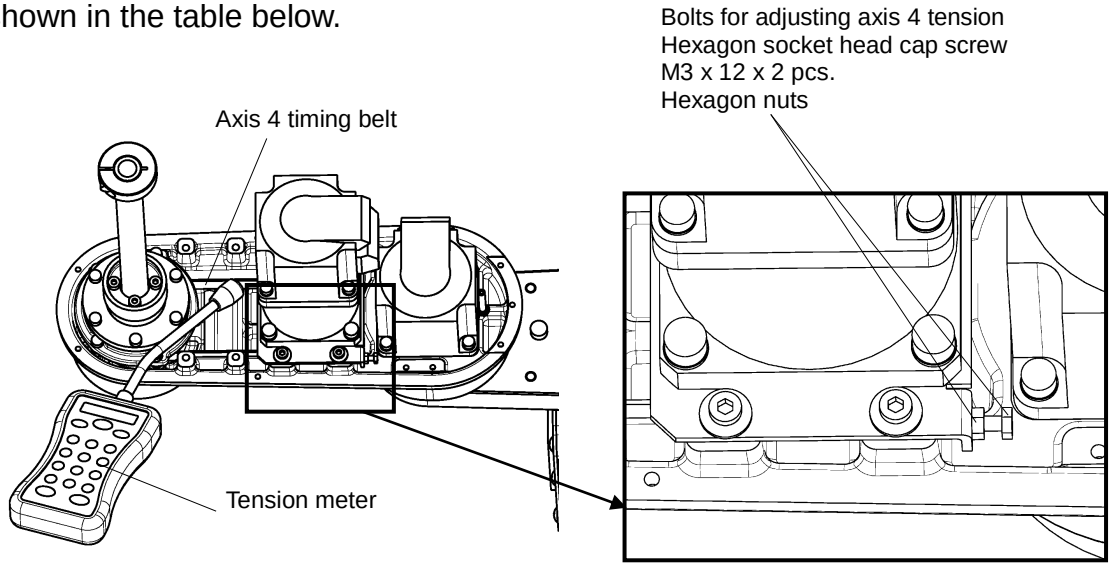


Fig. 2.37 Adjusting axis 4 tension (KHL-300, KHL-400)

Table 2.5 Value of tension of axis 4 timing belt (KHL-300, KHL-400)

Value of tension [N]	Unit mass [g/m]	Belt width [mm]	Span [mm]
66 to 88	2.2	12	105

12) Mount the axis 3 motor and timing belt. For the mounting procedures, see “Para. 2.5.3, Replacing Axis 3 Timing Belt” above.

13) Arrange the connectors and cables as originally set. (See the pictures you took beforehand.)

14) Perform home setting for Axes 3 and 4. When replacing the 3rd-axis timing belt, be sure to set the 4th-axis home position.

15) Carry out a test operation of Axes 3 and 4 and make sure that the belt tension is appropriate.

16) Attach the arm 2 cover. Now replacement of the axis 4 timing belt completes.

2.5.5 Check Timing Belt Adjustment

Perform inspection and adjustment of each timing belt semi-annually (every six (6) months).

1) Remove the arm 2 cover. (See “Para. 2.3.1, Arm 2 Cover.”)

2) If the belt is worn out, replace it. (See “Para. 2.5.3, Replacing Axis 3 Timing Belt.”) If scratches are found on the belt, please replace it or contact our Service Department.
   If the belt is loosened heavily, adjust its tension, referring the values of tension in Para. 2.5.3, Replacing Axis 3 Timing Belt and 2.5.4, Replacing Axis 4 Timing Belt.
   Note that the value of tension at replacement of timing belt (i.e., when mounting a new timing belt) is the same as the value of tension at adjustment. If the tension is appropriate, mount the arm 2 cover. Now the inspection is complete.

3) When adjustment of the tension is required, loosen the four (4) flange head bolts (M4 x 8) securing the axis 3 and axis 4 motor plates, respectively. Measure the tension on the tension meter while adjusting the tension adjustment bolt (axis 3: M3 x 12 x 2 bolts, axis 4: M3 x 12 x 2 bolts and hexagonal nut).

4) When the tension has fallen under the appropriate range, tighten the flange head bolts.

5) Tighten the tension adjustment bolts further and fasten with the hexagon nuts. If the bolt is not tightened any further, the bolt can come out while the robot is in operation.

6) Mount the arm 2 cover. Now the adjustment completes.

2.6 Filling Grease to Ball Screw Spline Unit and Replacement

The ball screw spline unit is to be replaced by our service engineer. If it is replaced by the customer, we will not guarantee any consequential trouble or accident.

DANGER

- The ball screw spline unit should be replaced with a new one only after the controller power supply plug is removed. If the work is done while the power is connected, you may get an electric shock or the robot may malfunction, which is very dangerous.

CAUTION

- Because the timing belt, nut and pulley are disconnected, the mechanical home point shifts and proper control cannot be done. To avoid this, home return operation is necessary after replacement of the ball screw spline unit. For the home return procedures, see “Section 7, Robot Home Point and Position Detector Error.”

2.6.1 Type of Ball Screw Spline Unit

The ball screw spline unit used in this robot is shown below.
When you place an order for the ball screw spline unit for replacement, specify the robot model (KHL-300, KHL-400) and our drawing number.

Table 2.6 Ball screw spline unit (KHL-300, KHL-400)

Description	Stroke	Our drawing No.	Unit code
Ball screw spline unit	160 mm	H852810	Y610A3NE0

2.6.2 Ball Screw Spline Unit Location

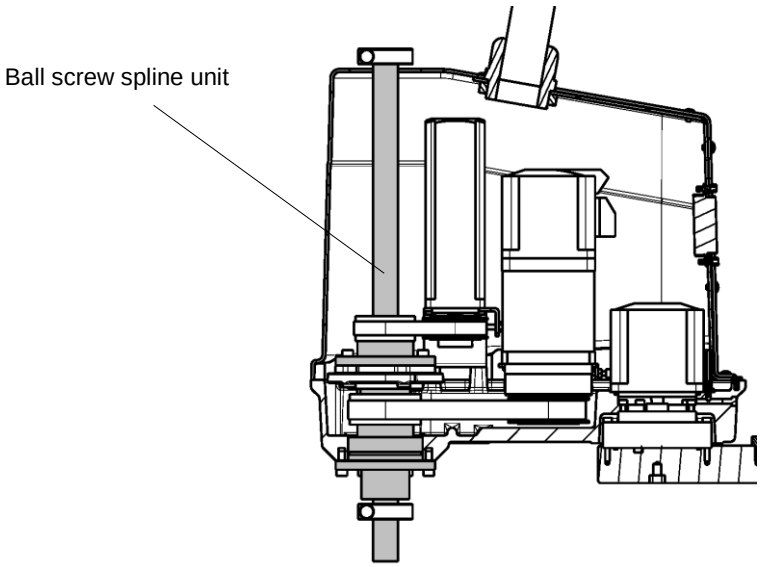


Fig. 2.38 Ball screw spline unit location (KHL-300, KHL-400)

2.6.3 Greasing Ball Screw Spline Unit and Applying Anticorrosive

! CAUTION

- When vertically moving the ball screw by hand, take careful precautions not to have your hand or finger caught.
- As there is a fear that the grease drops, cover the peripheral equipment, etc.

! CAUTION

- When the grease has run short, cut or scratch will be caused on the slide unit, etc., resulting in drop of the performance. To avoid this, take careful precautions to prevent shortage of the grease.
- Be sure to use the grease designated by CKD.
- Apply anticorrosive when dried up. If anticorrosive is not applied in such a case, rust will be generated on the ball screw spline unit.
- NEVER touch the ball screw spline unit with bare hand. Otherwise, the ball screw may be subjected to earlier rusting. Be sure to gloves when you want to tough it.

Basically, fill the grease to the ball screw spline unit every three (3) months.
If you have verified that there is not much grease, be sure to apply grease.
At daily inspection also, make sure that the ball screw spline unit is filled with a sufficient volume of grease.
Check the condition of anticorrosive in daily inspection. If anticorrosive is dried up, apply it.

Table 2.7 Recommended anticorrosive (KHL-300, KHL-400)

Recommended anticorrosive	Maker
KLUBER A20	NOK
WD-40	ST TRADING

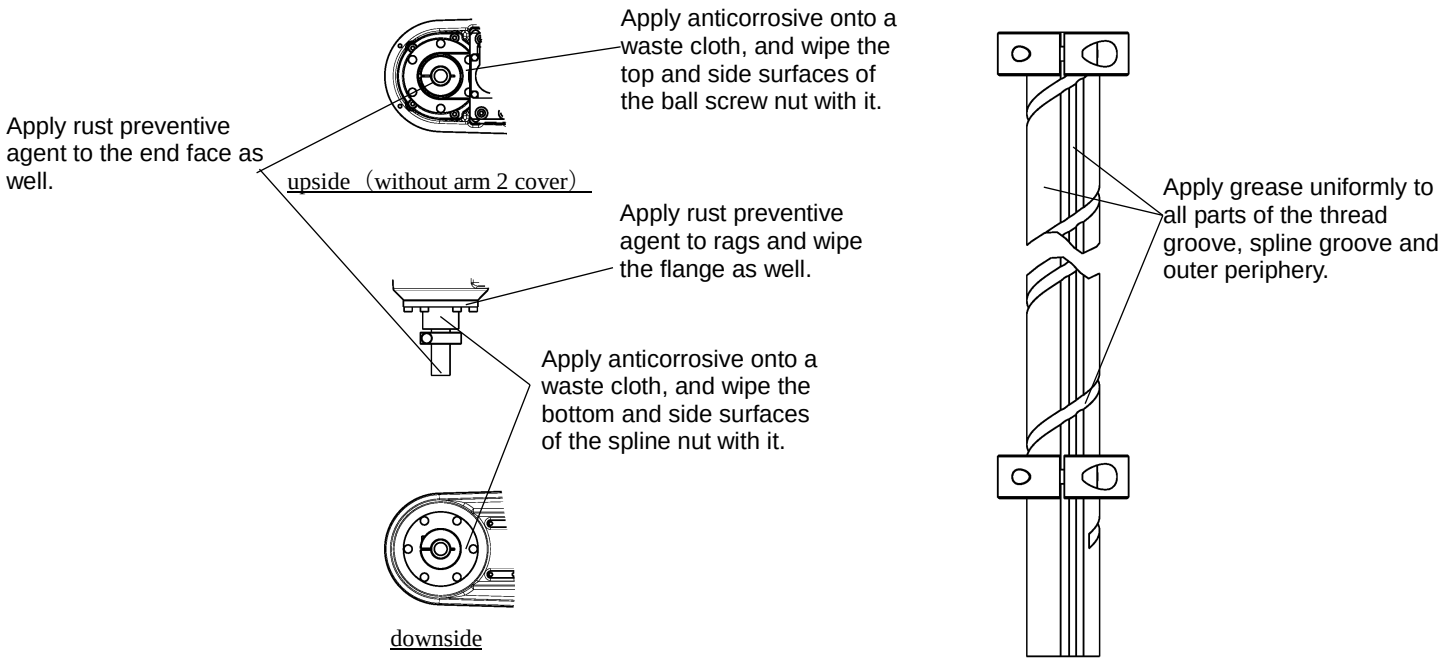


Fig. 2.39 Applying anticorrosive and grease to ball screw spline unit (KHL-300, KHL-400)

1) Remove the arm 2 cover (see “Para. 2.3.1, Arm 2 Cover.”)
2) Connect the controller power supply plug and turn off the servo system.
3) Move the arm to a position where Axis 3 can be moved over the full stroke by hand.
4) Push down the ball screw spline shaft to the lower limit while pressing the axis 3 brake release switch.

5) Directly apply the grease to the exposed shaft area by brash.
Apply the grease to such an extent that the shaft groove can be filled.

Table 2.8 Recommended grease (KHL-300, KHL-400)

Recommended grease	Maker
AFF grease	THK

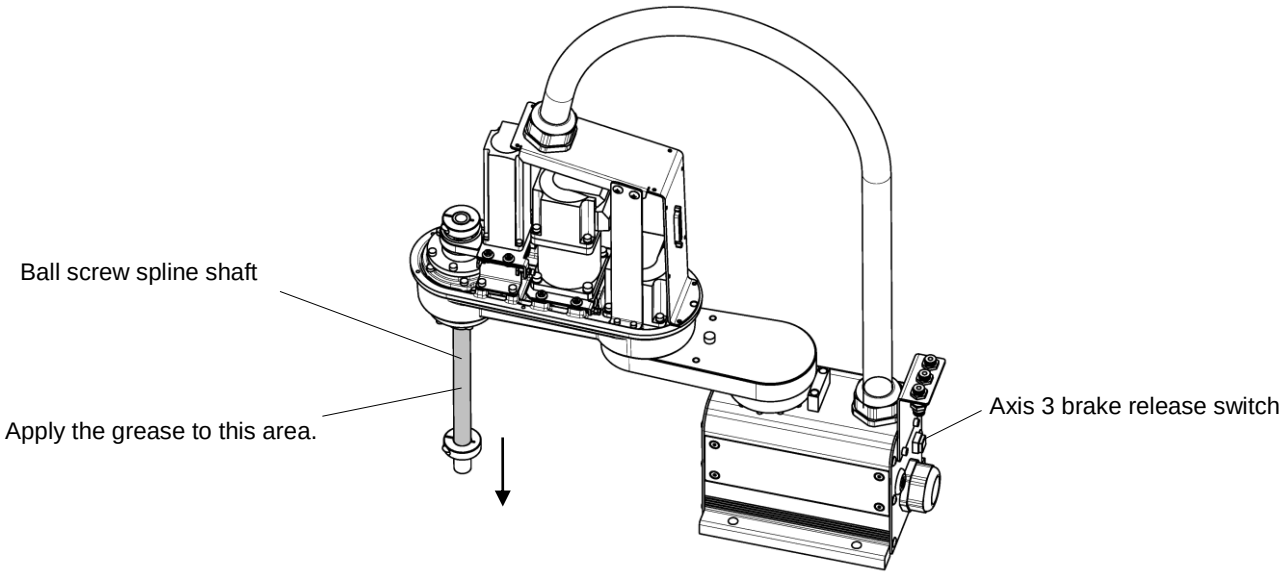


Fig. 2.40 Greasing lower side of ball screw spline unit (KHL-300, KHL-400)

6) Push up the shaft up to the upper limit while pressing the axis 3 brake release switch.

7) Directly apply the grease by brash to the shaft area sticking up from the cover.
Apply the grease to such an extent that the shaft groove can be filled. For the portions (two positions) to be coated with grease, see Figure 2.39.

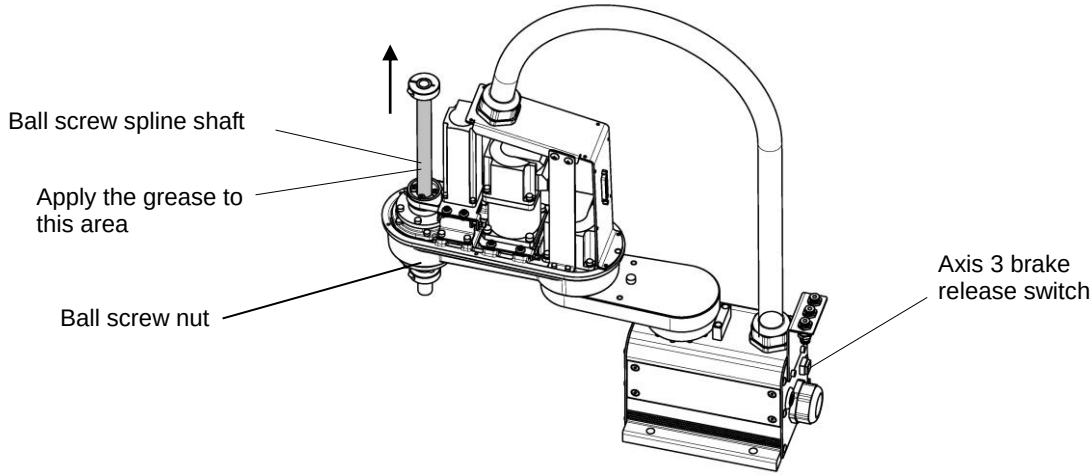


Fig. 2.41 Greasing upper side of ball screw spline unit (KHL-300, KHL-400)

8) Move the shaft up and down repeatedly while pressing the axis 3 brake release switch to fill the grease uniformly. Wipe out the surplus grease. Now the work completes.

2.6.4 Dismounting Ball Screw Spline Unit

DANGER

- The ball screw spline unit should be replaced with a new one only after the controller power supply plug is removed. If the work is done while the power is connected, you may get an electric shock or the robot may malfunction, which is very dangerous.

CAUTION

- Handle the ball screw spline unit with extreme care. If the unit drops or an unusually large external force is exerted on it, it cannot function any further.
- Replacement of the ball screw spline unit involves mounting and dismounting of the axis 3 and 4 motors and timing belts. Also observe the cautions on each work.
- Because the motor, timing belt, nut and pulley are disconnected, the mechanical home point shifts and proper control cannot be done. To avoid this, home return operation of axis 3 and 4 is necessary after replacement of the ball screw spline unit. For the home return procedures, see “Section 8, Robot Home Point and Position Detector Error.”
- NEVER touch the ball screw spline unit with bare hand. Otherwise, the ball screw may be subjected to earlier rusting. Be sure to gloves when you want to tough it.

In the descriptions on replacing the ball screw spline unit, the procedures for changing the axis 3 and 4 motors and timing belts are not included. For details, refer to the descriptions on replacement of each part (see “Para. 2.4.7, Dismounting Axis 3 Motor”, “Para. 2.4.9, Dismounting Axis 4 Motor”, “Para. 2.5.3, Replacing Axis 3 Timing Belt” and “Para. 2.5.4, Replacing Axis 4 Timing Belt.”)

1) Remove the arm 2 cover. (See “Para. 2.3.1, Arm 2 Cover.”)
2) Remove the cross recessed flat head screw (M3 x 6 x 1 pc.) and the hexagon socket head cap screws (M3 x 6 x 2 pcs.), and then remove the harness guide and the support plate.
3) Disconnect the hand, tool, etc. followed by the lower stoppers.
4) Remove the axes 3 motor assemblies as well as the axis 3 timing belt. And, loosen axis 4 belt tension.

5) Remove the hexagon socket head cap screws (M4 x 12 x 6 pcs.), and then pull out the ball screw nuts and the ball screw spline shaft together upward. Be cautious when pulling them out.

6) Remove the hexagon socket head cap screws (M4 x 16 x 4 pcs.) securing the axis 3 bracket (casting), and then remove the axis 3 bracket from Arm 2.

7) Remove four (4) hexagon socket head cap screws (M4 x 25) and washers, and then remove the axis 3 nut pulley and upper stopper which is secured to the ball screw nut.

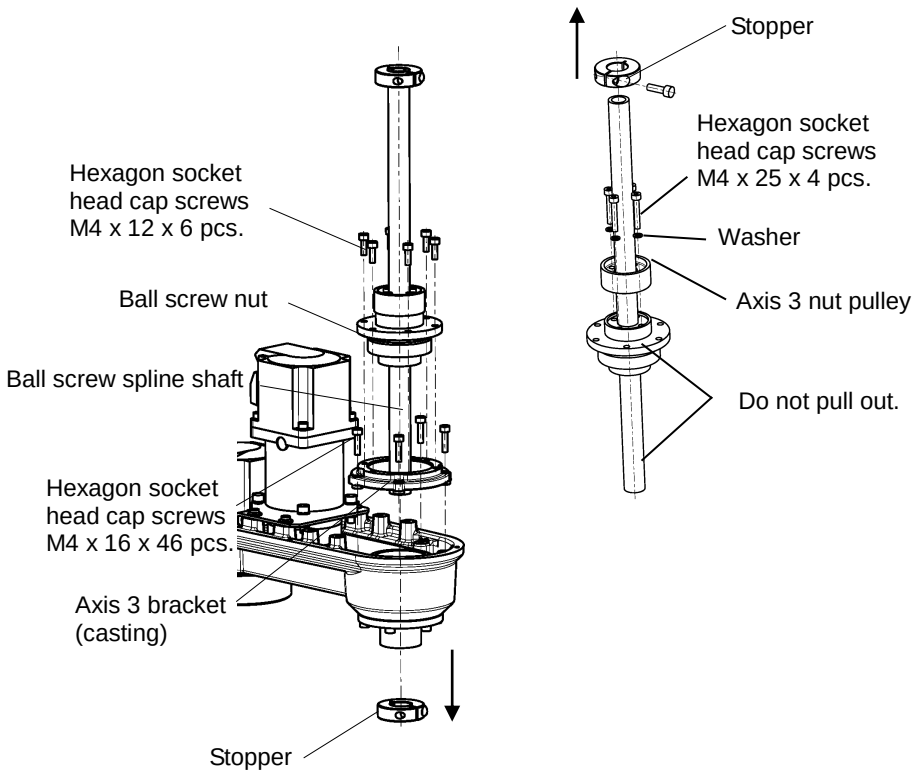


Fig. 2.42 Dismounting ball screw spline unit (KHL-300, KHL-400)

! CAUTION

- When the ball screw nut integrated with the ball screw spline shaft is disconnected, take utmost care not to cause the ball screw spline shaft to come off. Otherwise, the ball in the ball screw nut will drop and the ball screw nut integrated with the ball screw spline shaft cannot function any further.

8) Remove the hexagon socket head cap screw (M4 x 12 x 6 pcs.) securing the ball spline nut, and pull out the ball spline nut downward.
If it is hard to remove the ball spline nut, lightly tap the pulley with a plastic hammer or similar tool that does not make scratches and then remove the ball spline nut. If the pulley is pounded with a hammer or forcibly pulled out, Arm 2 may be deformed and, as a result, a new ball screw cannot be mounted accurately.

9) Disconnect the axis 4 nut pulley secured to the ball spline nut with the hexagon socket head cap screw (M4 x 10 x 6 pcs.).

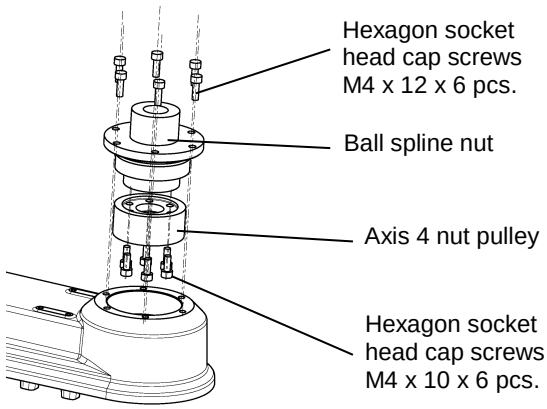


Fig. 2.43 Dismounting ball screw spline nut (KHL-300, KHL-400)

10) Insert the disconnected ball spline nut into the ball screw spline shaft.
A marking for phase adjustment is stamped on both the ball screw spline shaft and the ball spline nut. Align the two markings when inserting the ball spline nut. To prevent the nut from slipping off, wind cable ties around near the top and bottom of the shaft.

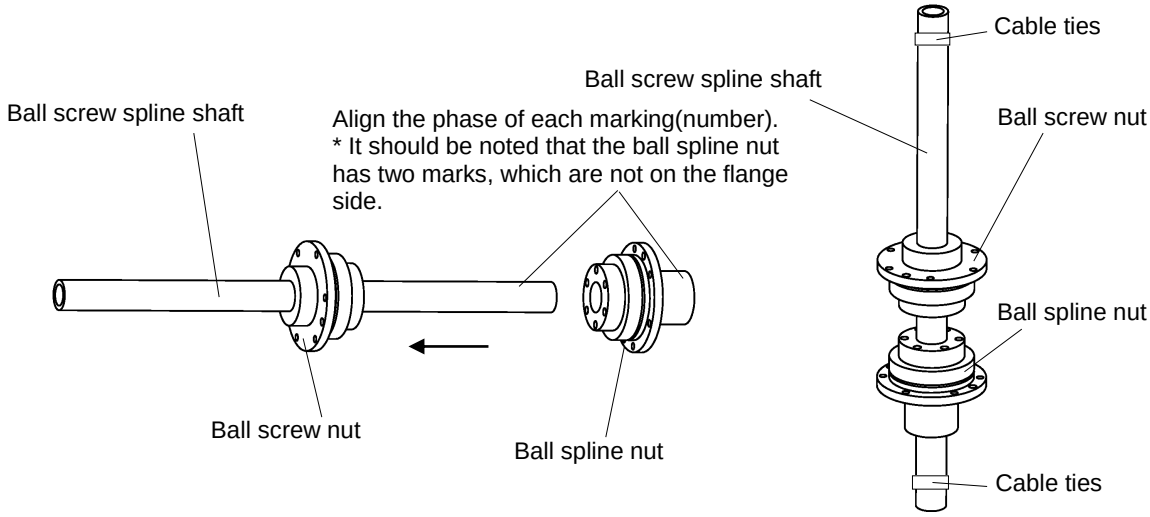


Fig. 2.44 Ball screw spline nut (KHL-300, KHL-400)

2.6.5 Mounting Ball Screw Spline Unit

DANGER

- The ball screw spline unit should be replaced with a new one only after the controller power supply plug is removed. If the work is done while the power is connected, you may get an electric shock or the robot may malfunction, which is very dangerous.

CAUTION

- Handle the ball screw spline unit with extreme care. If the unit drops or an unusually large external force is exerted on it, it cannot function any further.
- Replacement of the ball screw spline unit involves mounting and dismounting of Axes 3 and 4 motor assemblies and timing belts. Also observe the cautions on each work.
- Because the motor, timing belt, nut and pulley are disconnected, the mechanical home point shifts and proper control cannot be done. To avoid this, home return operation of axis 3 and 4 is necessary after replacement of the ball screw spline unit. For the home return procedures, see “Section 8, Robot Home Point and Position Detector Error.”
- DO NOT pull out the ball screw shaft from the ball screw nut. Otherwise, the ball in the ball screw nut will drop and the ball screw nut integrated with the ball screw shaft cannot function any further.
- NEVER touch the ball screw spline unit with bare hand. Otherwise, the ball screw may be subjected to earlier rusting. Be sure to gloves when you want to tough it.

1) Disconnect the ball spline nut from the new ball screw spline unit.

2) Mount the axis 4 nut pulley on the ball spline nut with the hexagon socket head cap screws (M4 x 10 x 6 pcs.) and washers.
The bolts are difficult to tighten because the pulley rotates. Thus, tighten them while holding the pulley with pliers or the likes. In doing so, use a waste cloth to protect the pulley from scratches.

3) Mount the ball spline nut on Arm 2 with the hexagon socket head cap screws (M4 x 12 x 6 pcs.) and washers. When doing so, be careful with the orientation of the removal tap.

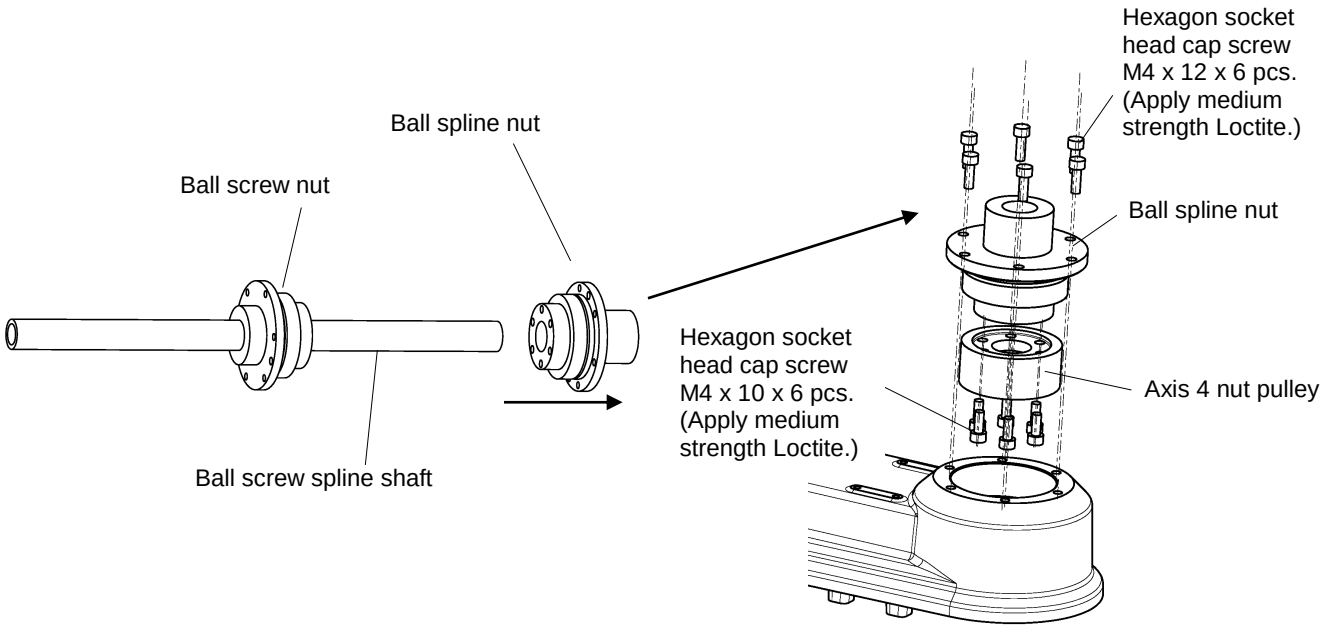


Fig. 2.45 Mounting ball spline nut (KHL-300, KHL-400)

4) Fasten the pulley for the axis 3 nut to the ball screw nut with the hexagon socket head cap screws (M4 x 25 x 4 pcs.) and the washers and fasten upper stopper..

5) Temporarily fasten the axis 3 bracket (casting) to Arm 2 with the hexagon socket head cap screws (M4 x 16 x 4 pcs.). Fasten the ball screw nut to the axis 3 bracket (casting) with the hexagon socket head cap screws (M4 x 12 x 6 pcs.). At this time, hang the axis 4 timing belt on the axis 4 pulley.

6) Mount one stopper at 27 mm from the bottom end of the ball screw spline shaft. Install the stoppers by aligning the notches of the stoppers with the leftmost spline groove.

7) Move the ball screw spline shaft up and down to make it fit. After that, holding the 3rd-axis bracket (casting) so that it does not move, additionally tighten the hexagon socket head bolts (M4 x 16 x 4 bolts) fixing the 3rd-axis bracket (casting).

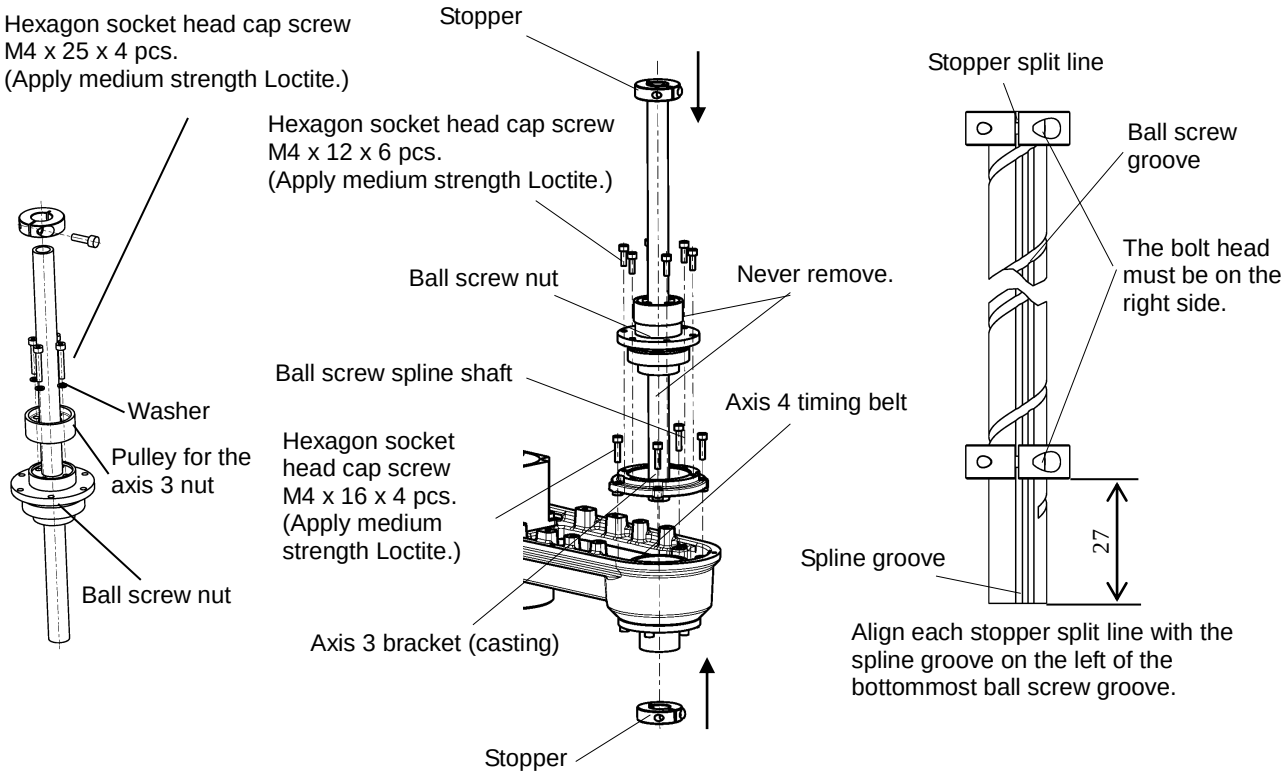


Fig. 2.46 Mounting ball screw spline nut (KHL-300, KHL-400)

8) Mount the axis 4 motor assembly and adjust the belt tension. (See "Para. 2.5.4, Replacing Axis 4 Timing Belt.")

9) Mount the axis 3 motor assembly and the axis 3 timing belt, and then adjust the belt tension. (See "Para. 2.5.3, Replacing Axis 3 Timing Belt.")

10) Mount the harness guide and the support plate with the cross recessed flat head screw (M3 x 6 x 1 pc.) and the hexagon socket head cap screws (M3 x 6 x 2 pcs.), and restore the connectors and the cables to the original conditions. (Refer to the photos taken in advance for reference.)

11) Perform home setting for Axes 3 and 4.
When performing home setting for the axis 4, align the stopper split line with the home point match-mark on the ball spline nut.
After home setting, remove the mating mark from the old ball spline nut, and attach it to the new one. For the location of home point match-mark, see Para. 8.4.1, Location of Robot Home Point Match-Marks (KHL-300, KHL-400).

12) Carry out a test operation of Axes 3 and 4 and make sure that each part operates properly.

13) Mount the arm 2 cover. Now replacement of the ball screw spline unit completes.

2.7 Reduction Gear Replacement

The reduction gear is to be replaced by our service engineer. If it is replaced by the customer, we will not guarantee any consequential trouble or accident.

DANGER

- The reduction gear should be replaced with a new one only after the controller power supply plug is removed. If the work is done while the power is connected, you may get an electric shock or the robot may malfunction, which is very dangerous.

CAUTION

- Because the reduction gear is disconnected, the mechanical home point shifts and proper control cannot be done. To avoid this, home return operation is necessary after replacement of the reduction gear. For the home return procedures, see “Section 8. Robot Home Point and Position Detector Error.”

2.7.1 Type of Reduction Gear

The reduction gears used in this robot are shown below.
When you place an order for the reduction gear for replacement, specify the robot model (KHL-300, KHL-400), axis name, type and our drawing number.

Table 2.9 Type of reduction gear (KHL-300, KHL-400)

Description	Axis name	Our drawing No.	Unit code
Reduction gear	Axis 1	S890907	Y610A3NG0
	Axis 2	S890906	Y610A3NH0
	Axis 4	S890969	Y610A3NJ0

2.7.2 Reduction Gear Locations

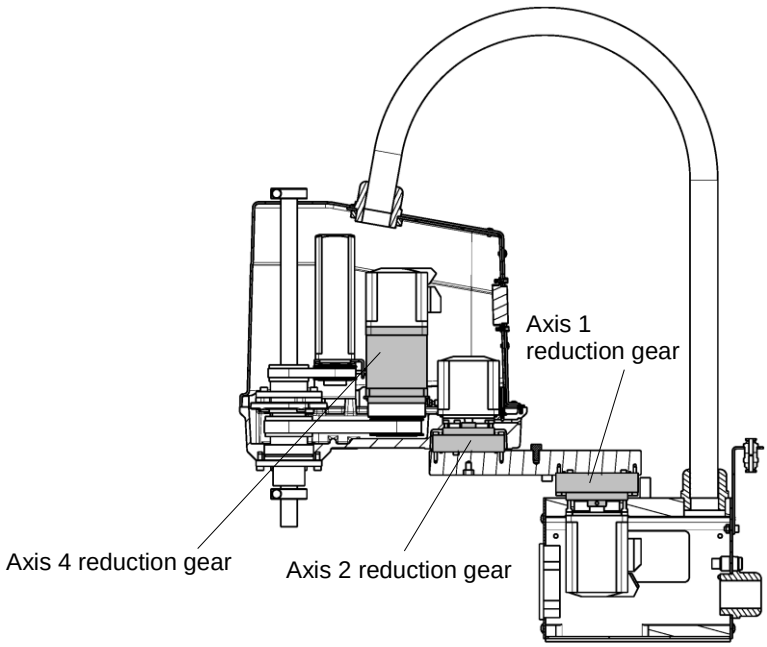


Fig. 2.47 Reduction gear locations (KHL-300, KHL-400)

2.7.3 Dismounting Axis 1 Reduction Gear

1) Remove the base front cover and the base side covers. (See “Para. 2.3.2, Base Covers.”)
2) Remove four (4) hexagon socket head cap screws (M4 x 12) and the washers that secure the axis 1 motor assembly, pull out the axis 1 motor assembly, and then remove the O-ring (CO0534A).
(See “Para. 2.4.3, Dismounting Axis 1 Motor.”)
3) Remove sixteen (16) hexagon socket head cap screws (M3 x 20) that secure the base, and then remove Arm 1.

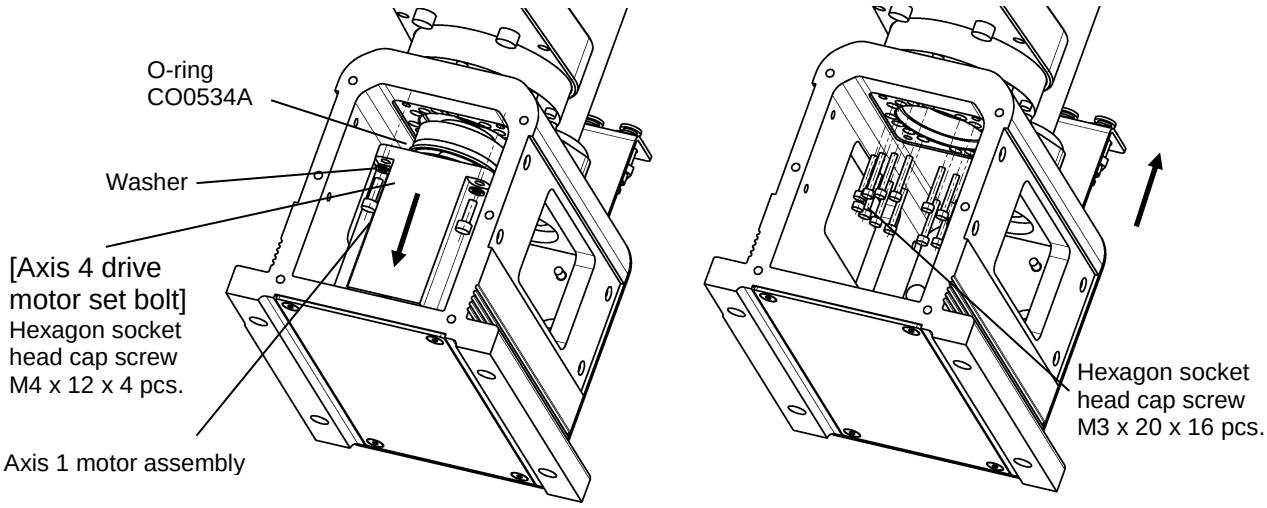


Fig. 2.48 Dismounting axis 1 motor assembly and Arm 1 (KHL-300, KHL-400)

! CAUTION

- Arm 1 should always be mounted and dismounted by two (2) or more persons. When removing the Arm 1 set bolts, take careful precautions because Arm 1 will drop. Also, if an excessively large impact is imposed on the arm, the robot will be damaged.

4) Remove twelve (12) hexagon socket head cap screws (M3 x 25) that secure the axis 1 reduction gear to Arm 1, and then remove the axis 1 reduction gear. Also remove the O-ring mounted in the groove of Arm 1 at this time. Also, remove the liquid gasket attached to the base mounting surface of the axis 1 reduction gear with the back of a cutter or a similar tool without damaging.

5) Remove the wave generator from the axis 1 motor. (See “Para. 2.4.3, Dismounting Axis 1 Motor.”)

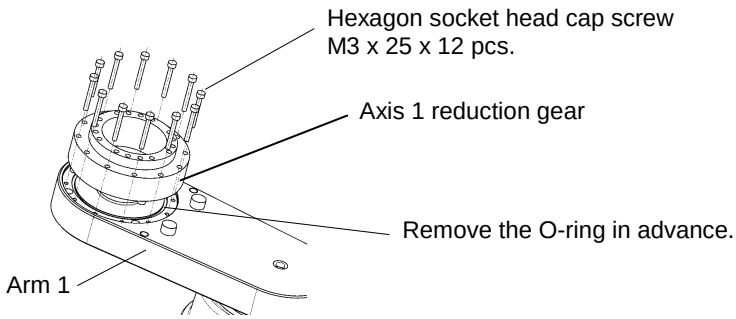


Fig. 2.49 Dismounting axis 1 reduction gear (KHL-300, KHL-400)

2.7.4 Mounting Axis 1 Reduction Gear

! CAUTION

- Handle the reduction gear with extreme care. If it drops or an unusually large external force is exerted on it, the reduction gear cannot function any further.
- Use the wave generator which is attached to the new reduction gear.
  If the old center gear is used as it is, abnormal noise will be caused, the service life will shorten or positioning accuracy will deteriorate due to incompatibility with the new reduction gear.
- Also use the “O” ring attached to the new reduction gear. Be sure to set the “O” ring.
  Unless the “O” ring is set, grease will leak from the axis 1 reduction gear set surface.
  When mounting the reduction gear, take careful precautions not to break the “O” ring.

1) Mount a new wave generator provided as an accessory with a new reduction gear. For the mounting procedure, see item 1) in “Para. 2.4.4, Mounting Axis 1 Motor.”)

2) Cleanly wipe off dusts and stains on the axis 1 reduction gear of Arm 1. Apply grease to an O-ring attached to the new reduction gear, and then mount it in the O-ring groove of Arm 1.

3) Secure the axis 1 reduction gear with twelve (12) hexagon socket head cap screws (M3 x 25).

Recommended anticorrosive	Maker
SK-Ⅱ	HDS

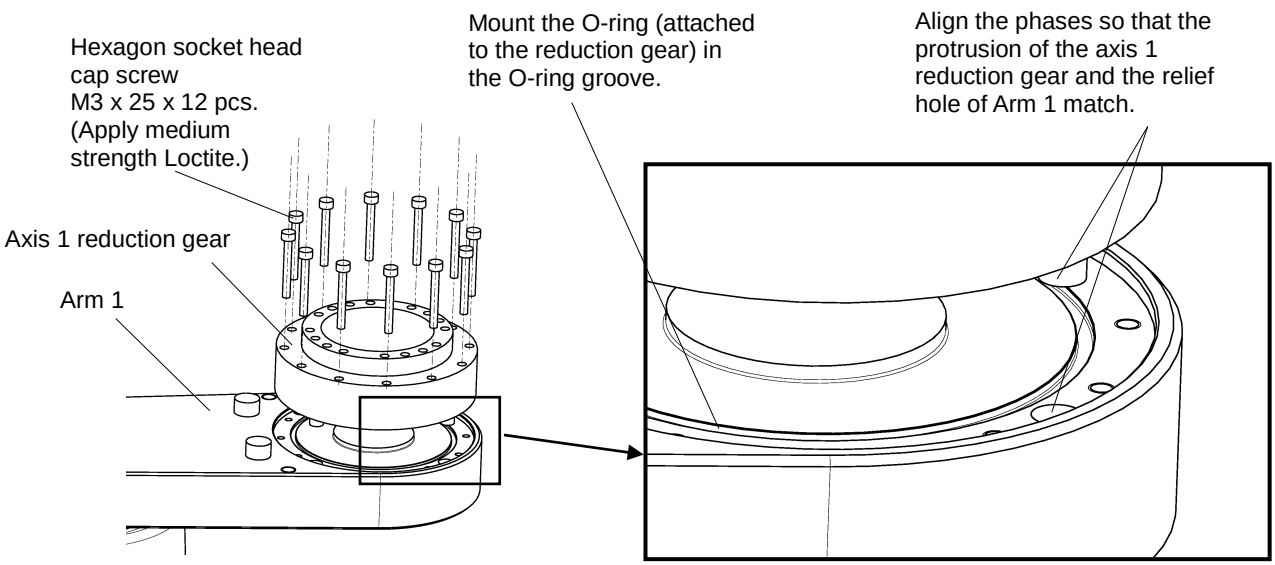


Fig. 2.50 Mounting axis 1 reduction gear (KHL-300, KHL-400)

4) Apply grease at a thickness of the mark onto the inside of the axis 1 reduction gear's main body. The mark is to gear inside wall from the protrusion on Arm 1. Apply an appropriate amount of grease to the wave generator also. Apply liquid gasket onto the base mounting surface of the axis 1 reduction gear.

Amount of grease filled in Axis 1
13 g

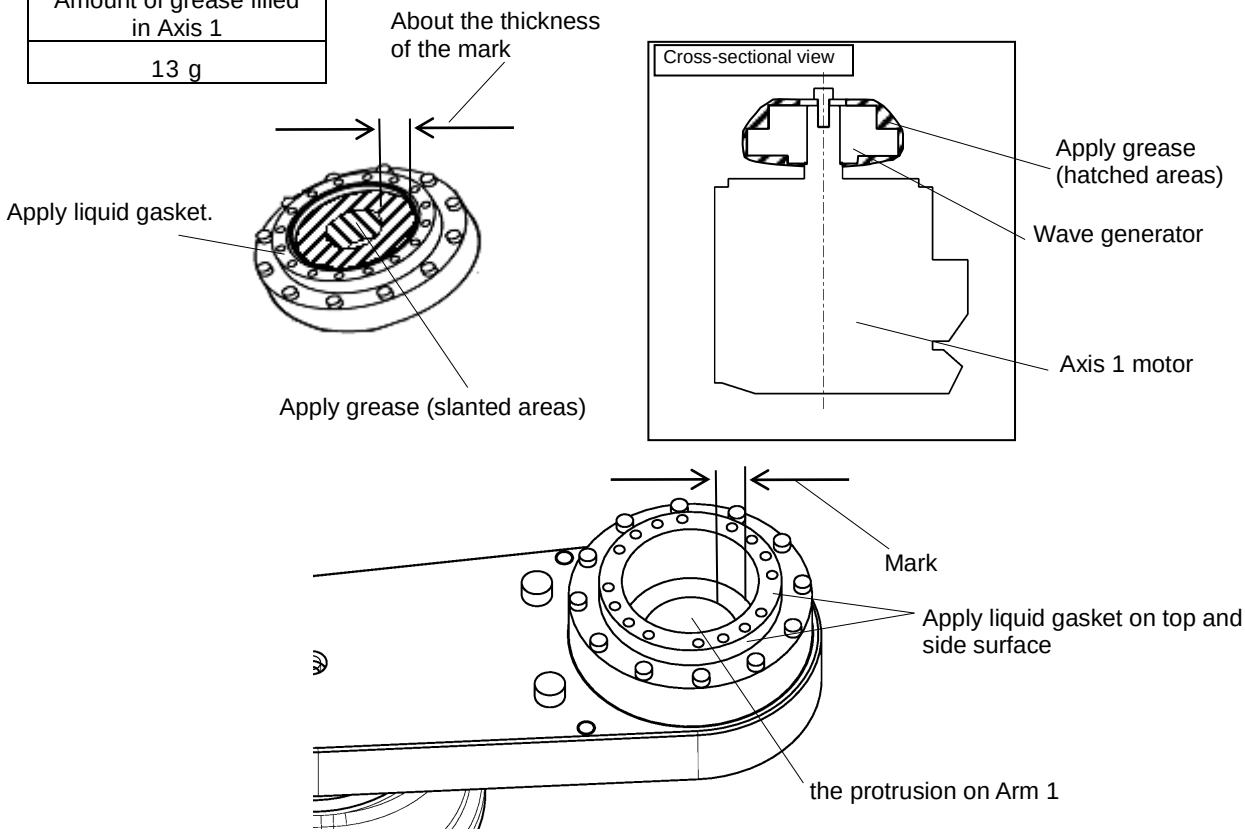


Fig. 2.51 Application of grease to axis 1 reduction gear (KHL-300, KHL-400)

! CAUTION

- Be sure to use the grease designated by CKD.
  Increase in internal pressure will adversely affect the starting torque and damage the internal seal. To avoid this, be sure to observe the grease filling volume.

5) Secure Arm 1 to the base with sixteen (16) hexagon socket head cap screws (M3 x 20). Apply grease to the O-ring (CO0534A), and then mount it to the base groove side surface.

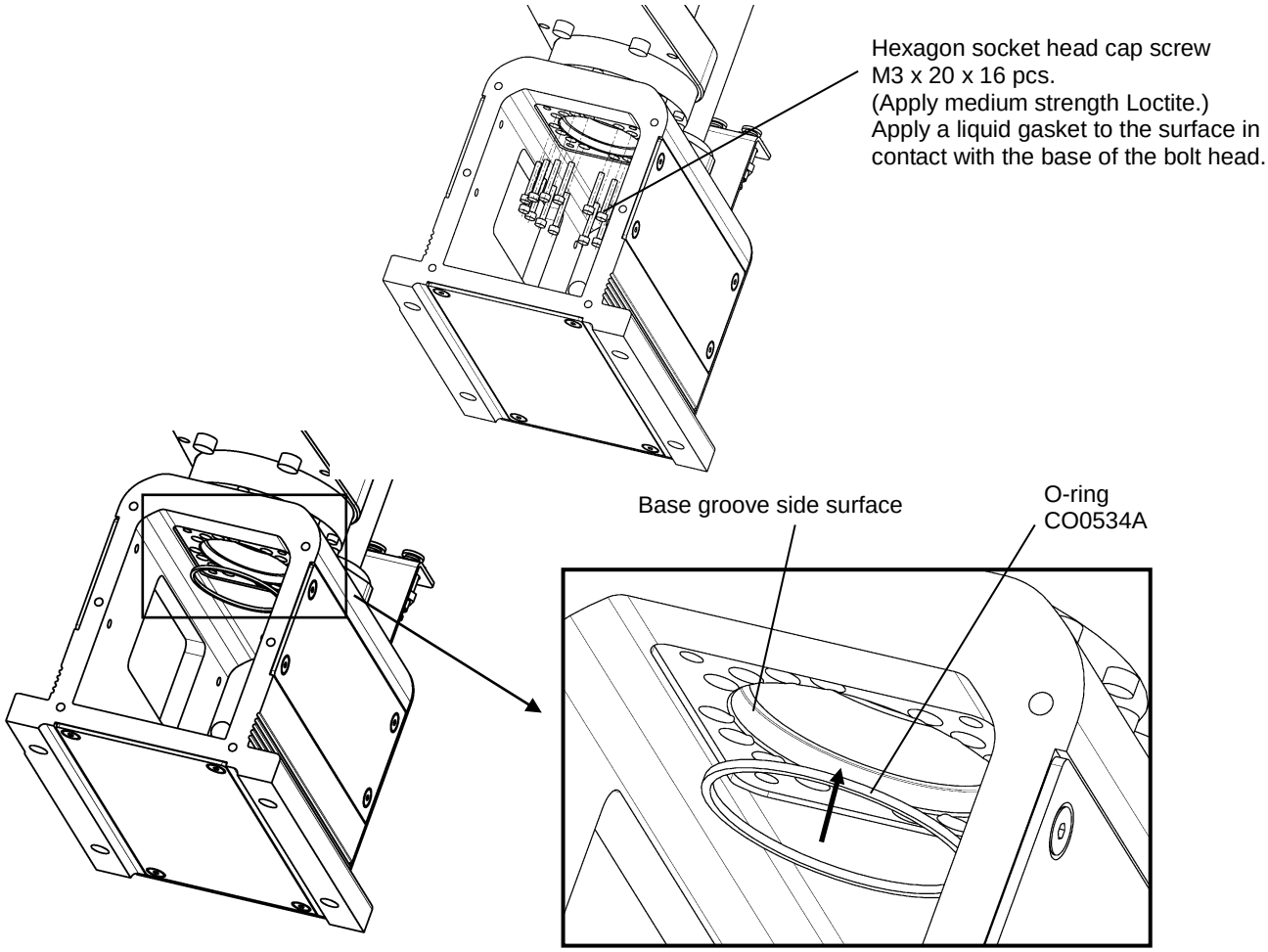


Fig. 2.52 Mounting arm 1 and O-ring (KHL-300, KHL-400)

6) Connect the connectors (J1AS and J1BS) of the cables.

7) Mount the axis 1 motor assembly. (See “Para. 2.4.4, Mounting Axis 1 Motor.”)

8) Manually move the 1st arm and make sure of its smooth movement.

9) Mount the base front cover and the base side covers. (See “Para. 2.3.2, Base Covers.”)

10) Set up the axis 1 home position to complete axis 1 reduction gear replacement.

11) Carry out a test operation of Axis 1 to make sure that each part operates properly.

2.7.5 Dismounting Axis 2 Reduction Gear

1) Remove Arm 2 cover. (See “Para. 2.3.1, Arm 2 Cover.”)

2) Cut the cable ties of the cables with nippers. Disconnect connectors J2AS and J2AP (power drive cables), connectors J2BS and J2BP (encoder cables). It is recommended to take photos of the cable installation positions and the locations where cable ties are used so that these locations can be restored when needed.

3) Remove the harness guide and the support plate, and then remove the axis 2 motor assembly. Also remove the O-ring (CO0538A) of the O-ring groove. (See “Para. 2.4.5, Dismounting Axis 2 Motor.”)

4) Remove eight (8) hexagon socket head cap screws (M3 x 16) that secure Arm 2 and the reduction gear.

5) Remove eight (8) hexagon socket head cap screws (M3 x 25) that secure the axis 2 reduction gear mounted to Arm 1, and then remove the axis 2 reduction gear. At this time, remove the O-ring mounted in the O-ring groove of Arm 1. At this time, remove the liquid gasket attached to the base mounting surface of the axis 1 reduction gear without damaging. Also, remove the O-ring (that comes with the reduction gear) in the O-ring groove.

6) Remove the wave generator from the axis 2 motor. (See “Para. 2.4.5, Dismounting Axis 2 Motor.”)

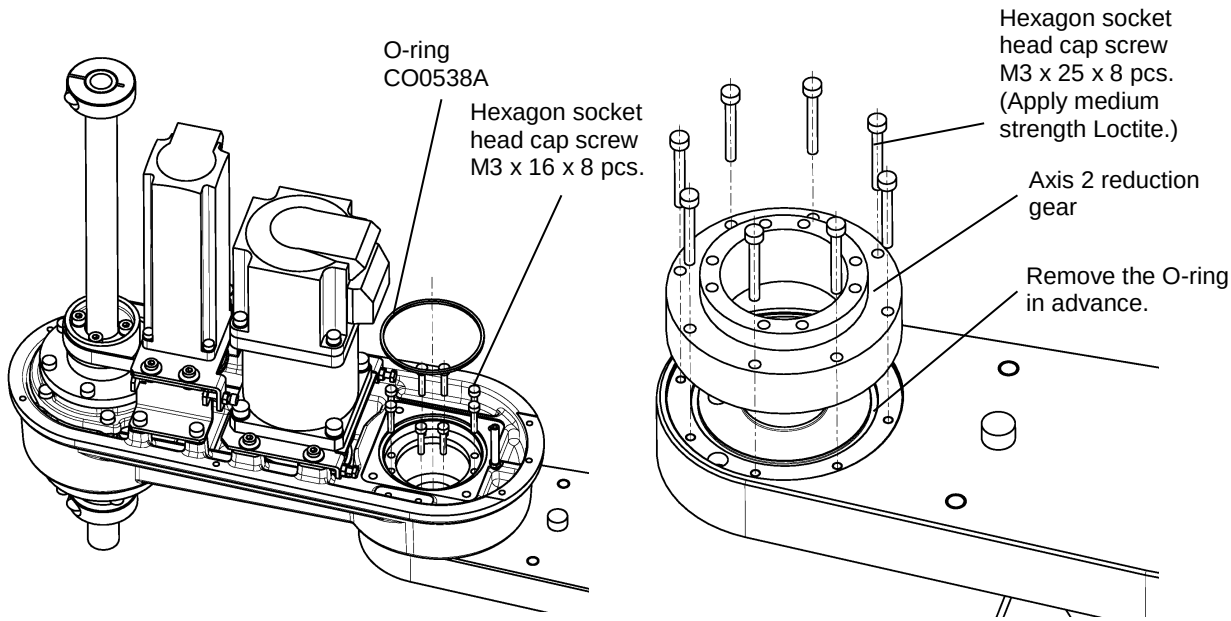


Fig. 2.53 Dismounting axis 2 reduction gear (KHL-300, KHL-400)

CAUTION

- Arm should always be mounted and dismounted by two (2) or more persons. When removing Arm set bolts, take careful precautions because Arm will drop. Also, if an excessively large impact is imposed on Arm, the robot will be damaged.

2.7.6 Mounting Axis 2 Reduction Gear

CAUTION

- Handle the reduction gear with extreme care. If it drops or an unusually large external force is exerted on it, the reduction gear cannot function any further.
- Use the wave generator which is attached to the new reduction gear.
- Also use the “O” ring attached to the new reduction gear. Be sure to set the “O” ring. Unless the “O” ring is set, grease will leak from the axis 2 reduction gear set surface. When mounting the reduction gear, take careful precautions not to break the “O” ring.

1) Mount the wave generator attached to the new reduction gear to the axis 2 motor. At this time, apply grease to the O-ring (CO0538A) and then mount it to the axis 2 motor flange rabbet. (See “Para. 2.4.6, Mounting Axis 2 Motor.”)
2) Cleanly wipe off dusts and stains on the reduction gear of Arm 1.
   Apply grease to an O-ring attached to the new reduction gear, and then mount it in the O-ring groove of Arm 1.
3) Secure the axis 2 reduction gear to Arm 1 with eight (8) hexagon socket head cap screws (M3 x 25).
4) Apply grease to the axis 2 reduction gear. (See “Para. 2.7.4, Mounting Axis 1 Reduction Gear.”) However, the amount of grease filled is different from that for the axis 1 reduction gear. Regarding the filled amount for the axis 2 reduction gear, see the following.)

Amount of grease filled in Axis 2
8.9 g

5) Apply liquid gasket onto the arm 2 mounting surface of the new reduction gear.

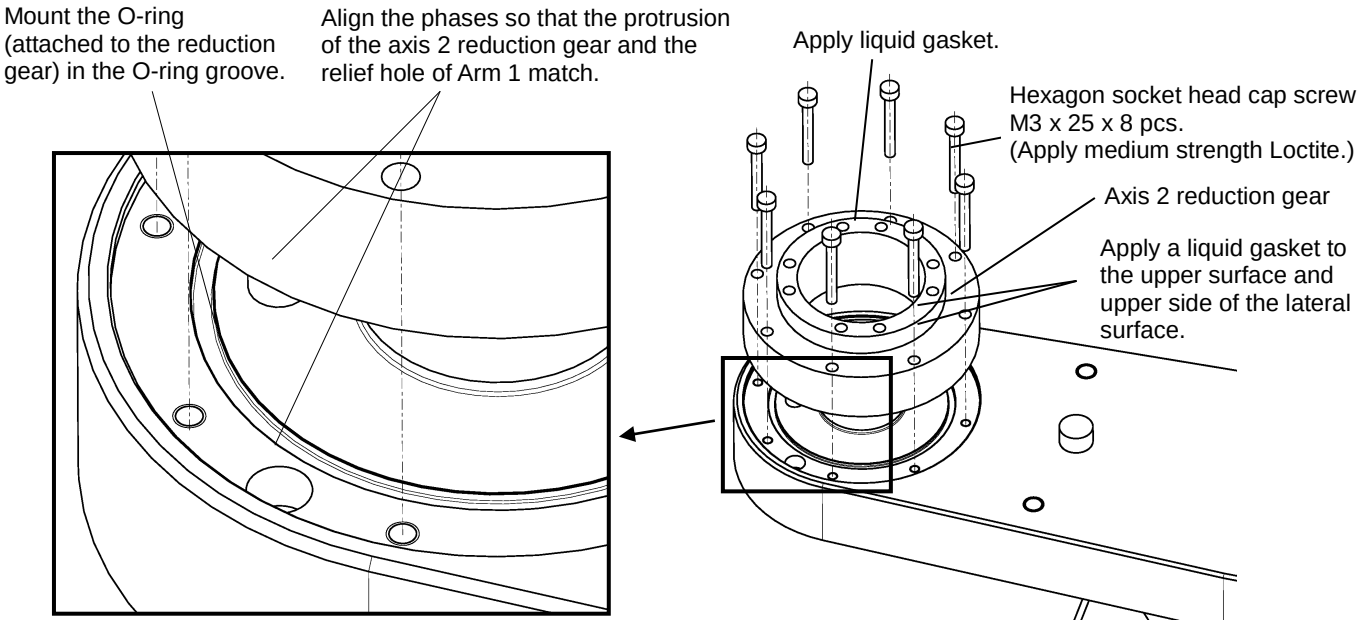


Fig. 2.54 Mounting axis 2 reduction gear (KHL-300, KHL-400)

6) Secure Arm 2 to the new reduction gear with eight (8) hexagon socket head cap screws (M3 x 16).

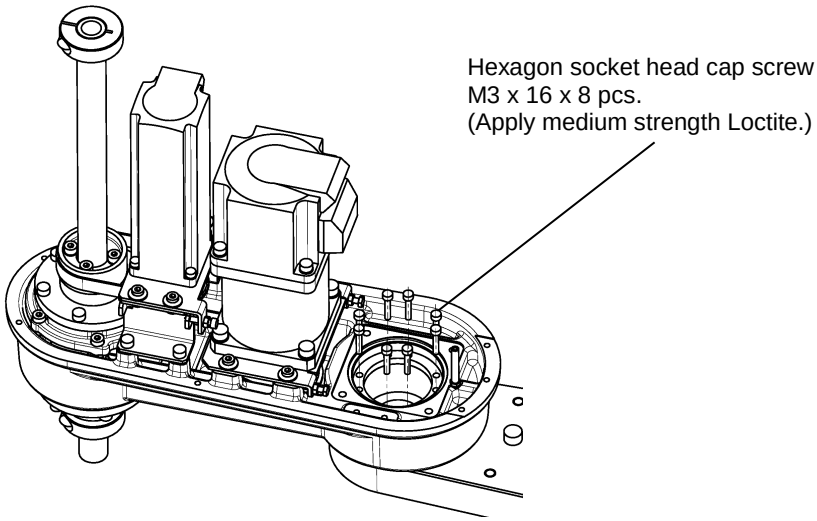


Fig. 2.55 Mounting Arm 2 (KHL-300, KHL-400)

7) Mount the axis 2 motor assembly, the harness guide and the support plate. Put back the cables to the original locations, and then mount Arm 2 cover. For the installation procedure, see "2.4.6 Installation of the 2nd-axis motor"
8) Manually move the 2nd arm and make sure of its smooth movement.

9) Set up the home positions of axes 2 to complete axis 4 reduction gear replacement.

2.7.7 Replacing Axis 4 Reduction Gear

! CAUTION

- Handle the reduction gear with extreme care. If it drops or an unusually large external force is exerted on it, the reduction gear cannot function any further.
- Be sure to tighten the coupling connecting the reduction gear and motor shaft.

1) Remove Arm 2 cover. (See “Para. 2.3.1, Arm 2 Cover.”)
2) Cut off the cable tie with a nipper, and remove the J4AS and J4AP (2nd axis power cable) and the J4BS and J4BP (2nd axis encoder cable). It is recommended to take a photograph beforehand to make sure that the cable routing position and cable tie position can be easily identified at the time of re-assembling.
3) Referring to "2.5.4 Replacement of 4th-axis timing belt", remove only the 3rd-axis motor assembly and 4th-axis motor assembly from the 2nd arm. Other parts need not be removed.
4) Remove the cap attached to the lateral side of the axis 4 reduction gear, then loosen the coupling bolt (M3) securing the axis 4 motor shaft and the input shaft of the axis 4 reduction gear.
5) Remove the hexagon socket head cap screws (M4 x 12 x 4 pcs.) and washers securing the motor, and draw out the axis 4 motor upward.
6) While holding the axis 4 motor pulley with pliers or the likes, remove the hexagon socket head cap screw (M4 x 12 x 6 pcs.) to remove the pulley. In doing so, use a waste cloth (or the like) as a cushion to protect the pulley from scratches.
7) Remove the hexagon socket head cap screws (M5 x 16 x 4 pcs.) and washers securing the axis 4 motor plate and reduction gear to the motor base, then dismount the reduction gear.

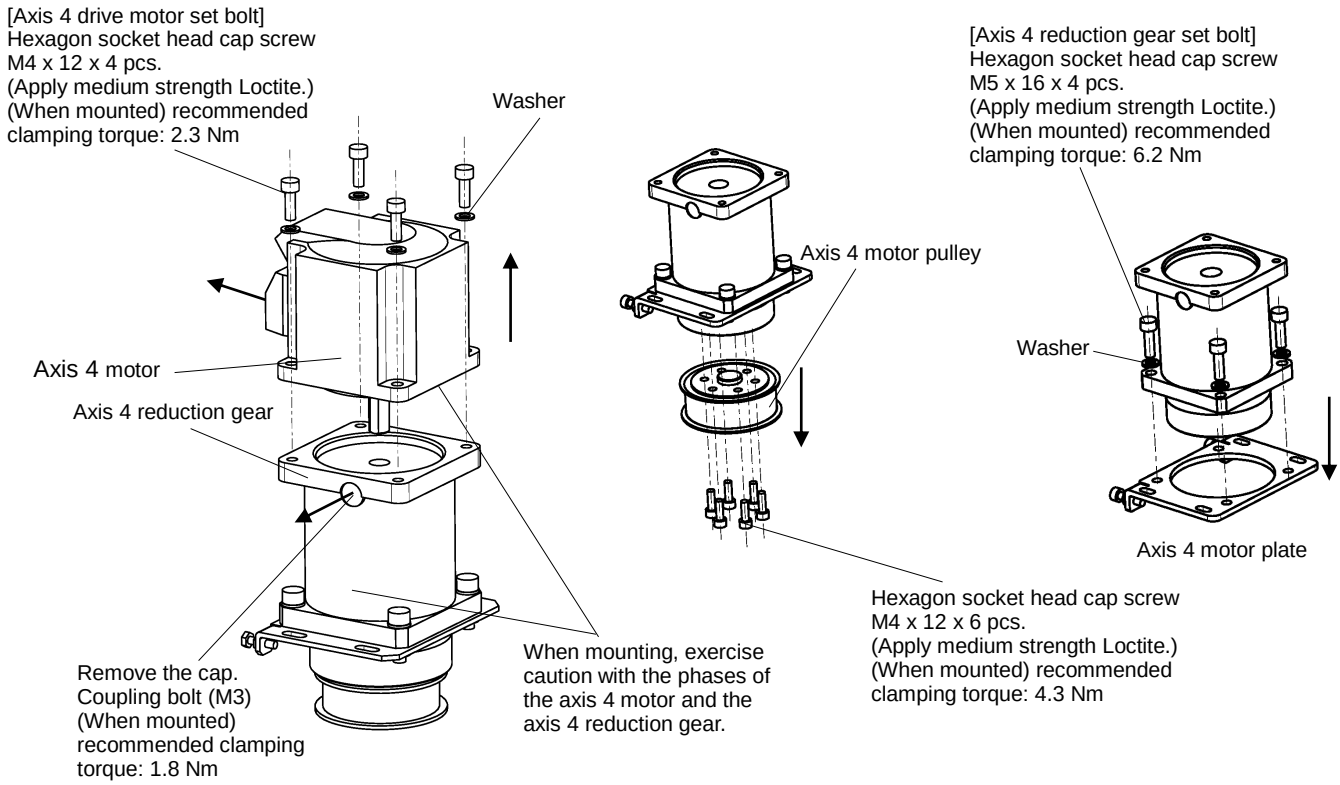


Fig. 2.56 Replacing axis 4 reduction gear (KHL-300, KHL-400)

8) Assemble the new reduction gear, motor and pulley in the reverse order of Steps 4) to 7) above. Be careful with the phases of the axis 4 motor, the axis 4 reduction gear and the axis 4 motor plate at this time.

9) Assemble the axis 4 motor assembly and timing belt according to Steps 11) through 15) of “Para. 2.5.4, Replacing Axis 4 Timing Belt” above, then mount Arm 2 cover.

10) Mount the arm 2 cover. Now replacement of Axis 4 Reduction Gear completes.

Table of Contents

＜確認用＞Tables and Drawings

3. Maintenance of the Main Robot (KHL-500, KHL-600, KHL-700)

3.1 Details of Inspection

3.1.1 Check of Each Bolt (or Screw) for Clamping

1) Tool Set Bolts

Using the hexagonal wrench key, make sure that the clamping bolts (M4 x 4 pcs.) of the tool set flange (option), which are clamped to the tool shaft, are tightened completely. If loose, tighten them completely.

Using the hexagonal wrench key, make sure that the mounting bolts (M4 x 4 pcs.), which secure the tool to the tool flange, are tightened completely. If loose, tighten them completely. (Loctite not necessary)

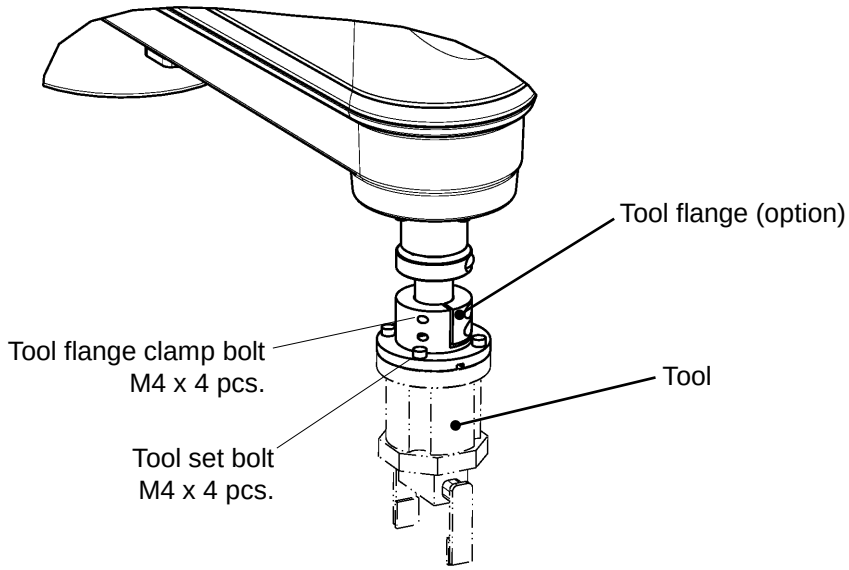


Fig. 3.1 Tool set bolts

2) Robot Installation Bolts

Make sure, using the hexagonal wrench key, that the installation bolts of the main robot base are tightened completely. If loosened, tighten them completely. (Loctite is not necessary)

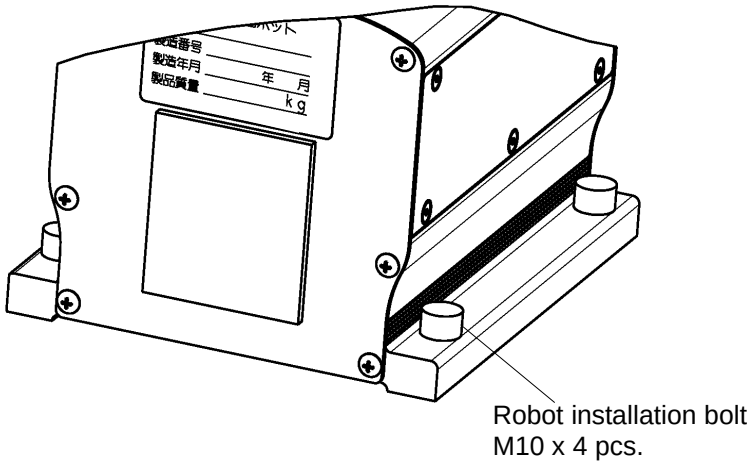


Fig. 3.2 Robot installation bolts (KHL-500, KHL-600, KHL-700)

3) Motor Set Bolts

Make sure, using the hexagonal wrench key, that the bolts for securing each axis drive motor are tightened completely. If loosened, tighten them completely. Also make sure that the motor and motor plate bolts are tightened completely. For the places where the following bolts are used, see “Para. 3.4, Replacing Motor.”

Table 3.1 Motor and motor plate set bolt (KHL-500, KHL-600, KHL-700)

Location of bolt	Type	Bolts used	Reference Para.
Axis 1 drive motor set bolt	M5 x 16	4 pcs.	3.4.4 Mounting Axis 1 Motor
Axis 2 drive motor set bolt	M4 x 14	4 pcs.	3.4.6 Mounting Axis 2 Motor
Axis 3 drive motor set bolt	M4 x 12	4 pcs.	3.4.8 Mounting Axis 3 Motor
Axis 3 motor plate set bolt	Flange head bolt M4 x 10	4 pcs.	3.4.8 Mounting Axis 3 Motor
Axis 4 drive motor set bolt	M4 x 12	4 pcs.	3.4.10 Mounting Axis 4 Motor
Axis 4 reduction gear set bolt	M5 x 16	4 pcs.	3.7.7 Replacing Axis 4 Reduction Gear
Axis 4 motor plate set bolt	Flange head bolt M4 x 10	4 pcs.	3.5.4 Replacing Axis 4 Timing Belt

* For the recommended clamping torque, see Para. 1.5 Clamping Hexagon Socket Head Cap Screws and Set screws
* It is not necessary to apply Loctite to the flange head bolts of Axes 3 and 4 motor plate set bolts.

3.1.2 Check of Each Cable and Air Tube for Abrasion

Disassemble the arm 2 cover and the base rear cover, and make sure that each cable is not worn out, broken or cracked. Especially, carefully inspect the vicinity of the cable outlets.
For how to dismount the covers, see “Para. 3.3, Dismounting and Mounting Each Cover.”
The figure below shows an example of air tube installation.

Also inspect the wear and disorder of the air tube as well as the pipe connection. Make sure that the air tube is not worn out and is installed properly, and pipe connection is correct. Otherwise, correct them.

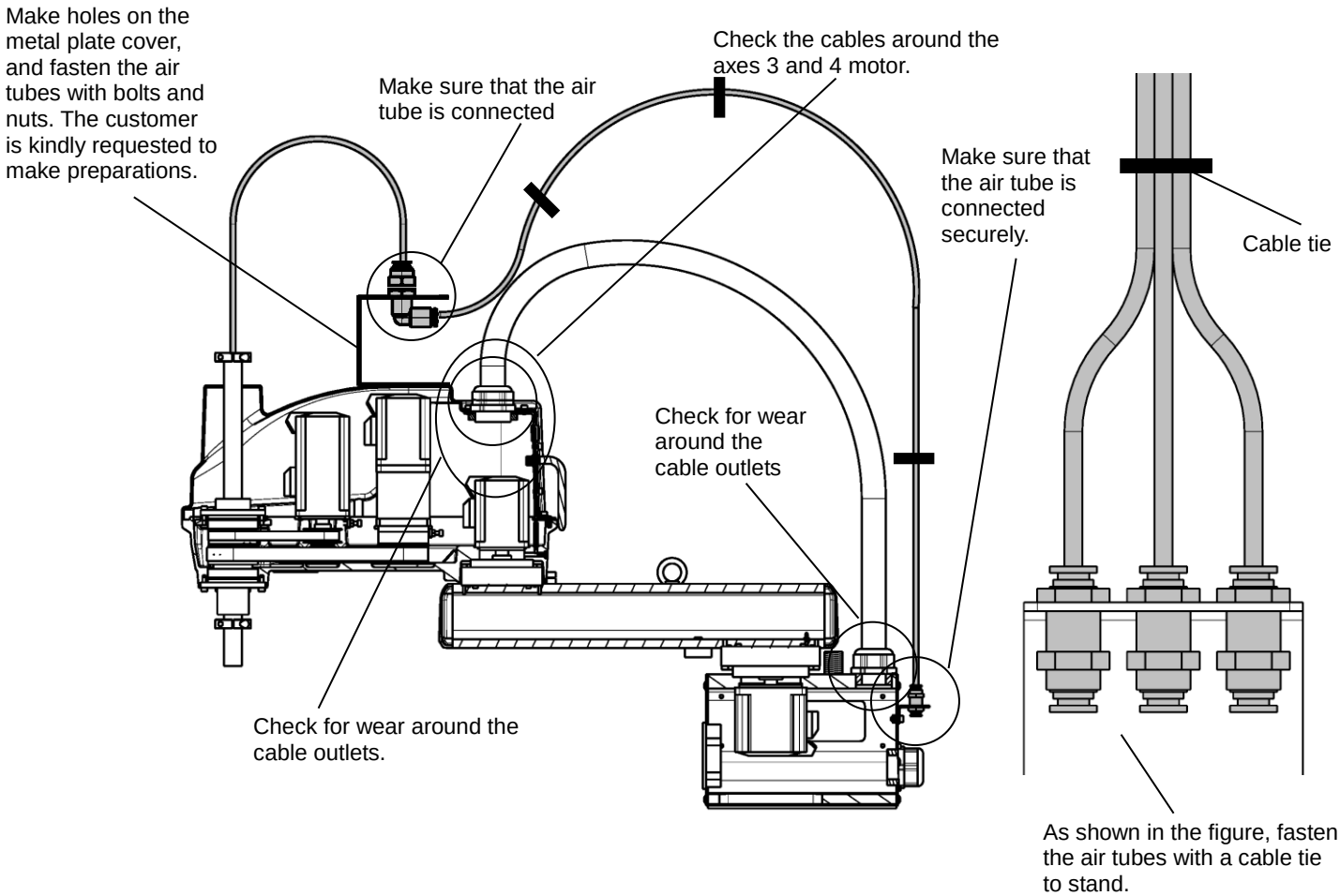


Fig. 3.3 Cable inspection locations (KHL-500, KHL-600, KHL-700)

CAUTION

- The air tube is a consumable item. Check the condition during periodic inspection. If any damage is found, replace it.
- Please note that Fig. 3.3 shows a piping example and does not warrant damage to the air tube and its accessories.

3.1.3 Check of Cable Clamp Tightening

Using a wrench, make sure that the clamps securing the cable are not loose. There are two clamps, one on the arm 2 side and the other on the base side. If they are loose, apply Loctite (low adhesive force) and tighten them. When checking the tightened clamps, check the one on the base side first. By checking the tightness of the clamp on the base side first, the twist of the cable can be adjusted slightly on the arm 2 side. Make sure to tighten the clamps in the posture as shown in the figure below. If the clamps are tightened while the arm is bent, the cable cannot be installed correctly.

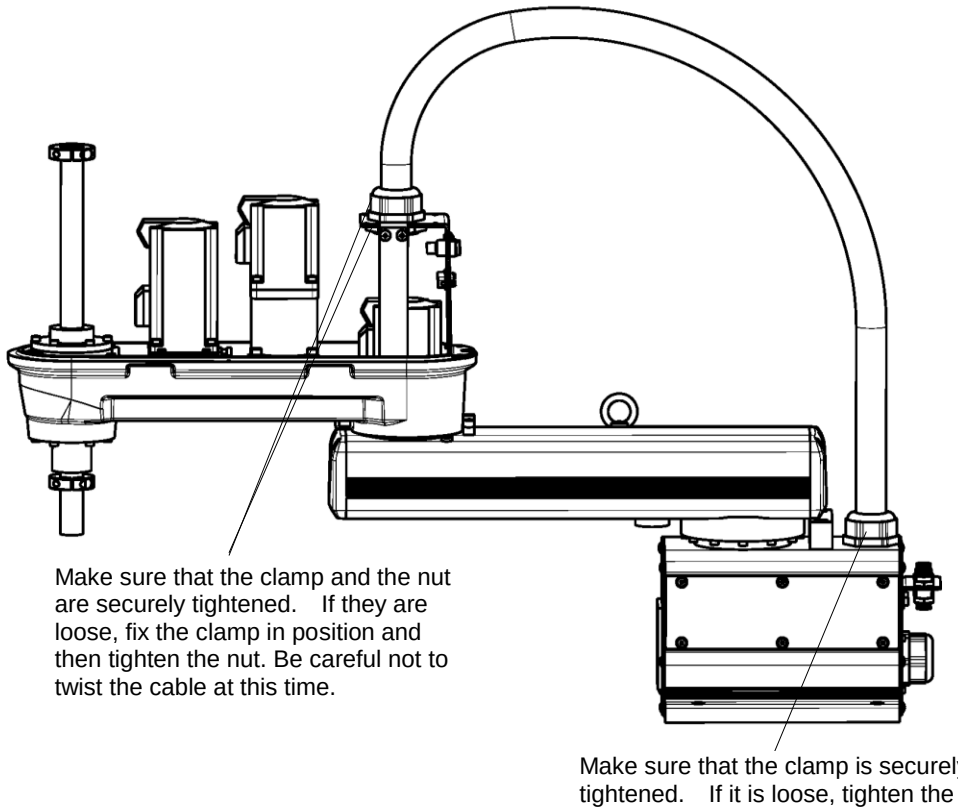


Fig. 3.4 Cable clamp inspection locations (KHL-500, KHL-600, KHL-700)

3.1.4 Check of Each Axis for Operation

Connect the power plug of the controller to the power source, then keep the EMERGENCY pushbutton switch in the depressed condition. Move each axis by hand and make sure that it can move smoothly.
For Axis 3, when the brake release switch is pressed, the brake is released. Take careful precautions at this time as the tool shaft may drop according to the weight of the hand and tool.

3.2 Layout of Robot Components and Drive Mechanism

The layout of the robot mechanical components is shown in Fig. 3.5.

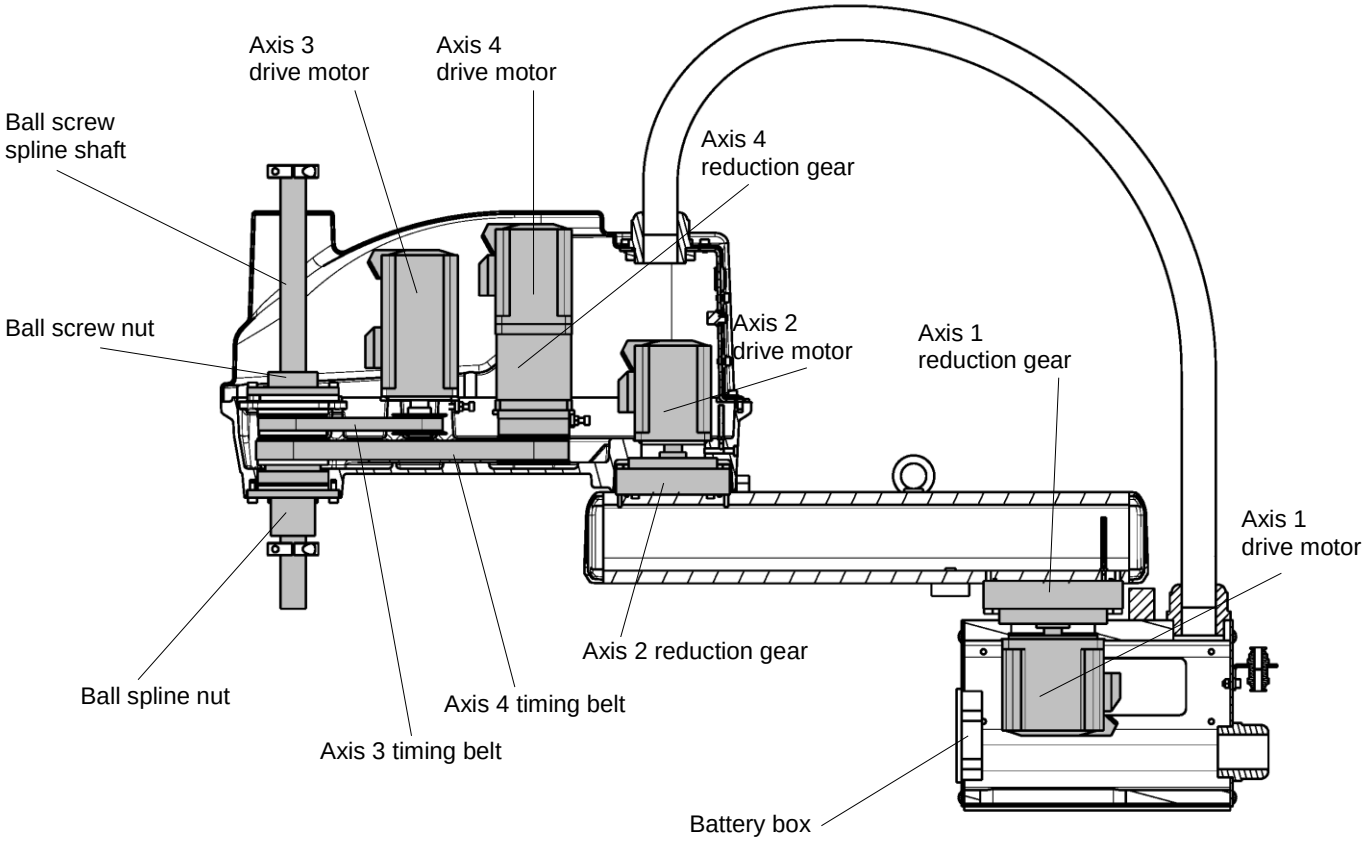


Fig. 3.5 Layout of robot mechanical components (KHL-500, KHL-600, KHL-700)

3.3 Dismounting and Mounting Each Cover

This paragraph describes the dismounting and mounting of the covers, which are common to the maintenance and replacement of each unit.

DANGER

- When opening the cover, take careful precautions not to allow entry of moisture or contaminant into the robot. If the power is turned on while moisture or contaminant is left, you may get an electric shock or the robot may malfunction, which is very dangerous.

CAUTION

- When mounting the arm 2 cover and base rear cover, take careful precautions not to catch any cable in it. If the cable is bent and pushed by force, it will be broken. Each cable is secured to the plate, etc. with cable ties. After the cover is disconnected, make sure of the cable layout and return the cables to natural wiring state.

3.3.1 Arm 2 Cover

The arm 2 cover is secured to Arm 2 and the harness guide with 14 hexagon socket head cap screws (M3 x 16 x 4 pcs., M4 x 6 x 8 pcs., M4 x 10 x 2 pcs.) and nylon washers. (It is not necessary to apply Loctite when installing.)

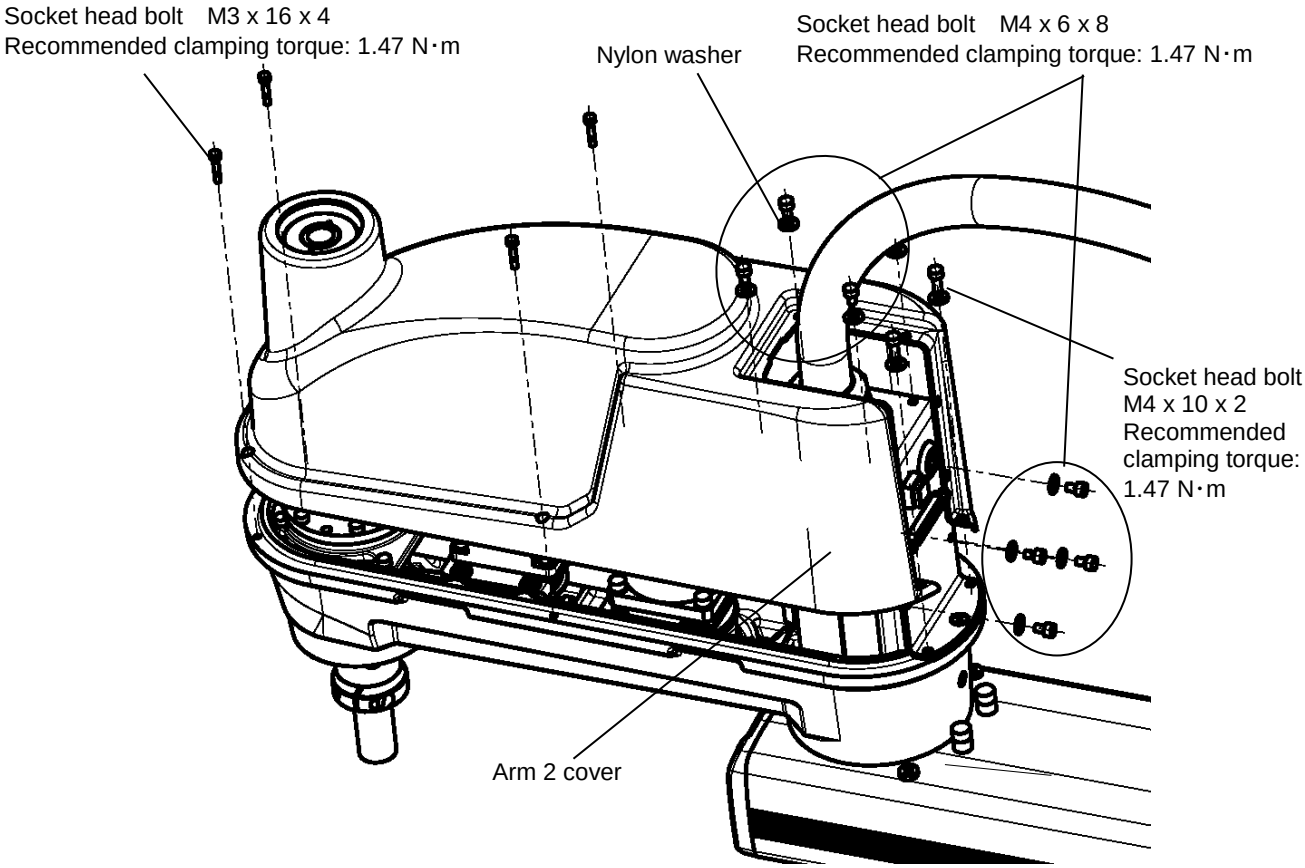


Fig. 3.6 Arm 2 cover (KHL-500, KHL-600, KHL-700)

After the cover is mounted, manually move up and down the ball screw spline shaft while pressing the brake release switch, and make sure that the ball screw hole for the arm 2 cover will not interfere with the ball screw stopper.

3.3.2 Base Covers

There are four (4) types of base covers: base front cover, base rear cover, base side cover and base cover. (It is not necessary to apply Loctite to all the covers when installing.)

Each of the base front cover and the base rear cover is secured to the base with six (6) cross truss head screws (M4 x 6). They can be dismounted from the base when these fastening screws are removed, but do not pull them with force as they are

connected with the connectors inside.

Each of the left and right base side covers is secured to the base with six (6) hex countersunk screws (M4 x 12).

The base cover is secured to the base with six (6) hex countersunk screws (M4 x 8).

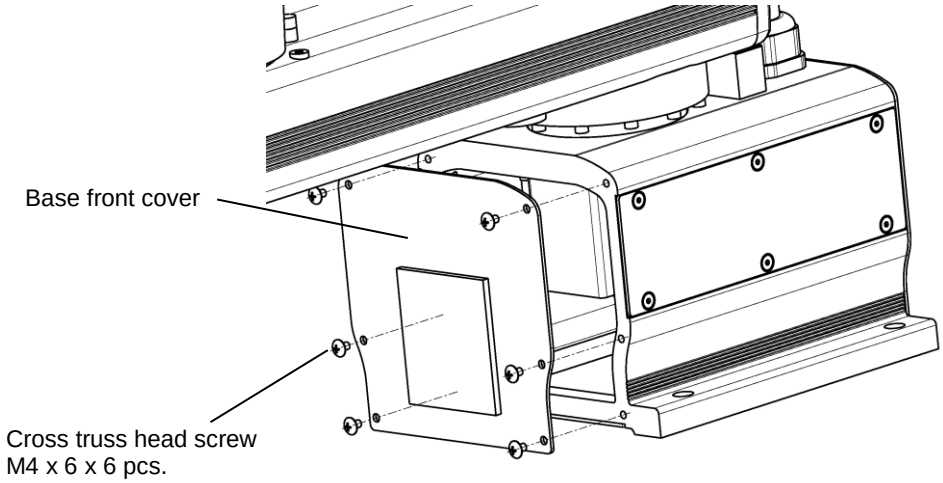


Fig. 3.7 Base front cover (KHL-500, KHL-600, KHL-700)

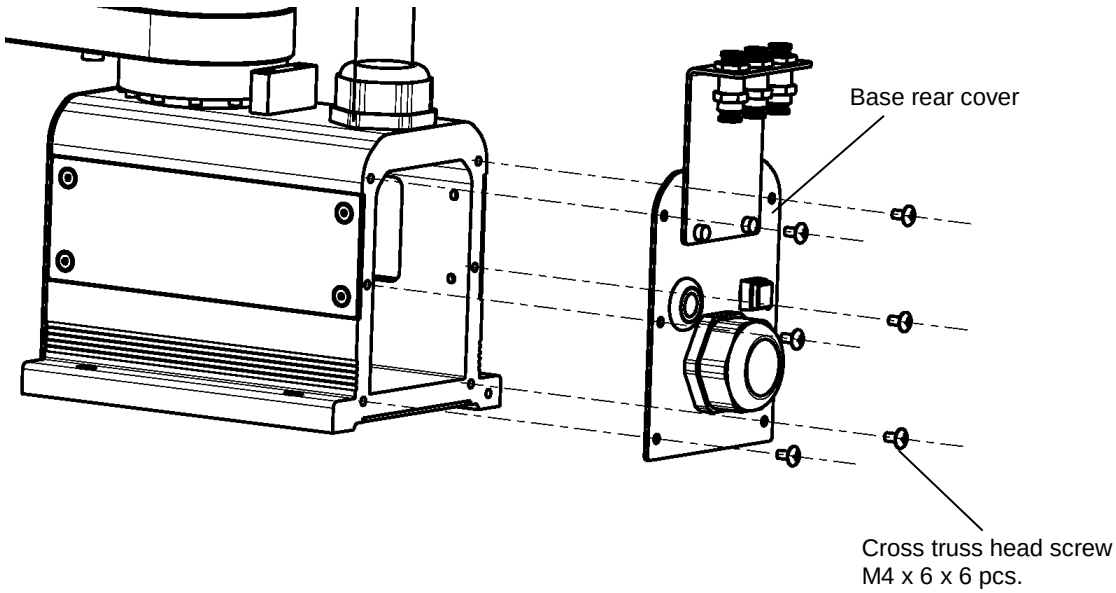


Fig. 3.8 Base rear cover (KHL-500, KHL-600, KHL-700)

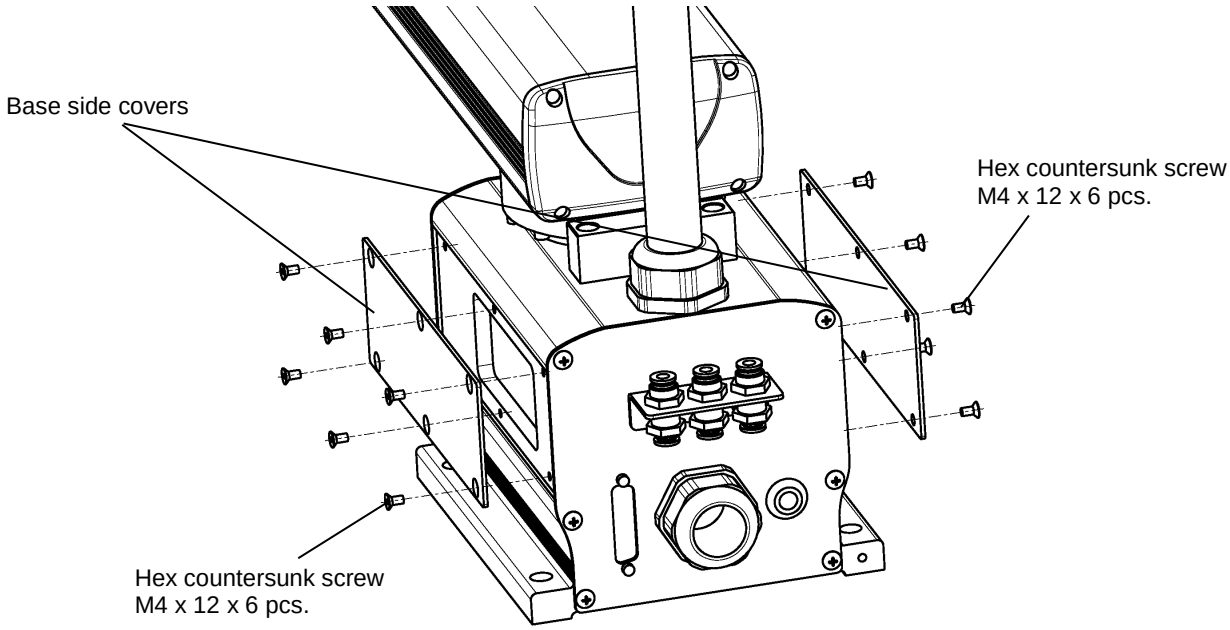


Fig. 3.9 Base side covers (KHL-500, KHL-600, KHL-700)

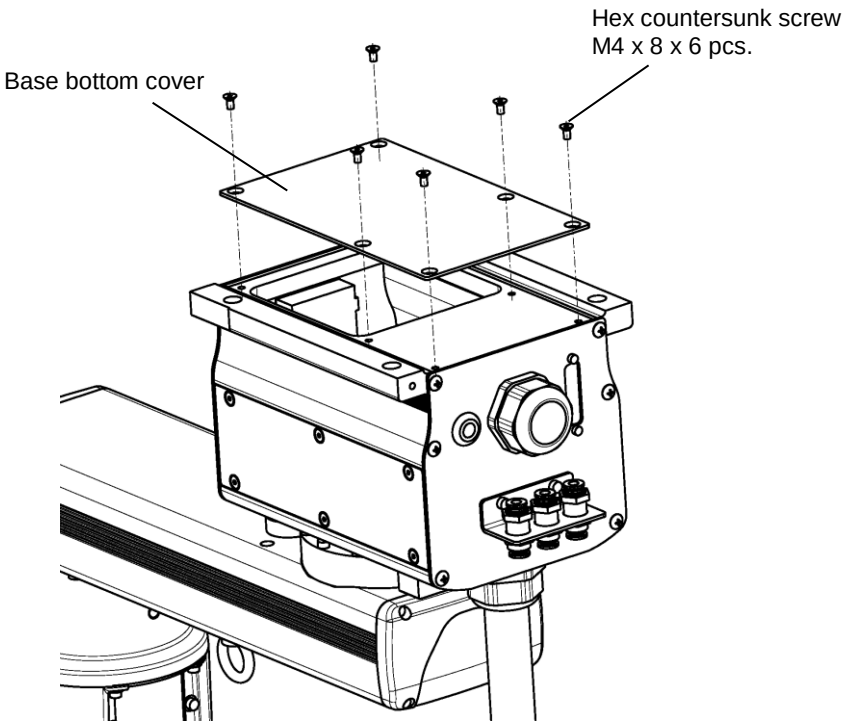


Fig. 3.10 Base bottom cover (KHL-500, KHL-600, KHL-700)

3.4 Replacing Motor

The motor is to be replaced by our service engineer. If it is replaced by the customer, we will not guarantee any consequential trouble or accident.

DANGER

- The motor should be replaced with a new one only after the controller power supply plug is removed. If the work is done while the power is connected, you may get an electric shock or the robot may malfunction, which is very dangerous.

CAUTION

- When replacing the motor, take careful precautions not to exert a heavy impact on the motor shaft. Otherwise, the motor and encoder may be damaged.
- NEVER disassemble the motor and encoder. Otherwise, they cannot be used due to positional shift, etc.
- Once the motor has been changed, the mechanical home point origin (or origin) will shift and precise control will not be possible. To avoid this, home return operation is necessary after motor replacement.
  For the home return procedures, see “Section 8. Robot Home Point and Position Detector Error.”

3.4.1 Type of Motor

The motors employed in this robot are shown below. When you place an order for a replacement motor, make sure of the robot model (KHL-500, KHL-600, KHL-700), the serial number, the axis name, and our drawing number according to the following table.

For the location where the serial number plate is attached, see the “Safety Manual.”

The motor and pulley for Axis 3 are connected using a key. Thus, key alignment is necessary during motor replacement.

For the type of the key, also see the table below.

Table 3.2 Type of Motor (KHL-500, KHL-600, KHL-700)

Description	Axis name	Type	Our drawing No.	Unit code
AC servo motor	Axis 1		S875289	Y610A3M20
	Axis 2		S875290	Y610A3M30
	Axis 3		S746337	Y610A3430
	Axis 4		S875291	Y610A3M40
Key	Axis 3	Square key 4 x 4 x 16		

* The key to be used with Axis 2 is attached to the motor.

3.4.2 Motor Locations

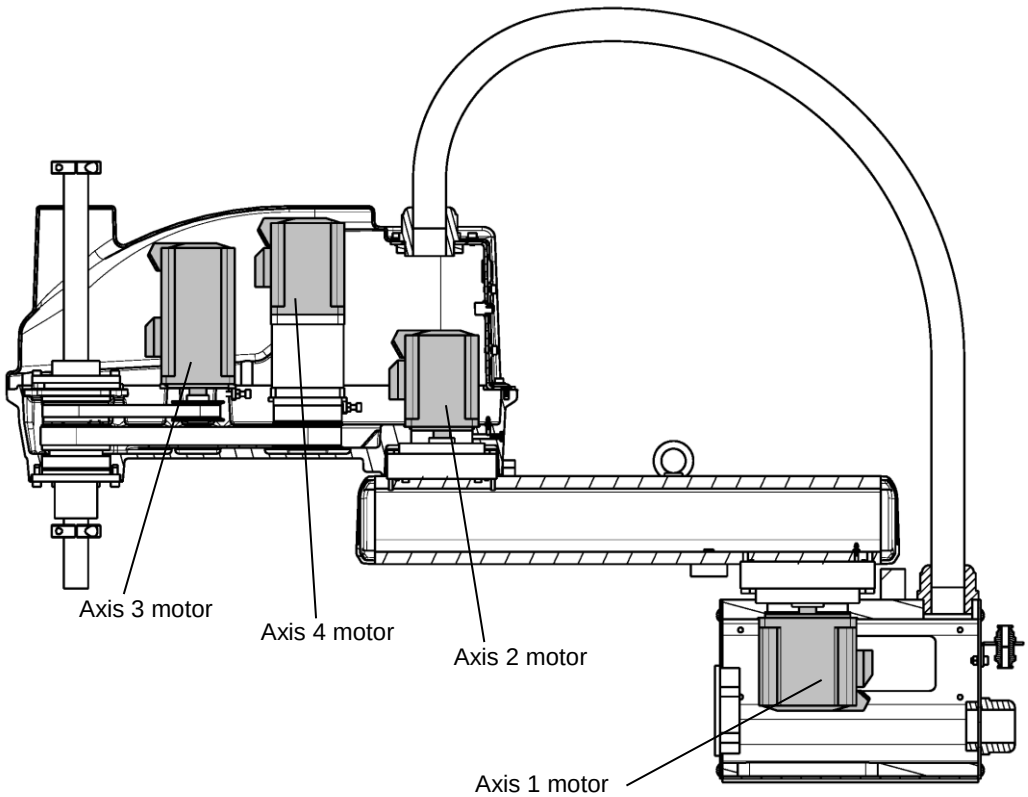


Fig. 3.11 Motor locations (KHL-500, KHL-600, KHL-700)

3.4.3 Dismounting Axis 1 Motor

1) Remove the base front cover and both of the base side covers. (See “Para. 3.3.2, Base Covers.”) The battery for position detection is being connected to the base front cover, so do not forcibly pull it or unplug the connector.

2) Remove the four hexagon socket head cap screws (M5 x 16 x 4 pcs.) and the washers that secure the axis 1 motor, pull the axis 1 motor assembly in the axis direction and then pull it out. Have a waste cloth handy as grease may drip from the motor mounted section when pulling out the motor assembly. At this time, remove the O-ring (CO0545A) being mounted on the base groove side surface. Also, when pulling out the motor assembly, do not pull it with force as the motor connector is connected.

3) Remove the connectors of the axis 1 motor, i.e., J1AS and J1AP (power drive cable), and J1BS and J1BP (encoder cables).

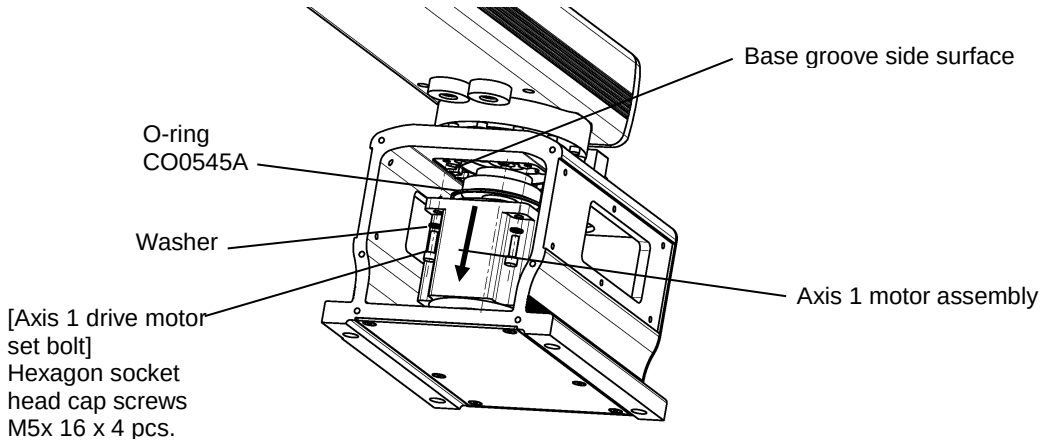


Fig. 3.12 Dismounting axis 1 motor assembly (KHL-500, KHL-600, KHL-700)

4) Remove the hexagon socket head cap screw (M4 x 10 x 1 pc.) from the end of the axis while securing the protrusion on the wave generator with pliers or the like. Use a cushioning material such as a waste cloth to protect the wave generator from being scratched when securing it. After removing the hexagon socket head cap screw, remove the holding plate and the wave generator.

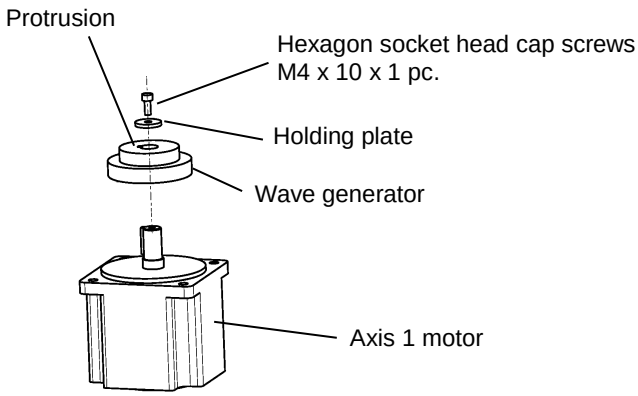


Fig. 3.13 Dismounting axis 1 wave generator (KHL-500, KHL-600, KHL-700)

3.4.4 Mounting Axis 1 Motor

1) Mount the wave generator, and secure it with the hexagon socket head cap screw (M4 x 10 x 1 pc.) and the holding plate. When securing the wave generator, hold the protrusion on the wave generator with pliers or the like, and then tighten the hexagon socket head cap screw (M4 x 10 x 1 pc.) at the end of the axis. Use a cushioning material such as a waste cloth to protect the wave generator from being scratched when securing it.

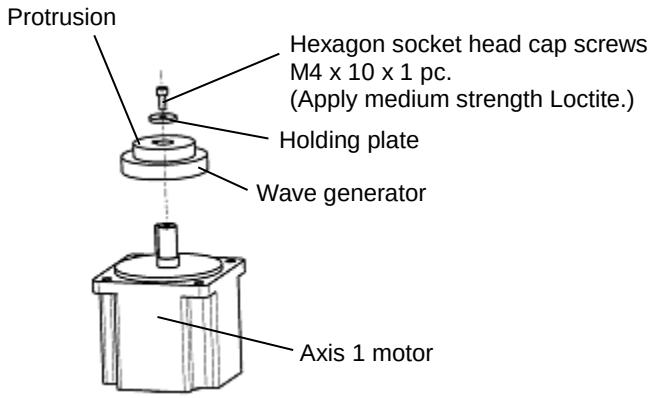


Fig. 3.14 Mounting axis 1 wave generator (KHL-500, KHL-600, KHL-700)

2) Apply grease to the O-ring (CO0545A) and mount it to touch the base groove side surface. Be careful not to drop the O-ring while doing so.

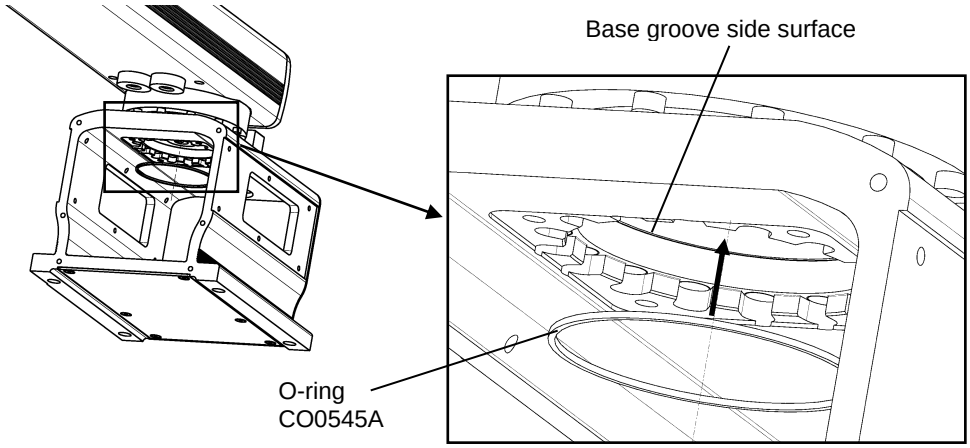


Fig. 3.15 Mounting axis 1 base side O-ring (KHL-500, KHL-600, KHL-700)

3) Apply an appropriate amount of grease onto the all surfaces of the wave generator mounted to the axis 1 motor.

Recommended grease	Maker
SK-1A	HDS

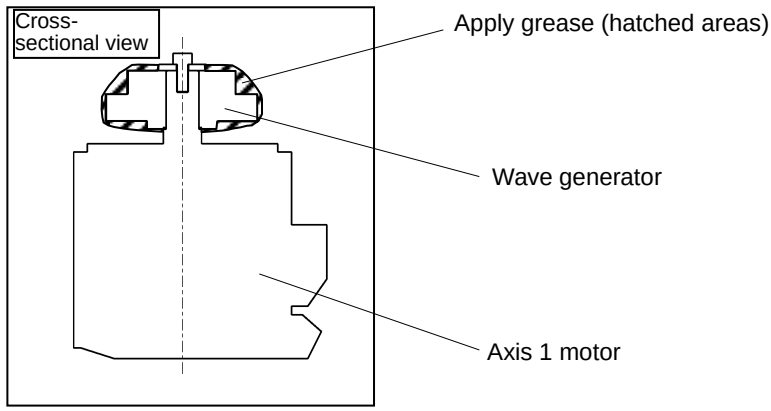


Fig. 3.16 Apply grease onto wave generator (KHL-500, KHL-600, KHL-700)

4) Connect the connectors of the axis 1 motor, i.e., J1AS and J1AP (power drive cable), and J1BS and J1BP (encoder cables).

5) Insert the axis 1 motor assembly into the base while paying attention to the motor's mounting phase, the orientations of the reduction gear main body and the wave generator when the motor is inserted, and the position of the O-ring (it should not move).

6) Secure the axis 1 motor assembly with four (4) hexagon socket head cap screws (M5 x 16) and washers.

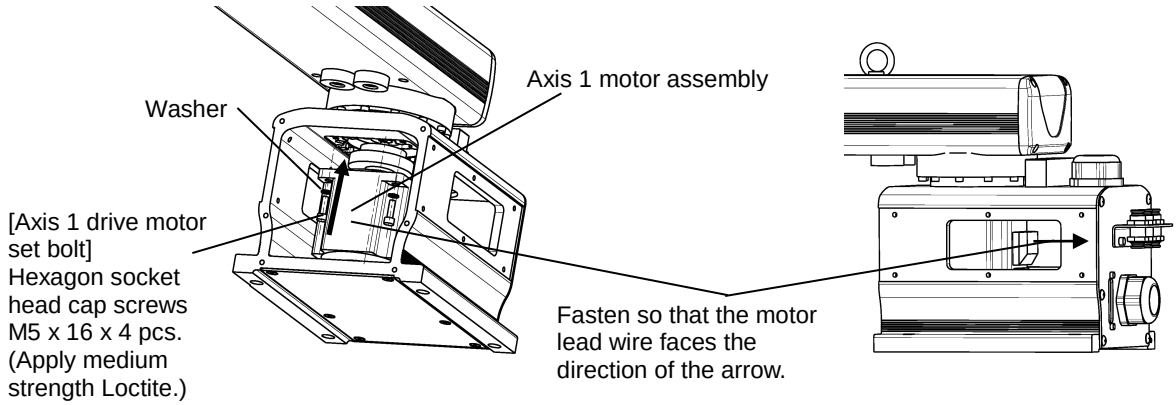


Fig. 3.17 Mounting axis 1 motor assembly (KHL-500, KHL-600, KHL-700)

7) After changing Axis 1 motor, move Arm 1 by hand and check that there is no abnormal sound before turning on the power.

8) Mount the base front cover and the base side covers. (See “Para. 3.3.2, Base Covers.”)

9) Turn on the power and set up the axis 1 home position to complete axis 1 motor replacement.
(Check the coordinates of Axes 2 to 4 and set up the home position if necessary. See “Section 7, Robot Home Point and Position Detector Error”.)

! CAUTION

- Do not forget to mount the O-ring.
  If the O-ring is not mounted, grease will leak from the motor mounted surface.

3.4.5 Dismounting Axis 2 Motor

1) Disconnect the arm 2 cover. (See “Para. 3.3.1, Arm 2 Cover.”)
2) Cut the cable ties of the cables with nippers or the like, and remove J2AS and J2AP (axis 2 power drive cables), J2BS and J2BP (axis 2 encoder cables). It is recommended to take photos of the cable installation positions and the locations where cable ties are used so that these locations can be restored when needed.
3) Remove the harness guide being secured with one (1) hex countersunk screw (M4 x 8) and the support plate being secured with two (2) hexagon socket head cap screws (M4 x 8).

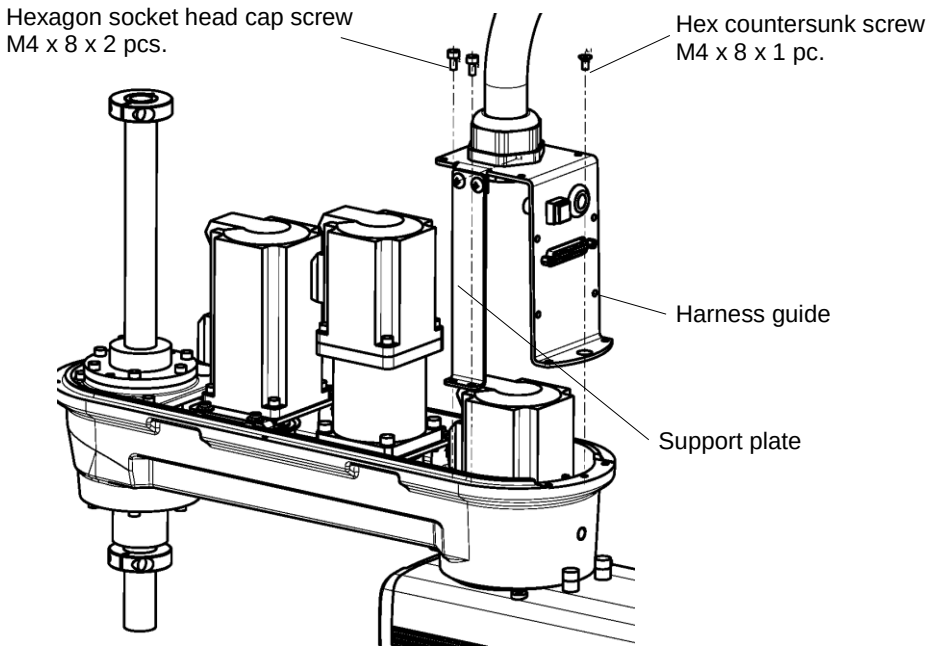


Fig. 3.18 Dismounting harness guide and support plate (KHL-500, KHL-600, KHL-700)

4) Remove four (4) hexagon socket head cap screws (M4 x 16) and washers securing the axis 2 motor. Also remove the O-ring (CO0538A).

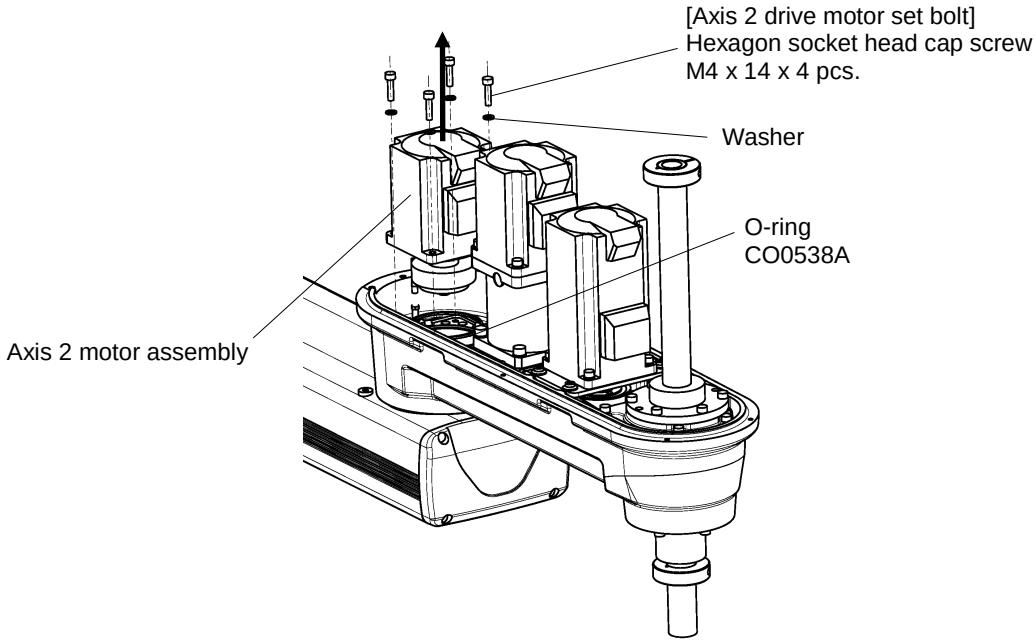


Fig. 3.19 Dismounting axis 2 motor assembly (KHL-500, KHL-600, KHL-700)

5) Remove the wave generator from the axis 2 motor assembly. (Same as Step 4 in “Para. 3.4.3, Dismounting Axis 1 Motor.”)

3.4.6 Mounting Axis 2 Motor

1) Apply grease to the O-ring (CO0538A) and mount it to the inlaid part of the axis 2 motor.
2) Mount the wave generator to the axis 2 motor. (Same as Step 1 in “Para. 3.4.4, Mounting Axis 1 Motor.”)
3) Apply an appropriate amount of grease onto the all surfaces of the wave generator mounted to the axis 2 motor. (Same as Step 3 in “Para. 3.4.4, Mounting Axis 1 Motor.”)
4) Insert the axis 2 motor assembly into Arm 2 while paying attention to the motor's mounting phase, the orientations of the decelerator main body and the wave generator when the motor is inserted (align the long sides of the ovals of the reduction gear and wave generator), and the position of the O-ring (it should not move).

5) Secure the axis 2 motor with four (4) hexagon socket head cap screws (M4 x 16) and washers.

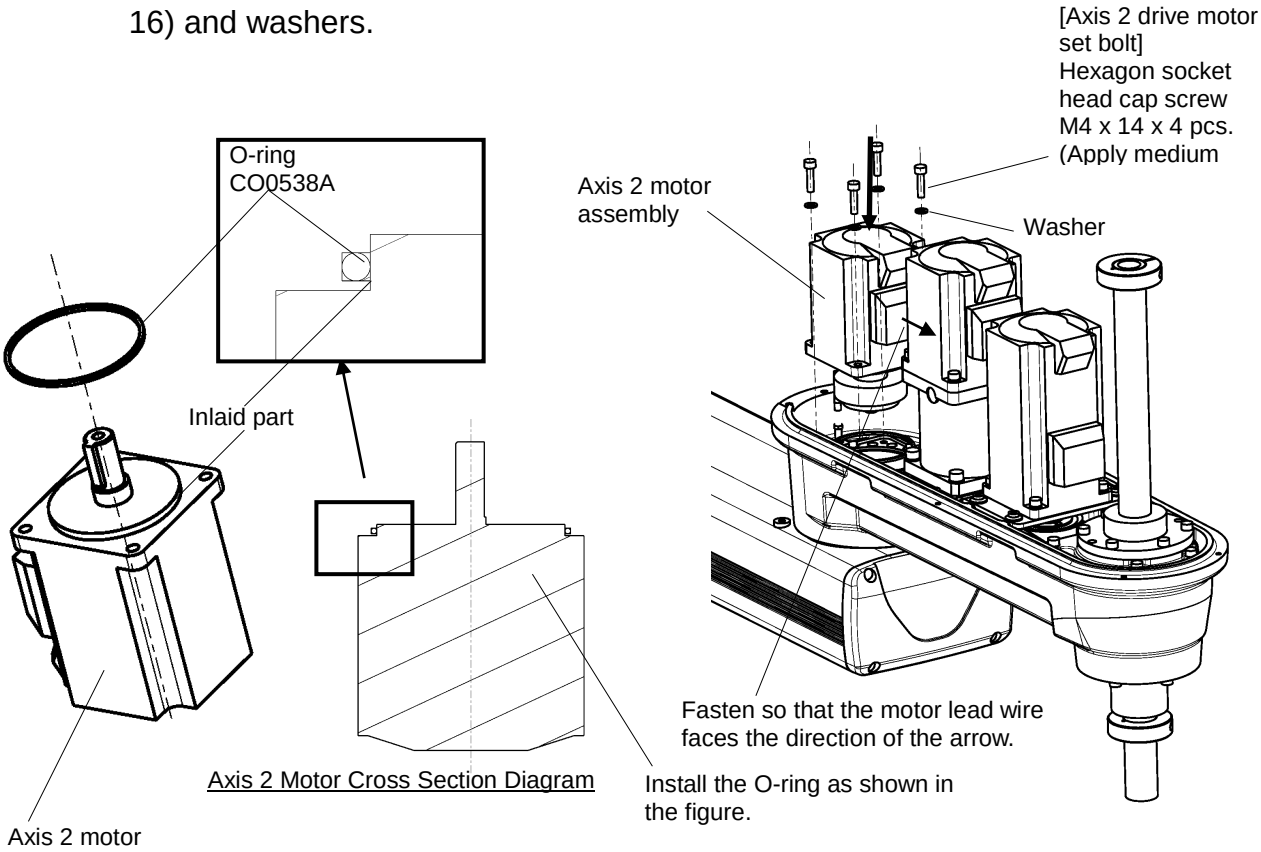


Fig. 3.20 Mounting axis 2 motor assembly (KHL-500, KHL-600, KHL-700)

! CAUTION

- Do not forget to mount the O-ring.
  If the O-ring is not mounted, grease will leak from the motor mounted surface.

6) Secure the harness guide and the support plate with one (1) hex countersunk screw (M4 x 8, application of Loctite not necessary) and two (2) hexagon socket head cap screws (4 x 8).

7) Move Arm 2 by hand and check that there is no abnormal sound before turning on the power.

8) Connect J2AS and J2AP (axis 2 power drive cables), J2BS and J2BP (axis 2 encoder cables).

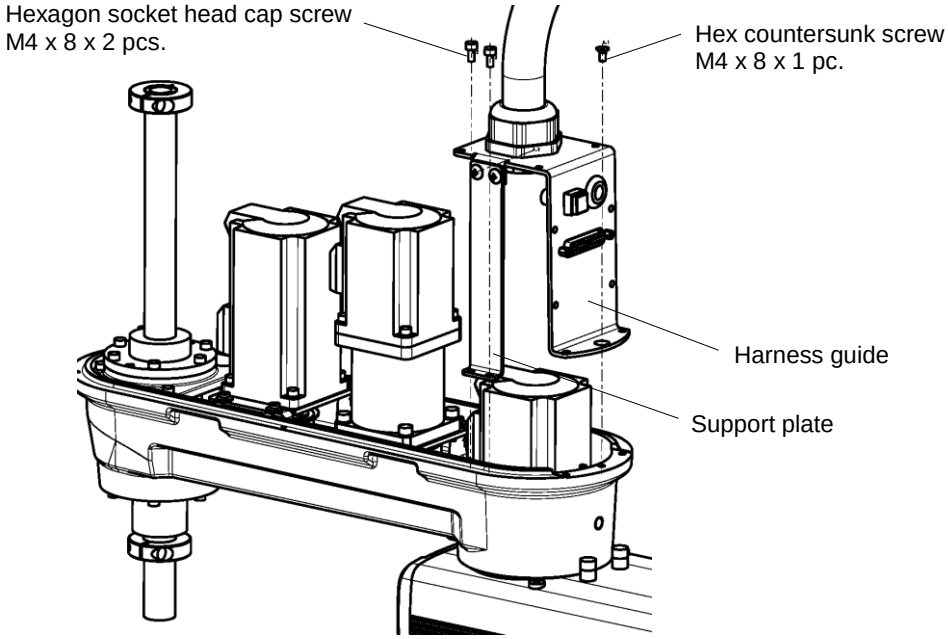


Fig. 3.21 Mounting harness guide and support plate (KHL-500, KHL-600, KHL-700)

9) Restore the cables in A 2 to the original conditions.

10) mount Arm 2 cover.

11) Turn on the power and set up the home positions of axes 2 to complete axis 2 motor replacement (see “Section 7, Robot Home Point and Position Detector Error”).

3.4.7 Dismounting Axis 3 Motor

! CAUTION

- The axis 3 motor is provided with a brake. At replacement of the axis 3 motor, this brake becomes inoperative. Before starting the work, therefore, move down the ball screw spline to the lower limit. Otherwise, the shaft will drop due to the dead weight of the shaft or workpiece, and your hand or finger may be caught.

1) Remove the arm 2 cover. (See “Para. 3.3.1, Arm 2 Cover.”)

2) Cut the cable ties of the cables with nippers.
It is recommended to take photos of the cable installation positions and the locations where cable ties are used so that these locations can be restored when needed.

3) Disconnect connectors J3AS and J3AP (power drive cables), connectors J3BS and J3BP (encoder cables) and connectors J3DS and J3DP (brake cables) for the axis 3, which are connected to the connector panel.

4) Loosen the axis 3 tension adjustment bolt (M4 x 16 x 2 and hexagonal nuts) and remove the flange head bolts (M4 x 10 x 4) securing the axis 3 motor plate to cancel the axis 3 timing belt tension. Then draw out axis 3 the motor assembly upward.

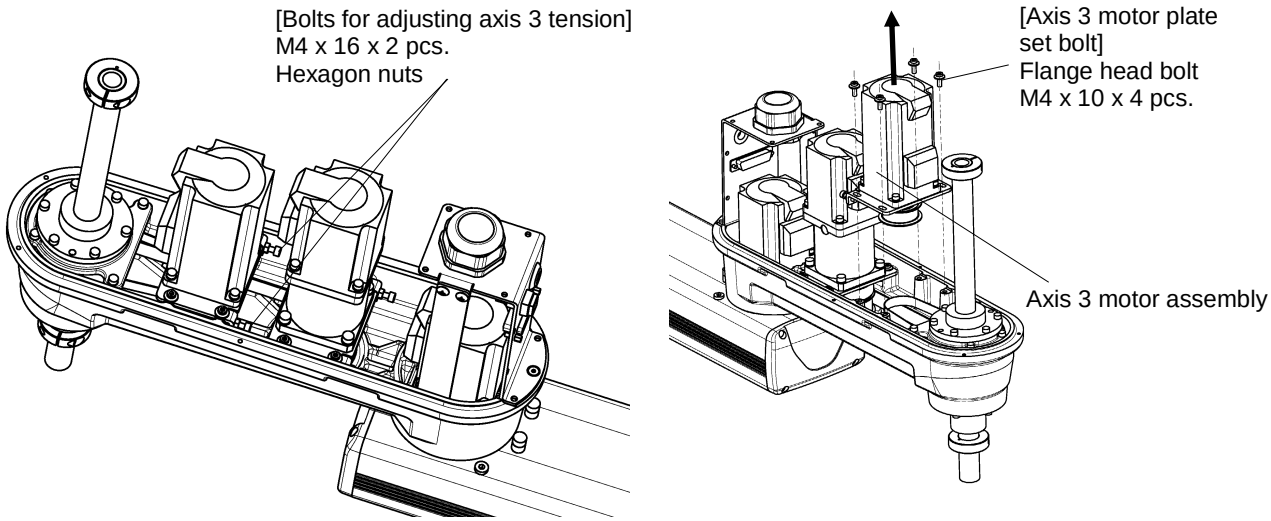


Fig. 3.22 Dismounting axis 3 motor assembly (KHL-500, KHL-600, KHL-700)

5) Remove one (1) hexagon socket head cap screw at the end of the axis (M3 x 8). (Same as Step 4 in “Para. 3.4.3, Dismounting Axis 1 Motor.”) Next, pull out the washer, holding plate, pulley and key.

6) Remove four (4) hexagon socket head cap screws (M4 x 12) and washers that secure the axis 3 motor and then disassemble the axis 3 motor plate and the axis 3 motor.

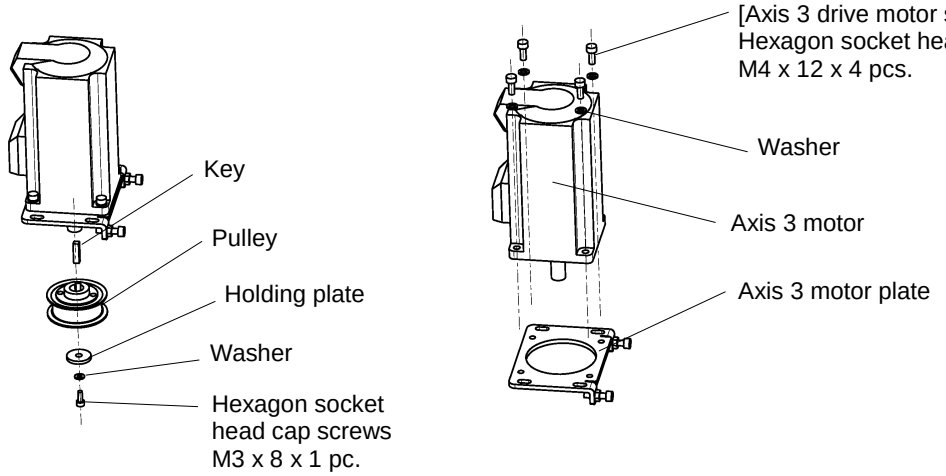


Fig. 3.23 Dismounting axis 3 motor pulley and plate (KHL-500, KHL-600, KHL-700)

3.4.8 Mounting Axis 3 Motor

1) Perform key alignment, using the new axis 3 motor and pulley. At this time, no clearance should exist between the motor shaft and pulley.

2) Secure the axis 3 motor to the axis 3 motor plate with four (4) hexagon socket head cap screws (M4 x 12) and washers. Be careful with the mounting phases of the axis 3 motor and the axis 3 motor plate at this time.

3) Mount the key and the axis 3 motor pulley, and then secure them with the holding plate, washers and one (1) hexagon socket head cap screw (M3 x 8).

! CAUTION

- Perform key alignment very carefully. If there is a clearance between the motor shaft and pulley, positioning accuracy will drop and the life of the parts will shorten.

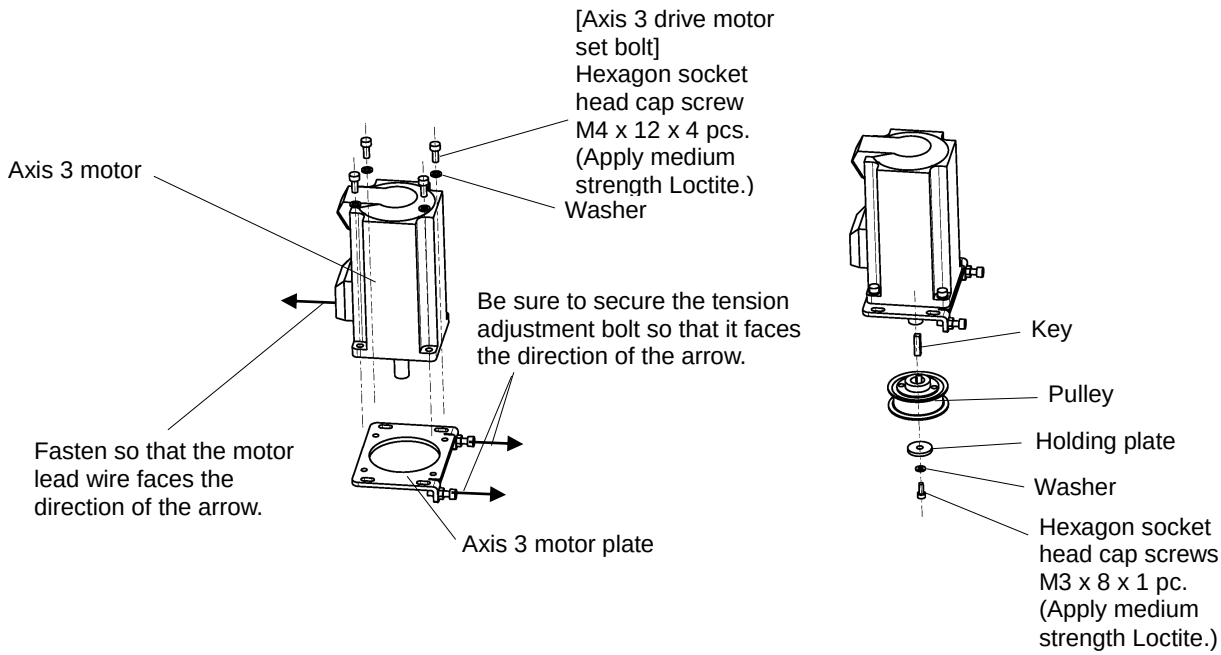


Fig. 3.24 Mounting axis 3 pulley and plate (KHL-500, KHL-600, KHL-700)

4) Hang the axis 3 motor timing belt to the arm 3 motor pulley, and temporarily secure the axis 3 motor plate to Arm 2 with four (4) flange head bolts (M4 x 10, application of Loctite not necessary). Be careful with the motor mounting phase at this time. Apply tension using two (2) axis 3 tension adjustment bolts (M4 x 16, application of Loctite not necessary). (For the belt replacement procedures and tension adjustment values, see “Para. 3.5.3, Replacing Axis 3 Timing Belt.”) Then, tighten and secure the temporarily tightened flange head bolts with hex nuts.

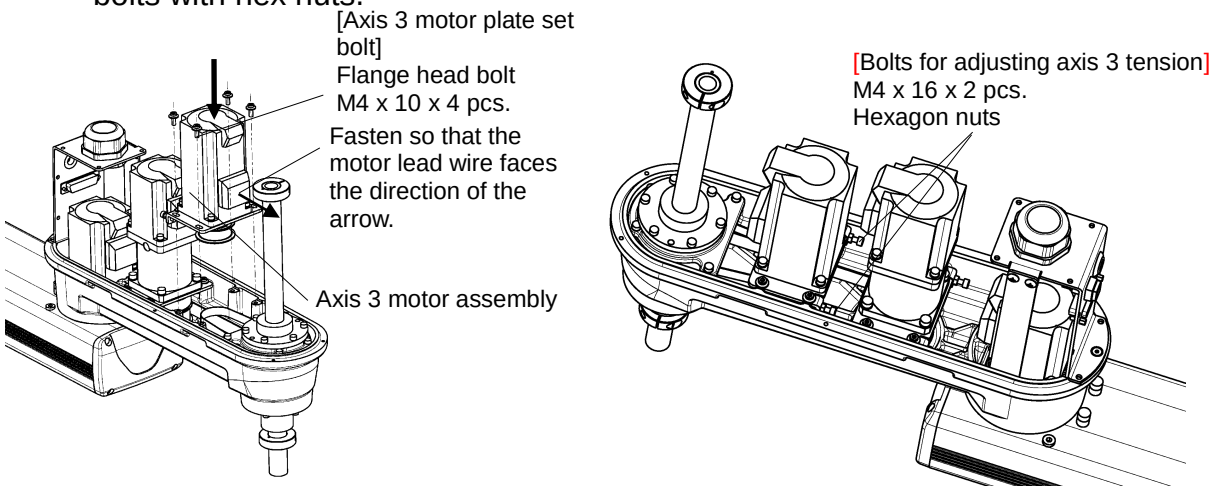


Fig. 3.25 Mounting axis 3 motor assembly (KHL-500, KHL-600, KHL-700)

5) Connect the connectors. (See the pictures taken in Para. 3.4.7, Step 2.)

6) Mount the arm 2 cover and perform home setting for Axes 3 and 4. Now, the axis 3 motor replacement is complete. Need perform home setting for Axes 4 at this time.

7) Carry out a test operation of Axes 3 and 4 and make sure that each part operates properly.

3.4.9 Dismounting Axis 4 Motor

1) Remove the arm 2 cover. (See “Para. 3.3.1, Arm 2 Cover.”)

2) Cut the cable ties of the cables with nippers.
It is recommended to take photos of the cable installation positions and the locations where cable ties are used so that these locations can be restored when needed.

3) Disconnect connectors J4AS and J4AP (power drive cables) and connectors J4BS and J4BP (encoder cables) of the axis 4 motor.

4) Remove the cap attached to the lateral side of the axis 4 reduction gear and loosen the coupling bolt (M4) securing the axis 4 motor shaft and input shaft of the axis 4 reduction gear.
If the hexagonal hole of the bolt is out of phase, adjust the phase by turning the ball screw spline shaft by hand.

5) Remove four (4) hexagon socket head cap screws (M4 x 12) and washers that secure the axis 4 motor, and then pull the axis 4 motor upward.

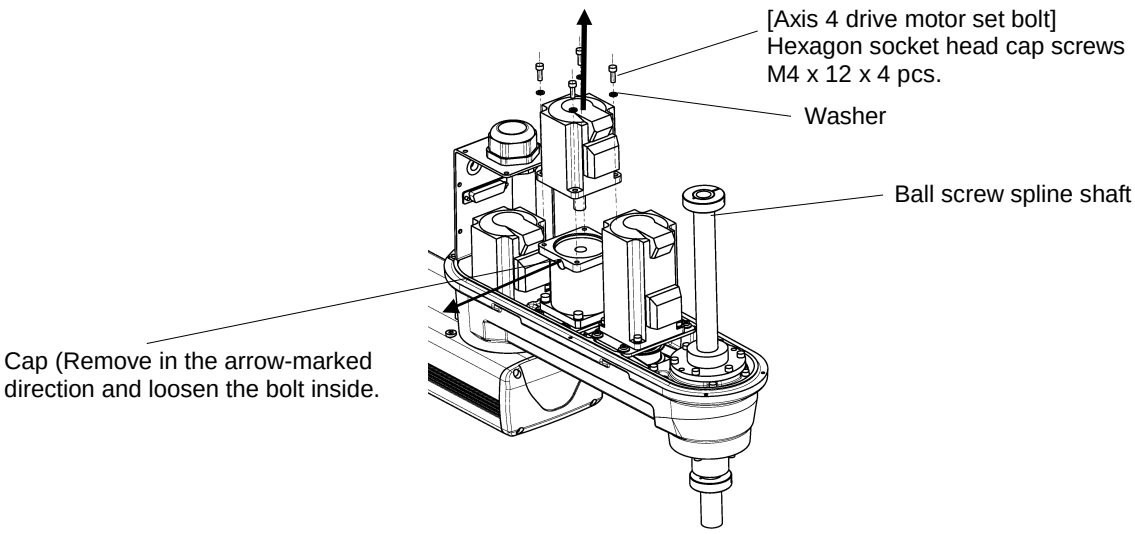


Fig. 3.26 Dismounting axis 4 motor (KHL-500, KHL-600, KHL-700)

3.4.10 Mounting Axis 4 Motor

1) Mount the new motor to the reduction gear with four (4) hexagon socket head cap screws (M4 x 12) and washers. Be careful with the phase when mounting the motor. (Recommended clamping torque: 3.3 N·m)

2) Tighten the coupling of the axis 4 reduction gear by means of the attached bolt (M4) to mount the cap. (Recommended clamping torque: 4.3 N·m)

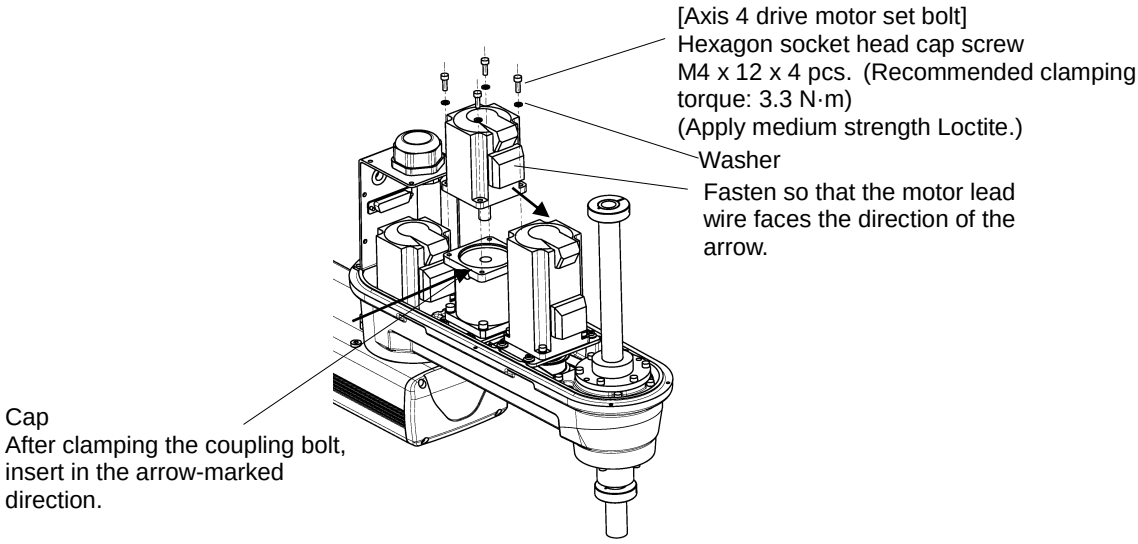


Fig. 3.27 Mounting axis 4 motor (KHL-500, KHL-600, KHL-700)

3) Connect the connectors of the axis 4 motor, i.e., J4AS and J4AP (power drive cables), and J4BS and J4BP (encoder cables).

4) Restore the cables to the original conditions and then mount the arm 2 cover.

5) Set up the home positions of Axes 3 and 4 to complete motor replacement. During the replacement of the axis 4 motor, it is necessary to set up the home position of Axis 3.

6) Carry out a test operation of Axes 3 and 4 and make sure that each part operates properly.

3.5 Adjusting and Replacing Timing Belt

The timing belt is to be replaced by our service engineer. If it is replaced by the customer, we will not guarantee any consequential trouble or accident.

DANGER

- The timing belt should be replaced with a new one only after the controller power supply plug is removed. If the work is done while the power is connected, you may get an electric shock or the robot may malfunction, which is very dangerous.

CAUTION

- The axis 3 motor is provided with a brake. At replacement of the axis 3 timing belt, this brake becomes inoperative. Before starting the work, therefore, move down the shaft to the lower limit. Otherwise, the shaft will drop due to the dead weight of the shaft or workpiece, and your hand or finger may be caught.
- Because the timing belt is disconnected, the mechanical home point shifts and proper control cannot be done. To avoid this, home return operation is necessary after replacement of the timing belt. For the home return procedures, see “Section 8, Robot Home Point and Position Detector Error.”

3.5.1 Type of Timing Belt

The timing belts used in this robot are shown below.
When you place an order for a replacement belt, specify the robot model (KHL-500, KHL-600, KHL-700), the serial number, the axis name, and our drawing number.
For the location where the serial number plate is attached, see the “Safety Manual.”

Table 3.3 Type of timing belt (KHL-500, KHL-600, KHL-700)

Description	Axis name	Width	Our drawing No.
Timing belt	Axis 3	10 mm	S875174
	Axis 4	15 mm	S875175

3.5.2 Timing Belt Locations

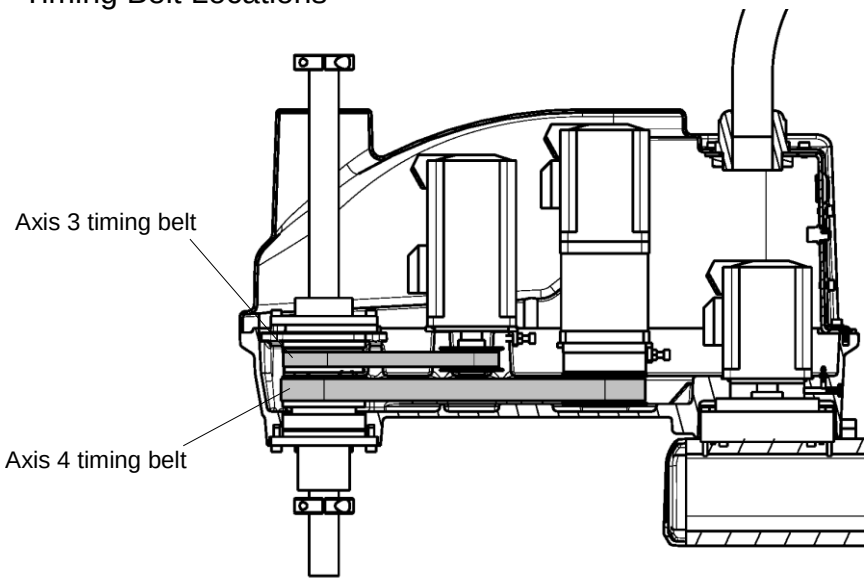


Fig. 3.28 Timing belt locations (KHL-500, KHL-600, KHL-700)

3.5.3 Replacing Axis 3 Timing Belt

1) Remove the arm 2 cover. (See “Para. 3.3.1, Arm 2 Cover.”)

2) Cut the cable ties of the cables with nippers. It is recommended to take photos of the cable installation positions and the locations where cable ties are used so that these locations can be restored when needed.

3) Disconnect the axis 3 motor assembly. For the disconnecting procedures, see Steps 1) through 4) of “Para. 3.4.7, Dismounting Axis 3 Motor.”

! CAUTION

- The axis 3 motor is provided with a brake. At replacement of the axis 3 timing belt, this brake becomes inoperative. Before starting the work, therefore, move down the shaft to the lower limit. Otherwise, the shaft will drop due to the dead weight of the shaft or workpiece, and your hand or finger may be caught.

4) Remove the four (4) hexagon socket head cap screws (M4 x 16) and the bottom stopper that secure the axis 4 bracket (remove the hand and other parts). Pull out the ball screw nut together with the axis 4 bracket, the ball screw shaft and the top stopper from Arm 2. Caution must be exercised when pulling them out.

Note that if the ball screw nut is pulled out of the shaft, the ball falls off from the ball screw nut and, consequently, the ball screw spline unit can no longer be used.

5) Disconnect the axis 3 timing belt.

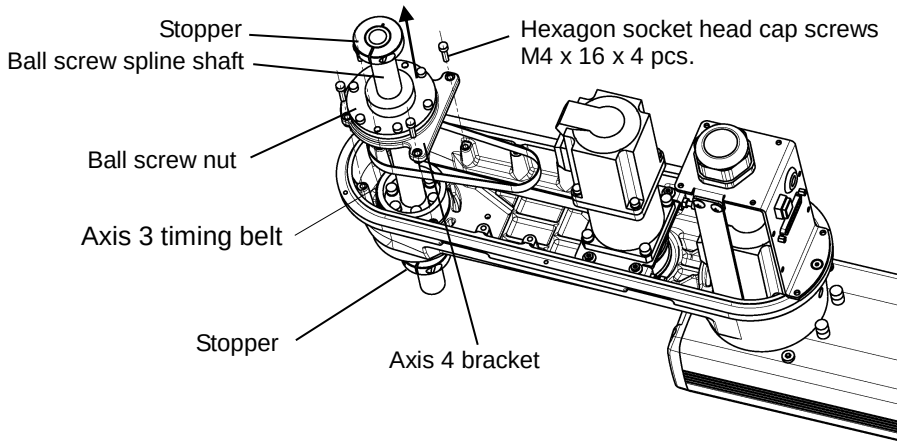


Fig. 3.29 Replacing axis 3 timing belt (KHL-500, KHL-600, KHL-700)

6) Mount the new timing belt. Insert the ball screw spline shaft into the ball spline nut, and mount the stoppers. (For the insertion of the ball screw spline shaft, see “Para. 3.6.5, Mounting Ball Screw Spline Unit.”)

7) Hang the timing belt to the axis 3 motor assembly which was previously removed in 3), and temporarily secure it to Arm 2 with four (4) flange head bolts (M4 x 10, application of Loctite not necessary). Move the ball screw spline unit up and down to make it fit in. Apply tension using two (2) axis 3 tension adjustment bolts (M4 x 16, application of Loctite not necessary).
While pulling the axis 3 motor plate with the axis 3 tension adjustment bolts, measure the tension with a tension meter. Tighten the flange head bolt at the location where the tension reaches a value slightly smaller than 49 N (because the tension gets larger by retightening of the flange head bolt). Adjust so that the tensile value becomes between 49 and 57 N when the flange head bolt is retightened. Then, secure with the hex nut.

The values to be used for the tension meter are as shown in the table below.

Table 3.4 Value of tension of axis 3 timing belt (KHL-500, KHL-600, KHL-700)

Value of tension [N]	Unit mass [g/m]	Belt width [mm]	Span [mm]
49 to 57	2.2	10	100

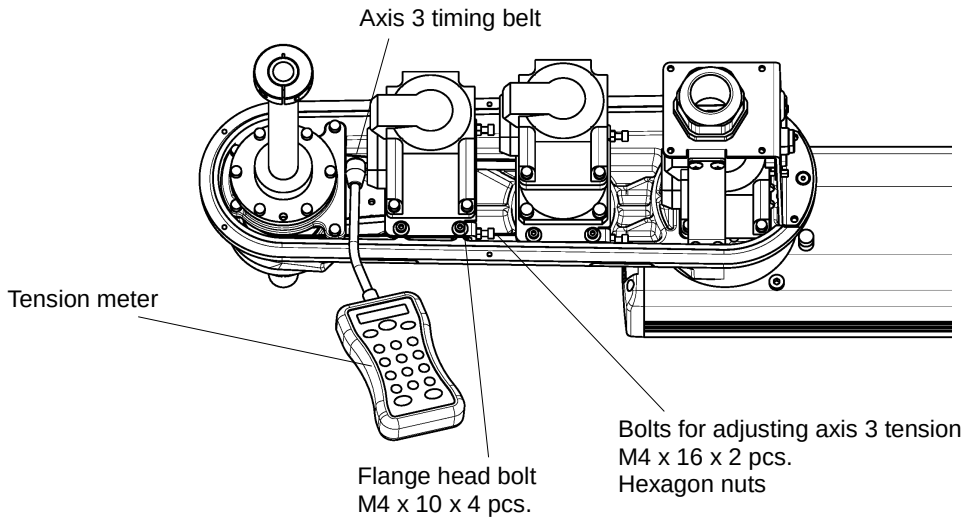


Fig. 3.30 Adjusting axis 3 tension (KHL-500, KHL-600, KHL-700)

8) Connect the connectors and return them to their original location, mount Arm 2 cover, and perform home setting for Axes 3 and 4. This completes the replacement of the timing belt.

9) Carry out a test operation of Axes 3 and 4 and make sure that each part operates properly.

3.5.4 Replacing Axis 4 Timing Belt

CAUTION

- When the axis 4 timing belt is replaced with a new one, the axis 3 should be disassembled also due to the structure. Therefore, strictly observe the cautions on replacement of the axis 3 timing belt and motor also.
- When the ball screw nut integrated with the ball screw spline shaft is disconnected, take utmost care not to cause the ball screw spline shaft to come off. Otherwise, the ball in the ball screw nut will drop and the ball screw nut integrated with the ball screw spline shaft cannot function any further.

1) Remove the arm 2 cover, the axis 3 motor assembly, the axis 3 timing belt, the ball screw nut and the ball screw spline shaft.
For the disconnecting procedures, see Steps 1) through 5) of “Para. 3.5.3, Replacing Axis 3 Timing Belt.”

2) Loosen two (2) tension adjustment bolts (M4 x 16) for the axis 4, remove four (4) flange head bolts (M4 x 10) securing the axis 4 motor plate, and then pull out the axis 4 motor assembly. Pull out the axis 4 timing belt upward and then install a new belt.

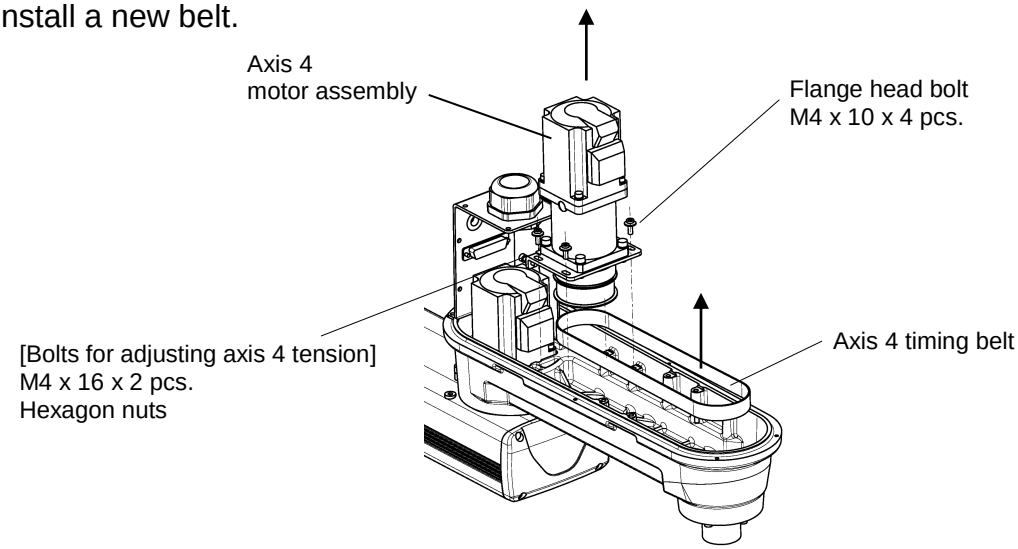


Fig. 3.31 Dismounting harness guide and support plate (KHL-500, KHL-600, KHL-700)

3) Temporarily secure the ball screw nut and the ball screw spline shaft which were removed in Step 1) above and the axis 4 bracket above to Arm 2 using four (4) hexagon socket head cap screws (M4 x 16). In doing so, mount the axis 3 timing belt and the axis 4 timing belt through the ball screw spline shaft first.

For the mounting of the ball screw spline unit and the stoppers, see “Para. 3.6.5, Mounting Ball Screw Spline Unit.”

4) Temporarily set the axis 4 motor assembly which was disconnected in Step 2) above to Arm 2 with the four (4) flange head bolts (M4 x 10 x 4 Loctite is not necessary) after setting the axis 4 timing belt to the axis 4 motor pulley. Be careful with the motor assembly mounting phase at this time.

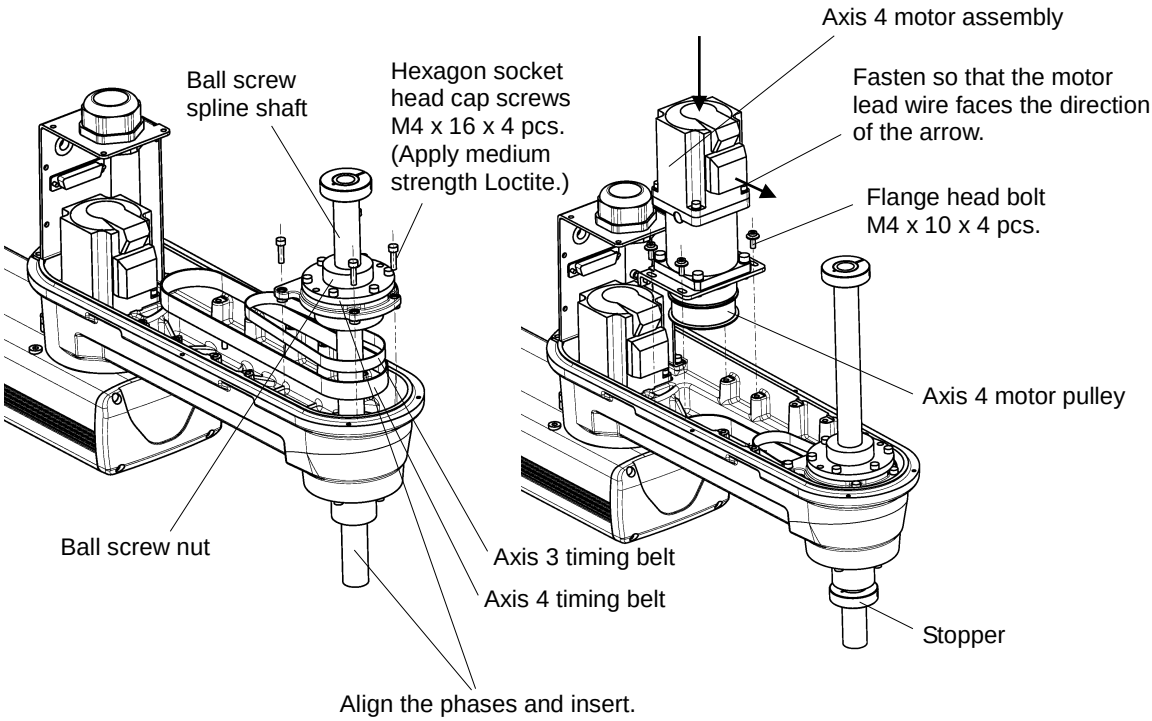


Fig. 3.32 Ball screw and axis 4 motor assembly (KHL-500, KHL-600, KHL-700)

5) While pulling the axis 4 motor plate with the axis 4 tension adjustment bolts, measure the tension with a tension meter. Tighten the flange head bolt at the location where the tension reaches a value slightly smaller than 150 N (because the tension gets larger by retightening of the flange head bolt). Adjust so that the tensile value becomes between 150 and 180 N when the flange head bolt is retightened. After that, gradually tighten the tension adjusting bolt, and fix it with a nut. If the tension adjusting bolt is not tightened in this step, the tension adjusting bolt may be disconnected during the robot operation. The values to be used for the tension meter are as shown in the table below.

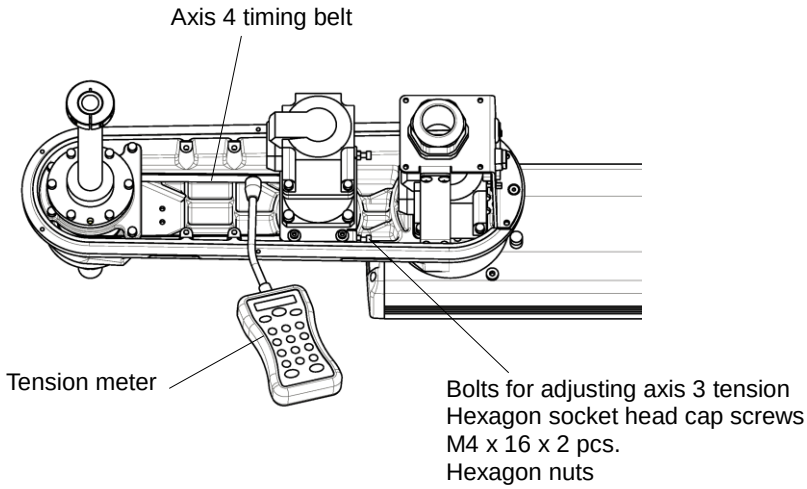


Fig. 3.33 Ball screw and axis 4 motor assembly (KHL-500, KHL-600, KHL-700)

Table 3.5 Value of tension of axis 4 timing belt (KHL-500, KHL-600, KHL-700)

Value of tension [N]	Unit mass [g/m]	Belt width [mm]	Span [mm]
150 to 180	4.1	15	190

6) Mount the axis 3 motor and timing belt. For the mounting procedures, see “Para. 3.4.8, Mounting Axis 3 Motor” and “Para. 3.5.3, Replacing Axis 3 Timing Belt” above.

7) Arrange the connectors and cables as originally set. (See the pictures you took beforehand.)

8) Perform home setting for Axes 3 and 4.

9) Carry out a test operation of Axes 3 and 4 and make sure that the belt tension is appropriate.

10) Attach the arm 2 cover. Now replacement of the axis 4 timing belt completes.

3.5.5 Check Timing Belt Adjustment

Perform inspection and adjustment of each timing belt semi-annually (every six (6) months).

1) Remove the arm 2 cover. (See “Para. 3.3.1, Arm 2 Cover.”)
2) If the belt is worn out, replace it. If cracks are observed or there is a serious abrasion (see "3.5.3 Replacement of the 3rd-axis timing belt"), replace the belt. If the belt is scratched, replace the belt or contact our service office. If the belt is seriously loosened, adjust the tension in conformity to "3.5.3 Replacement of the 3rd-axis timing belt" and 3.5.4 Replacement of the 4th-axis timing belt". If the belt is loosened heavily, adjust its tension, referring the following table. Note that the value of tension at replacement of timing belt (i.e., when mounting a new timing belt) is the same as the value of tension at adjustment If the tension is appropriate, mount the arm 2 cover. Now the inspection is complete.
3) When adjustment of the tension is required, loosen the four (4) flange head bolts (M4 x 10) securing the axis 3 and axis 4 motor plates, respectively. Measure the tension on the tension meter while adjusting the tension adjustment bolt (axis 3: M4 x 16 x 2 bolts, axis 4: M4 x 16 x 2 bolts and hexagonal nut).
4) When the tension has fallen under the appropriate range, tighten the flange head bolts.
5) Tighten the tension adjustment bolts further and fasten with the hexagon nuts. If the bolt is not tightened any further, the bolt can come out while the robot is in operation.
6) Mount the arm 2 cover. Now the adjustment completes.

3.6 Filling Grease to Ball Screw Spline Unit and Replacement

The ball screw spline unit is to be replaced by our service engineer. If it is replaced by the customer, we will not guarantee any consequential trouble or accident.

DANGER

- The ball screw spline unit should be replaced with a new one only after the controller power supply plug is removed. If the work is done while the power is connected, you may get an electric shock or the robot may malfunction, which is very dangerous.

CAUTION

- Because the timing belt, nut and pulley are disconnected, the mechanical home point shifts and proper control cannot be done. To avoid this, home return operation is necessary after replacement of the ball screw spline unit. For the home return procedures, see “Section 7, Robot Home Point and Position Detector Error.”

3.6.1 Type of Ball Screw Spline Unit

The ball screw spline unit used in this robot is shown below.
When you place an order for the ball screw spline unit for replacement, specify the robot model (KHL-500, KHL-600, KHL-700) and our drawing number.

Table 3.6 Ball screw spline unit (KHL-500, KHL-600, KHL-700)

Description	Stroke	Our drawing No.	Unit code
Ball screw spline unit	150mm	H852666	Y610A3LT0
	300mm	H852702	Y610A3ME0

* Stroke 300 mm is optional.

3.6.2 Ball Screw Spline Unit Location

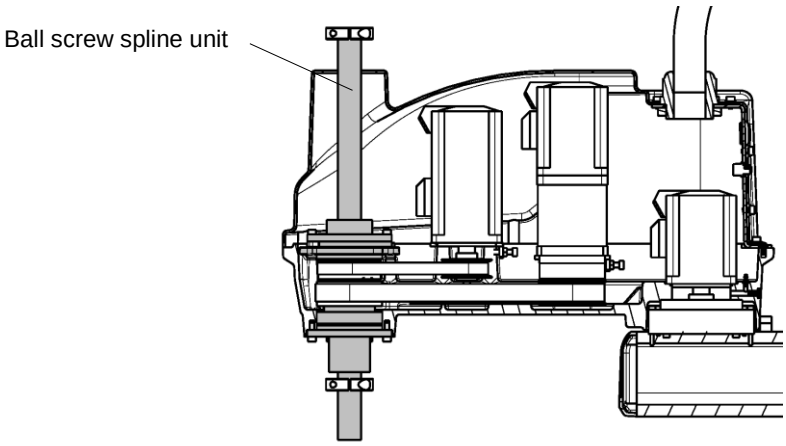


Fig. 3.34 Ball screw spline unit location (KHL-500, KHL-600, KHL-700)

3.6.3 Greasing Ball Screw Spline Unit and Applying Anticorrosive

! CAUTION

- When vertically moving the ball screw by hand, take careful precautions not to have your hand or finger caught.
- As there is a fear that the grease drops, cover the peripheral equipment, etc.

! CAUTION

- When the grease has run short, cut or scratch will be caused on the slide unit, etc., resulting in drop of the performance. To avoid this, take careful precautions to prevent shortage of the grease.
- Be sure to use the grease designated by CKD.
- Apply anticorrosive when dried up. If anticorrosive is not applied in such a case, rust will be generated on the ball screw spline unit.
- NEVER touch the ball screw spline unit with bare hand. Otherwise, the ball screw may be subjected to earlier rusting. Be sure to gloves when you want to tough it.

Basically, fill the grease to the ball screw spline unit every three (3) months.
If you have verified that there is not much grease, be sure to apply grease.
At daily inspection also, make sure that the ball screw spline unit is filled with a sufficient volume of grease.
Check the condition of anticorrosive in daily inspection. If anticorrosive is dried up, apply it.

Table 3.7 Recommended anticorrosive (KHL-500, KHL-600, KHL-700)

Recommended anticorrosive	Maker
KLUBER A20	NOK
WD-40	ST TRADING

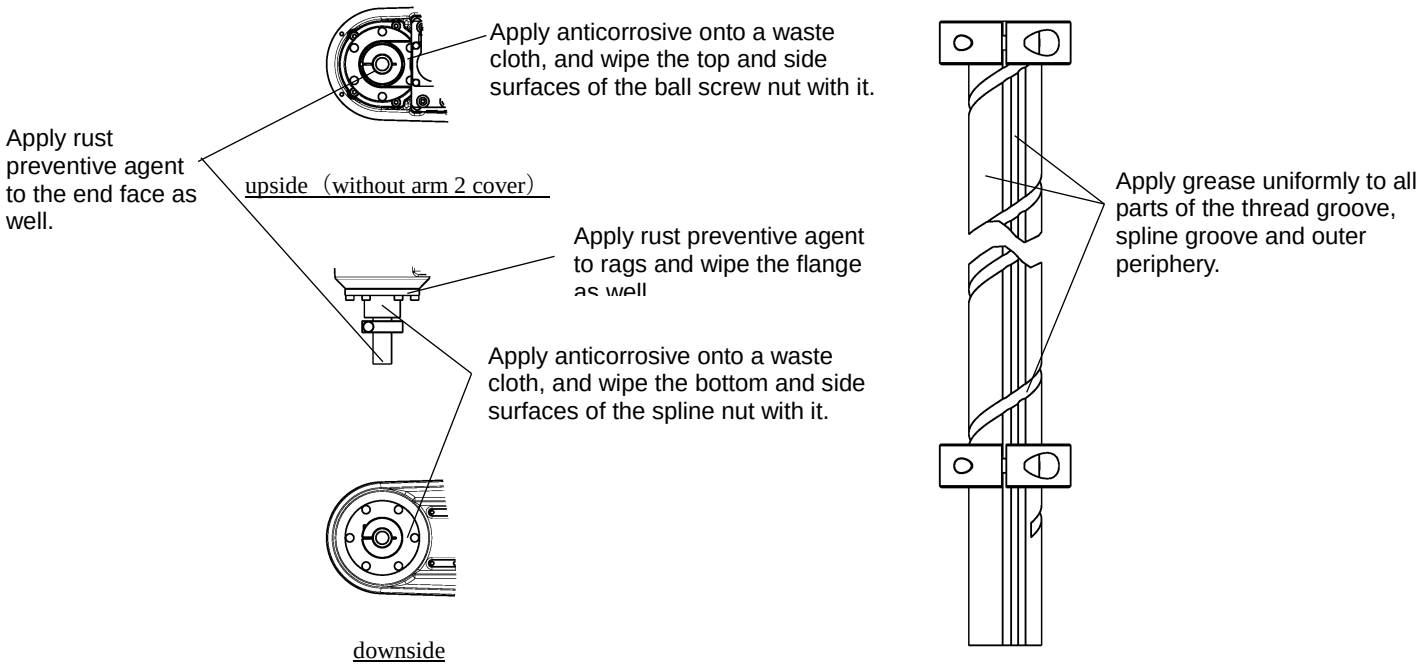


Fig. 3.35 Applying anticorrosive and grease to ball screw spline unit (KHL-500, KHL-600, KHL-700)

1) Remove the arm 2 cover (see “Para. 3.3.1, Arm 2 Cover.”)
2) Connect the controller power supply plug and turn off the servo system.
3) Move the arm to a position where Axis 3 can be moved over the full stroke by hand.
4) Push down the ball screw spline shaft to the lower limit while pressing the axis 3 brake release switch.

5) Directly apply the grease to the exposed shaft area by brash.
Apply the grease to such an extent that the shaft groove can be filled. Wipe out the surplus grease.

Table 3.8 Recommended grease (KHL-500, KHL-600, KHL-700)

Recommended grease	Maker
AFF grease	THK

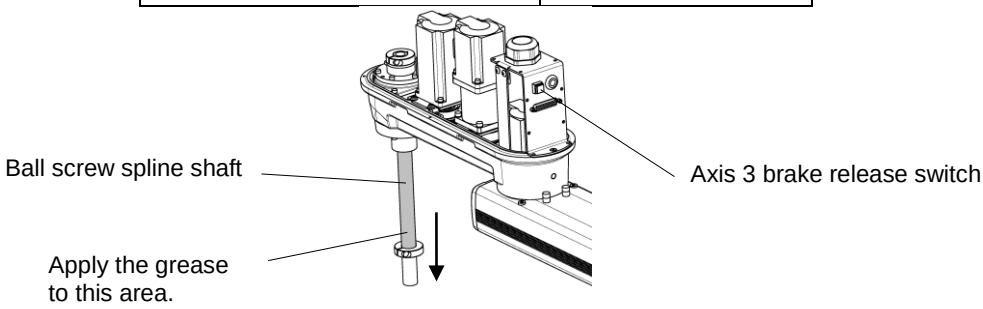


Fig. 3.36 Greasing lower side of ball screw spline unit (KHL-500, KHL-600, KHL-700)

6) Push up the shaft up to the upper limit while pressing the axis 3 brake release switch.

7) Directly apply the grease by brash to the shaft area sticking up from the cover.
Apply the grease to such an extent that the shaft groove can be filled. Wipe out the surplus grease.

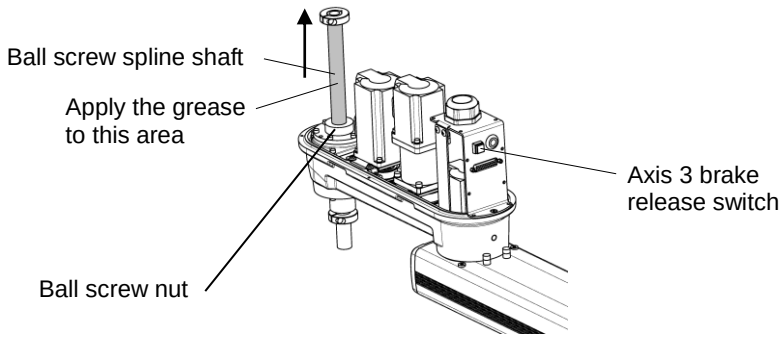


Fig. 3.37 Greasing upper side of ball screw spline unit (KHL-500, KHL-600, KHL-700)

8) Move the shaft up and down repeatedly while pressing the axis 3 brake release switch to fill the grease uniformly. Wipe out the surplus grease. Now the work completes.

3.6.4 Dismounting Ball Screw Spline Unit

DANGER

- The ball screw spline unit should be replaced with a new one only after the controller power supply plug is removed. If the work is done while the power is connected, you may get an electric shock or the robot may malfunction, which is very dangerous.

CAUTION

- Handle the ball screw spline unit with extreme care. If the unit drops or an unusually large external force is exerted on it, it cannot function any further.
- Replacement of the ball screw spline unit involves mounting and dismounting of the axis 3 and 4 motors and timing belts. Also observe the cautions on each work.
- Because the motor, timing belt, nut and pulley are disconnected, the mechanical home point shifts and proper control cannot be done. To avoid this, home return operation of axis 3 and 4is necessary after replacement of the ball screw spline unit. For the home return procedures, see “Section 8, Robot Home Point and Position Detector Error.”
- NEVER touch the ball screw spline unit with bare hand. Otherwise, the ball screw may be subjected to earlier rusting. Be sure to gloves when you want to tough it.

In the descriptions on replacing the ball screw spline unit, the procedures for changing the axis 3 and 4 motors and timing belts are not included. For details, refer to the descriptions on replacement of each part (see “Para. 3.4.7, Dismounting Axis 3 Motor”, “Para. 3.4.9, Dismounting Axis 4 Motor”, “Para. 3.5.3, Replacing Axis 3 Timing Belt” and “Para. 3.5.4, Replacing Axis 4 Timing Belt.”)

1) Remove the arm 2 cover. (See “Para. 3.5.1, Arm 2 Cover.”)
2) Disconnect the hand, tool, etc. followed by the upper and lower stoppers.
3) Disconnect the axis 3 and 4 motor assemblies.
4) Remove four (4) hexagon socket head cap screws (M4 x 16) securing the axis 4 bracket, and then pull the ball screw nut, the ball screw spline shaft and the axis 4 bracket upward together. Caution must be exercised when pulling them out. A
5) Remove the timing belts from Axes 3 and 4.

6) Remove six (6) hexagon socket head cap screws (M4 x 12) securing the ball screw nut, and then pull it out of the axis 4 bracket. If it cannot be pulled out by hand, use a removal tap. Remove the stopper on the upper side as well.

7) Remove four (4) hexagon socket head cap screws (M5 x 20) and washers, and then remove the axis 3 nut pulley which is secured to the ball screw nut.

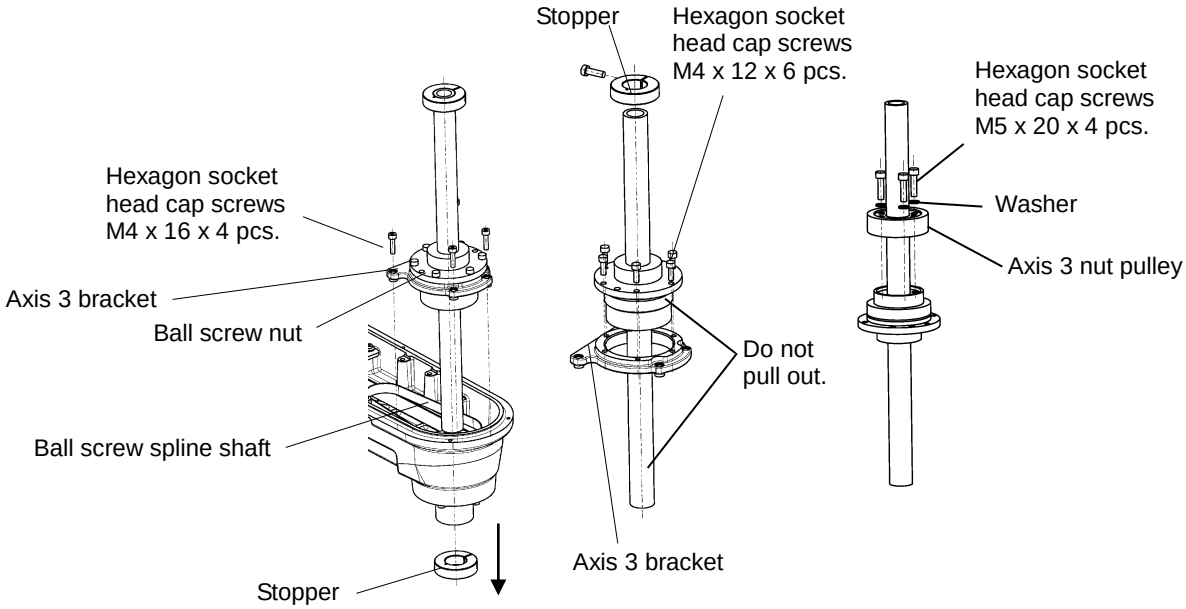


Fig. 3.38 Dismounting ball screw spline unit (KHL-500, KHL-600, KHL-700)

! CAUTION

- When the ball screw nut integrated with the ball screw spline shaft is disconnected, take utmost care not to cause the ball screw spline shaft to come off. Otherwise, the ball in the ball screw nut will drop and the ball screw nut integrated with the ball screw spline shaft cannot function any further.

8) Remove the hexagon socket head cap screw (M4 x 12 x 6 pcs.) securing the ball spline nut, and pull out the ball spline nut downward.
If the ball spline nut is hard to remove, screw a bolt into the ball spline nut tap (M4) to remove it.

9) Disconnect the axis 4 nut pulley secured to the ball spline nut with the hexagon socket head cap screw (M5 x 12 x 6 pcs.). When it is hard to disconnect, screw the bolt into the tap for disassembly (M4) machined on the pulley and disconnect.

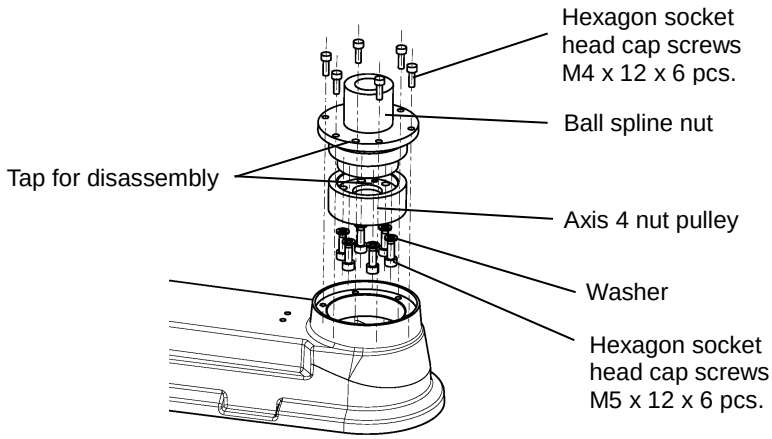


Fig. 3.39 Dismounting ball screw spline nut (KHL-500, KHL-600, KHL-700)

10) Insert the disconnected ball spline nut into the ball screw spline shaft.
A marking for phase adjustment is stamped on both the ball screw spline shaft and the ball spline nut. Align the two markings when inserting the ball spline nut. To prevent the nut from slipping off, wind cable ties around near the top and bottom of the shaft.

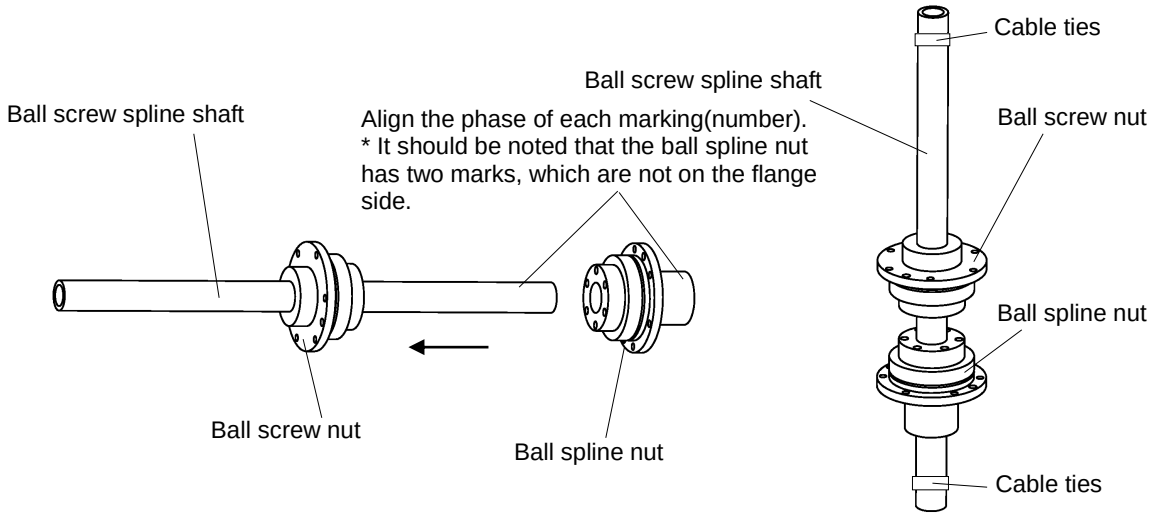


Fig. 3.40 Ball screw spline nut (KHL-500, KHL-600, KHL-700)

3.6.5 Mounting Ball Screw Spline Unit

! DANGER

- The ball screw spline unit should be replaced with a new one only after the controller power supply plug is removed. If the work is done while the power is connected, you may get an electric shock or the robot may malfunction, which is very dangerous.

! CAUTION

- Handle the ball screw spline unit with extreme care. If the unit drops or an unusually large external force is exerted on it, it cannot function any further.
- Replacement of the ball screw spline unit involves mounting and dismounting of Axes 3 and 4 motor assemblies and timing belts. Also observe the cautions on each work.
- Because the motor, timing belt, nut and pulley are disconnected, the mechanical home point shifts and proper control cannot be done. To avoid this, home return operation is necessary after replacement of the ball screw spline unit. For the home return procedures, see “Section 8, Robot Home Point and Position Detector Error.”
- DO NOT pull out the ball screw shaft from the ball screw nut. Otherwise, the ball in the ball screw nut will drop and the ball screw nut integrated with the ball screw shaft cannot function any further.
- NEVER touch the ball screw spline unit with bare hand. Otherwise, the ball screw may be subjected to earlier rusting. Be sure to gloves when you want to tough it.

1) Disconnect the ball spline nut from the new ball screw spline unit.

2) Mount the axis 4 nut pulley on the ball spline nut with the hexagon socket head cap screws (M5 x 12 x 6 pcs.) and washers.
The bolts are difficult to tighten because the pulley rotates. Thus, tighten them while holding the pulley with pliers or the likes. In doing so, use a waste cloth to protect the pulley from scratches.

3) Mount the ball spline nut on Arm 2 with the hexagon socket head cap screws (M4 x 12 x 6 pcs.) and washers. When doing so, be careful with the orientation of the removal tap.

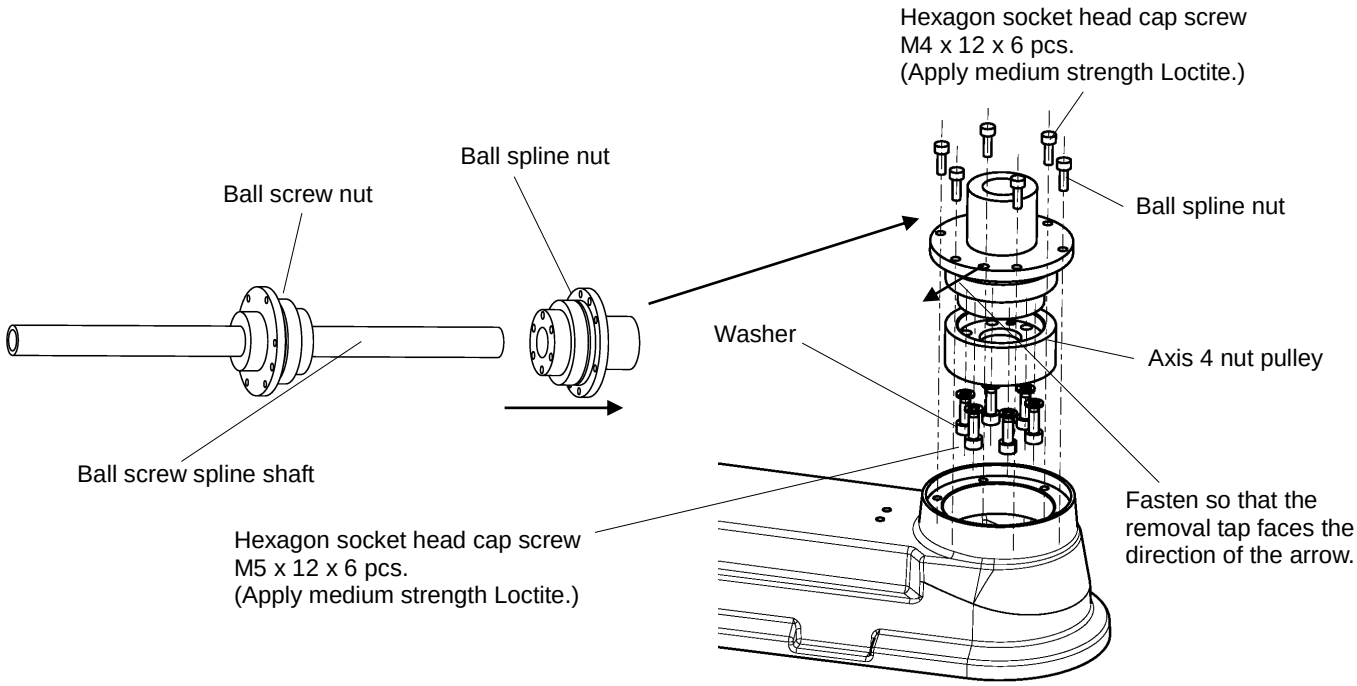


Fig. 3.41 Mounting ball spline nut (KHL-500, KHL-600, KHL-700)

4) Mount the axis 4 timing belt and axis 4 motor assembly, then adjust the belt tension. (See “Para. 3.5.4, Replacing Axis 4 Timing Belt.”)

5) Temporarily tighten the axis 4 bracket to Arm 2 with four (4) hexagon socket head cap screws (M4 x 16).

6) Secure the axis 3 nut pulley to the ball screw nut with four (4) hexagon socket head cap screws (M5 x 20) and washers.

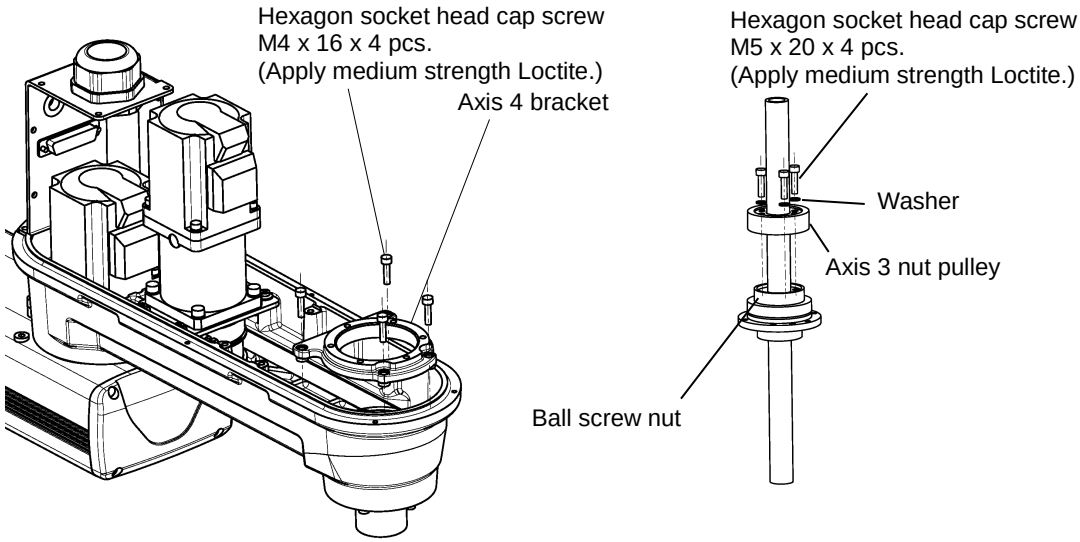


Fig. 3.42 Axis 3 bracket and pulley (KHL-500, KHL-600, KHL-700)

7) Mount the ball screw nut and the ball screw spline shaft together through the ball spline nut, and then mount it to the axis 3 bracket with six (6) hexagon socket head cap screws (M4 x 12). At this time, align the phases of both markings put on the tip of the ball spline nut and the ball screw spline shaft.

8) Mount a stopper at a position 42 mm from both the top and the bottom of the ball screw spline shaft.
When mounting each stopper, align its split line with the left end of the spline groove.

9) Manually move the shaft in the vertical direction. Make sure of its smooth operation. After that, hold the bracket so that it does not move, and tighten the bolt temporarily locking the 3rd-axis bracket.

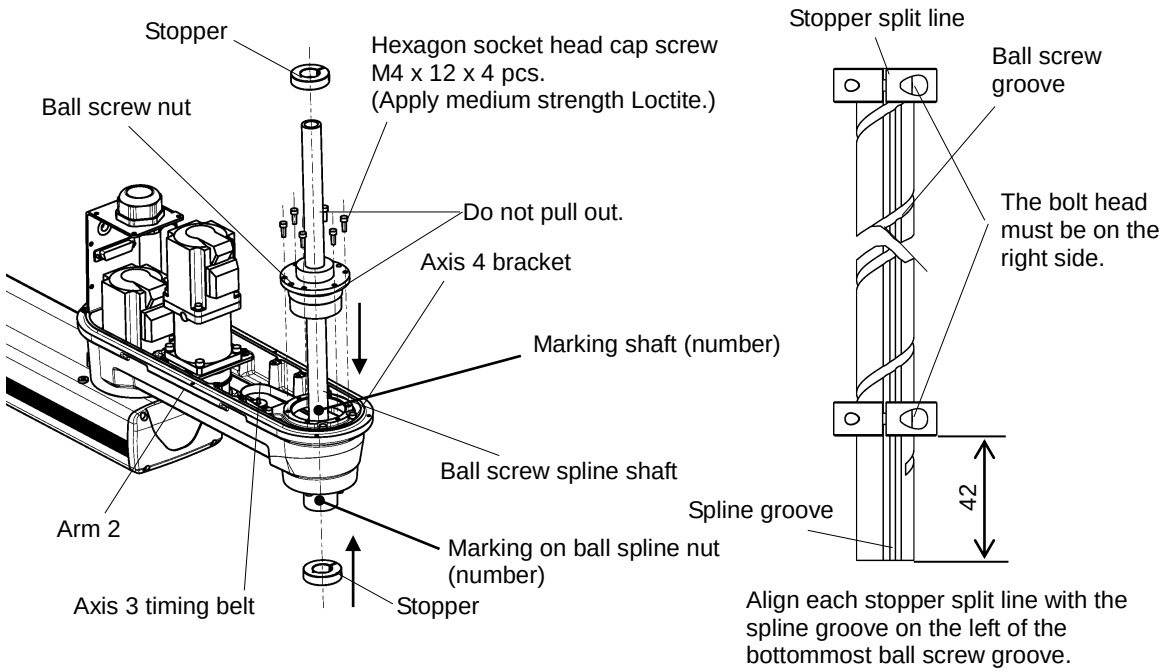


Fig. 3.43 Mounting ball screw spline nut (KHL-500, KHL-600, KHL-700)

10) Mount the axis 3 motor assembly, then adjust the belt tension. (See “Para. 3.5.3, Replacing Axis 3 Timing Belt.”)

11) Arrange the connectors and cables as originally set. (See the pictures you took beforehand.)

12) Perform home setting for Axes 3 and 4.
When performing home setting for Axis 4, align the stopper split line with the mating mark on the ball spline nut.
After home setting, remove the mating mark from the old ball spline nut, and attach it to the new one.

13) Turn on the power. Press the brake release switch in the servo off mode, and manually move the ball screw in the vertical direction. Make sure of its smooth operation.

14) Carry out a test operation of Axes 3 and 4 and make sure that each part operates properly.

15) Mount the arm 2 cover. Now replacement of the ball screw spline unit completes.

3.7 Reduction Gear Replacement

The reduction gear is to be replaced by our service engineer. If it is replaced by the customer, we will not guarantee any consequential trouble or accident.

DANGER

- The reduction gear should be replaced with a new one only after the controller power supply plug is removed. If the work is done while the power is connected, you may get an electric shock or the robot may malfunction, which is very dangerous.

CAUTION

- Because the reduction gear is disconnected, the mechanical home point shifts and proper control cannot be done. To avoid this, home return operation is necessary after replacement of the reduction gear. For the home return procedures, see “Section 5, Robot Home Point and Position Detector Error.”

3.7.1 Type of Reduction Gear

The reduction gears used in this robot are shown below.
When you place an order for the reduction gear for replacement, specify the robot model (KHL-500, KHL-600, KHL-700), axis name, type and our drawing number.

Table 3.9 Type of reduction gear (KHL-500, KHL-600, KHL-700)

Description	Axis name	Our drawing No.	Unit code
Reduction gear	Axis 1	S875237	Y610A3LW0
	Axis 2	S875238	Y610A3LX0
	Axis 4	S875239	Y610A3LY0

3.7.2 Reduction Gear Locations

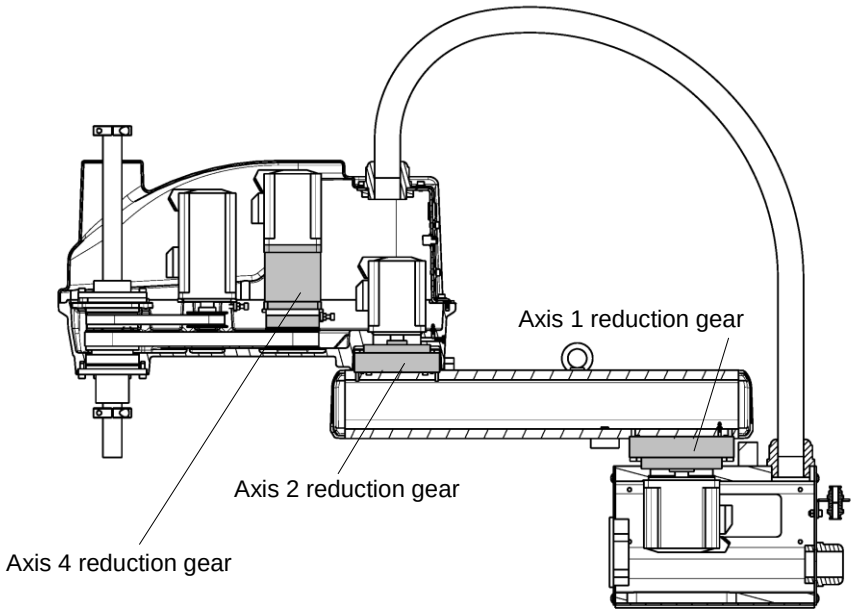


Fig. 3.44 Reduction gear locations (KHL-500, KHL-600, KHL-700)

3.7.3 Dismounting Axis 1 Reduction Gear

1) Remove the base front cover and the base side covers. (See “Para. 3.3.2, Base Covers.”)
2) Remove four (4) hexagon socket head cap screws (M5 x 16) and the washers that secure the axis 1 motor assembly, pull out the axis 1 motor assembly, and then remove the O-ring (CO0545).
(See “Para. 3.4.3, Dismounting Axis 1 Motor.”)
3) Remove sixteen (16) hexagon socket head cap screws (M4 x 20) that secure the base, and then remove Arm 1.

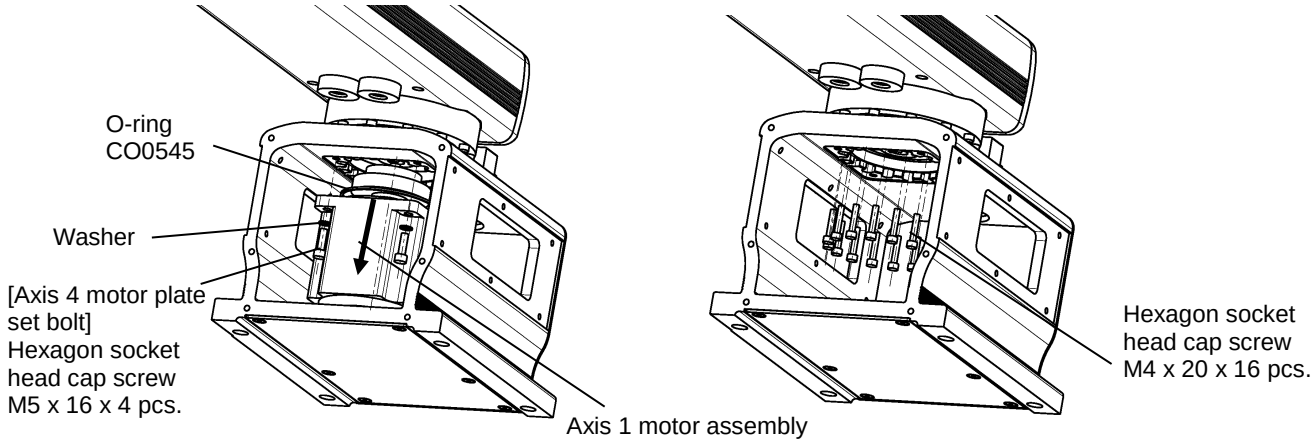


Fig. 3.45 Dismounting axis 1 motor assembly and Arm 1 (KHL-500, KHL-600, KHL-700)

! CAUTION

- Arm 1 should always be mounted and dismounted by two (2) or more persons. When removing the Arm 1 set bolts, take careful precautions because Arm 1 will drop. Also, if an excessively large impact is imposed on the arm, the robot will be damaged.

4) Remove twelve (12) hexagon socket head cap screws (M4 x 30) that secure the axis 1 reduction gear to Arm 1, and then remove the axis 1 reduction gear. Also remove the O-ring mounted in the groove of Arm 1 at this time. Also, remove the liquid gasket attached to the base mounting surface of the axis 1 reduction gear with the back of a cutter or a similar tool without damaging.

5) Remove the wave generator from the axis 1 motor. (See “Para. 3.4.3, Dismounting Axis 1 Motor.”)

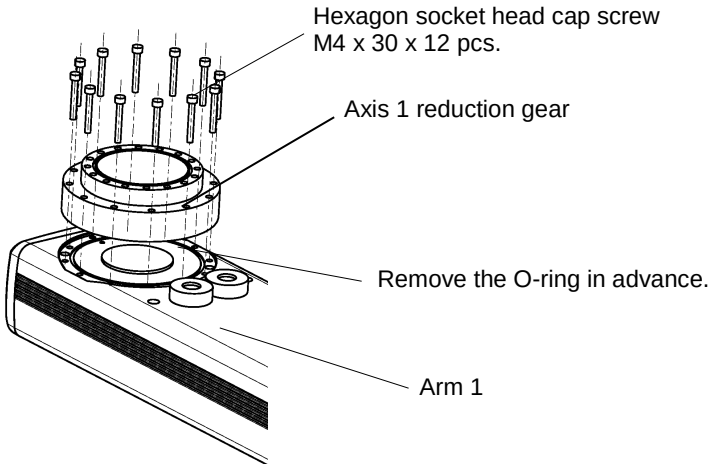


Fig. 3.46 Dismounting axis 1 reduction gear (KHL-500, KHL-600, KHL-700)

3.7.4 Mounting Axis 1 Reduction Gear

! CAUTION

- Handle the reduction gear with extreme care. If it drops or an unusually large external force is exerted on it, the reduction gear cannot function any further.
- Use the wave generator which is attached to the new reduction gear.
  If the old center gear is used as it is, abnormal noise will be caused, the service life will shorten or positioning accuracy will deteriorate due to incompatibility with the new reduction gear.
- Also use the “O” ring attached to the new reduction gear. Be sure to set the “O” ring. Unless the “O” ring is set, grease will leak from the axis 1 reduction gear set surface. When mounting the reduction gear, take careful precautions not to break the “O” ring.

Recommended grease	Maker
SK-1A	HDS

1) Mount a new wave generator provided as an accessory with a new reduction gear. For the mounting procedure, see “Para. 3.4.4, Mounting Axis 1 Motor.”)
2) Cleanly wipe off dusts and stains on the axis 1 reduction gear of Arm 1. Apply grease to an O-ring attached to the new reduction gear, and then mount it in the O-ring groove of Arm 1.
3) Secure the axis 1 reduction gear with twelve (12) hexagon socket head cap screws (M4 x 30).

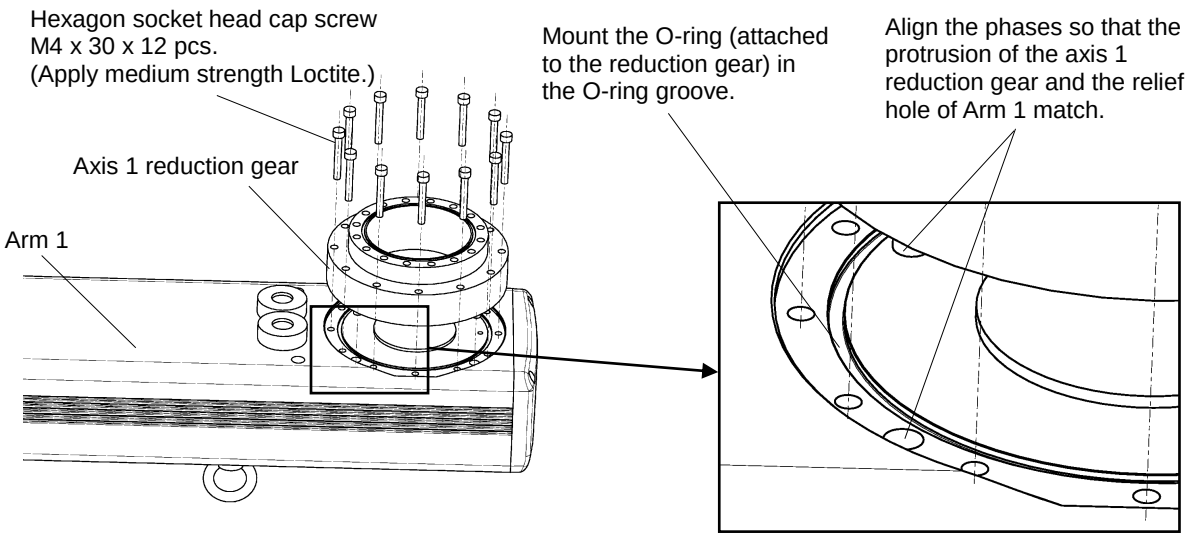


Fig. 3.47 Mounting axis 1 reduction gear (KHL-500, KHL-600, KHL-700)

4) Apply grease inside the 1st-axis reduction gear proper as shown on the diagram. Apply an adequate volume of grease on the wave generator side as well. Further, apply grease to the O-ring attached to the reducing gear, and insert the O-ring into the O-ring groove of the reducing gear.

Amount of grease filled in Axis 1
30 g

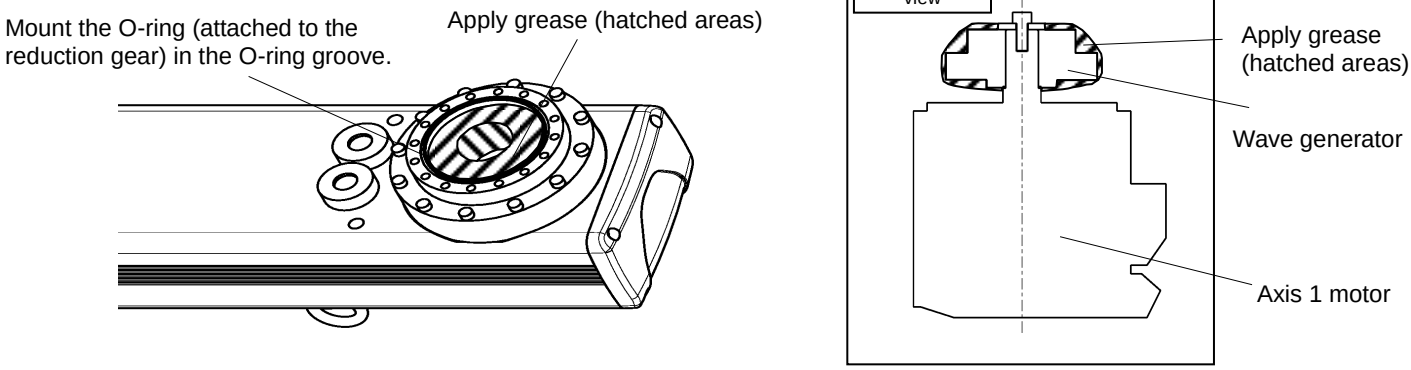


Fig. 3.48 Application of grease to axis 1 reduction gear (KHL-500, KHL-600, KHL-700)

! CAUTION

- Be sure to use the grease designated by CKD.
  Increase in internal pressure will adversely affect the starting torque and damage the internal seal. To avoid this, be sure to observe the grease filling volume.

5) Secure Arm 1 to the base with sixteen (16) hexagon socket head cap screws (M4 x 20). Apply grease to the O-ring (CO0545), and then mount it to the base groove side surface.

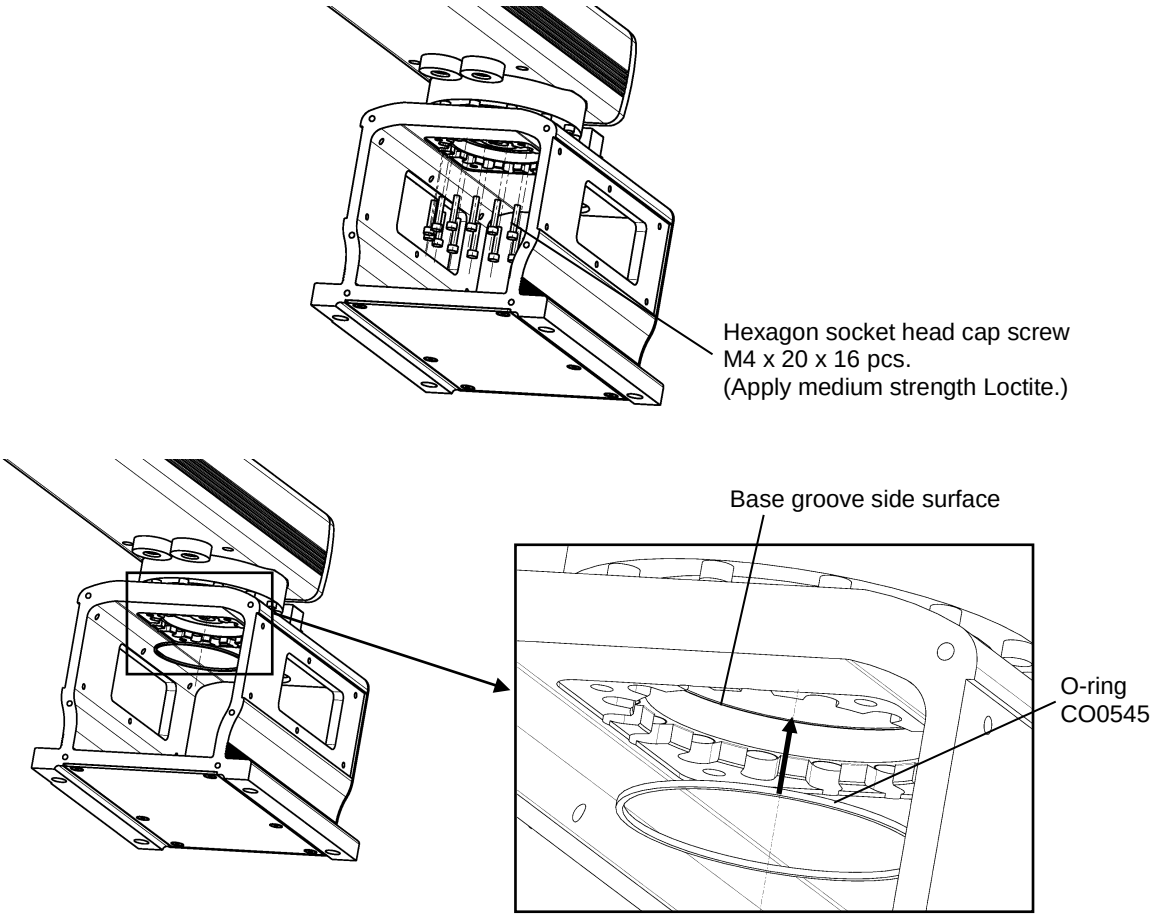


Fig. 3.49 Mounting arm 1 and O-ring (KHL-500, KHL-600, KHL-700)

6) Connect the connectors (J1AS and J1BS) of the cables.

7) Mount the axis 1 motor assembly. (See “Para. 3.4.4, Mounting Axis 1 Motor.”)

8) After changing Axis 1 motor, move Arm 1 by hand and check that there is no abnormal sound .

9) Mount the base front cover and the base side covers. (See “Para. 3.3.2, Base Covers.”)

10) Set up the axis 1 home position to complete axis 1 reduction gear replacement. Because the reduction gear is changed, home position settings of Axes 2 through 4 are required.

11) Carry out a test operation of Axis 1 to make sure that each part operates properly.

3.7.5 Dismounting Axis 2 Reduction Gear

1) Remove the arm 2 cover. (See “Para. 3.3.1, Arm 2 Cover.”)

2) Cut the cable ties of the cables with nippers. It is recommended to take photos of the cable installation positions and the locations where cable ties are used so that these locations can be restored when needed.

3) Remove J2AS and J2AP (axis 2 power drive cables), J2BS and J2BP (axis 2 encoder cables).

5) Remove the harness guide and the support plate, and then remove the axis 2 motor assembly. Also remove the O-ring (CO0583A) of the O-ring groove. (See “Para. 3.4.5, Dismounting Axis 2 Motor.”)

6) Remove twelve (12) hexagon socket head cap screws (M3 x 20) that secure Arm 2 and the reduction gear.

7) Remove twelve (12) hexagon socket head cap screws (M3 x 30) that secure the axis 2 reduction gear mounted to Arm 1, and then remove the axis 2 reduction gear. At this time, remove the O-ring mounted in the O-ring groove of Arm 1.

8) Remove the wave generator from the axis 2 motor. (See “Para. 3.4.5, Dismounting Axis 2 Motor.”)

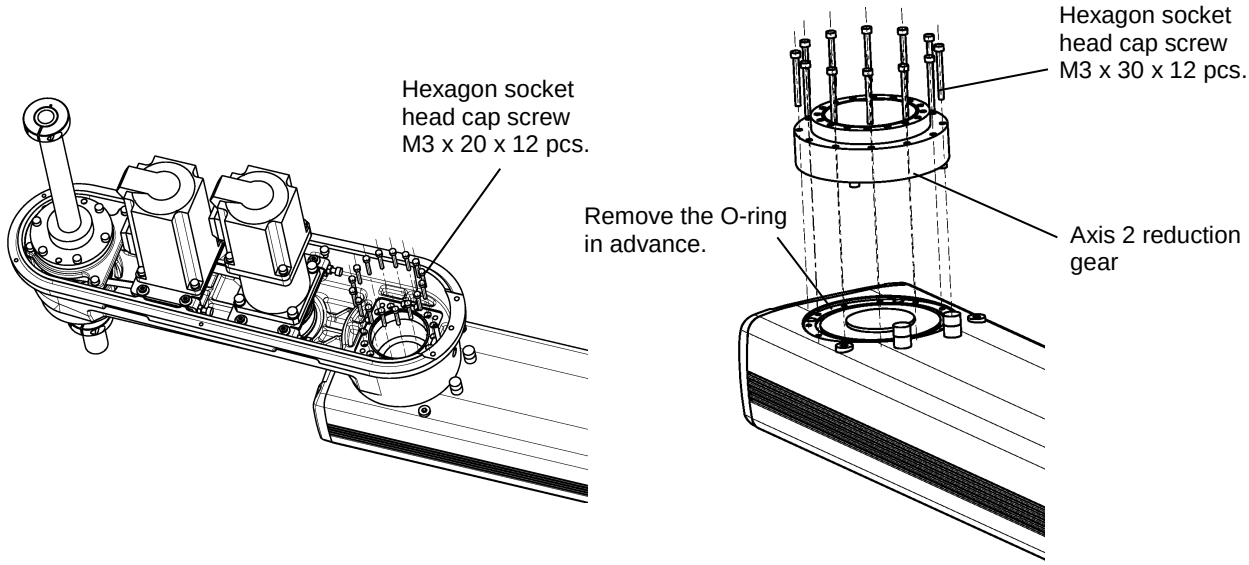


Fig. 3.50 Dismounting axis 2 reduction gear (KHL-500, KHL-600, KHL-700)

! CAUTION

- Arm should always be mounted and dismounted by two (2) or more persons. When removing Arm set bolts, take careful precautions because Arm will drop. Also, if an excessively large impact is imposed on Arm, the robot will be damaged.

3.7.6 Mounting Axis 2 Reduction Gear

! CAUTION

- Handle the reduction gear with extreme care. If it drops or an unusually large external force is exerted on it, the reduction gear cannot function any further.
- Use the wave generator which is attached to the new reduction gear.
- Also use the “O” ring attached to the new reduction gear. Be sure to set the “O” ring. Unless the “O” ring is set, grease will leak from the axis 2 reduction gear set surface. When mounting the reduction gear, take careful precautions not to break the “O” ring.

1) Mount the wave generator attached to the new reduction gear to the axis 2 motor. (See “Para. 3.4.6, Mounting Axis 2 Motor.”)
2) Cleanly wipe off dusts and stains on the reduction gear of Arm 1.
   Apply grease to an O-ring attached to the new reduction gear, and then mount it in the O-ring groove of Arm 1.
3) Secure the axis 2 reduction gear to Arm 1 with twelve (12) hexagon socket head cap screws (M3 x 30).
4) Apply grease to the axis 2 reduction gear. (See “Para. 3.7.4, Mounting Axis 1 Reduction Gear.” However, the amount of grease filled is different from that for the axis 1 reduction gear. Regarding the filled amount for the axis 2 reduction gear, see the following.)

Amount of grease filled in Axis 2
15 g

5) Apply grease to the other O-ring attached to the new reduction gear, and then mount it in the O-ring groove of the axis 2 reduction gear.

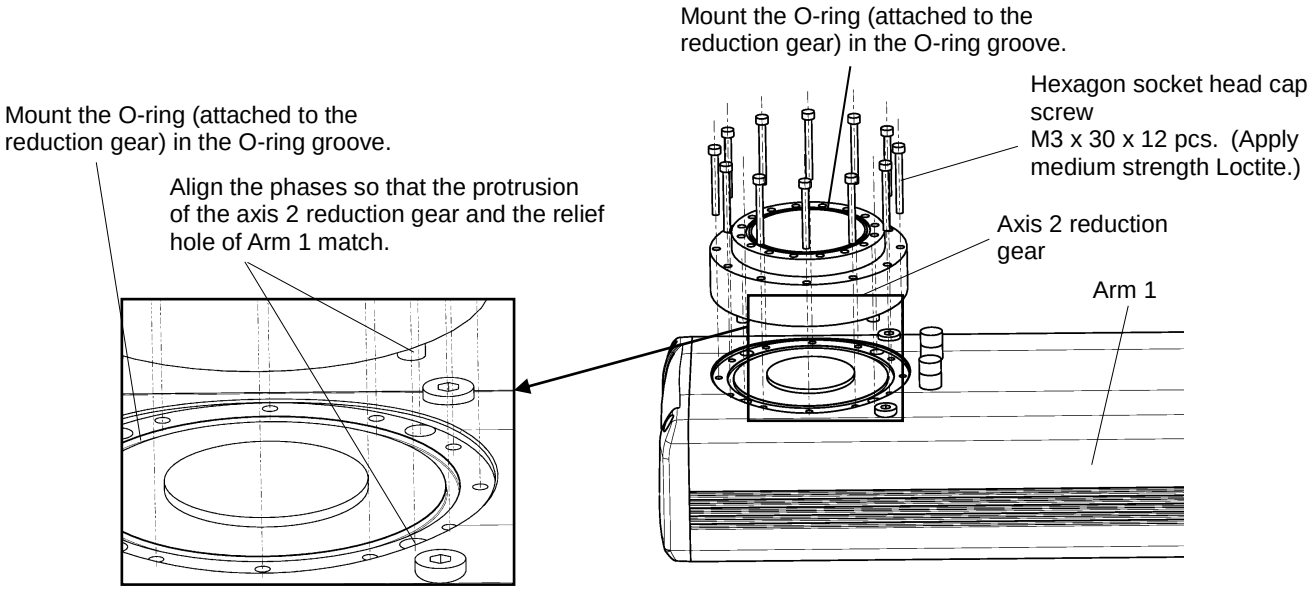


Fig. 3.51 Mounting axis 2 reduction gear (KHL-500, KHL-600, KHL-700)

6) Secure Arm 2 to the new reduction gear with twelve (12) hexagon socket head cap screws (M3 x 20).

7) Apply grease to the O-ring (CO0538A), and then mount it in the O-ring groove of Arm 2.

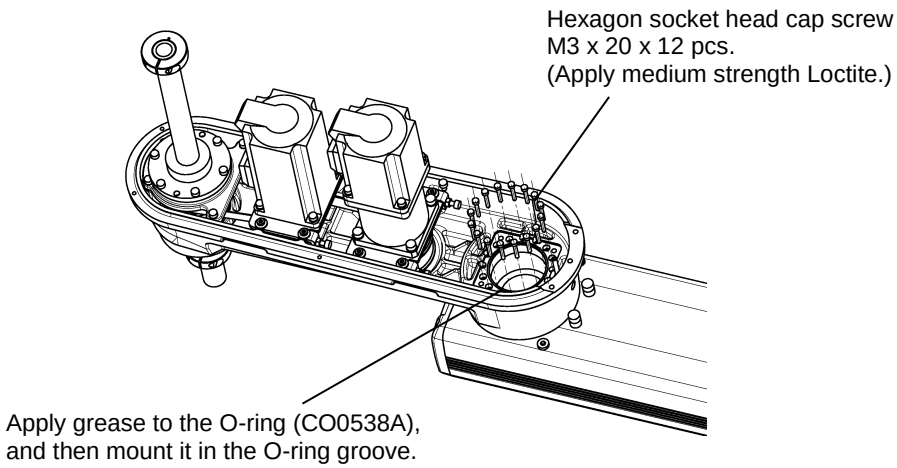


Fig. 3.52 Mounting arm 2 (KHL-500, KHL-600, KHL-700)

8) Mount the axis 2 motor assembly, the harness guide and the support plate. Put back the cables to the original locations, and then mount the arm 2 cover.

9) Move Arm 2 by hand and check that there is no abnormal sound before turning on the power.

10) Set up the home positions of axes 2 to complete axis 2 reduction gear replacement.

3.7.7 Replacing Axis 4 Reduction Gear

! CAUTION

- Handle the reduction gear with extreme care. If it drops or an unusually large external force is exerted on it, the reduction gear cannot function any further.
- Be sure to tighten the coupling connecting the reduction gear and motor shaft.

1) Remove the arm 2 cover. (See “Para. 3.3.1, Arm 2 Cover.”)

2) Cut the cable ties of the cables with nippers or the like, and remove J4AS and J4AP (axis 4 power drive cables), J4BS and J4BP (axis 4 encoder cables). It is recommended to take photos of the cable installation positions and the locations where cable ties are used so that these locations can be restored when needed.

3) Disconnect the axis 3 motor assembly and axis 4 motor assembly only from Arm 2. Other parts need not be removed.

4) Remove the cap attached to the lateral side of the axis 4 reduction gear, then loosen the coupling bolt (M4) securing the axis 4 motor shaft and the input shaft of the axis 4 reduction gear.

5) Remove the hexagon socket head cap screws (M4 x 12 x 4 pcs.) and washers securing the motor, and draw out the axis 4 motor upward.

6) While holding the axis 4 motor pulley with pliers or the likes, remove the hexagon socket head cap screw (M4 x 12 x 6 pcs.) to remove the pulley. In doing so, use a waste cloth (or the like) as a cushion to protect the pulley from scratches.

7) Remove the hexagon socket head cap screws (M5 x 16 x 4 pcs.) and washers securing the axis 4 motor plate and reduction gear to the motor base, then dismount the reduction gear.

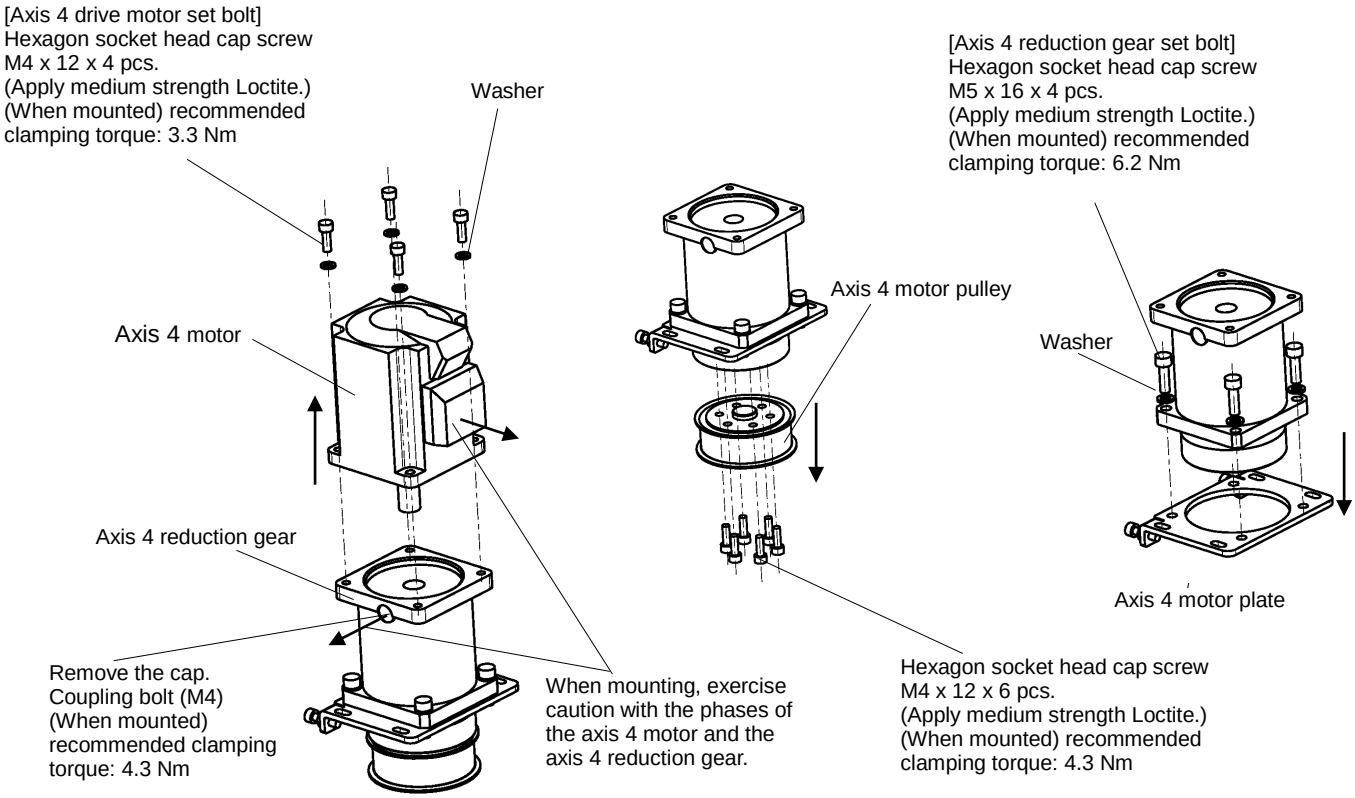


Fig. 3.53 Replacing axis 4 reduction gear (KHL-500, KHL-600, KHL-700)

8) Assemble the new reduction gear, motor and pulley in the reverse order of Steps 3) to 6) above. Be careful with the phases of the axis 4 motor, the axis 4 reduction gear and the axis 4 motor plate at this time.

9) Assemble the axis 4 motor assembly and timing belt according to Steps 11) through 15) of “Para. 3.5.4, Replacing Axis 4 Timing Belt” above.

10) Mount the arm 2 cover. Now replacement of the axis 4 reduction gear completes.

Table of Contents

＜確認用＞Tables and Drawings

4. Maintenance of Controller (KSL3000)

4.1 Cautions on Maintenance and Inspection

When performing maintenance and inspection of the controller, follow the items given below so that the work can be carried out safely.

! DANGER

- If the power remains connected, the servo power printed board, servo printed board and switching power supply are charged, and touching them could lead to electric shocks. To avoid this, be sure to remove the power supply plug before starting the work.

! CAUTION

- Before removing the controller cover for maintenance or inspection, be sure to remove the power supply plug of the controller from the power source.
  Also, turn off the power breaker when connecting or disconnecting the power cable.
- DO NOT touch the servo driver for at least two (2) minutes after the power supply has been removed. The large-capacity capacitor in the servo driver may be charged with voltage, and touching the servo driver could lead to electric shocks.
- DO NOT disconnect the battery connector at other than battery replacement. Otherwise, files saved in the memory may be lost.

4.2 Layout of Controller Parts

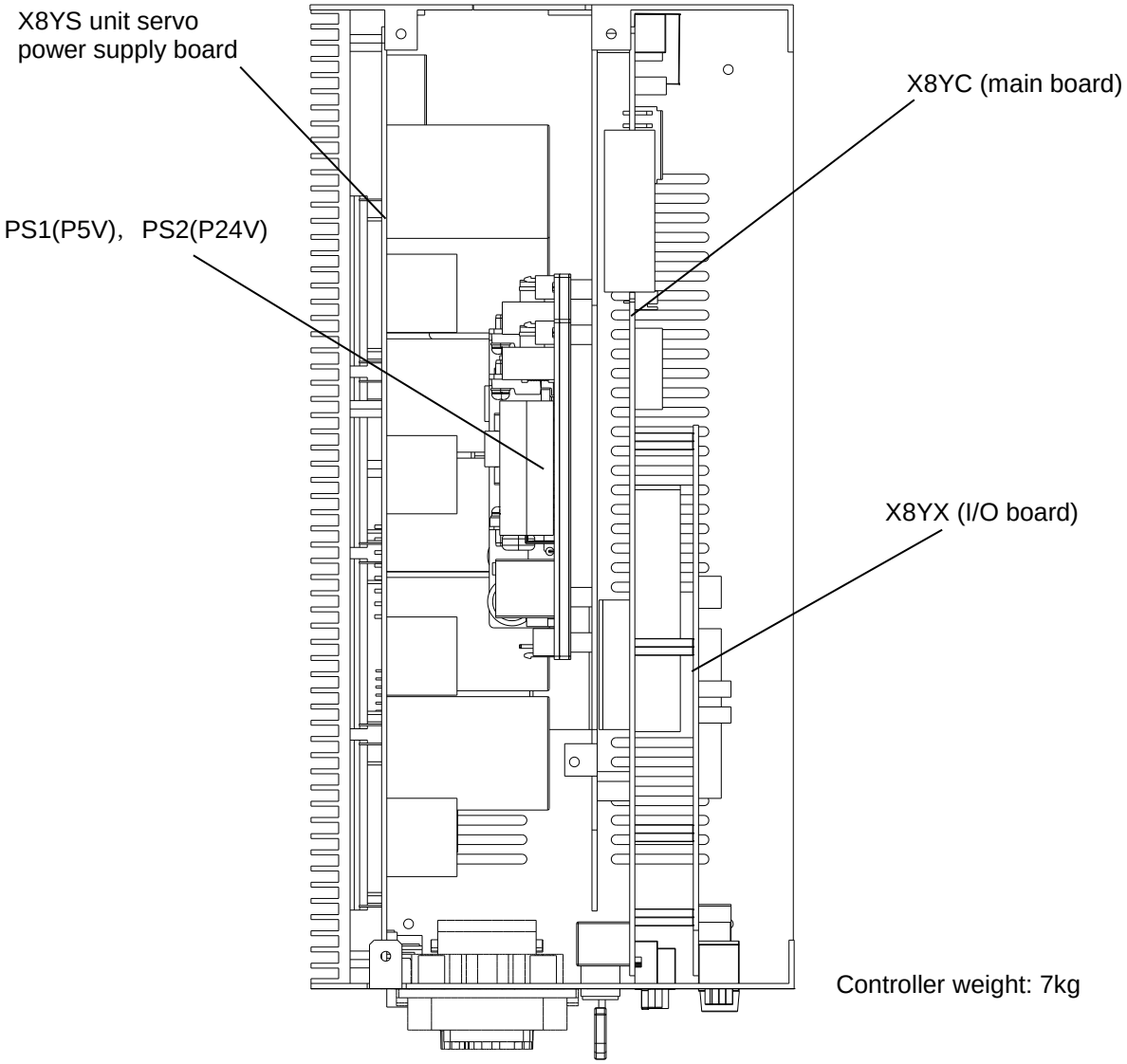


Fig. 4.1 Layout of controller parts (KSL3000)

Table 4.1 Controller parts (KSL3000)

Part name	Descriptions
PS1, PS2	PS1 (P5V), PS2 (P24V) output switching power supply
X8YC	Main control printed board
X8YX	I/O output printed board
X8YS	Servo power module

4.3 Maintenance Procedures

4.3.1 Check of Controller Air Vent Holes

If the air vent holes are blocked, the controller may overheat and malfunction. To avoid this, perform check on the air vent holes to make sure that air is flowing freely through them.

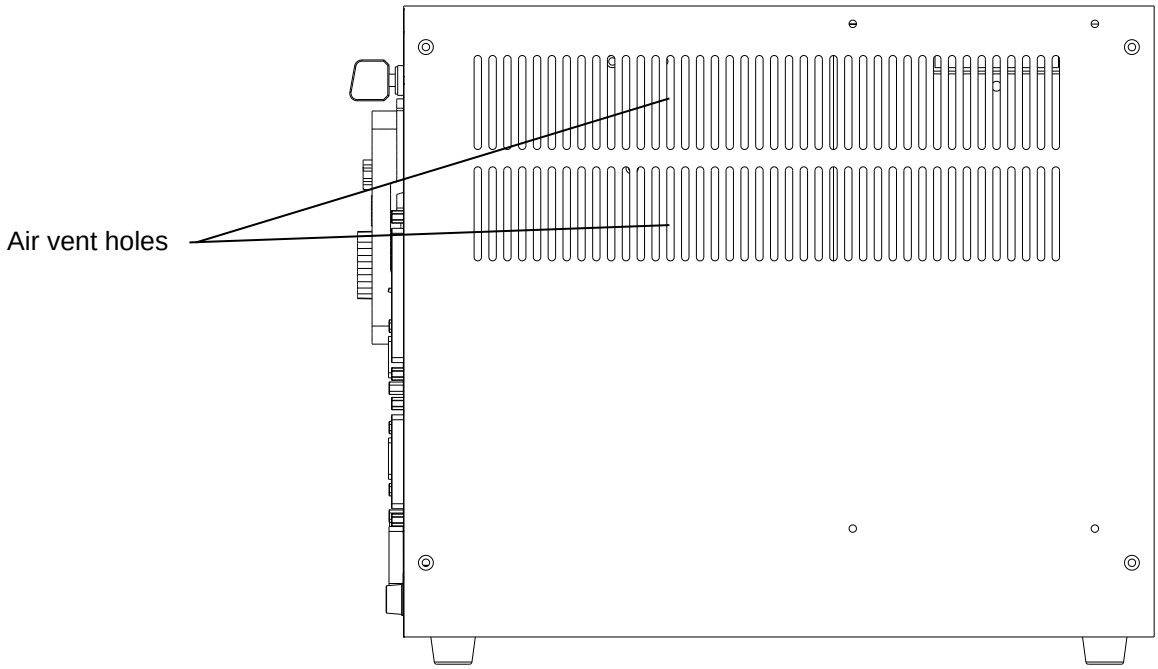


Fig. 4.2 Controller side views (KSL3000)

1) If there is any obstacle, move it away from the air vent hole so that air flow is not blocked.

2) Make sure that no contaminant is left on the air vent holes. If any contaminant is left on the vent hole, remove it.

4.3.2 Check of Safety Devices for Function

Make sure that the EMERGENCY stop pushbutton switches equipped on the teach pendant work properly. Also make sure that the safety devices controlled by the external operation input signals work correctly.

1) Make sure that the EMERGENCY (emergency stop) switch provided on the teach pendant functions properly.
   a) Turn around the key at front of controller for selecting the TEACH.
   b) Turn the EMERGENCY switch [1] clockwise and make sure that the EMERGENCY switch [1] turns off.
   c) Press the SERVO ON switch [2] on the teach pendant to turn on the servo power while keeping the ENABLE switch [3] at the neutral position, and make sure that the SERVO ON LED [2] is illuminated.

      Note: The servo power cannot be turned on in the TESTRUN mode.

   d) Press the EMERGENCY STOP switch [1] on the teach pendant and make sure that the servos are turned off. The SERVO ON LED [2] goes out.

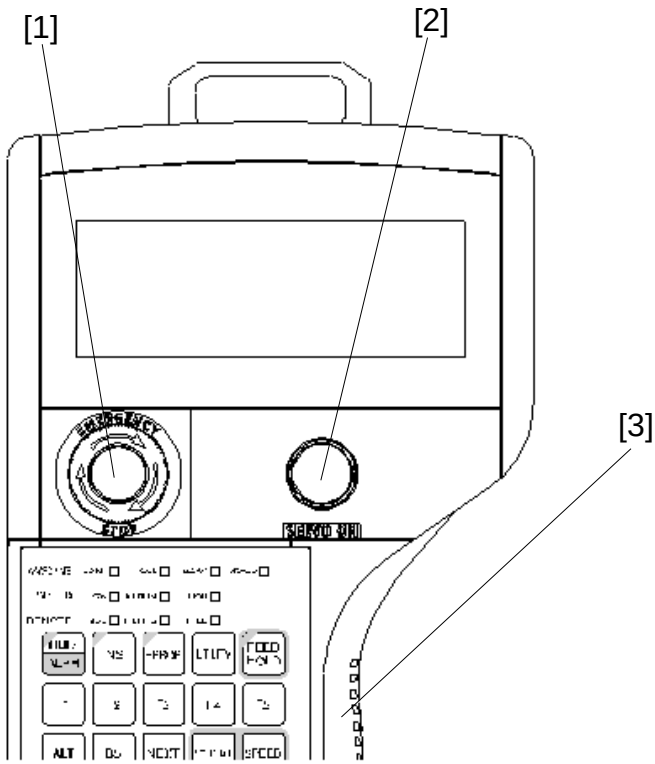


Fig. 4.3 EMERGENCY STOP switch provided on teach pendant (KSL3000)

At this time, make sure that the EMERGENCY STOP switch [1] remains depressed.

e) Turn the EMERGENCY STOP switch [1] clockwise and make sure that the EMERGENCY switch [1] turns off.

2) Make sure that the safety devices controlled by the external operation input signals work properly.

a) Connect the power supply plug to the power source to turn on the servo power. Then turn on (or trip) the safety devices connected with external operation input signal “emergency stop” (such as external emergency stop switch, photoelectric type sensing safety device and foot switch) to make sure that the servo power is turned off.

b) Set ON the safety devices connected with external operation input signal “low speed command”, and make sure that each signal functions properly.

4.3.3 Battery Replacement

The memory equipped on the X8YC printed board of the robot controller is backed up by a lithium battery to save the data. Replace the battery every five (5) years. The lithium battery will turn its life when used for a predetermined time. If it is used, neglecting the life, the battery voltage will drop to below the voltage required for keeping the memory data, resulting in the data being lost and faults caused by leakage of the battery liquid.

If the following alarm has occurred, replace the battery with a new one.

- 1–145 MAIN Battery alarm

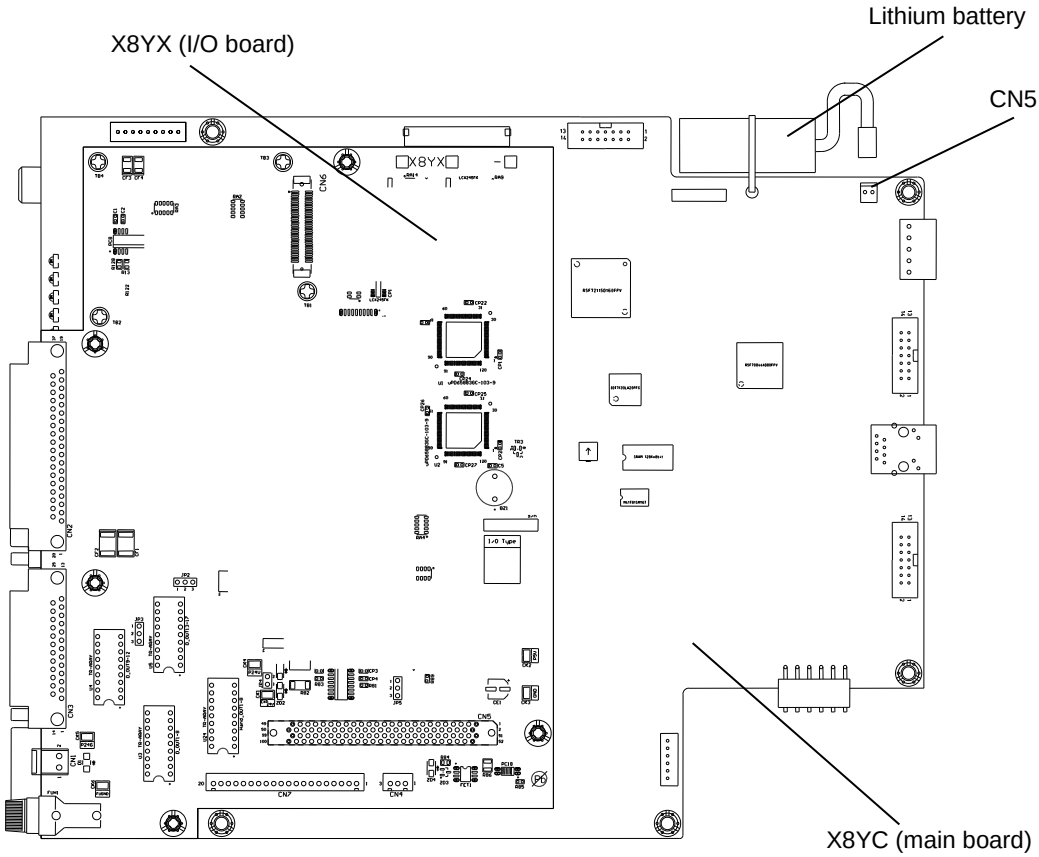


Fig. 4.4 Location of lithium battery (KSL3000)

Table 4.2 Battery replacement (KSL3000)

Type of battery	Manufacturer	Battery service life
ER6C WK27	Hitachi Maxell	10 years (at room temperature)

Note: The battery life is ten (10) years at the room temperature. As it differs with the external environment such as operating temperature and humidity, we recommend to replace the battery every five (5) years.
Only the battery shown in the table above should be used. As this is an exclusive battery, contact CKD at order entry.

[Battery replacement procedures]

1) If the battery is to be kept removed for more than one (1) minute, copy all programs and various parameters stored in the internal memory to the personal computer. In the worst case, all memory data are lost.
2) Disconnect the controller's power plug from the power supply.
3) Have a new battery ready, remove eight (8) countersunk screws (M3 x 6) that secure the cover, and then remove the cover from the main body.
4) Remove the battery from the cable ties securing the battery.
(For the battery position, see Fig. 4.4.)
5) Remove the battery connector from CN5 of the X8YC board. Immediately connect the connector of the new battery to CN5. (If the battery is kept removed for more than one (1) minute, all memory data are lost.)
Even if not used, the lithium battery capacity decreases by natural discharge. Use a lithium battery which is within three (3) years (kept at the room temperature) from purchasing.
6) Secure the battery connected to CN5 with cable ties.
7) Using countersunk screws (M3 x6 x 8 pcs.), mount the cover on the controller.
8) If the battery is kept removed for more than one (1) minute, connect the power supply plug of the controller to the power source and load the USB memory or personal computer in which the TSPC (option) is already installed.
If the controller has detected the battery voltage drop alarm even before the five (5)-year replacement period, replace the battery immediately.

DANGER

- Waste battery should be disposed of according to the user's in-house regulations. NEVER drop the battery into fire. NEVER short-circuit, charge, disassemble or heat it. Otherwise, liquid leakage or rupture may be caused.

4.3.4 Replacement of Switching Power Supply Unit

The life of the switching power supply unit (5 VDC/24 VDC) used in the robot controller differs with the operating conditions. This unit uses an aluminum electrolytic capacitor, and if the load current is large, the running time is long and the ambient temperature is high, the life will reduce.
As the life varies largely with the user's operating conditions (5 to 10 years), replace the power supply unit every five (5) years for preventive maintenance.

[Replacement procedures]

1) Turn off the power breaker and disconnect the power supply plug from the power source.
2) Disconnect the ACIN connector from the controller.
3) Remove the key from the controller.
4) Remove eight (8) countersunk screws (M3 x 6) that secure the cover, and then remove the cover from the main body.

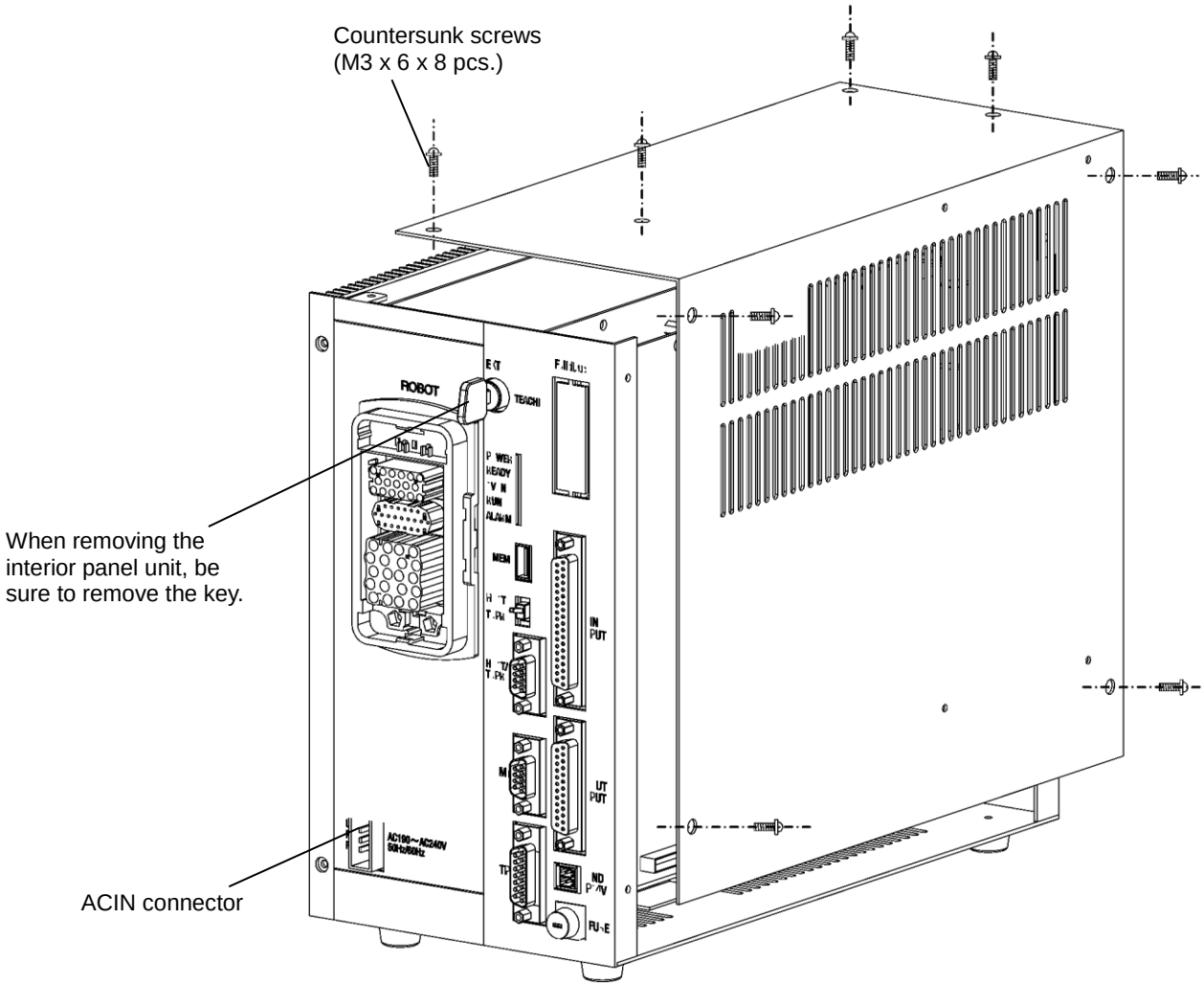


Fig. 4.5 Removing cover (KSL3000)

5) Remove the DC cable (blue and red), the SVIF cable (blue) and the encoder cable (blue) connected to the X8YC (main board) as well as the hand I/O cable (blue) and the brake cable (blue) connected to the X8YX (I/O board).

6) Remove the cables (red x 1 line, blue x 1 line, black x 2 lines) connected to the PS1 and the PS2.
(See Fig. 5.9.)

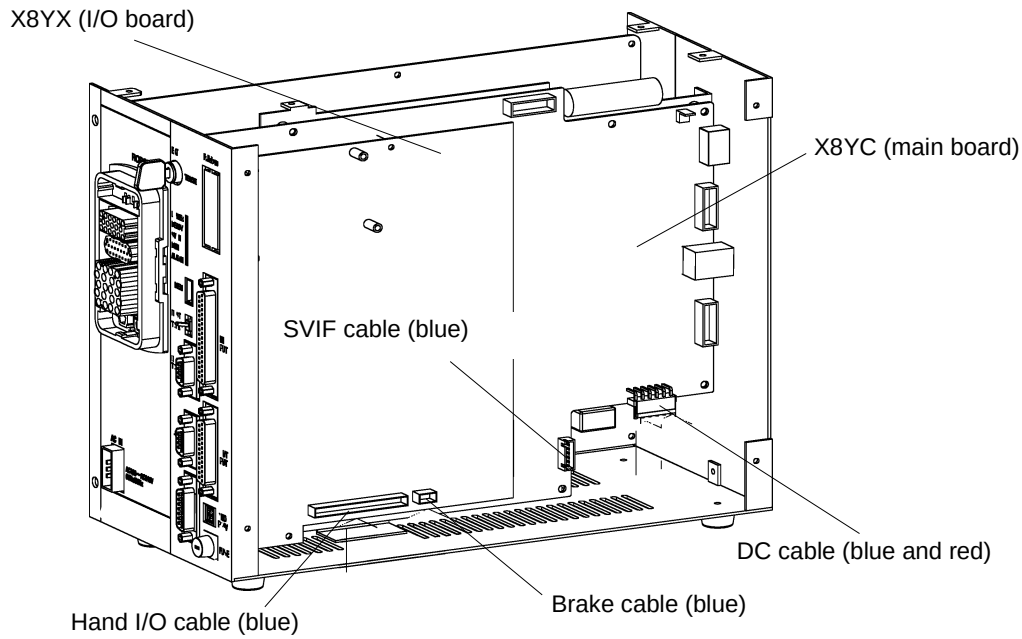


Fig. 4.6 Controller interior (KSL3000)

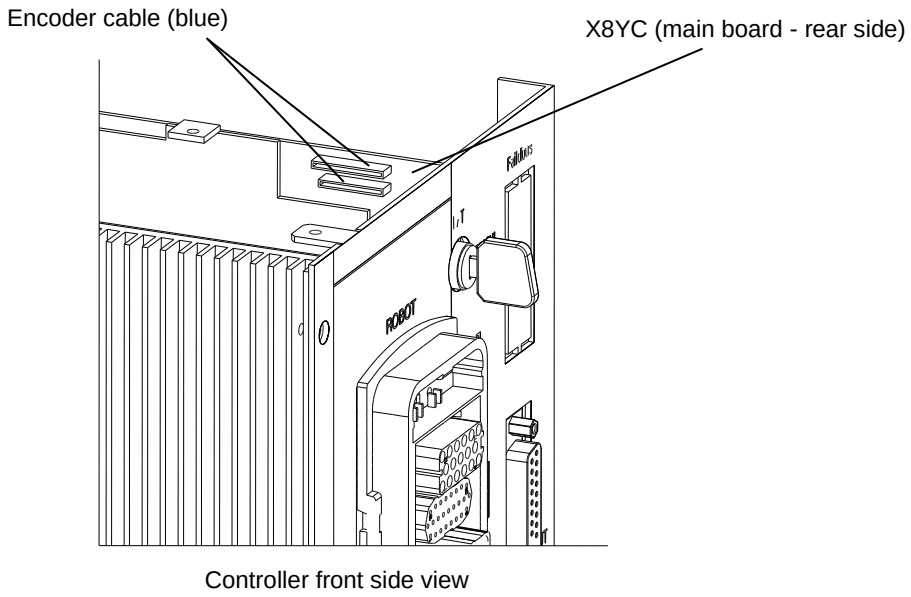


Fig. 4.7 Controller interior (KSL3000)

7) Remove one (1) countersunk screw (M3 x 6) that secures the interior panel unit. Pull out the interior panel unit toward the rear of the controller.
When removing the interior panel unit, be sure to remove the key.

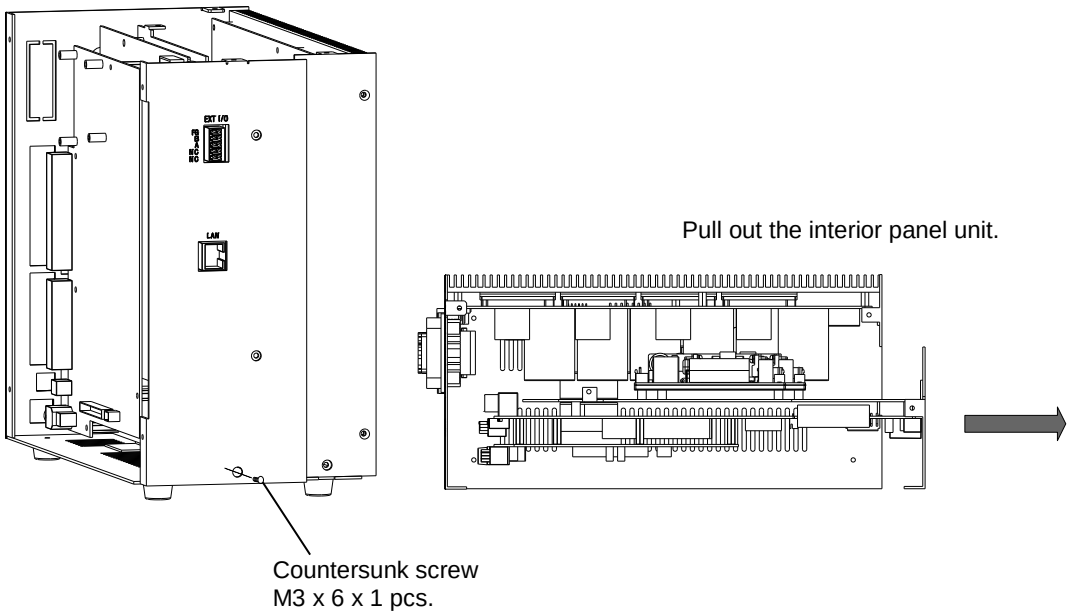


Fig. 4.8 Removing interior panel unit (KSL3000)

8) Remove four (4) sems screws (M3 x 8) that secure each of the switching power supplies (PS1, PS2), and then remove the switching power supplies from the interior panel unit.

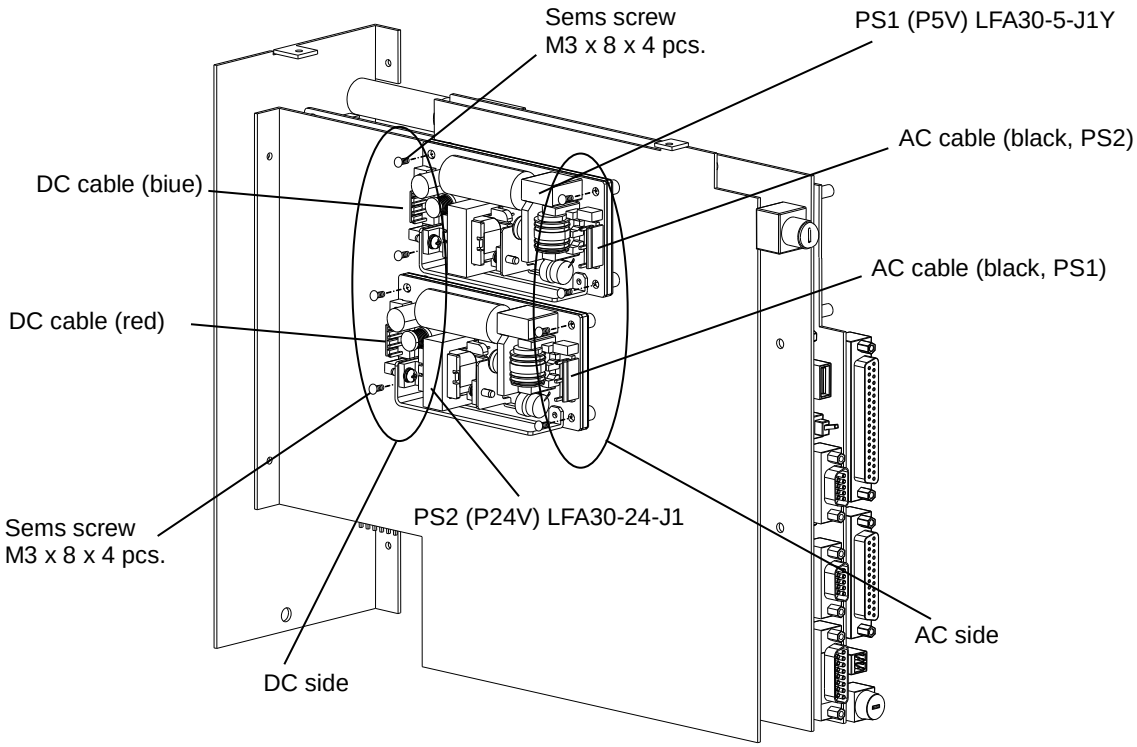


Fig. 4.9 Side view of interior panel unit assembly (KSL3000)

9) Using four (4) sems screws (M3 x 8), secure each of the new switching power supplies to the main body.
Note) The PS1 and PS2 switching power supplies have the same installation pitch. Never install the PS1 and the PS2 upside down or right and left in reverse.

10) Attach a cable to each of the PS1 and the PS2. (See Fig. 4.9.)
Note) On the PS1, connect the DC cable (red) to the DC side and the AC cable (black, indicated as PS1) to the AC side and, on the PS2, connect the DC cable (blue) to the DC side and the AC cable (black, indicated as PS2).

11) Insert the removed interior panel unit into the controller, and then secure it with one (1) countersunk screw (M3 x 6).

12) Connect the DC cable (blue and red), the SVIF cable (blue) and the encoder cable (blue) to the X8YC (main board) and, also, connect the hand I/O cable (blue) and the brake cable (blue) to the X8YX (I/O board). (See Fig. 4.6.)

13) Mount the cover to the main body using eight (8) countersunk screws (M3 x 6).

4.3.5 Replacement of Fuse (X8YX Printed Board)

If the current exceeding the specified current has run through the I/O unit, the fuse of the front of the controller is blown out. If the alarm saying “I/O Fuse Broken (8–273)” is displayed, replace the fuse with a new one.
If the fuse of the output module has been blown out, examine and identify a fault circuit, remedy the cause, then replace the fuse.

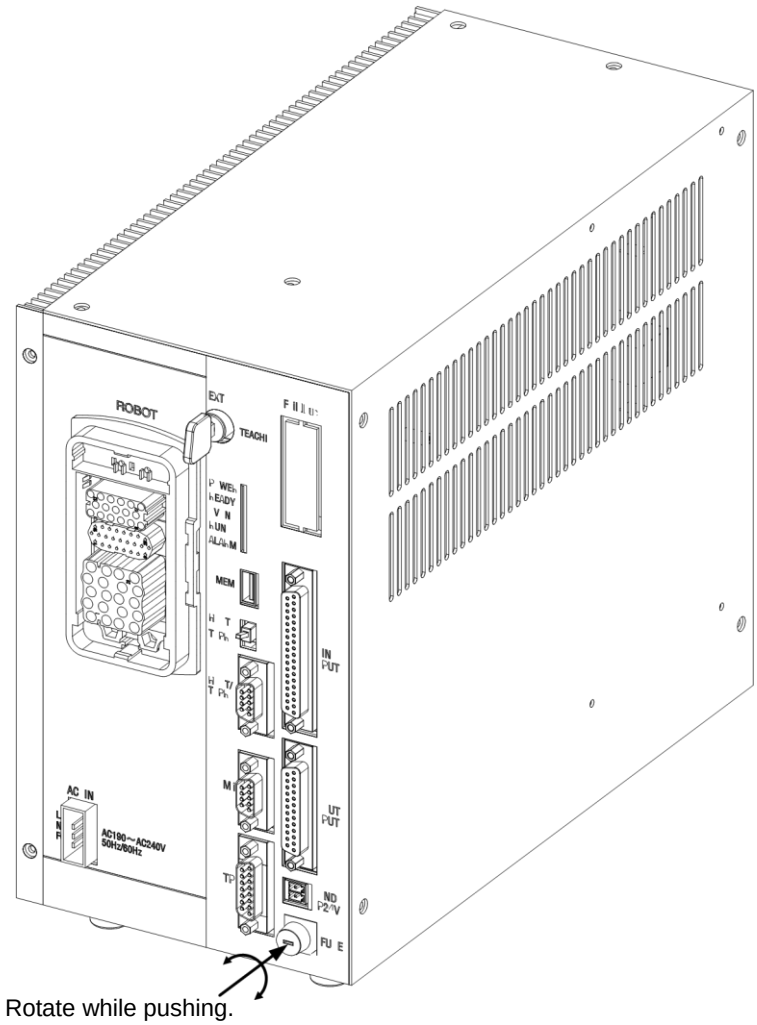


Fig. 4.10 Changing fuse (KSL3000)

Table 4.3 Fuse replacement (KSL3000)

Type of fuse	Manufacturer
51NM030H	PICO

[Replacement procedures]

1) Remove the power supply plug of the controller from the power source.
2) Remove the fuse holder shown in the above figure. (To release the lock, push and turn the holder 90° counterclockwise.)
3) Remove the fuse and set a new fuse in the fuse holder.
4) Mount the fuse holder. (To lock the holder, push and turn the holder 90° clockwise.)
5) Connect the power supply plug of the controller to the power source and make sure that no error will occur.

4.3.6 Replacement of Output ICs (X8YX Printed Board)

If the current exceeding the specified current has run through the output unit, the transistor output ICs on the X8YX printed board are damaged.
When this happens, replace the ICs.
Before the replacement, examine and identify an fault circuit, remedy the cause, then replace the ICs.
The relationship between the output ICs and output signals is shown below.

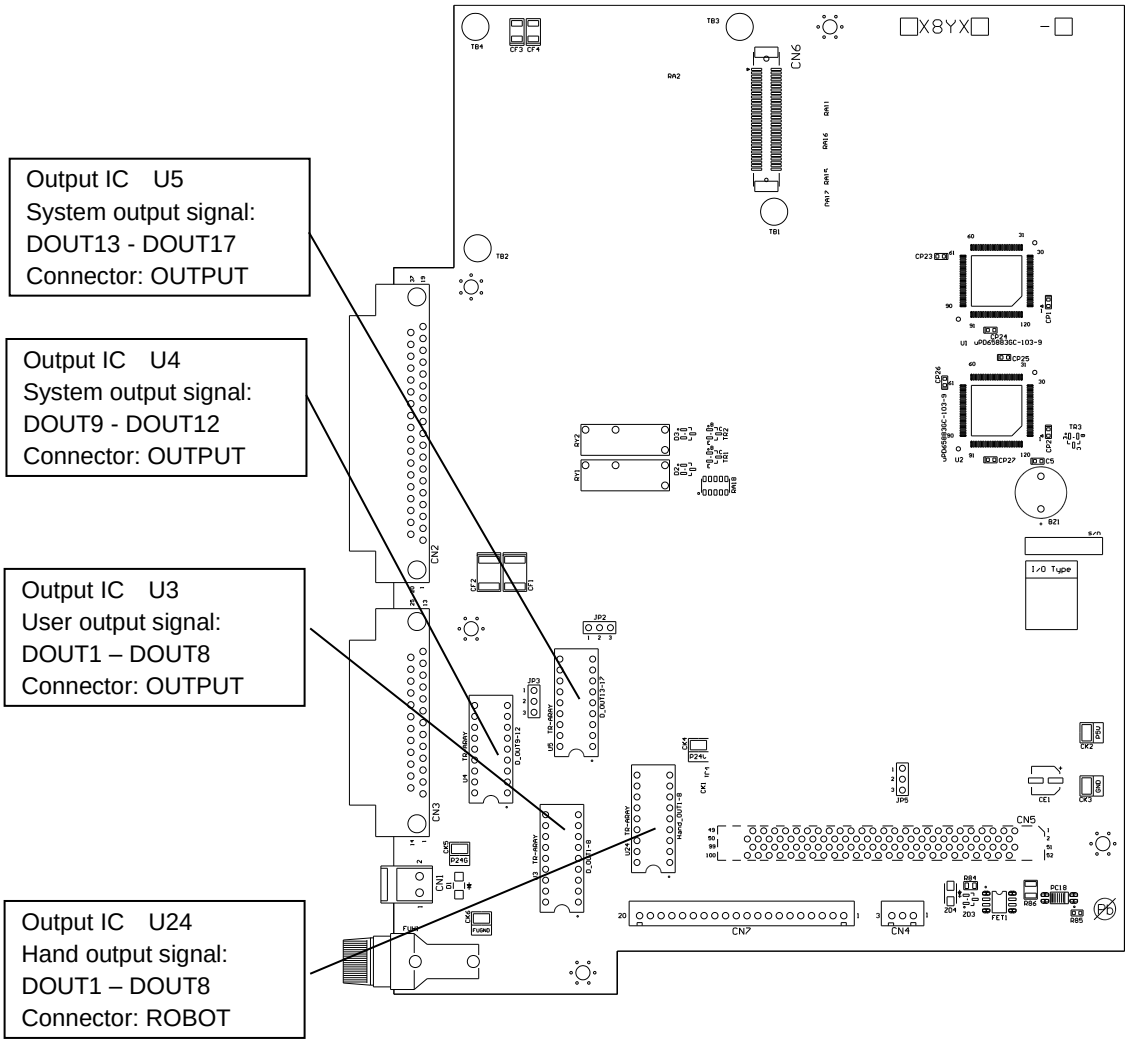


Fig. 4.11 I/O Board (KSL3000)

There are two types of transistor output ICs. Refer to the following for the output types.

Table 4.4 Transistor output ICs (KSL3000)

	Output type	Transistor output IC type	Maker
(1)	Type-N	TD62084APG	Toshiba
(2)	Type-P	M54562WP	Mitsubishi Electric

[Replacement procedures]

1) Turn off the breaker for power supply.

2) Disconnect the ACIN connector from the controller.

3) Remove eight (8) countersunk screws (M3 x 6) that secure the cover, and then remove the cover from the main body.

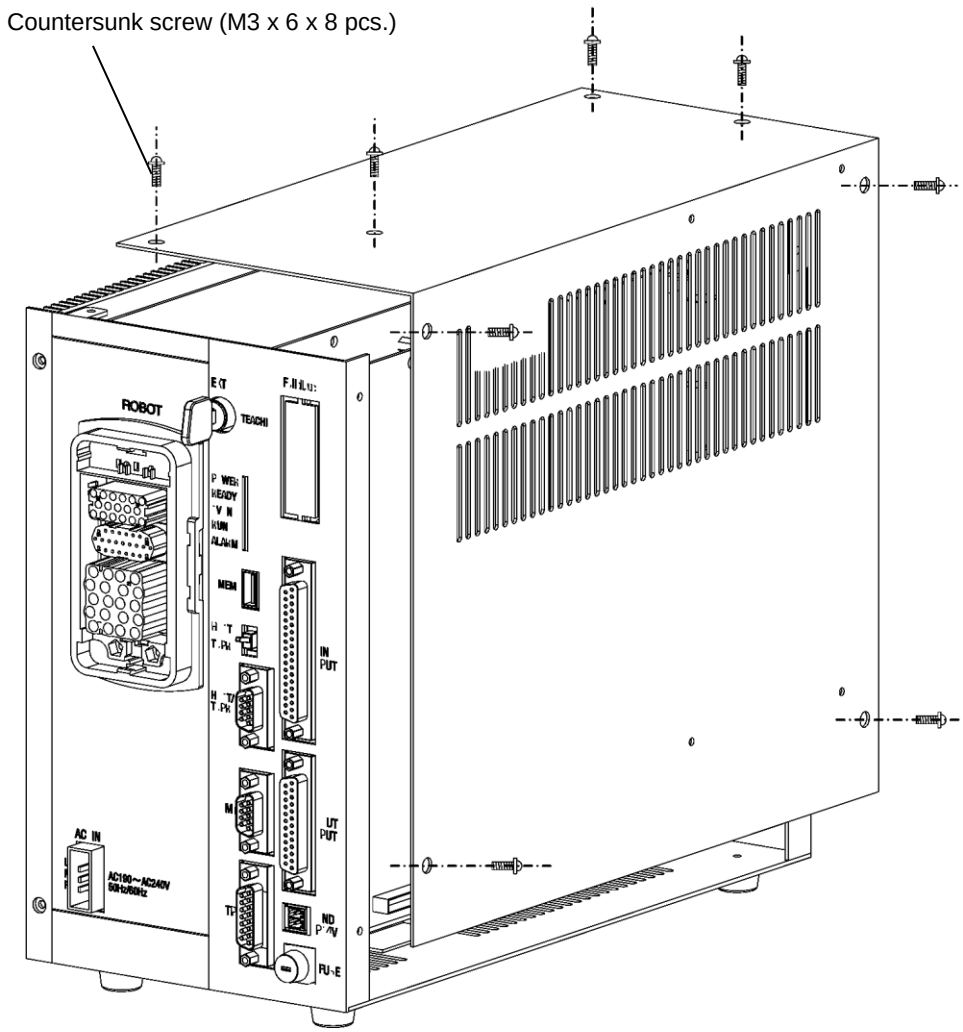


Fig. 4.12 Removing cover (KSL3000)

4) Disconnect the hand I/O cable (blue) and the brake cable (blue) that are connected to the X8YX (I/O board).

5) Remove five (5) sems screws (M3 x 8) that secures the X8YX board, and then remove the X8YX board.

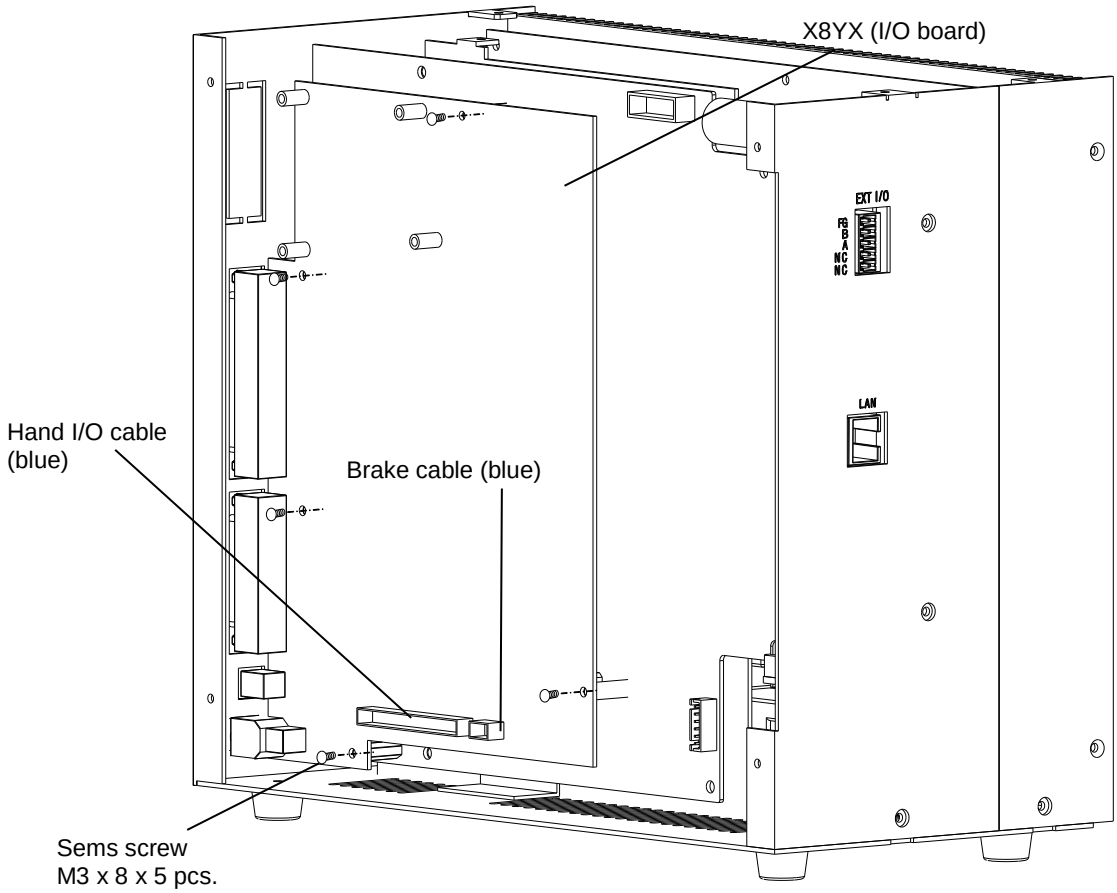


Fig. 4.13 Removing X8YX board (KSL3000)

6) Remove the transistor output IC shown in Fig. 4.11 from the outlet.

7) Mount a new transistor output IC to the outlet.
Note) Pay attention to the model number and orientation of the transistor output IC.

8) Mount the X8YX board to the main body using five (5) sems screws (M3 x 8).

9) Connect the hand I/O cable (blue) and the brake cable (blue) to the X8YX (I/O board), and then mount the main body cover to the main body with eight (8) countersunk screws (M3 x 6).

10) Connect the controller main body power supply plug.

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＜確認用＞Tables and Drawings

5. Robot Home Point and Position Detector Error

5.1 Setting Robot Home Point

Before delivery from our plant, home point setting is performed for the robot after its arm is secured with clamp for home point setting.
At the time of home point setting, position data of the motor position detector (i.e., encoder) is backed up by batteries, and coordinates of the robot need not be set each time the power is connected.
The position data of the motor position detector comes in the two (2) types; Servo offset and multi-turn data.

Servo offset
At home point setting operation of the robot (i.e., ZEROP operation and REORG operation), the data are written into the parameter file. As the data is backed up by batteries, the parameters should be loaded again from the attached system disk at replacement of the main control printed board.

Multi-turn data:
This data is kept in the encoder by battery backup, which differs from the backup battery of the main control printed board. When the battery voltage drops, correct multi-turn data cannot be guaranteed and the encoder itself outputs an alarm. This data is set to zero (0) at home point setting operation of the robot (i.e., ZEROP operation and REORG operation). Likewise, it is set to zero (0) also by multi-turn data reset operation.

5.2 Position Detector Error

If a position detector error (encoder error) occurs, either of the following errors is shown on the error display of the robot controller.

Error code	Error content	Remarks
8–601	Axis1 Enc multi count err	
8–602	Axis2 Enc multi count err	
8–603	Axis3 Enc multi count err	
8–604	Axis4 Enc multi count err	

The position detector error is an error detected by the encoder itself. Even if the data in the parameter file is lost (or changed) to change the home point coordinates of the robot, for instance, a position detector error will not occur. If the machine coordinates have changed without causing a position detector error, the mechanical connecting position of the servo motor and mechanical unit shifted or the data in the parameter file described above was changed. (Ex.: Tooth skip of timing belt, etc.)

Errors detected by the encoder itself include the battery voltage drop, error caused by temperature rise in the encoder, counter overflow, internal counter data inconsistency, etc. Among these errors, the error that occurs most frequently is the battery voltage drop that is caused by the absence of maintenance at specified change intervals due to a long-term shutdown or cable breakage.
To prevent the position detector error, therefore, replace the batteries on a regular basis. For the battery replacement, see “Para. 8.3 , Replacing Position Detector (or Encoder) Batteries”.
Also, a heavy vibration should not be exerted on the robot or the robot should not be moved suddenly by hand when the power is disconnected. Especially, when transporting and storing the robot, secure the robot in a posture for shipment, using the attached clamps.

Restoration from position detector error:
The restoring operation from the position detector error comes in the following four (4) manners. Make sure on the error display that a position detector error is generated. Identify the type of the position detector error and position data on the encoder status display, then perform each restoring operation. For encoder status display, see “Para. 5.5, Encoder Status Display.”

[1] Encoder error reset operation: See Para. 5.6
[2] Multi-turn data reset operation: See Para. 5.7.
[3] ZEROP operation: See Para. 5.8.
[4] HOME operation: See Para. 5.9.

(1) When a position detection error has occurred during normal operation with the mechanical connection position unchanged:

A position detector error may occur after battery voltage drop, or battery or cable replacement. When this happens, execute the following restoring operation.

1) Execute “[1] Encoder error reset operation.”

2) Make sure that the error has been reset, referring to the error display.

After resetting the error, effect an emergency stop, manually move each axis to the motion limit and make sure that a soft limit error generates.

1.1) **When the error has been reset:**

Connect the controller power (DO NOT turn on the servo power), and make sure by moving the arm, etc. by hand that the position detector error will not occur again. Then disconnect the controller power and turn on again to make sure that the same error will not recur.

1.1.1) **When the error occurs again:**

The position detector has possibly malfunctioned.

1.1.2) **When the error will not occur again:**

Turn on the servo power. Select the TEACHING mode and gradually move each axis at LOW-SPEED to make sure of its soft stroke. If the soft stroke or machine coordinate is abnormal, perform “[4] Multi-turn data reset operation.”

1.2) **When the error is not reset:**

Replace the batteries, then perform “[1] Encoder error reset operation” again. Make sure again that the error has been reset, referring to the error display.

1.2.1) **When the error has been reset:**

Execute the same operation as in Para. 1.1) above.

1.2.2) **When the error cannot be reset:**

The position detector has possibly malfunctioned, or the encoder cable has broken.

(2) When the mechanical connecting position with the motor has changed after motor or belt replacement:

A position detector error may occur after replacement and adjustment of the servo motor or timing belt. When this happens, execute the following restoring operation.

1) Execute “[2] HOME operation.”
2) Execute “5.9.5 Transfer of Home Position Data.”
3) Make sure that the error has been reset, referring to the error display.

After resetting the error, effect an emergency stop, manually move each axis to the motion limit and make sure that a soft limit error generates. If the mechanical interference is caused before generation of the soft stroke limit error, repeat the restoring operation in the manner described above.

! CAUTION

Some error may be caused according to the adjusting method. Re-teaching of the teach points may be required under some circumstances.

! DANGER

- When moving the robot by hand while the power is connected, be sure to assure the safe work and effect an emergency stop beforehand.
- In the above situation, if the work is to be done while the axis 3 brake release switch is pressed, be sure to perform the work by two (2) persons.
  One person should carry out the work while the other is monitoring the work outside the hazardous zone. The latter person should watch the work and be ready to turn off the controller switch if any abnormality occurs. Once the controller power is turned off, the motor brake actuates even if the axis 3 brake release switch is kept pressed.
- If the axis 3 brake release switch is pressed while the robot is carrying a heavy workpiece, the axis 3 may drop suddenly. To avoid this, the customer should take all necessary measures by themselves.

5.3 Replacing Position Detector (or Encoder) Batteries

! CAUTION

- The batteries should be disposed of according to the user's in-house regulations. NEVER drop the battery into fire. NEVER short-circuit, charge, disassemble or heat it. Otherwise, liquid leakage or rupture may be caused.

To keep the data of the position detector attached to the motor, they are backed up by batteries. Be sure to replace the batteries with new ones at the time of annual inspection. When the robot is not used for a long term (i.e., the batteries are left intact in the power OFF condition), replace the batteries at the time of robot startup. As a yardstick, the shutdown period is two (2) months.
(Three (3) size AA batteries)

! CAUTION

- When the battery voltage has dropped, a battery alarm will generate. If the batteries are replaced just after generation of the battery alarm, the battery voltage returns to normal with the battery alarm reset automatically. Unless the batteries are changed just after generation of the battery alarm, however, the battery voltage will drop further and a battery error will occur. Under this condition, position data detected by the encoder is not reliable. As a result, a position detection error occurs and the robot enters an emergency stop state so that the servo system cannot be turned on. If the power is turned off in this condition, the position data is lost.

  To avoid the above, be sure to replace the batteries with new ones at the time of annual inspection.

5.3.1 Battery Box Location

The battery box for the position detector is provided inside the battery box cover of the base unit.

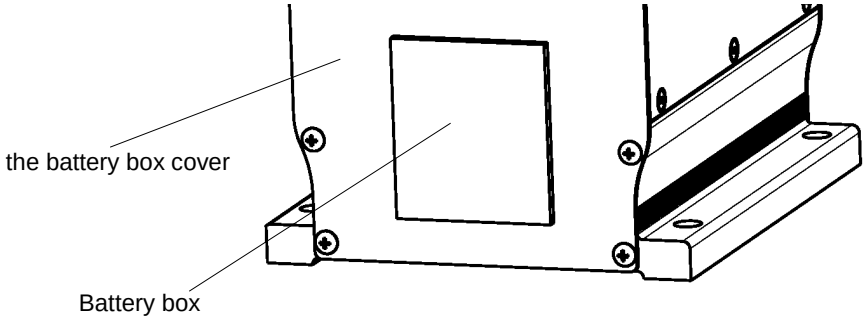


Fig. 5.1 Battery box location

5.3.2 Replacing Batteries

! DANGER

- Only after assuring the safe work, replace the batteries with new ones while the power is turned on and an emergency stop is activated on the robot.

1) Assure the safe work. Then keep the power ON and press the EMERGENCY pushbutton switch to effect an emergency stop on the robot. Unless the safe work can be assured, turn the power off.

2) Open the battery box cover and remove the batteries.
Set the three (3) new batteries, taking care of the "+" and "–" polarities.
To replace the batteries while the power is turned off, finish the replacement within five (5) minutes.

3) If alarms don't clear in table 5.1 "1-40x Axis x Enc Battery low (Battery alarm)" after you reset alarm, please try to the method of 4). When alarms are cleared by this method, finish work after closing the cover.

4) Please remove the battery box cover "Fig.5.1". Eject connector by reference of the next Fig and check electric voltage about 4.5V by tester. If electric voltage is

low, it has possibilities of bad fit. Please remove the battery and return the battery after cleaning the bracket of the battery box. If electric voltage is about 4.5V for tester, return to method of 3). And please don’t remove connector.

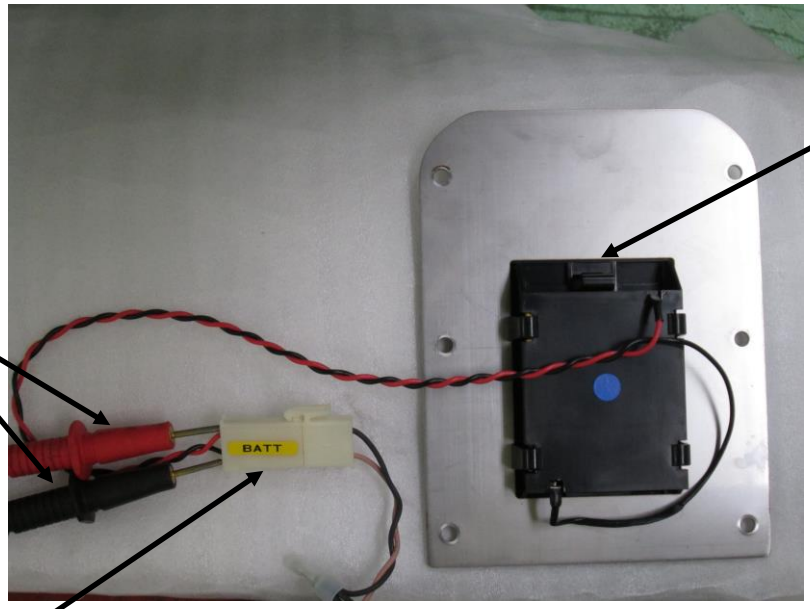


Fig. 5.2 check of battery bad fit

5.3.3 Battery Error Code

When a position detector error including battery error has occurred, the following error code is shown on the error display.

When electric voltage decreased, the following error code is shown on the error display. When the following error code is shown in the error history at generation of a position detector error, the error can be identified as the battery error.

Table 5.1 1-40 x battery error code

Error code	Error content	Remarks
1-401	Axis1 Enc Battery low (Battery alarm)	
1-402	Axis2 Enc Battery low (Battery alarm)	
1-403	Axis3 Enc Battery low (Battery alarm)	
1-404	Axis4 Enc Battery low (Battery alarm)	

If the error in table 5.1 occurred, please replace battery immediately. If unattended, level 8 errors such as listed in Table 5.2 to 5.4 occur. In addition, it is possible to lost robot origin position information.

Table 5.2 8-60 x battery error code

Error code	Error content	Remarks
8-601	Axis1 Enc multi count err	
8-602	Axis2 Enc multi count err	
8-603	Axis3 Enc multi count err	
8-604	Axis4 Enc multi count err	

If the error in table 5.2 displayed, counter skipping may be occurring due to insufficient battery power. Change the battery. If changing the battery does not correct the problem and the error is still displayed, the encoder may be faulty. In such a case, it is necessary to change the motor. Please consult our service representative.

Table 5.3 8-61 x battery error code

Error code	Error content	Remarks
8-611	Axis1 Enc battery empty	
8-612	Axis2 Enc battery empty	
8-613	Axis3 Enc battery empty	
8-614	Axis4 Enc battery empty	

If this error is displayed, the battery power may be insufficient. Change the battery. And it is possible to lose robot origin position information because the battery power was insufficient. If alarm does not clear after you replace battery, Please set origin position by referring to “Section 8, Robot Home Point and Position Detector Error.”

Table 5.4 8-40 x battery error code

Error code	Error content	Remarks
8-401	Axis1 Encoder abnormal	
8-402	Axis2 Encoder abnormal	
8-403	Axis3 Encoder abnormal	
8-404	Axis4 Encoder abnormal	

In the case of level 8 battery errors, the above two types errors in table 5.2 and 5.3 are basically displayed; however, the errors in table 5.4 may be displayed in rare cases. If this error is displayed, change the battery. And it is possible to lose robot origin position information because the battery power was insufficient. If alarm does not clear after you replace battery, Please set origin position by referring to “Section 8, Robot Home Point and Position Detector Error.”.

The battery error is one of the position detector errors (i.e., encoder errors), and there is other cause leading to the position detector error. The restoring method from the position detector error varies with the error contents generated. To properly execute the restoring method from the position detector error, therefore, read through and completely understand the descriptions carried in “Section 5, Robot Home Point and Position Detector Error.”

5.4 About Home Position

Home position what need at the moment of home position setting is shown. When the robot is moved to home position about 1 axis, 2 axis or 4 axis, suit to home point match-marks. See “Para. 5.4.1 to 5.4.2, Locations of Robot Home Point Match-Marks.” The 3 axis of robot don’t have home point match-marks. See “Para. 5.4.3 to 5.4.4, Home Position of 3 axis” and move to that position.

5.4.1 Locations of Robot Home Point Match-Marks (KHL-300,KHL-400)

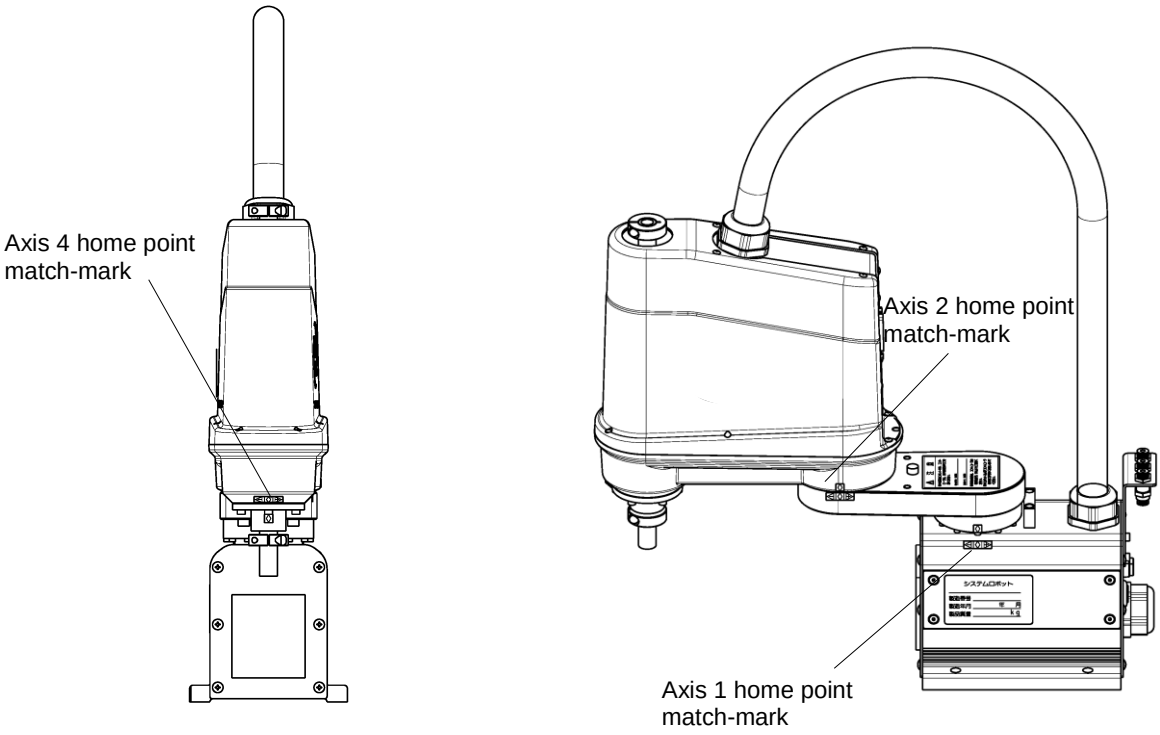


Fig. 5.3 Locations of home point match-marks (KHL-300, KHL-400)

5.4.2 Locations of Robot Home Point Mach-Mark (KHL-500, KHL-600 and KHL-700)

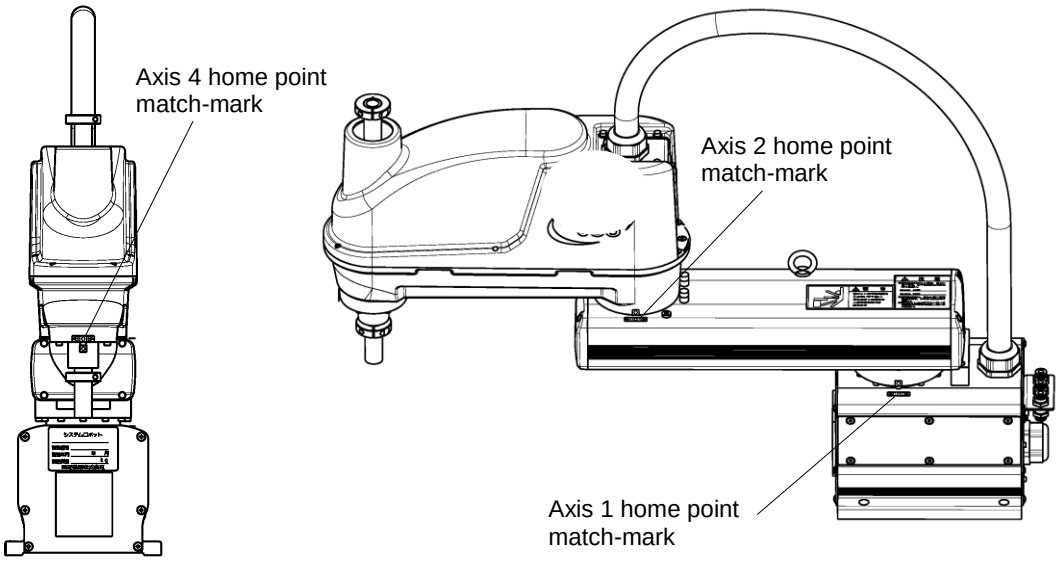


Fig. 5.4 Locations of home point match-marks (KHL-500, KHL-600 and KHL-700)

5.4.3 Home Position of 3 axis (KHL-300 and KHL-400)

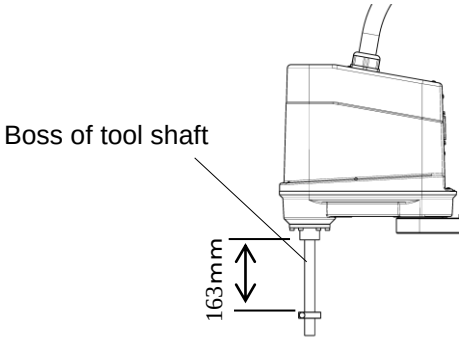


Fig. 5.5 Dimension of axis 3 home point (KHL-300, KHL-400)

5.4.4 Home Position of 3 axis (KHL-500, KHL-600 and KHL-700)

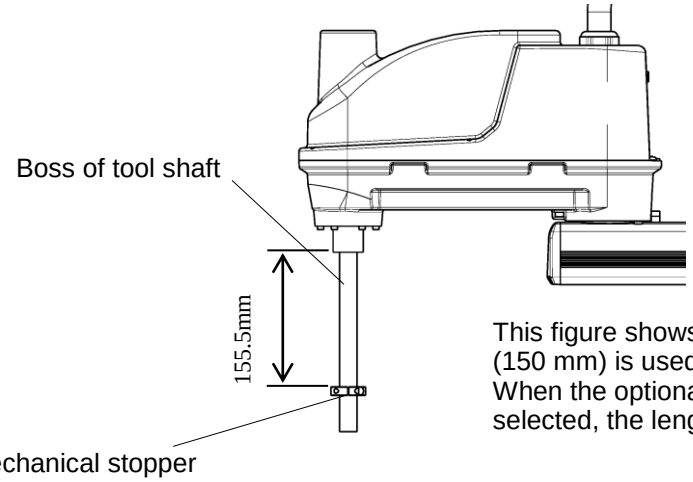


Fig. 5.6 Dimension of axis 3 home point (KHL-500, KHL-600 and KHL-700)

5.5 Encoder Status Display

Call the encoder status screen on the teach pendant display, and make sure of the position data and the type of position detector error there. The type of the position detector error (i.e., error status) is expressed as shown below. The multi-turn data, home position data within one (1) full turn of motor and error status are displayed under the column of [MULTI], [SINGLE] and [Err-df], respectively.
To call the encoder status screen, observe the following procedures.

Table 5.5 Error status table

Error status	Description
0000	Signifies the normal condition.
0100	This error occurs when a heavy vibration has been exerted on the robot or when the robot has been moved fast by hand while the power drive cable was disconnected while the power was off. The multi-turn data has possibly shifted.
0200	Because axis feed was not executed after the power was connected, the encoder resolution has deteriorated. During axis feed, the encoder resolution returns to normal. No alarm will generate.
8000	The battery voltage has dropped. Replace the batteries.
4000	The battery voltage has dropped further than the above. An error has possibly occurred in the multi-turn data.
4200	Errors 4000 and 0200 have occurred at the same time.
C200	Errors 8000, 4000 and 0200 have occurred at the same time.

[1] Press the “UTILITY” key provided on the teach pendant. Press the [NEXT] key until [ENC] is displayed on the function menu.

[2] Press the [ENC] (F5) key, and the encoder status screen appears on the display.

If the error status shown in the error status table above is displayed, you can restore from the position detector error.

5.6 [1] Encoder Error Reset Operation

When the mechanical connecting position of the servo motor and mechanical unit remains unchanged, that is, after battery replacement due to battery voltage drop or cable replacement due to cable breakage, execute this operation.

1) Call the encoder status screen on the teach pendant display, referring to Para. 5.5 above.

2) Just after the encoder status screen is called, the cursor points out the [Err-df] column on the [E1] line. Move the cursor to a line for the system you wish to execute the encoder error reset operation by means of the cursor keys (i.e., [↑] and [↓] keys).

	MULTI	SINGLE	Err–df	ID
E1	0	00001234	0200	10
E2	0	00001234	0200	10
E3	0	00001234	**4200**	10
E4	0	00001234	0200	10
E5	0	00000000	0000	00

ERROR **RESET**

3) To reset the axis 3 encoder error, for instance, move the cursor to the [Err-df] column on the [E3] line and press the [RESET] (F3) key. If everything is OK, press the “EXE” key. Now the axis 3 encoder error has been reset.

4) Call the normal error screen, press the [RESET] (F3) key to reset the error of “8-603 Axis3 Enc multi count err.”

5.7 [2] Restoring Home Position Data by Multi-Turn Data Clear

When the mechanical connecting position of the servo motor and mechanical unit remains unchanged, that is, after battery replacement due to battery voltage drop or cable replacement due to cable breakage, execute this operation after encoder error reset operation.

1) See “Para. 5.4 About Home Position” and move to that position.
2) Select the TEACHING mode by means of the master mode switch. And see “Para. 5.5. Encoder Status Display”, and print Encoder Status Display.
3) When the encoder information screen appears, press the [ALT] and [0] keys at the same time to cancel the editing lock mode.
4) Set the cursor to an axis whose multi-turn data is to be reset to zero (0), and press the [F3] function key corresponding to the [RESET] key menu.
5) Turn off the controller power, then turn it on again.
6) Execute “Para. 5.10. affirmation” before moving robot. Move the robot to the teach points, etc. and make sure that the robot can be located at them exactly. (Thus, the robot can be restored completely to the original condition.)

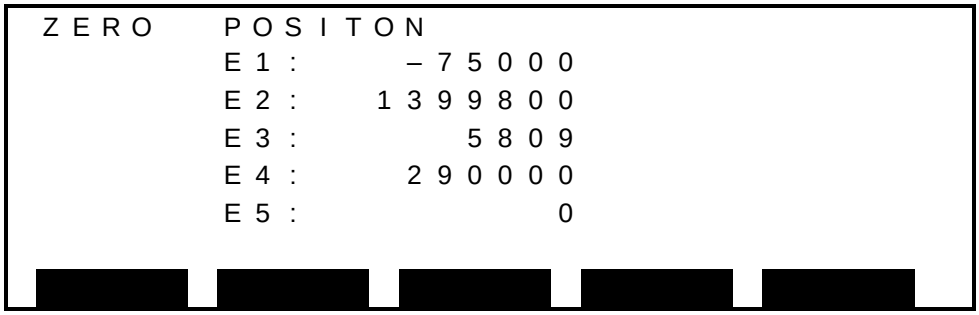
5.8 [3] Restoring Home Position Data by ZEROP Function

When mechanical joint positions have deviated due to motor change and so on, and when re-teaching is assumed, execute this operation.

! CAUTION

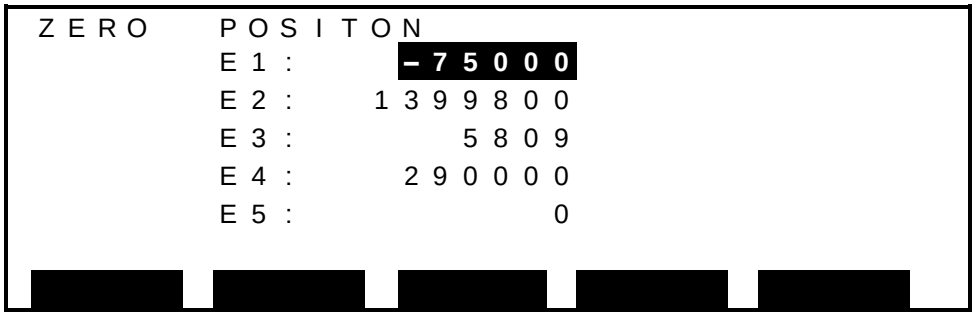
Some error may be caused according to the adjusting method. Re-teaching of the teach points may be required under some circumstances.

1) Select the TEACHING mode by means of the master mode switch.
2) See “Para. 5.4, About Home Position” and move to that position.
3) Press the [UTILITY] key equipped on the teach pendant.
4) Press the [NEXT] (F6) key on the teach pendant twice.
5) Turn off the servo power.
6) Press the [F3] key on the teach pendant to select the ZEROP mode.
7) The following home point setting screen is called..

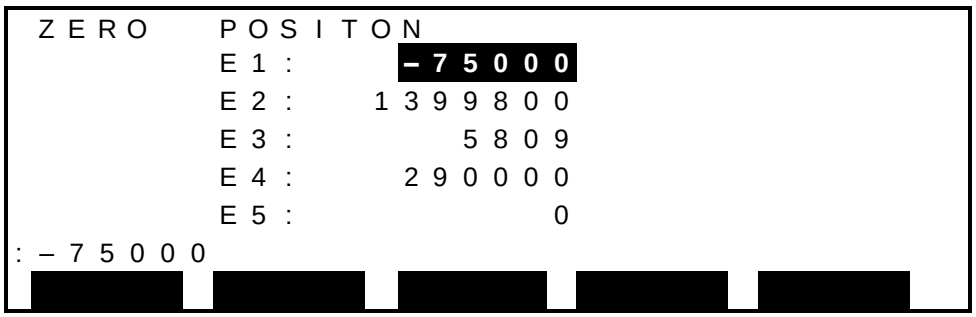


8) Press the [ALT] and [0] keys on the teach pendant at the same time.
9) The following home point editing screen appears.

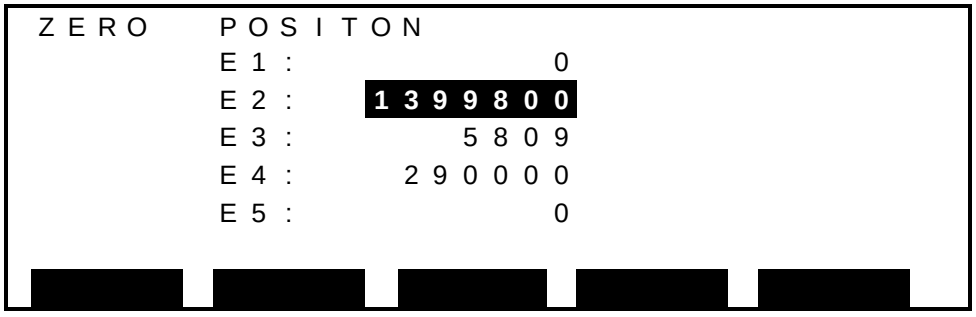
10) The numerical value of E1 (axis 1) is inversely displayed.



11) Press the “EXE” key on the teach pendant, and the value of “E1” is displayed at the lower left side. Set “0” in lieu of this value and press the “EXE” key. Then the E1 value becomes “0”.



12) When the “ ↓ ” key on the teach pendant is pressed, the following E2 value is displayed by reversed image. Perform setting in the same manner as above.



CAUTION

- Axis 3 and 4 of the robot are interlocked with each other. Be sure to strictly observe the order of the home point setting.

  E1 (axis 1) → E2 (axis 2) → E4 (axis 4) → E3 (axis 3)

13) Turn off the controller power, then turn it on again.

14) Execute “Para. 5.10. affirmation” before moving robot. Move the robot to the teach points, etc. and make sure that the robot can be located at them exactly.

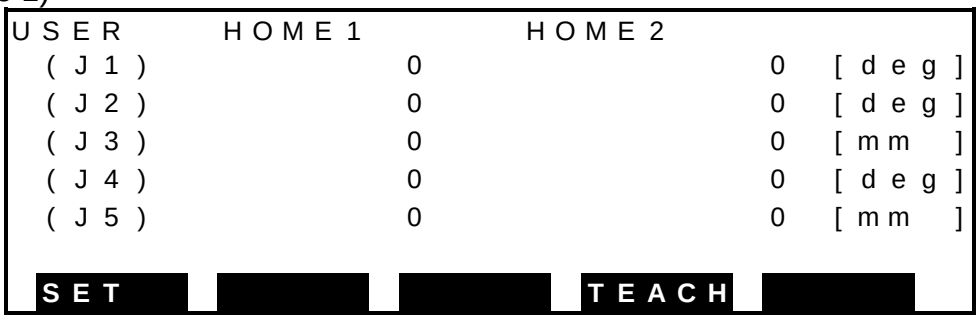
5.9 [4] Restoring Home Position Data by HOME Function

5.9.1 Outline of HOME Function

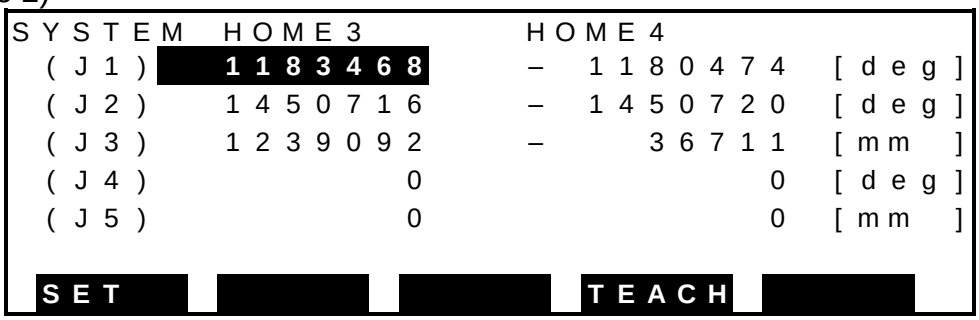
This function memorizes a specific coordinate value in each axis and restores the original home position data by using the HOME function when the machine home position data has been destroyed.

The set points are provided for HOME1 to HOME4, and Axis 1 to Axis 3 plus (+) side mechanical stopper positions are set in HOME3, and Axis 1 to Axis 3 minus (–) mechanical stopper positions in HOME4. Axis 4 is set at the 0° position according to the home point match-mark.
For HOME1 and HOME2, you can specify any values. It is recommended that when building up a system, you specify the place for securing the robot end.

(Page 1)



(Page 2)



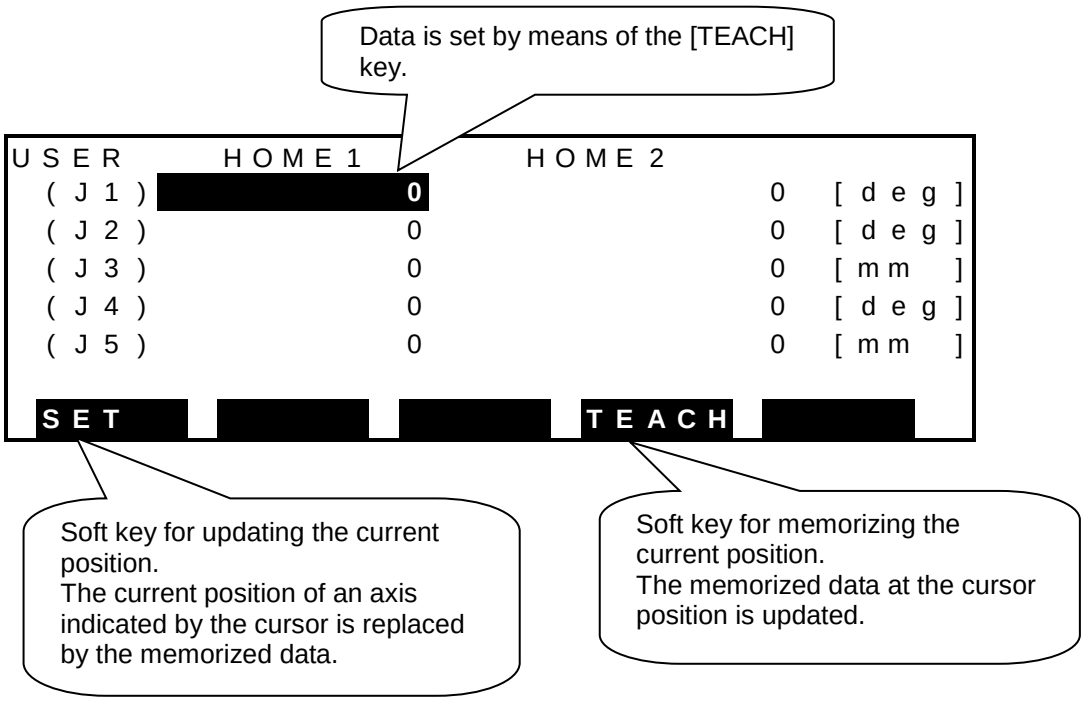
Caution: This function is used to restore the machine home point of each axis. NEVER use the function at other than the setting for restoration.

5.9.2 Setting HOME1 and HOME2

CAUTION

When home position is right data, execute “Para. 5.9.2 Setting HOME1 and HOME2”. When you execute this setting after you became to need home position setting, home position data can’t restore by right.

1) Guide the robot to secure the tool shaft at a desired position.
2) Turn off the servo power.
3) Press the [UTILITY] key equipped on the teach pendant.
4) Press the [NEXT] key until the [REORG] (F1) menu appears, then press the [REORG] key.



5) When the above screen appears, memorize the position where the robot was secured for each axis by moving the cursor and using the [TEACH] (F4) key mode.

5.9.3 How to Restore Data by HOME1 or HOME2

When mechanical joint positions have deviated due to motor change and so on, and when re-teaching is assumed, execute this operation.

! CAUTION

Some error may be caused according to the adjusting method. Re-teaching of the teach points may be required under some circumstances.

1) Guide the robot and secure it at the position set in HOME1 or HOME2 above.
2) Turn off the servo power.
3) Press the [UTILITY] key equipped on the teach pendant.
4) Press the [NEXT] key until the [REORG] (F1) menu appears, then press the [REORG] key.
5) Move the cursor to each axis under HOME1 of the REORG screen, then press the [SET] (F1) key to update the coordinate value set in HOME1 to the position where the robot was secured.
6) Can used robot immediately after execute to restore data by HOME1 or HOME2. But the format of home position data differ from data are factory-set. In case of you continue to use without change, when battery empty, When you execute to restore home position data by multi-turn data clear, home position data can't restore by right. See "Para. 5.9.5, Change for Home Position Data Form" and execute this operation.
7) Execute "Para. 5.10. affirmation" before moving robot. Move the robot to the teach points, etc. and make sure that the robot can be located at them exactly.

! CAUTION

- Axes 3 and 4 of the robot are interlocked with each other. Unless the specified procedures are followed, therefore, the current position of the robot may shift.
  When restoring the home point of Axis 3 (or Axis 4) by using the [REORG] function, be sure to restore the home point of Axis 4 (or Axis 3) also.

  Operating procedures

  1) Secure Axes 3 and 4 to each mechanical stopper or specified position.
  2) Move the cursor to (J3) on the screen and press the [SET] (F1) key to restore the axis 3 home point.
  3) Likewise, move the cursor to (J4) on the screen and press the [SET] (F1) key to restore the axis 4 home point.

5.9.4 How to Restore Data by HOME3 or HOME4

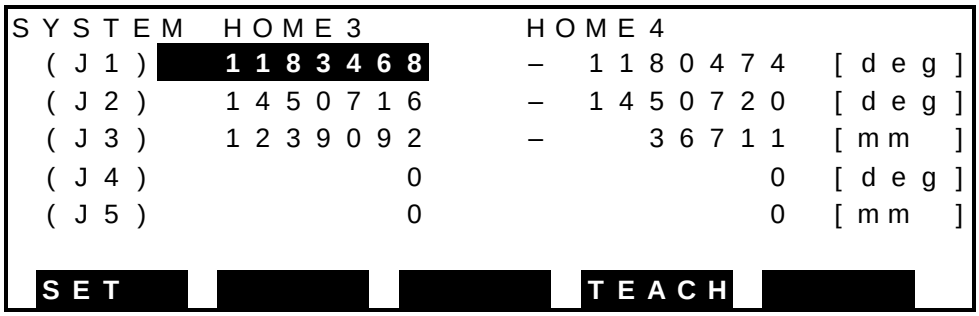
When mechanical joint positions have deviated due to motor change and so on, and when re-teaching is assumed, execute this operation. The plus (+) side mechanical stopper positions and minus (–) side mechanical stopper positions of Axes 1 to 3 are factory-set in HOME3 and HOME4, respectively. Axis 4 is set to the home point match-mark. (The 4 axis have the potential to differ from existing home position. Because the robot don't have the mechanical stopper of 4 axis.)
The machine home point can be restored, using the above.

! CAUTION

Some error may be caused according to the adjusting method. Re-teaching of the teach points may be required under some circumstances.

This paragraph deals with the restoration procedures, using HOME3.

1) Turn off the servo power.
2) Press the [UTILITY] key provided on the teach pendant.
3) Press the [NEXT] key until the [REORG] menu appears, then press the [REORG] (F1) key.
4) Press the [NEXT] key to call Page 2.



5) Contact Axis 1 of the robot to the plus (+) side mechanical stopper by hand.
6) Move the cursor to (J1) of HOME3, then press the [SET] (F1) key. Now, the machine home point of Axis 1 is restored.

7) Likewise, contact Axis 2 of the robot to the plus (+) side mechanical stopper by hand.

8) Move the cursor to (J2) of HOME3, then press the [SET] ([F1]) key. Now, the machine home point of Axis 2 is restored.

9) Set Axis 4 to the home point match-mark.

10) Contact Axis 3 of the robot to the plus (+) side mechanical stopper by hand.

11) Move the cursor to (J4) of HOME3, then press the [SET] ([F1]) key. Now, the machine home point of Axis 4 is restored.

12) Move the cursor to (J3) of HOME3, then press the [SET] ([F1]) key. Now, the machine home point of Axis 3 is restored.

13) Press the [ESC] key to escape from the HOME screen.

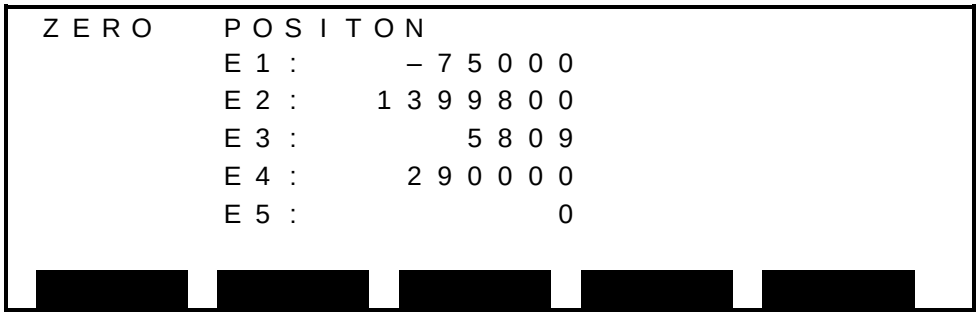
14) Can used robot immediately after execute to restore data by HOME3 or HOME4. But the format of home position data differ from data are factory-set. In case of you continue to use without change, when battery empty and you execute to restore home position data by multi-turn data clear, home position data can’t restore by right. See “Para. 5.9.5, Change for Home Position Data Form” and execute this operation.

15) Execute “Para. 5.10. Affirmation” before moving robot. Move the robot to the teach points, etc. and make sure that the robot can be located at them exactly.

8.9.5 Change for Home Position Data Form

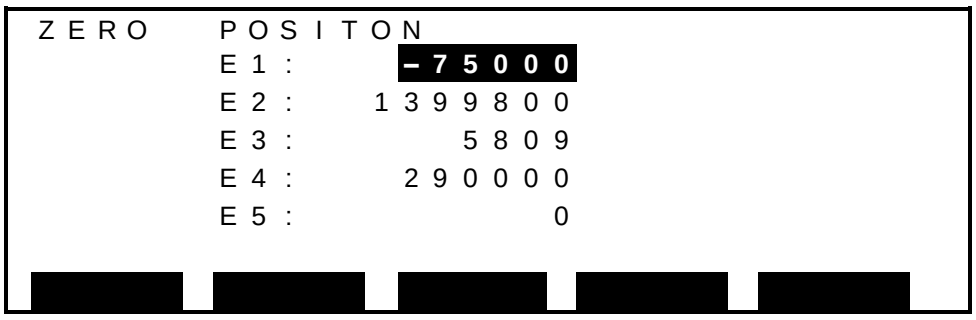
The format of servo offset and multi-turn data differ from format are factory-set after HOME operation. In case of you continue to use without change, when battery empty and you execute to restore home position data by multi-turn data clear, home position data can't restore by right. Restore format of home position data by this operation after HOME operation.

1) Select the TEACHING mode by means of the master mode switch.
2) Each axis of robot move zero position by DO function. Be careful setting low speed of OVRD. About DO function, See language manual.
3) Press the [UTILITY] key equipped on the teach pendant from initial screen.
4) Press the [NEXT] (F6) key on the teach pendant twice.
5) Turn off the servo power.
6) Press the [F3] key on the teach pendant to select the ZEROP mode.
7) The following home point setting screen is called..

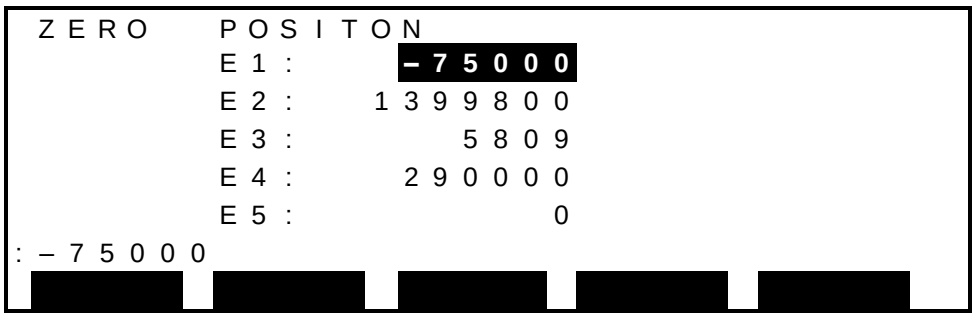


8) Press the [ALT] and [0] keys on the teach pendant at the same time.
9) The following home point editing screen appears.

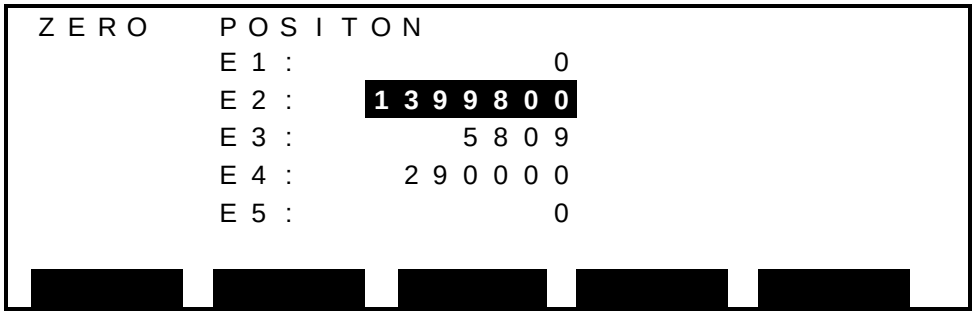
10) The numerical value of E1 (axis 1) is inversely displayed.



11) Press the [EXE] key on the teach pendant, and the value of “E1” is displayed at the lower left side. Set “0” in lieu of this value and press the [EXE] key. Then the E1 value becomes “0”.



12) When the [↓] key on the teach pendant is pressed, the following E2 value is displayed by reversed image. Perform setting in the same manner as above.



CAUTION

- Axis 3 and 4 of the robot are interlocked with each other. Be sure to strictly observe the order of the home point setting.

  E1 (axis 1) → E2 (axis 2) → E4 (axis 4) → E3 (axis 3)

13) Turn off the controller power, then turn it on again.

14) Execute “Para. 5.10. Affirmation” before moving robot. Move the robot to the teach points, etc. and make sure that the robot can be located at them exactly.

5.10 Affirmation

Effect an emergency stop, manually move each axis to the motion limit and make sure that a soft limit error generates. Make sure of the robot current position according to the POS data of the UTILITY mode. Make sure of teaching point, too.

! CAUTION

This affirmation is important for right home position. Definitely execute this affirmation after each setting home position. When home position data isn’t right and don’t execute this affirmation, have the potential to crash mechanical stopper.

5.11 Backup of Data

Connect the personal computer and controller using TSPC (option), then save the “MACHINE.PAR” file from the robot controller to the hard disk, etc. of the personal computer. Load the home position data to the system parameter file.
The home position data is the data characteristic of the robot, which differs with the robot you use. This data is necessary when you effect a cold start and restore the home position data again. Be sure to save the data.

Now, the operation is complete.

6. Replacement Parts for Maintenance

6.1 Cautions for maintenance replacement parts

! CAUTION

- With the exception of the encoder backup batteries, greases and hand I/O air tubes, all parts listed in List of Replacement Parts-Main Robot are custom-made to CKD specifications. Contact CKD at order entry.
- Parts replacement work must be done by CKD service engineer.
- CKD's warranty does not cover failures, accidents or any damages.

6.2 List of Replacement Parts – Main Robot (KHL-300, KHL-400)

	Part name	Type	Dwg. No.	Unit code	Maker	Q'ty	Remarks
1	AC servo motor		S890967	Y610A3NL0	SHIBAURA MACHINE	1	Axis 1
2			S890968	Y610A3NM0		2	Axis 2, 4
3			S777296	Y610A37A0		1	Axis 3
5	Reduction gear		S890907	Y610A3NG0	SHIBAURA MACHINE	1	Axis 1
6			S890906	Y610A3NH0		1	Axis 2
7			S890969	Y610A3NJ0		1	Axis 4
8	Timing pulley		S777399 (ball screw side)	Y610A3NK0	SHIBAURA MACHINE	1	Axis 3
9			S777400 (motor side)			1	Axis 3
10			S777401 (ball screw side)			1	Axis 4
11			S777402 (motor side)			1	Axis 4
12	Timing belt		S890882			1	Axis 3
13			S890883			1	Axis 4
14	Ball screw spline unit		H852810	Y610A3NE0	SHIBAURA MACHINE	1	Axis 3
16	Main body harness For KHL-300		F127776	Y610D0FD0	SHIBAURA MACHINE	1	
17	Main body harness For KHL-400		F127777	Y610D0FE0	SHIBAURA MACHINE	1	
19	Grease	SK-2 (For reduction gear)			HDS		Axis 1, 2
20		AFF grease (Lithium-based for ball screw)			THK		Axis 3
21	Air tube for hand I/O	TUZ0425R-20			–	*1	Color (Red)
22		TUZ0425BU-20			–		Color (Blue)
23		TUZ0425W-20			–		Color (White)
24	Encoder backup battery	Size AA alkali battery				3	All axes

*1 The minimum purchase unit of air tube is 20 m

6.3 List of Replacement Parts – Main Robot (KHL-500, KHL-600, KHL-700)

	Part name	Type	Dwg. No.	Unit code	Maker	Q'ty	Remarks
1	AC servo motor		S875289	Y610A3M20	SHIBAURA MACHINE	1	Axis 1
2			S875290	Y610A3M30		1	Axis 2
3			S746337	Y610A3430		1	Axis 3
4			S875291	Y610A3M40		1	Axis 4
5	Reduction gear		S875237	Y610A3LW0	SHIBAURA MACHINE	1	Axis 1
6			S875238	Y610A3LX0		1	Axis 2
7			S875239	Y610A3LY0		1	Axis 4
8	Timing pulley		S875171 (motor side)	Y610A3LZ0	SHIBAURA MACHINE	1	Axis 3
9			S875170 (ball screw side)			1	Axis 3
10			S875173 (motor side)			1	Axis 4
11			S875172 (ball screw side)			1	Axis 4
12	Timing belt		S875174			1	Axis 3
13			S875175			1	Axis 4
14	Ball screw spline unit		H852666(Z150)	Y610A3LT0	SHIBAURA MACHINE	1	Axis 3
15			H852702(Z300)	Y610A3ME0		1	
16	Main body harness For KHL-500		F127778	Y610D0FF0	SHIBAURA MACHINE	1	
17	Main body harness For KHL-600		F127779	Y610D0FG0	SHIBAURA MACHINE	1	
18	Main body harness For KHL-700		F127780	Y610D0FH0	SHIBAURA MACHINE	1	
19	Grease	SK-1A (For reduction gear)			HDS		Axis 1, 2
20		AFF grease (Lithium-based for ball screw)			THK		Axis 3
21	Air tube for hand I/O	TUZ0604R-20			—	*1	Color (Red)
22		TUZ0604BU-20			—		Color (Blue)
23		TUZ0604W-20			—		Color (White)
24	Encoder backup battery	Size AA alkali battery				3	All axes

*1 The minimum purchase unit of air tube is 20 m.

6.4 List of Replacement Parts – Controller (KHL-300, KHL-400/KSL3000)

No.	Part name	Type	Unit code	Maker	Q'ty	Remarks
1	PS1 (Switching power supply)	LFA30F-5-J1Y		COSEL	1	P5V power supply
2	PS2 (Switching power supply)	LFA30F-24-J1			1	P24V power supply
3	Lithium battery	ER6C WK27		Hitachi Maxell	1	For X8YC printed board
4	Fuse	51NM030H		PICO	1	For X8YX printed board
5	Printed board	X8YCB (Main control)	Y610A90B0	SHIBAURA MACHINE	1	
6		X8YSC (Servo)	Y610A9050		1	
7		X8YXA (I/O board)	Y610A9020		1	Type-N
8		X8YXB (I/O board)	Y610A9030		1	Type-P
9	Transistor output IC	TD62084APG		Toshiba	4	Type-N
10		TD62783APG			4	Type-P
11	Teach pendant	TP1000	Y610A2600	SHIBAURA MACHINE	1	With 5 m-long cable
12		TP3000	Y610A43A0		1	With 5 m-long cable High-performance TP (Teaching Pendant)
13	System disk	TS3000SYS	Y610A3HC0	SHIBAURA MACHINE	1	CD-ROM

6.5 List of Replacement Parts – Controller (KHL-500～KHL-700/KSL3000)

No.	Part name	Type	Unit code	Maker	Q'ty	Remarks
1	PS1 (Switching power supply)	LFA30F-5-J1Y		COSEL	1	P5V power supply
2	PS2 (Switching power supply)	LFA30F-24-J1			1	P24V power supply
3	Lithium battery	ER6C WK27		Hitachi Maxell	1	For X8YC printed board
4	Fuse	51NM030H		PICO	1	For X8YX printed board
5	Printed board	X8YCB (Main control)	Y610A90B0	SHIBAURA MACHINE	1	
6		X8YSB (Servo)	Y610A9040		1	
7		X8YXA (I/O board)	Y610A9020		1	Type-N
8		X8YXB (I/O board)	Y610A9030		1	Type-P
9	Transistor output IC	TD62084APG		Toshiba	4	Type-N
10		TD62783APG			4	Type-P
11	Teach pendant	TP1000	Y610A2600	SHIBAURA MACHINE	1	With 5 m-long cable
12		TP3000	Y610A43A0		1	With 5 m-long cable High-performance TP (Teaching Pendant)
13	System disk	TS3000SYS	Y610A3HC0	SHIBAURA MACHINE	1	CD-ROM