THP700/TS3100
Industrial Robot

MAINTENANCE MANUAL

Notice

1. Make sure that this instruction manual is delivered to the final user of this product.
2. Before using this product robot, read through and completely understand this manual.
3. After reading through this manual, keep it nearby for future reference.

January, 2011

TOSHIBA MACHINE CO., LTD.

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WARRANTY

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

1. Warranty period
   Toshiba Machine agrees to repair or replace as necessary all defective material or workmanship up to the period shown below, whichever comes first.
   1) Twenty-four (24) months from the date of dispatch from our plant.
   2) Eighteen (18) months from the date of machine installation at customer's job site.
   3) 4,000 running hours from the date of initial machine operation.

2. Contents of warranty
   1) Only the product is subject to Toshiba Machine'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) Toshiba Machine 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
   Toshiba Machine'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 Toshiba Machine 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, Toshiba Machine will not guarantee the basic performance of the product.

2) If the customer did not observe the warnings and cautions described in this manual, Toshiba Machine 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 Toshiba Machine as of now.

(*1) The consumable parts signify the replacement parts for maintenance as listed in Section 5 of this manual.

INTRODUCTION

This manual describes the maintenance of this product, THP700, and the TS3100 controller.

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 turn off the main power switch of the controller 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 Toshiba Machine'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.

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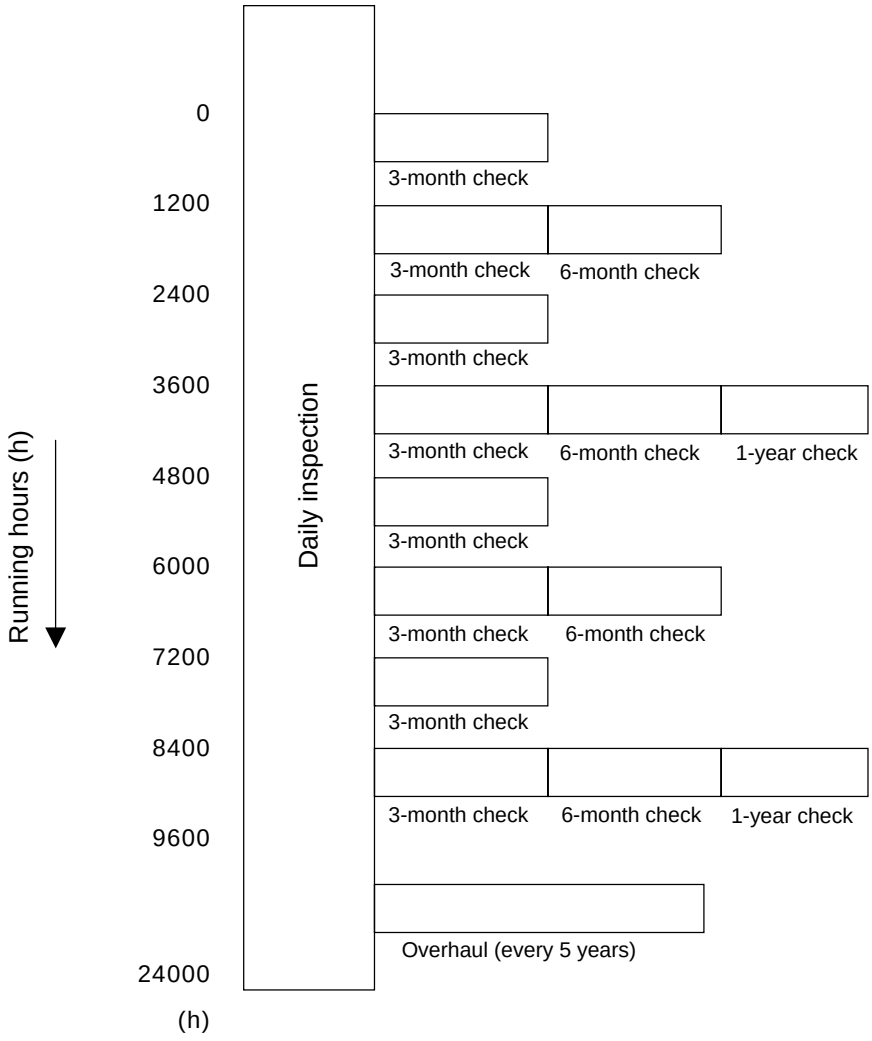
1. Maintenance

1.1 Maintenance Schedule

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:
  16 hours × 25 days × 3 months = 1,200 hours
- When the system is operated for 24 hours per day:
  24 hours × 25 days × 3 months = 1,800 hours

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

Description	Check position	D	Q	S	A	Refer to
Make sure that all bolts are completely tightened and secured. Otherwise, tighten the bolts completely.	Tool set bolts	○	○	○	○	Para. 2.2.1
	Robot installation bolts	○	○	○	○	
	Bolts for each joint reduction gear				○	
	Motor set bolts				○	
Make sure that no cut or scratch is found. Clean the contaminant, if any.	Entire robot	○	○	○	○	
	Arm 2 interior			○	○	
Make sure that enough volume of grease is filled. Otherwise, fill the grease.	Ball screw shaft	○	○	○	○	Para. 2.7.3
	Reduction gear interior				○	Para. 2.8.3
Make sure that each timing belt is not worn off or cracked. Check each timing belt for tension.	Arm 2 interior			○	○	Para. 2.6.5
Make sure that the cables and air tubing are not worn out.	Cables and air tubing of each unit			○	○	Para. 2.2.2
Make sure that each axis can be operated properly by moving the axis by hand.	Entire robot			○	○	Para. 2.2.3

1.2.2 Inspection at Power ON (at Operation)

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

Description	Check position	D	Q	S	A	Refer to
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 the repeatability.	Entire robot		○	○	○	
Replace the batteries for position detection with new ones.	Battery box				○	Para. 2.9.2

1.2.3 Overhaul

Description	Maintenance parts	Every 5 years	Refer to
Check for the consumable parts and replace as necessary.	Reduction gears, ball screws, motors, belts	○	Para. 2.4 ~ 2.7
Replace the battery with a new one.	Backup battery in the controller	○	Para. 3.3.3
Replace the switching power supply unit with a new one.	In the controller	○	Para. 3.3.4

1.3 Maintenance Tools

We recommend to use the following tools for maintaining the robot and controller.

- Phillips screwdrivers
- Hexagonal wrench set: M3 ~ M16
- Torque wrench set: M4 ~ M14
- Nippers
- Pliers
- Torque wrench extension bar
- Plastic hammer

Recommended provisions other than the tools:

- Grease gun
- Waste cloth
- Vice (clamp)
- Liquid gasket (recommendation: 1211 made by ThreeBond)
- Seal tape
- Loctite adhesives (242; mid adhesive force)
- Belt tension meter
- TSPC program creation/teaching support software (option)

1.4 Maintenance Contract and Repair

1.4.1 Maintenance Contract

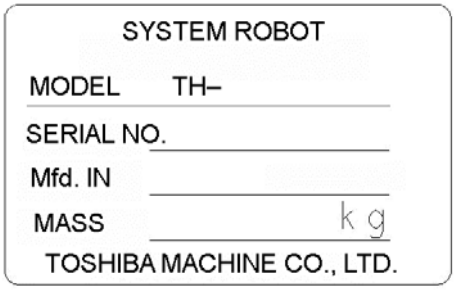
For the inspection items for maintenance and inspection to be done semi-annually and after, it is rather difficult for the user to execute, except for greasing and lubrication. We recommend that the user contact Toshiba Machine Service Department and conclude an after-sale service contract with us.

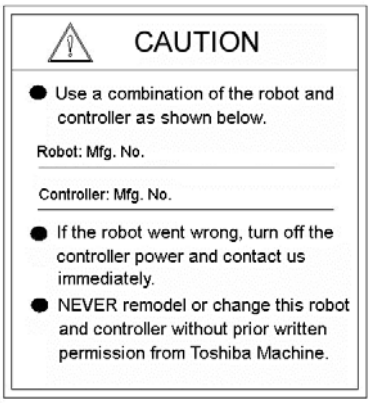
1.4.2 Repair

If a fault has occurred or if repair is necessary, turn off the controller power and contact the Toshiba Machine Service Department. At this time, advise us of the details of the fault and the following information stated on the robot and controller.

- 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.





1.4.3 Modification

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

! 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.

2. Maintenance of the Main Robot

2.1 Cautions on Maintenance and Inspection

When performing inspection or maintenance of the robot, strictly observe the following precautions to protect yourself and coworkers.

! DANGER

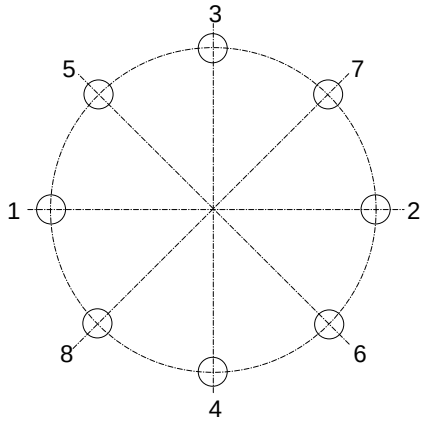
- Be sure to turn off the main power switch of the controller before approaching the robot for maintenance and inspection.
- When moving the robot by hand while the power is turned on, be sure to assure the safe work and effect an emergency stop beforehand.
- In the above situation, if the work is to be done while the axis 3 motor brake OFF 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 OFF switch is kept pressed.
- If the axis 3 motor brake OFF 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.

2.1.1 Clamping Hexagon Socket Head Cap Screws

This robot uses hexagon socket head cap screws at places requiring mechanical strength. At the time of factory-assembly, lock adhesives are applied and each screw is tightened with the following clamping torque.
When these screws are tightened again according to the inspection and maintenance as stipulated in this manual, use a torque wrench, etc. 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.

Screw	M3	M4	M5	M6	M8	M10	M14
Clamping torque	2.0 N·m	4.7N·m	9.0N·m	15N·m	37N·m	75N·m	110N·m

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



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.

2.2 Details of Inspection

2.2.1 Check of Each Bolt (or Screw) for Clamping

(1) Tool Set Bolts

Make sure, using the hexagonal wrench key, that the hexagon socket head cap screws of the tool set flange (option), which are clamped to the tool shaft are tightened completely. If loosened, tighten them completely.

Make sure, using the hexagonal wrench key, that the hexagon socket head cap screws securing the tool flange and tool are tightened completely. Otherwise, tighten them completely.

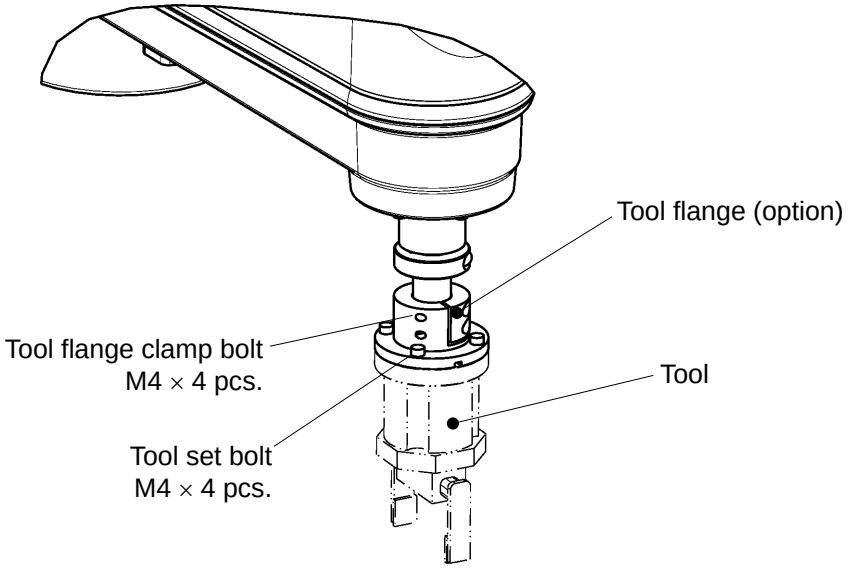


Fig. 2.1 Tool set bolts

(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.

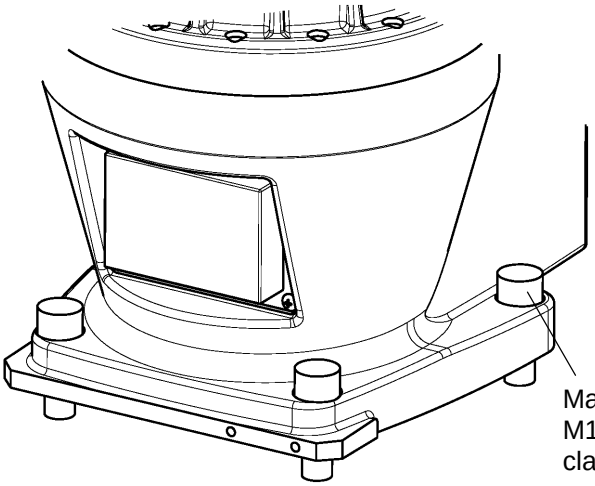


Fig. 2.2 Robot base set bolts

(3) Bolts for each joint

Make sure, using the hexagonal wrench key, that the bolts for the axis 1 and 2 joints (i.e., bolts for clamping each reduction gear and arm) are tightened completely. If loosened, tighten them completely.

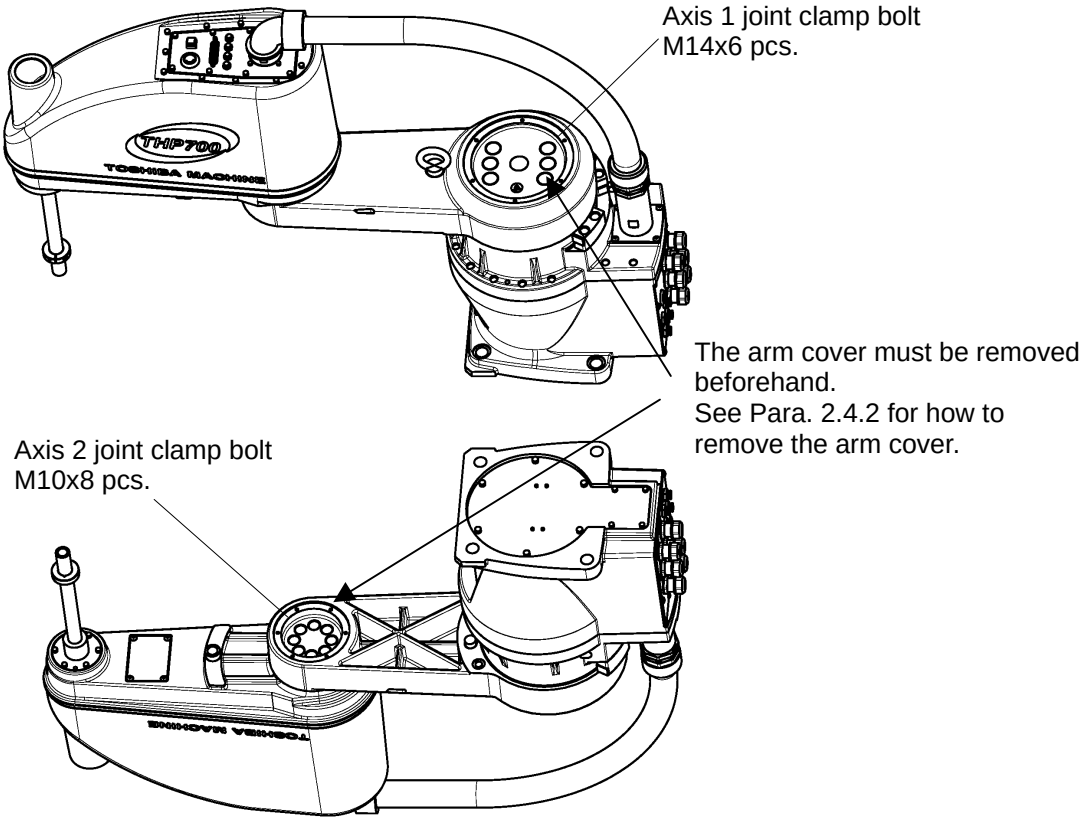


Fig. 2.3 Axes 1 and 2 set bolts

(4) 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 base set bolts are tightened completely. For the places where the following bolts are used, see Para. 2.5.

Location of bolt	Type	Bolts used	Reference Para.
Axis 1 drive motor set bolt	M8x20	4 pcs.	2.5.3 Dismounting Axis 1 Motor
Axis 1 motor base set bolt	M6x30	11 pcs.	2.5.3 Dismounting Axis 1 Motor
Axis 2 drive motor set bolt	M5x16	4 pcs.	2.5.5 Dismounting Axis 2 Motor
Axis 2 motor base set bolt	M6x20	10 pcs.	2.5.5 Dismounting Axis 2 Motor
Axis 3 drive motor set bolt	M4x16	4 pcs.	2.5.7 Dismounting Axis 3 Motor
Axis 3 motor base set bolt	M4x12	4 pcs.	2.5.7 Dismounting Axis 3 Motor
Axis 4 drive motor set bolt	M4x16	4 pcs.	2.5.9 Dismounting Axis 4 Motor
Axis 4 reduction gear set bolt	M5x16	4 pcs.	2.8.8 Mounting Axis 4 Reductgion Gear
Axis 4 motor base set bolt	M4x12	4 pcs.	2.6.4 Replacing Axis 4 Timing Belt

For the recommended clamping torque, see page 14.

2.2.2 Check of Each Cable and Air Tube for Abrasion

Disassemble the arm 2 cover and base cover and make sure that each cable and air tube are not worn out, broken or cracked. Especially, take careful precautions to inspect the vicinity of the cable outlets of the axis 1 joint and axis 2 joint.
For how to dismounting the covers, see Para. 2.4.

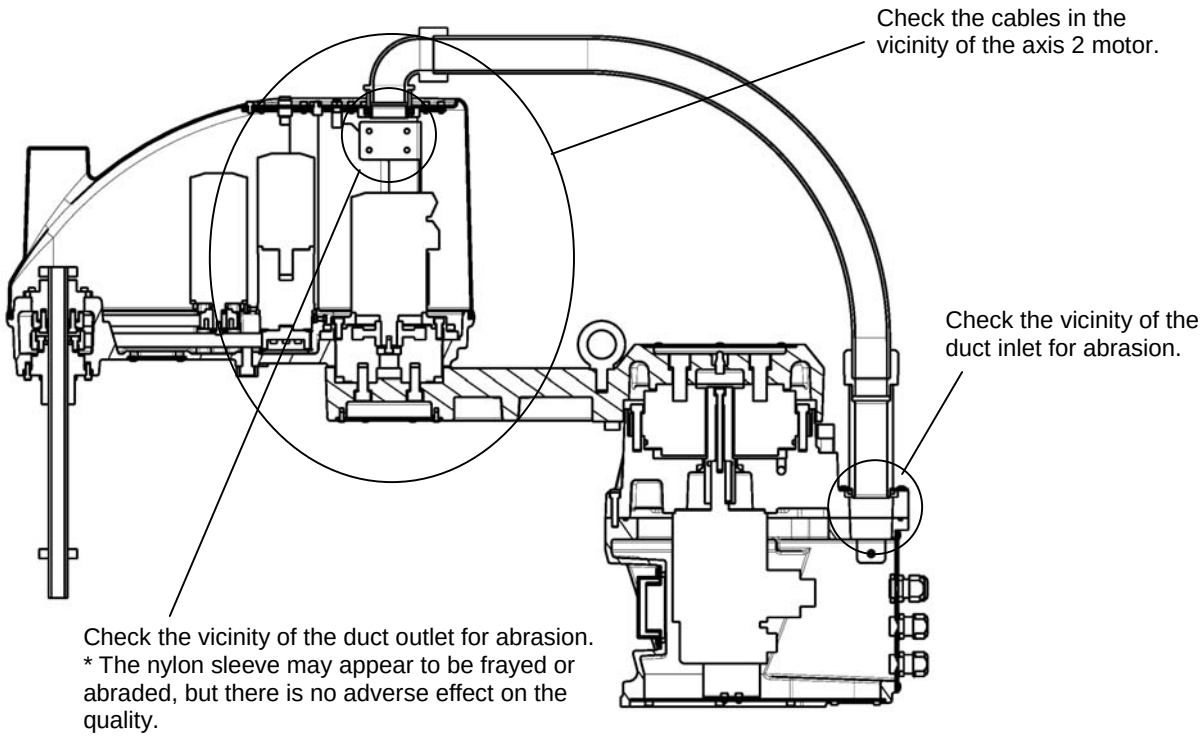


Fig. 2.4 Cable and air tube check points

2.2.3 Check of Each Axis for Operation

Turn on the main power switch of the controller, then keep the EMERGENCY pushbutton switch in the depressed condition. Move each axis by hand and make sure that it can move smoothly.
For the axis 3, when the brake OFF pushbutton 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.

2.3 Layout of Robot Components and Drive Mechanism

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

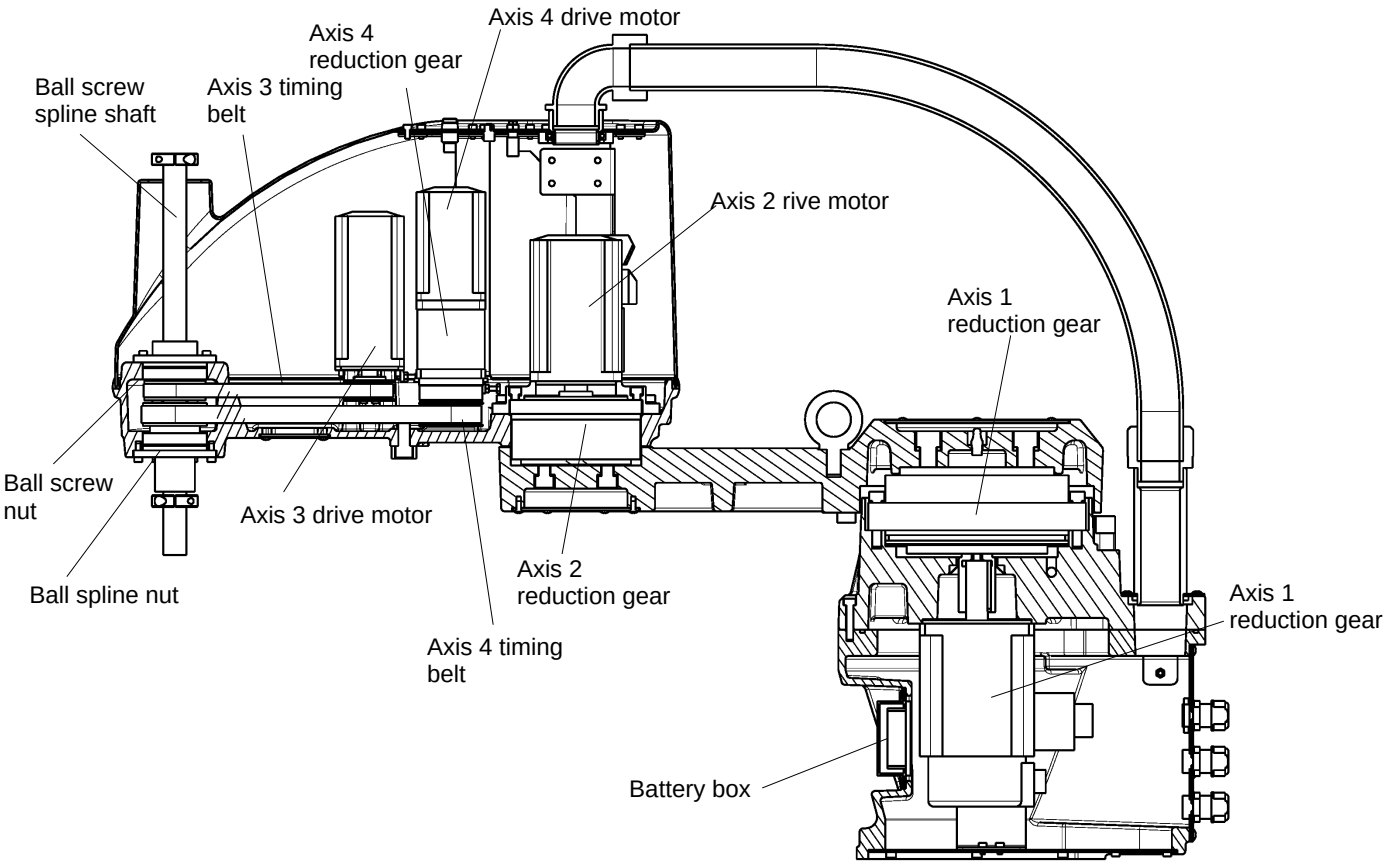


Fig. 2.5 Layout of robot mechanical components

2.4 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, 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 TY-RAP. After the cover is disconnected, make sure of the cable layout and return the cables to natural wiring state.

2.4.1 Arm 2 Cover

The arm 2 cover is secured to the cover set bracket with eleven (11) socket head bolts (M4x8). As the arm 2 cover is inserted into the arm 2, it can be lifted once the screws are removed. The inserted unit may not be disengaged easily, however. When this happens, it is recommended that the axis 3 be lowered beforehand until the ball screw stopper enters the cover so that you can hold the ball screw hole ("A" part in Fig. 2.6) when lifting up the cover. The packing attached to the cover can be disconnected together with the cover.

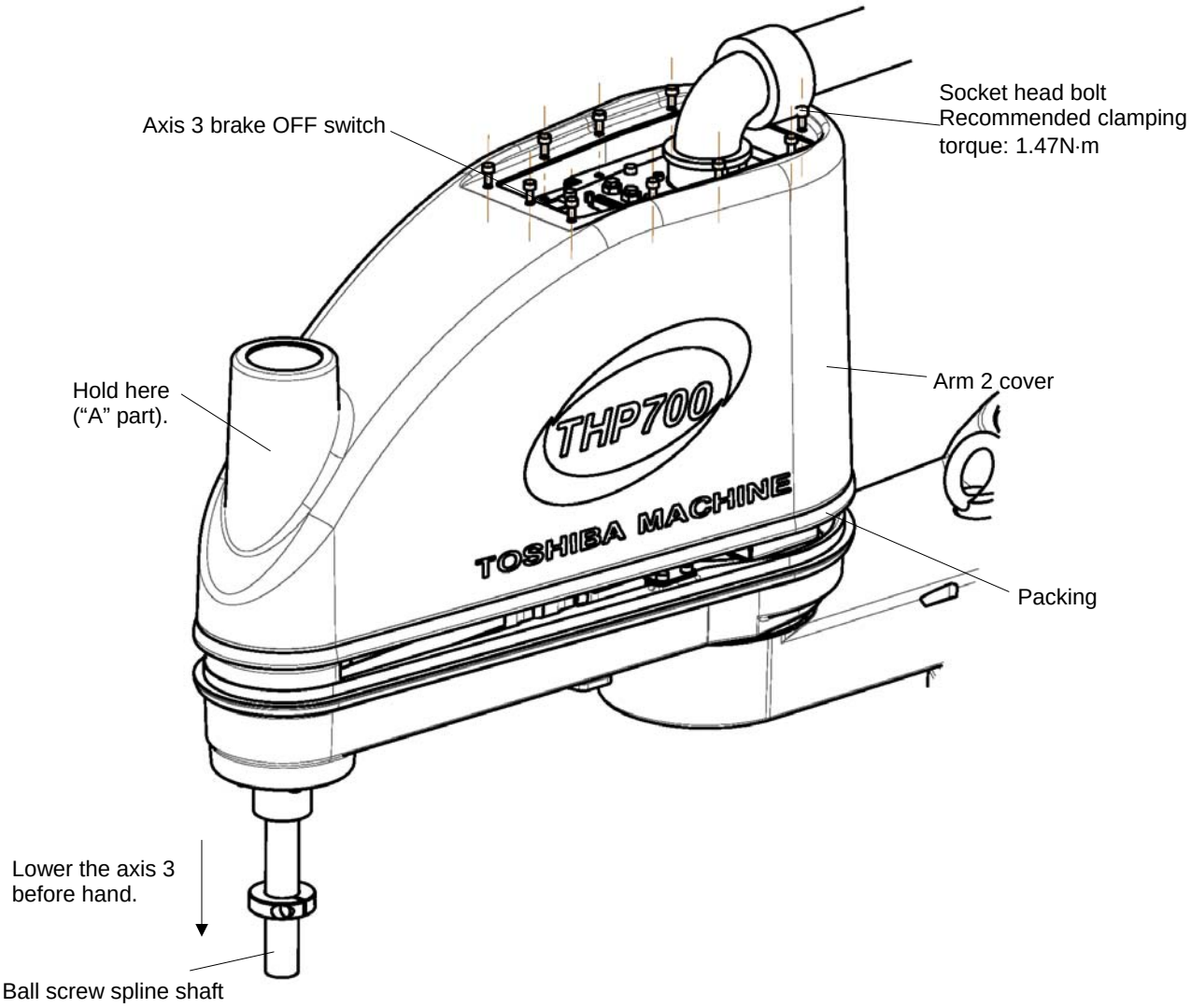


Fig. 2.6 Arm 2 cover

Nylon washers are used to protect the cover. When mounting the cover, be sure to set them. Also, take utmost care not to turn up the packing attached under the cover. After the cover is mounted, manually move up and down the ball screw spline shaft while pressing the brake OFF switch, and make sure that the ball screw hole will not interfere with the ball screw stopper.

2.4.2 Arm 1 Covers

One of two arm-1 covers is provided on top of the axis 1 (the arm 1 upper cover), and the other at the bottom of the axis 2 (the arm 1 lower cover). Each cover is secured to the arm 1 with six cross truss head screws (M4x8).

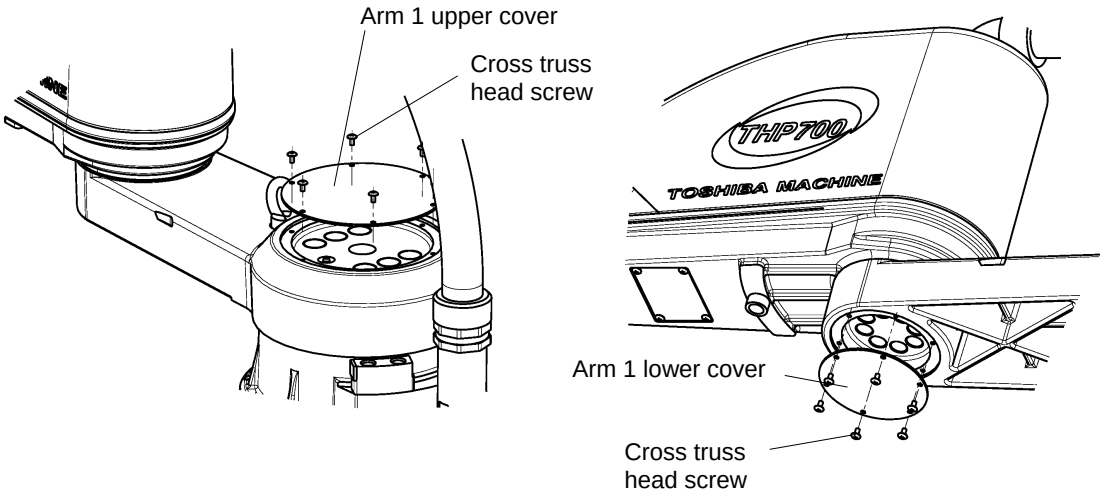


Fig. 2.7 Arm 1 covers

2.4.3 Base Covers

In all, two (2) base covers are provided; the cover also serving as the connector panel cover and cover also used as the battery box cover.
The former cover is secured to the base with twelve (12) cross truss head screws (M4x6).
The latter cover is secured to the base with four (4) cross truss head screws (M4x6).
Though each cover can be disconnected when the clamp bolts are removed, it is connected to the cables inside. DO NOT pull the cover by force.

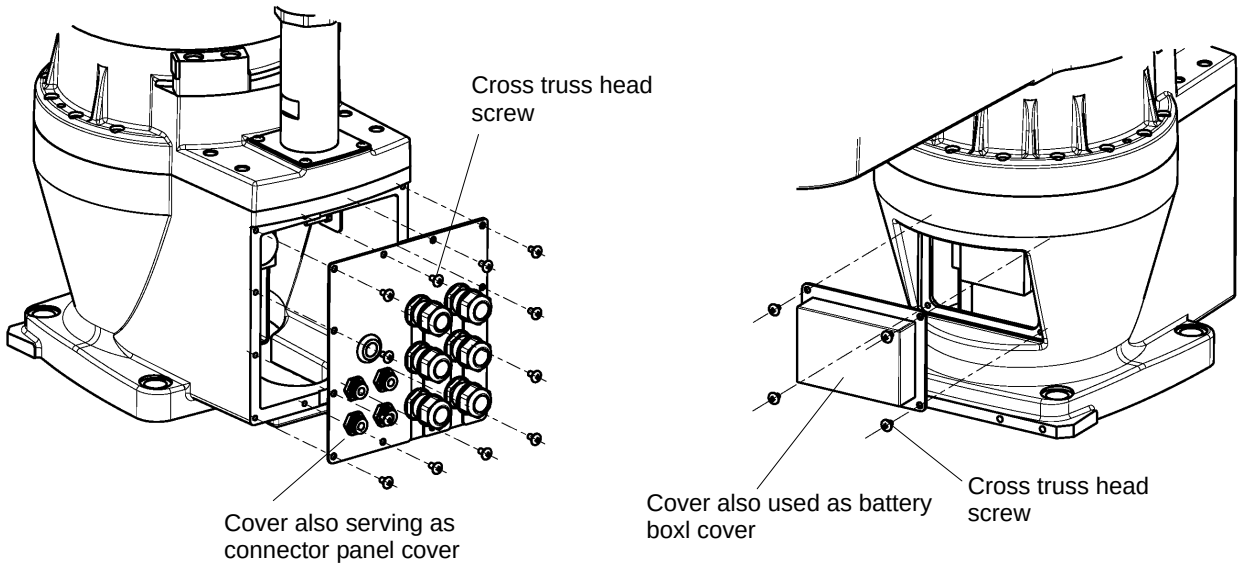


Fig. 2.8 Base covers

2.5 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 is turned off with the power supply plug removed. If the work is done while the power is turned on, 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 4.
- The robot needs to be placed sideways, depending on the axis of which motor is to be replaced. Provide a sufficient service clearance for motor replacement beforehand.

2.5.1 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 (THP700), 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 motors for the axes 1 to 3 are connected with other components such as the reduction gear and pulley by using a key. Thus, key alignment is necessary during motor replacement.
For the type of the key, also see the table below.

Description	Axis name	Type	Our drawing No.	Unit code
AC servo motor	Axis 1		S874940	Y610A3JS0
	Axis 2		S746326	Y610A3400
	Axis 3		S746336	Y610A3420
	Axis 4		S816701	Y610A3950
Key	Axis 2	Square key 6x6x20		
	Axis 3	Square key 5x5x16		

* The key to be used with the axis 1 is attached to the motor.

2.5.2 Motor Locations

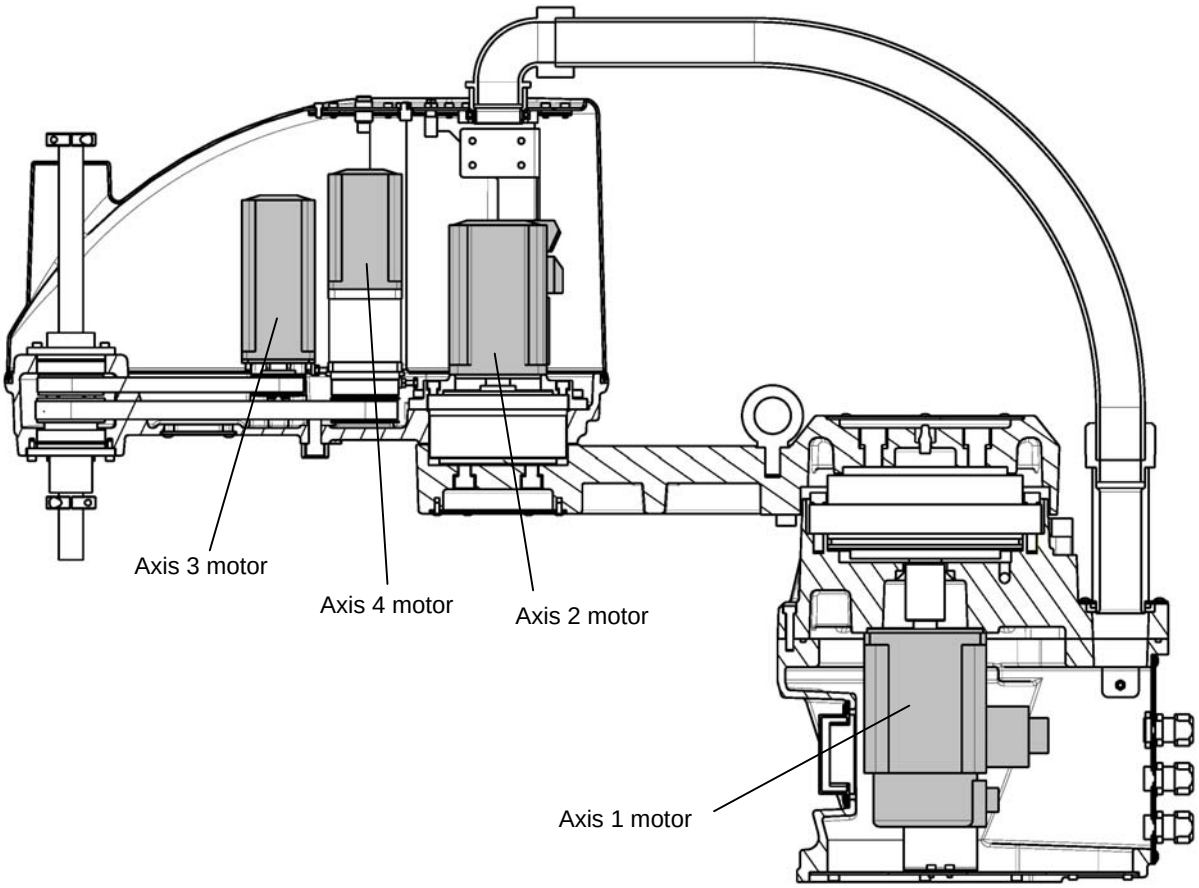


Fig. 2.9 Motor locations

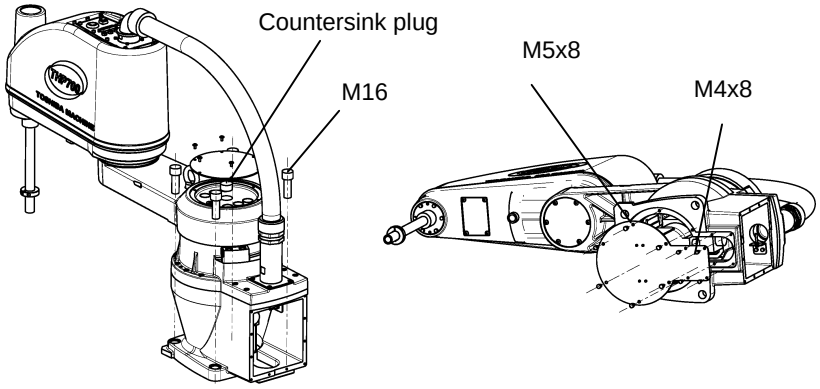
2.5.3 Dismounting Axis 1 Motor

1) Remove the rear one of the covers attached to the base. (See "Para. 2.4.3.")

2) Disconnect the axis 1 motor connectors, J1AS (power drive cable: cannon connector) and J1BS (encoder cable).

3) Remove the four bolts (M16) securing the robot, remove the countersink plug from the center of the arm 1, and then place the robot sideways.
Before placing the sideways, provide a cushion to put the robot on it. More than one person is required to handle the robot.

4) The cover on the bottom of the base is secured with the six bolts (M5x8) and four bolts (M4x8). Remove all the bolts to detach the cover from the base.

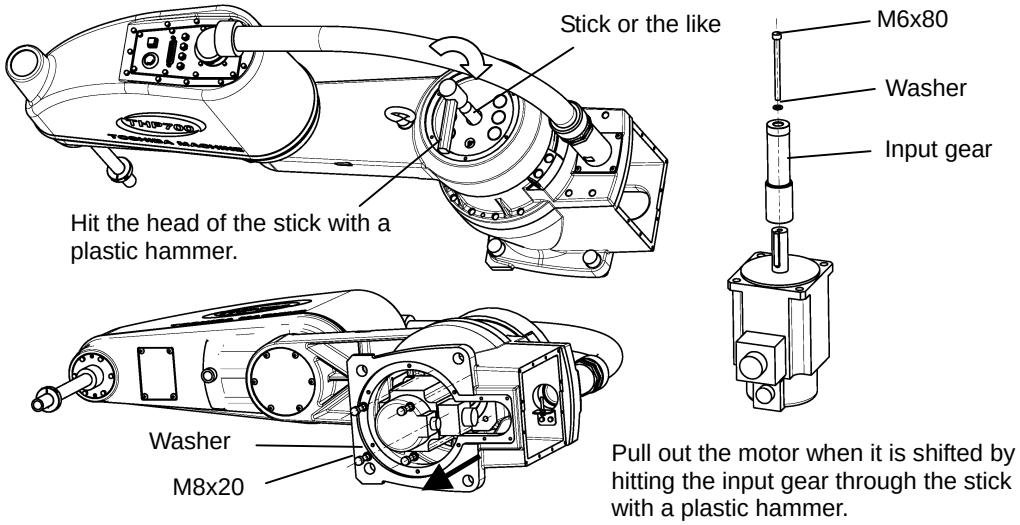


5) Remove the four bolts (M8x20) securing the motor, insert a stick into the hole, which was closed the countersink plug, until the stick comes into contact with the input gear, and then lightly hit the stick with a plastic hammer. When the motor is shifted and becomes movable, pull it out.
When the motor is pulled out, grease can drip from the mounting section. Prepare a waste cloth (or the like) and close the motor-mounting section with the cloth.

6) Secure the input gear, using a vice, etc. and remove the bolt (M6 × 80) at the shaft end. When securing the input gear, use a shock-resistant material such as waste cloth in such a manner that the tooth top or tooth surface is not cut or scratched. After removing the bolt, draw the washer and input gear upward.

! CAUTION

- When dismounting the input gear, DO NOT knock it with excessive force. Otherwise, the encoder may be damaged.

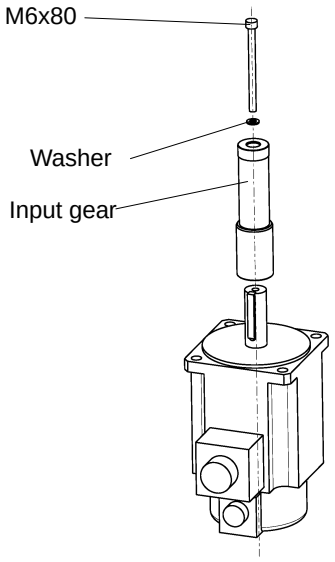


2.5.4 Mounting Axis 1 Motor

1) Mount the input gear, then secure them with the bolt (M6x80) and washer. Secure the input gear, using a vice, etc. and tighten the bolt (M6x80) at the shaft end. When securing the input gear, use a shock-resistant material such as waste cloth in such a manner that the tooth top or tooth surface is not cut or scratched.

! CAUTION

- When mounting the input gear, DO NOT knock it with excessive force. Otherwise, the encoder may be damaged.



2) To secure the motor to the base, reverse the removal steps 4) and 5) in "Para. 2.5.3."
In the steps, pay attention to the motor mounting phase. (See the figure in "Para. 2.5.3.")

3) Install the robot as it was originally installed.

4) Connect the axis 1 motor cannon connectors (for the power drive cable and encoder cable).

5) Return the cables in the base as originally arranged, then attach the cover to the base.

6) After the axis 1 motor is replaced with a new one and before the power is turned on, move the arm 1 by hand to make sure that no abnormal noise is heard.

7) Turn the power on and perform home setting for the axis 1. Now, the motor replacement completes.
(Check for the coordinates of the axes 2, 3 and 4, and perform home setting when necessary.)

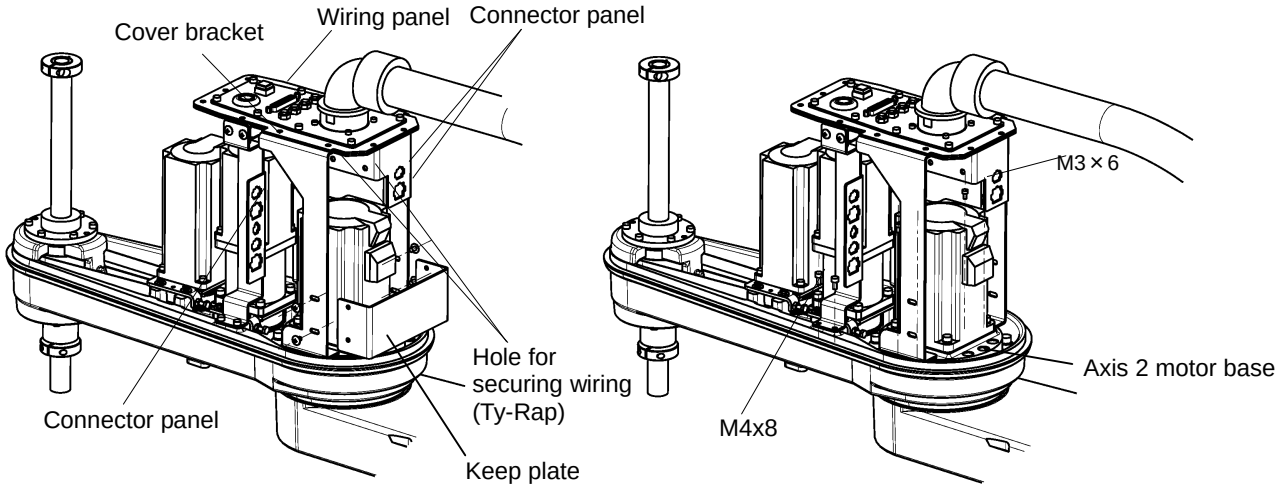
2.5.5 Dismounting Axis 2 Motor

1) Disconnect the arm 2 cover. (See Para. 2.4.1.)

2) Cut the Ty-Rap used to secure the cables to the cover bracket, using nippers or the likes, and remove the keep plate that is secured with the four bolts (M4x6). It is recommended that you should take pictures of the appearance beforehand, so restoration will be done easily since the pictures show the routing of the cables and the Ty-Rap position.

3) Disconnect connectors J2AS and J2AP (power drive cables) and connectors J2BS and J2BP (encoder cables) of the axis 2 motor.

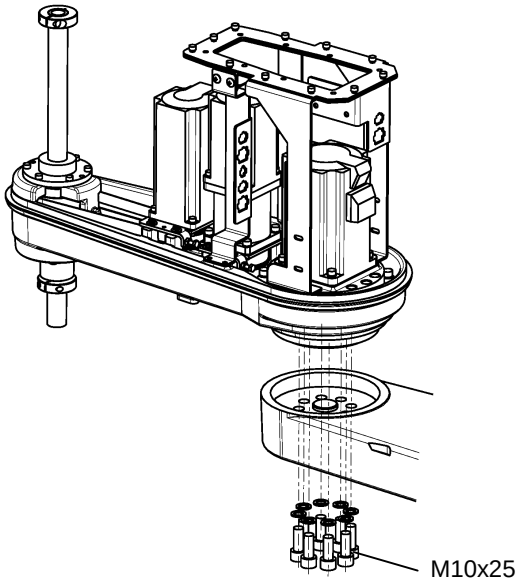
4) Remove the four (4) bolts (M3x6) fixing the cover bracket and the axis 2 motor base, and remove the four (4) bolts (M4x8) fixing the cover bracket and the arm 2.



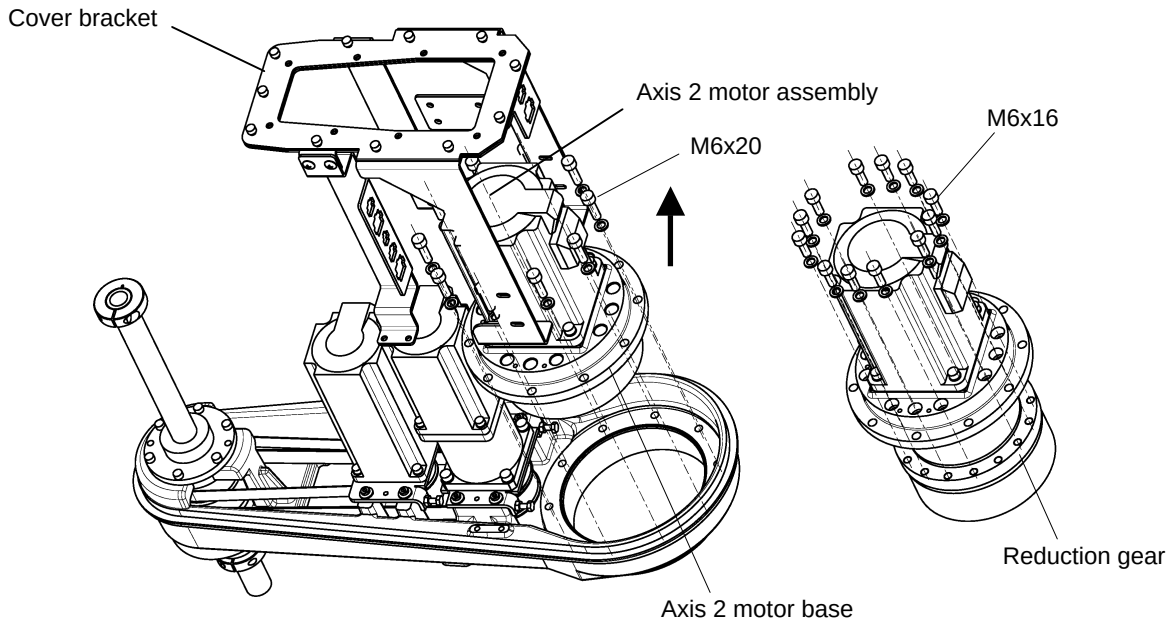
5) Remove the arm 1 cover on the side of the axis 2. (See "Para. 2.4.2.")

6) Remove the eight bolts (M10x25) securing the arms 1 and 2.
When the eight bolts are removed, the arms 1 and 2 are separated. Be careful not to drop the arm 2.

7) The arm 2 is connected with the base through the duct. Provide a cushion near the base, and place the arm 2 sideways on the cushion.

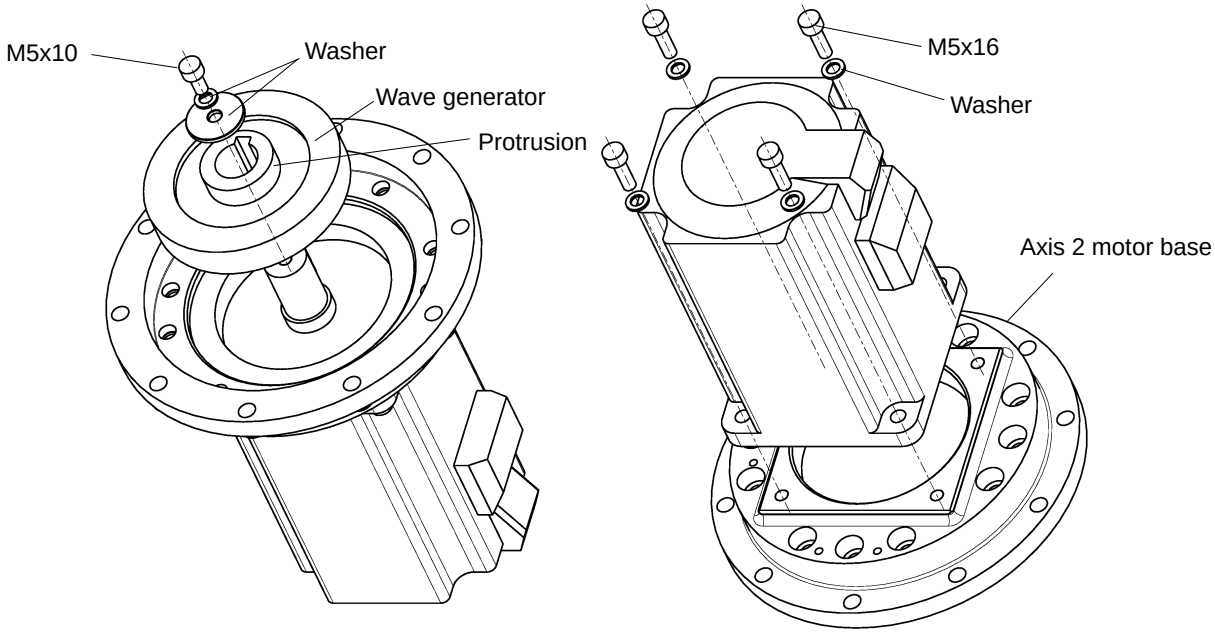


8) Remove the ten bolts (M6x20) securing the axis 2 motor base and the arm 2, and pull out the axis 2 motor assembly from the arm 2 while lifting the cover bracket.
Remove the 12 bolts (M6x16) securing the axis 2 motor base and the reduction gear, and pull out the axis 2 motor.



9) Remove the bolt (M5x10) from the end of the axis while holding the protrusion on the wave generator with pliers or the likes. Use a waste cloth (or the like) as a cushion to protect the wave generator from scratches when securing it. After removing the bolts, remove the washer and wave generator. Bear in mind that the key is removed.

10) Remove the four bolts (M5x16) securing the motor.



11) Separate the motor from the axis 2 motor base. Liquid gasket is applied to the motor mounting surface, so the motor may be hard to remove. Be careful to not to give excessive impact to the motor when removing it.

2.5.6 Mounting Axis 2 Motor

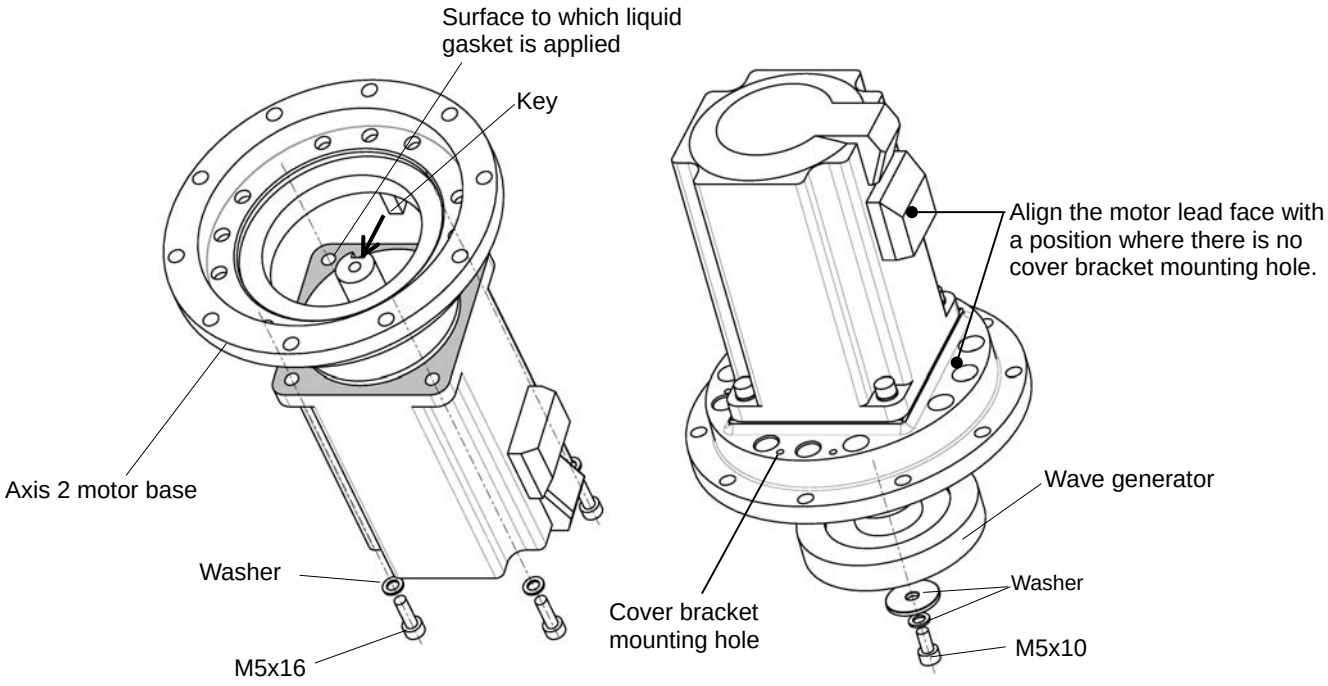
1) Perform key alignment, using the new motor and wave generator. At this time, no clearance should exist between the motor shaft and wave generator.

! CAUTION

- Perform key alignment very carefully. If there is a clearance between the motor shaft and wave generator, an abnormal noise may be heard at the time of operation. Also, positioning accuracy will drop and the life of the parts will shorten.

2) Secure the motor to the axis 2 motor base with the four bolts (M5x16).
Before mounting the motor, apply liquid gasket to the motor mounting surface.
Pay attention to the motor mounting phase.

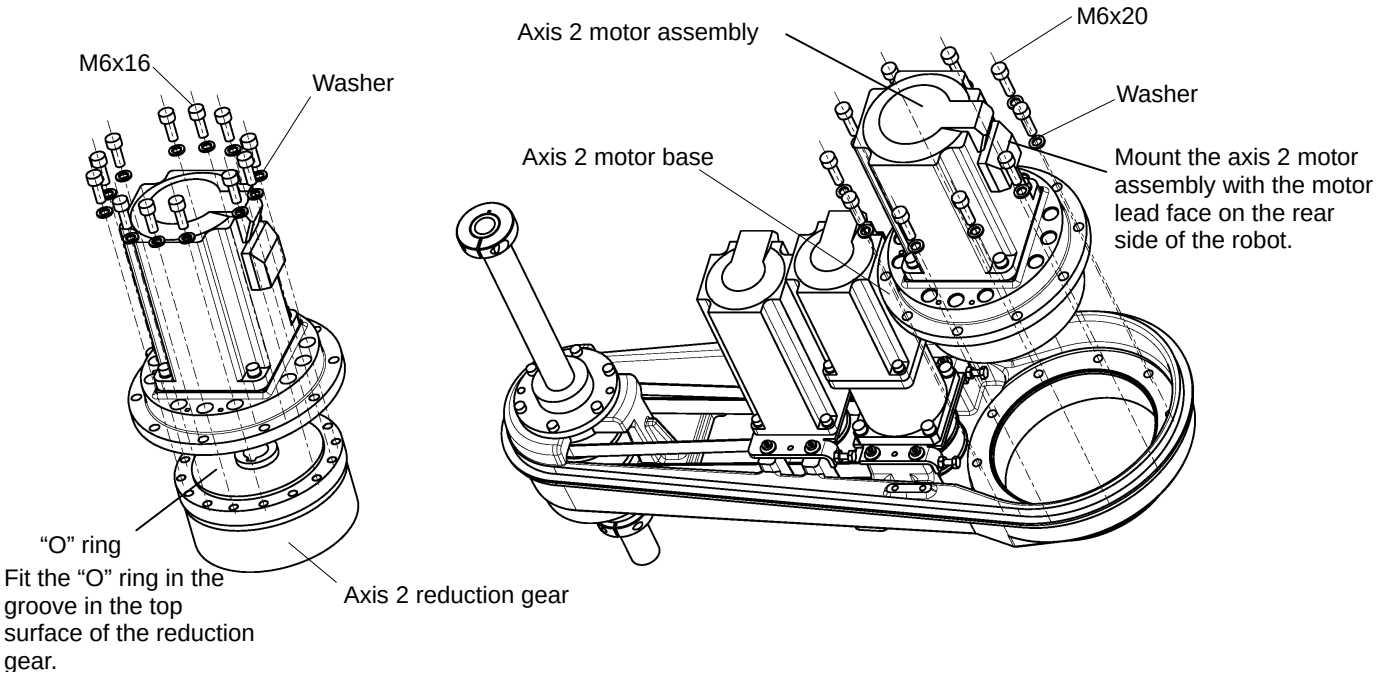
3) Mount the wave generator and the key, and secure them with the bolt (M5x10) and washers.
The wave generator must be mounted with the groove around the circumference on the motor side.
When securing the wave generator, hold the protrusion on the wave generator with pliers or the likes. In doing so, use a waste cloth (or the like) as a cushion to protect the wave generator from scratches.



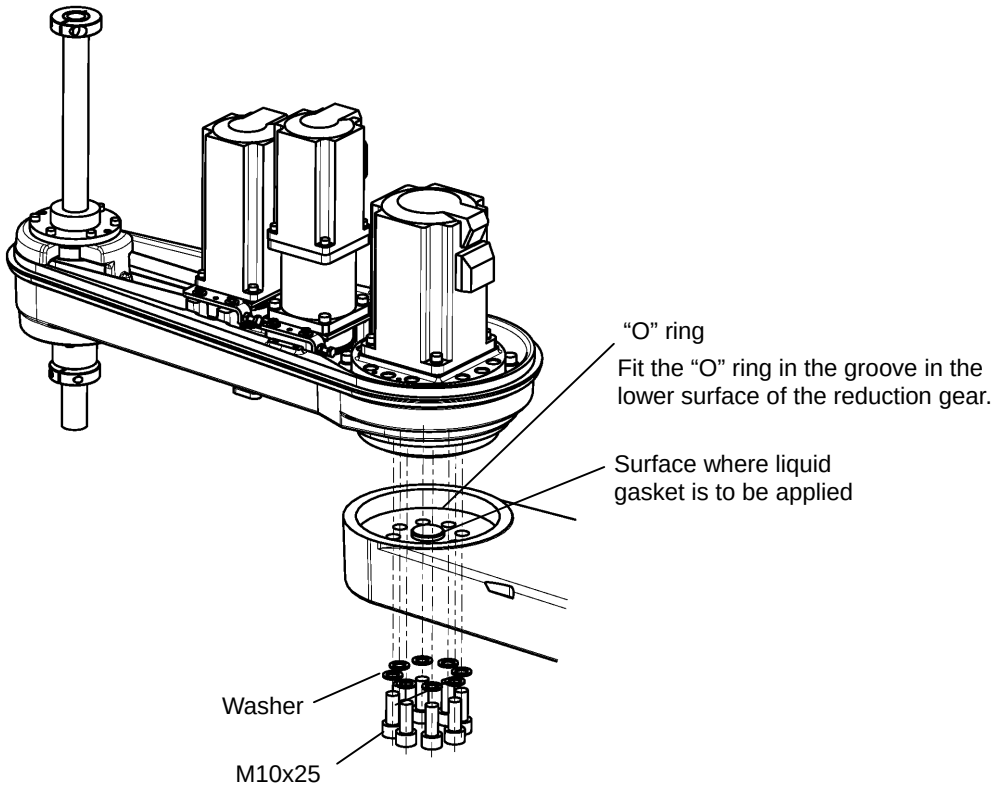
! CAUTION

- Be sure to mount the “O” rings and apply liquid gasket.
  Otherwise, grease will leak from through the axis 2 motor base mounting surface and the motor mounting surface.

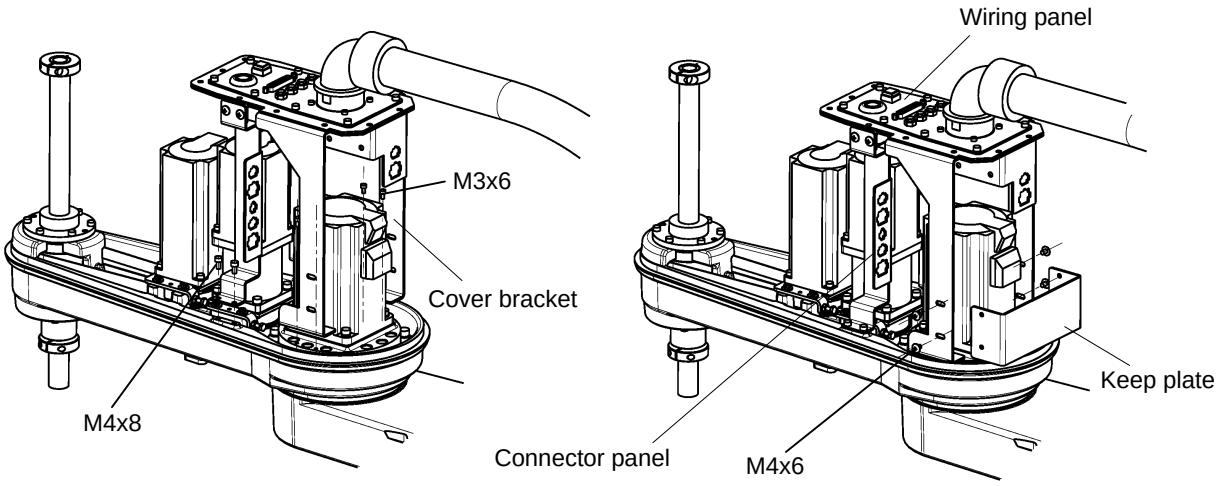
4) Secure the reduction gear to the axis 2 motor base with the 12 bolts (M6x16).
   In doing so, be sure to mount the “O” ring on the axis 2 reduction gear.
   Secure the axis 2 motor assembly to the arm 2 with the ten bolts (M6x20).
   While lifting the cover bracket, secure the axis 2 motor assembly.



5) Secure the arms 2 and 1 with the eight bolts (M10x25).
In doing so, apply liquid gasket to the round surface of the protrusion. Be sure to mount the "O" ring.
Be sure to apply sufficient Loctite to at least three threads of each bolt.



6) Mount the cover bracket on the arm 2.



7) Connect the axis 2 motor connectors (for the power drive cable and encoder cable).

8) Restore the cables in the arm 2 to their original routings, and mount all the covers.

9) After replacing the axis 2 motor and before turning on the power, move the arm 2 by hand in order to confirm that no abnormal noise is emitted.

10) Turn on the power, and perform home setting for the axis 2. This completes motor replacement.

2.5.7 Dismounting Axis 3 Motor

! CAUTION

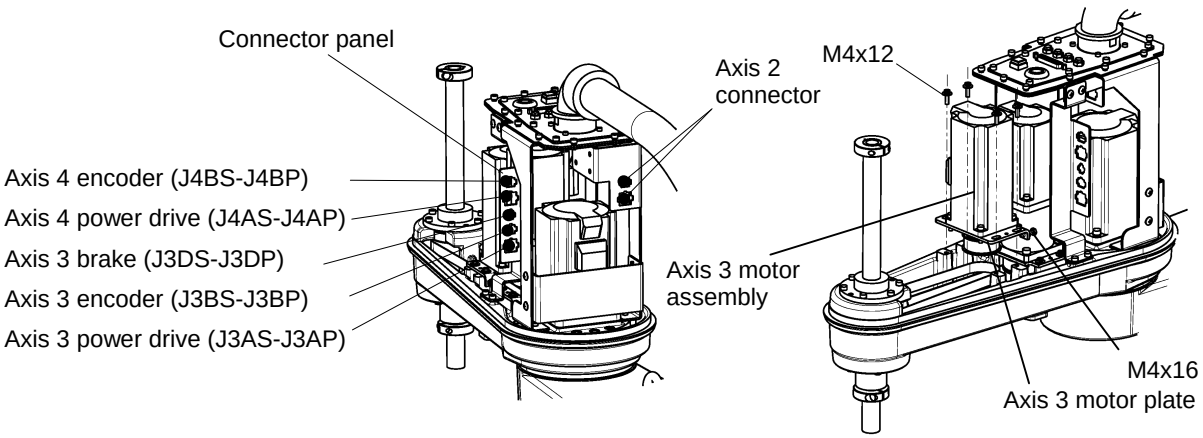
- The axis 3 motor is provided with a brake. At replacement of the axis 3 motor, this brake becomes inoperative. Before starting the work, therefore, move down the ball screw spline to the lower limit. Otherwise, the shaft will drop due to the dead weight of the shaft or workpiece, and your hand or finger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

1) Remove the arm 2 cover. (See Para. 2.4.1.)

2) 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.

3) Cut the TY-RAP for the cables secured to the axes 3 and 4 motor base plate.

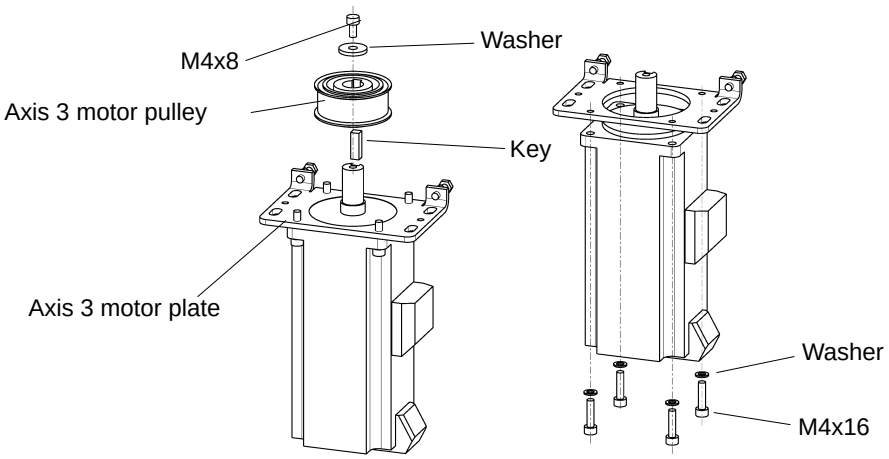
4) Remove the axis 3 tension adjustment bolts, (M4x16) and loosen the flange head bolts (M4x12) securing the axis 3 motor plate to cancel the axis 3 timing belt tension. Then draw out axis 3 the motor assembly upward.



5) Secure the axis 3 motor pulley, using a vice, etc. and remove the bolt (M4x8) at the shaft end. When securing the pulley, take careful precautions not to distort the pulley flange and not to damage the pulley.

6) After removing the bolt, draw out the washer, pulley and key.

7) Remove the four (4) bolts (M4x16) securing the motor, and separate the axis 3 motor from the motor plate.



2.5.8 Mounting Axis 3 Motor

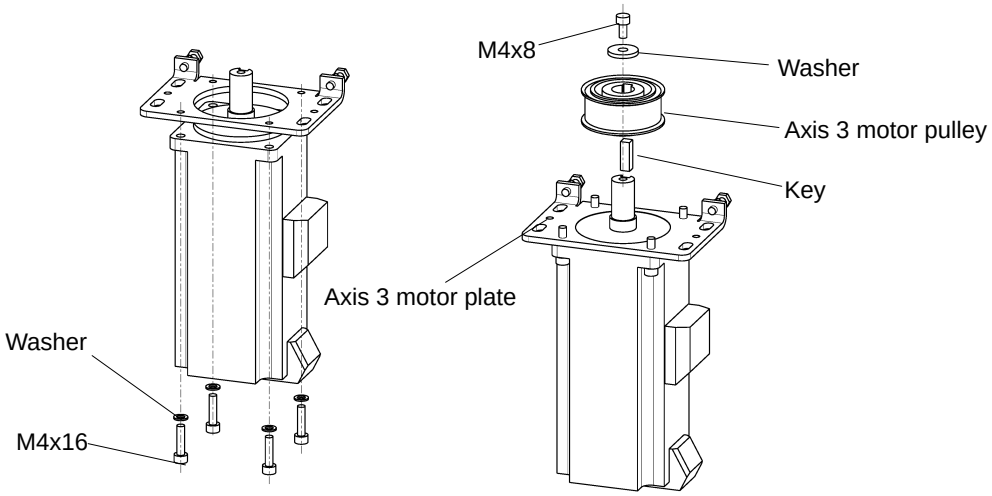
1) Perform key alignment, using the new motor and pulley. At this time, no clearance should exist between the motor shaft and pulley.

! 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.

2) Mount the motor on the axis 3 motor plate with four (4) bolts (M4x16).
Pay attention to the motor phase when mounting the motor.

3) Mount the axis 3 motor pulley and key, then secure them with the washer and bolt (M4x8).

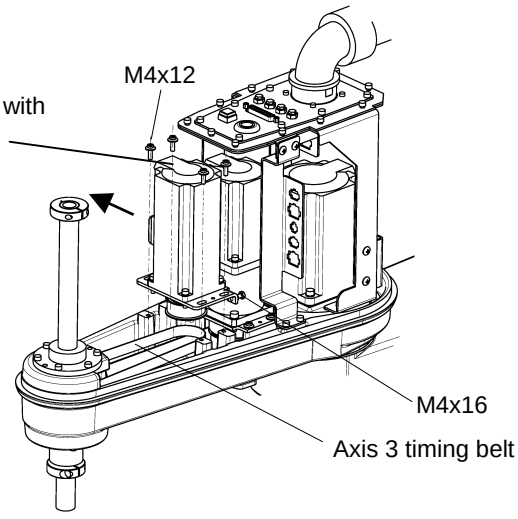


4) Temporarily clamp the axis 3 motor plate to the arm 2 with four (4) flange head bolts (M4x12). Pass the axis 3 timing belt to the axis 3 motor pulley, then exert a tension, using the axis 3 tension adjustment bolts (M4x16).
(For the belt replacement procedures and tension adjustment value, see Para. 2.6.3.) Then completely tighten and secure the bolts which were set temporarily.

5) Connect the connectors. (See the pictures you took beforehand.)

6) Mount the arm 2 cover and perform home setting for the axes 3 and 4. Now, the motor replacement completes.

Axis 3 motor assembly
Secure the axis 3 motor assembly with the motor lead face toward the direction indicated by the arrow.



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

2.5.9 Dismounting Axis 4 Motor

1) Remove the arm 2 cover. (See Para. 2.4.1.)

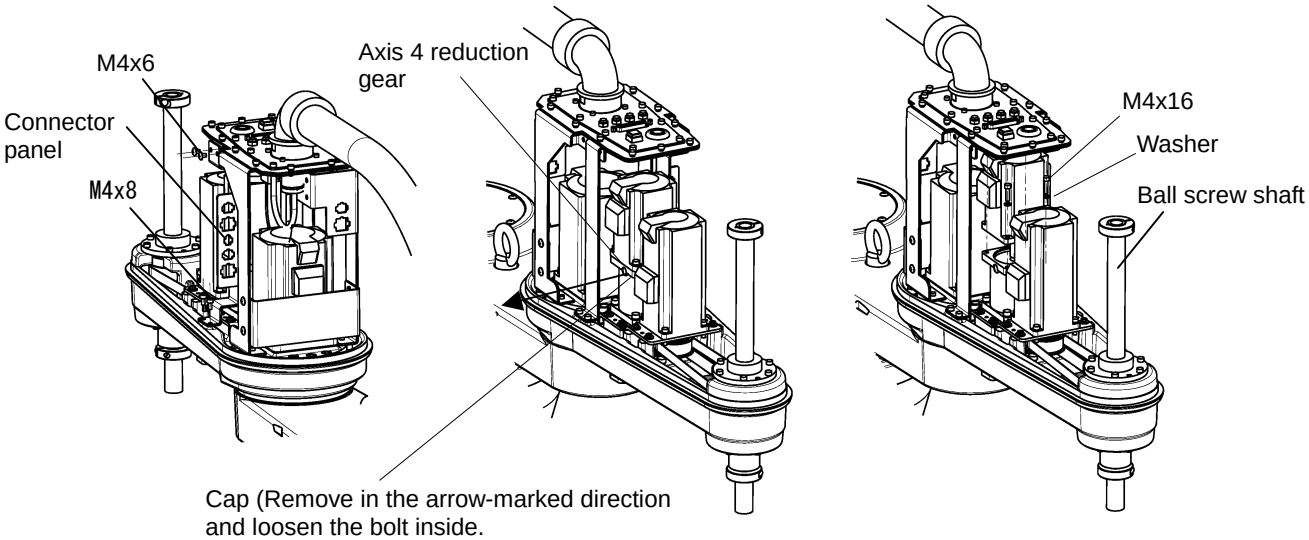
2) Disconnect connectors J4AS and J4AP (power drive cables) and connectors J4BS and J4BP (encoder cables) of the axis 4 motor. For the connector layout, see Para. 2.5.7.

3) Cut the Ty-Raps used to secure the axis 3 and axis 4 motor cables.
It is recommended that you should take pictures of the appearance beforehand, so restoration will be done easily since the pictures show the routing of the cables and the Ty-Rap positions.

4) Remove the connector panel, which is secured to the cover bracket and the arm 2 with the four bolts (M4x6, M4x8). There is no need to remove the axis 3 connectors.

5) Remove the cap attached to the lateral side of the axis 4 reduction gear and loosen the coupling bolt (M4x12) 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 shaft by hand.

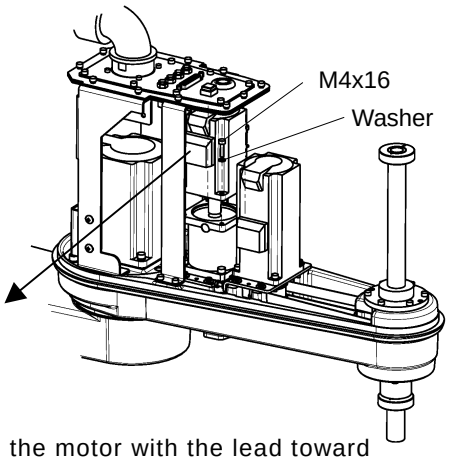
6) Remove the four (4) bolts (M4x16) securing the motor, then draw out the motor upward.



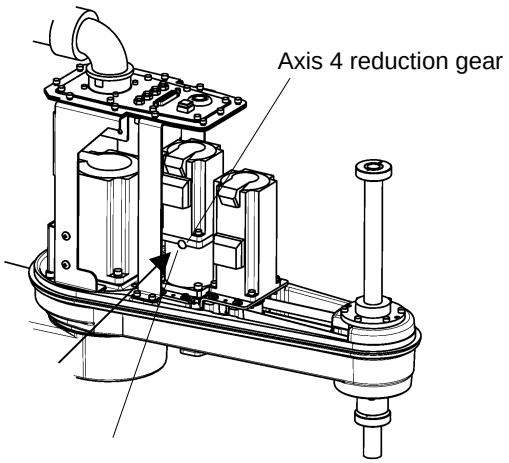
2.5.10 Mounting Axis 4 Motor

1) Mount the new motor on the axis 4 reduction gear with four (4) bolts (M4x16).

2) Tighten the coupling of the axis 4 reduction gear by means of the attached bolt (M4x12) to mount the cap. (Recommended clamping torque: 4.3 N·m)



Secure the motor with the lead toward the direction indicated by the arrow.



Cap
After clamping the coupling bolt, insert in the arrow-marked direction.

3) Connect the axis 4 motor connectors. (See the pictures you took beforehand.)

4) Mount the arm 2 cover and perform home setting for the axes 3 and 4. Now, the motor replacement completes.
After replacement of the axis 4 motor, be sure to execute home setting for the axis 3.

5) Carry out a test operation of the axes 3 and 4 and make sure that each part operates properly.

2.6 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 is turned off with the power supply plug removed. If the work is done while the power is turned on, 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 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.
- 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 4.

2.6.1 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 (THP700), the serial number, the axis name, and our drawing number.
For the location where the serial number plate is attached, see the "Safety Manual."

Description	Axis name	Width	Our drawing No.
Timing belt	Axis 3	10 mm	S860460
	Axis 4	15 mm	S860461

2.6.2 Timing Belt Locations

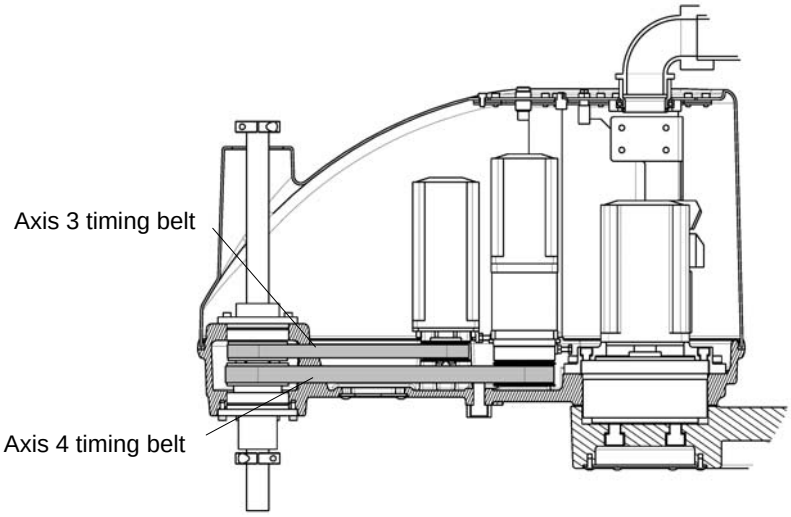


Fig. 2.11 Timing belt locations

2.6.3 Replacing Axis 3 Timing Belt

1) Remove the arm 2 cover. (See Para. 2.4.1.)

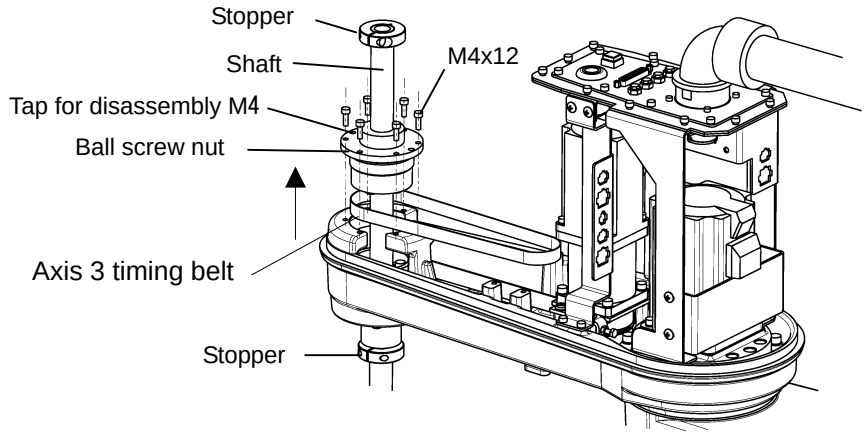
2) Disconnect the axis 3 motor assembly. For the disconnecting procedures, see Steps 1) through 4) of Para. 2.5.7.

! 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 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.

3) Remove the six bolts (M4x12), and pull out the ball screw nut together with the shaft and stopper from the arm 2. Caution should be taken when pulling them out. If they cannot be pulled out by hand, use a tap for disassembly. Note that if the ball screw nut is pulled out of the shaft, the ball drops off the ball screw nut, and the ball screw spline can no longer be used.

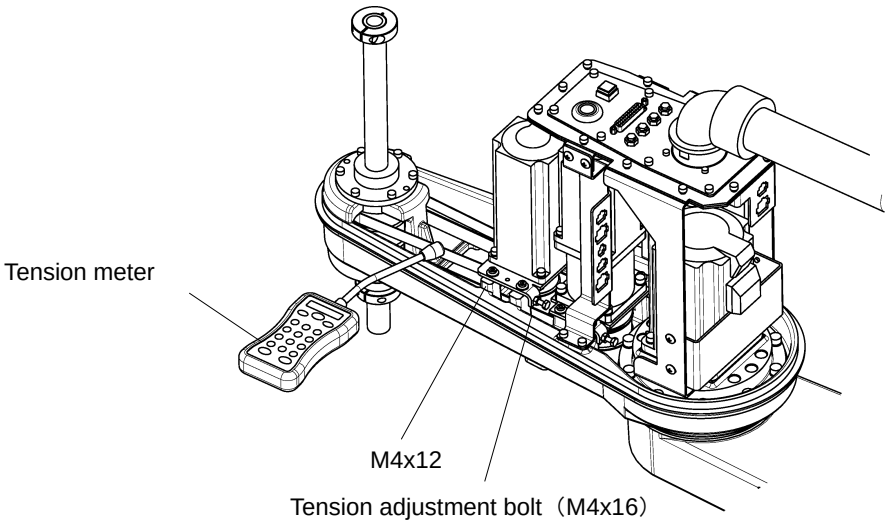
4) Disconnect the axis 3 timing belt.



5) Mount the new timing belt. Insert the ball screw shaft into the ball spline nut, and mount the stoppers. (For the insertion of the ball screw shaft, see "Para. 2.7.5.")

6) Temporarily secure the axis 3 motor assembly (which was removed in step 2) to the arm 2 with the four flange head bolts (M4x12). Place the timing belt on the axis 3 motor pulley, and apply tension to the timing belt, using the tension adjustment bolt (M4x16) for the axis 3.
While pulling the axis 3 motor bracket by means of the axis 3 tension adjustment bolt, measure the tension with a tension meter. Tighten the flange head bolts at a position where the tension is between 60 N and 74 N.

Value of tension [N]	Unit mass [g/m]	Belt width [mm]	Span [mm]
60～74	2.6	10	171



7) Connect the connectors, mount the arm 2 cover, and perform home setting for the axes 3 and 4. This completes the replacement of the timing belt.

8) Carry out a test operation of the axes 3 and 4 and make sure that each part operates properly.

2.6.4 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. (See Para. 2.4.1.)

2) Disconnect all the connectors, except the axis 2 cable connectors, from the connector panel.
It is recommended that you should take pictures of the appearance beforehand, so restoration will be done easily since the pictures show the routing of the cables and the Ty-Rap positions.

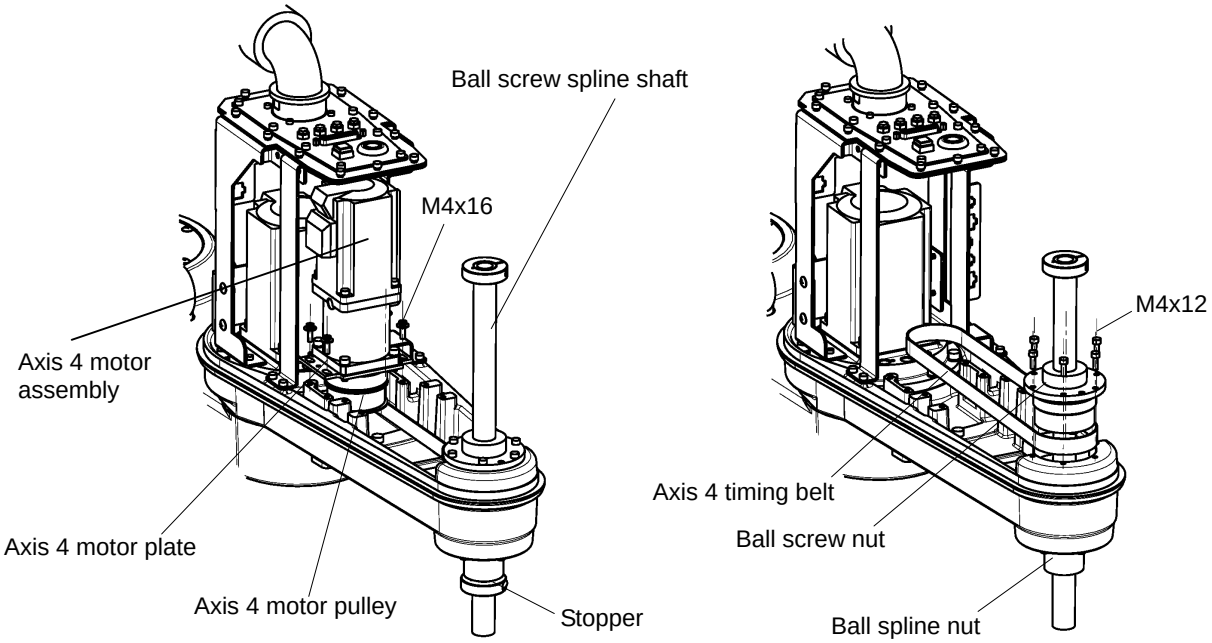
3) Disconnect the axis 3 motor base which remains attached with the motor and pulley. For the disconnecting procedures, see Steps 1) through 4) of Para. 2.5.7.

4) Dismount the axis 3 timing belt. For the disconnecting procedures, see Steps 1) through 3) of Para. 2.6.3.

5) Loosen the tension adjustment bolt (M4x16) for the axis 4, remove the flange head bolts (M4x12) securing the axis 4 motor plate, slide the axis 4 motor assembly toward the end of the arm 2, and then pull out the motor assembly upward.

6) Remove the lower and stopper. (The hand, etc. should be disconnected beforehand.)

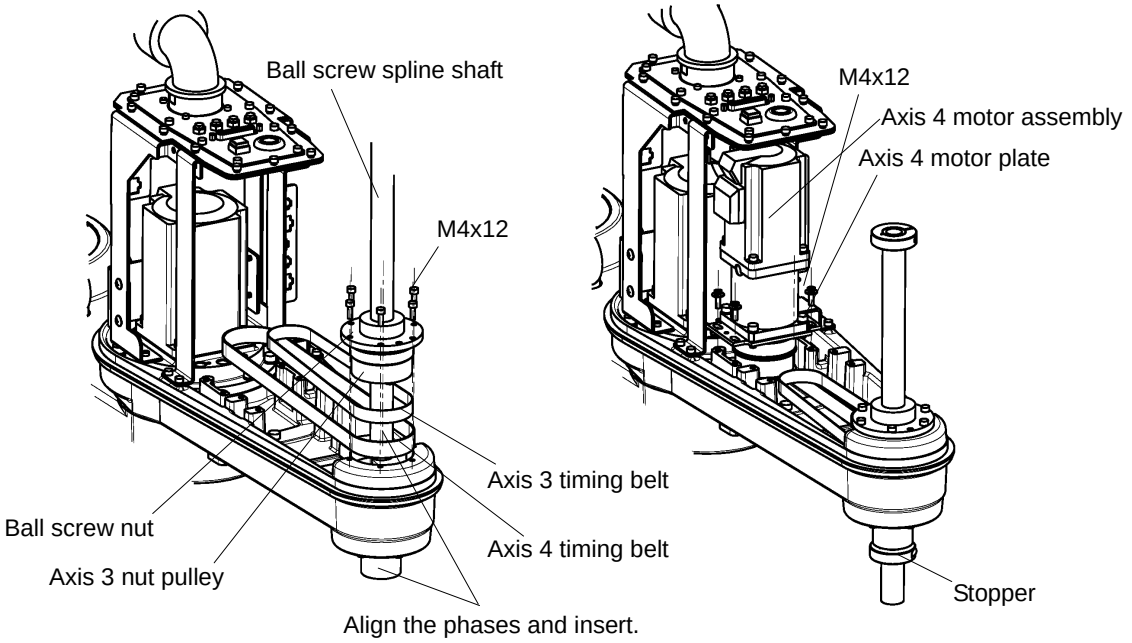
7) Remove the six (6) bolts (M4x12) securing the ball screw nut, then carefully draw out the ball screw nut integrated with the shaft upward. If the ball screw nut integrated with the shaft is drawn out diagonally with an unusually large force, the ball in the ball screw nut may drop.



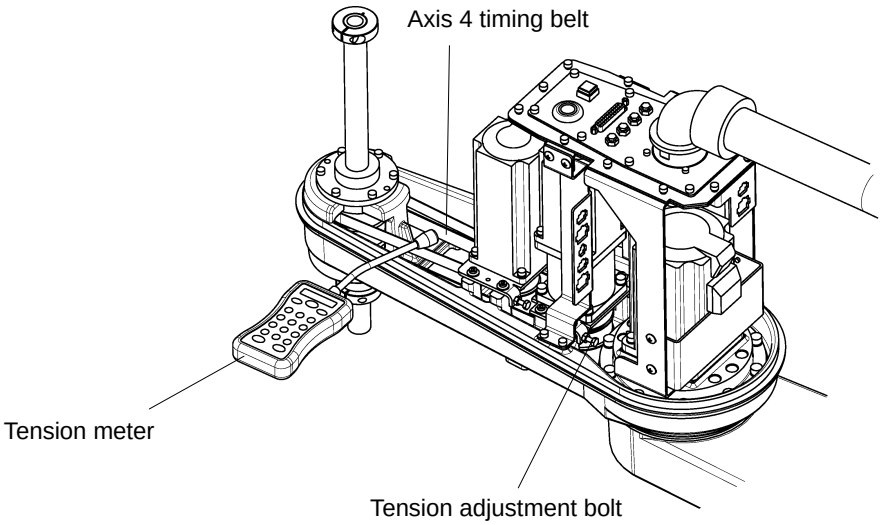
8) Draw out the axis 4 timing belt upward, then set a new belt.

9) Secure the ball screw nut and ball screw spline shaft which were disconnected in Step 7) above to the arm 2, using the six (6) bolts (M4x12).
In doing so, mount the axis 3 timing belt on the axis 3 nut pulley. (For the mounting of the ball screw spline, see "Para. 2.7.5.")

10) Temporarily set the axis 4 motor assembly which was disconnected in Step 5) above to the arm 2 with the four (4) flange head bolts (M4x12) after setting the axis 4 timing belt to the axis 4 motor pulley. Also mount the axis 4 tension adjustment bolt (M4x16).



11) While pushing the axis 4 motor plate by means of the axis 4 tension adjustment bolt, measure the tension on the tension meter. At a position where the tension has reached 190 to 210 N, tighten the flange head bolts.
The values used for the tension meter are tabled below.



	Value of tension [N]	Unit mass [g/m]	Belt width [mm]	Span [mm]
Tension after belt replacement	190～210	4.1	15	241

12) Mount the axis 3 motor and timing belt. For the mounting procedures, see Para. 2.5.7 and Para. 2.6.3 above.

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

14) Perform home setting for the axes 3 and 4.

15) Carry out a test operation of the 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.

2.6.5 Adjusting Timing Belt

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

1) Remove the arm 2 cover. (See Para. 2.4.1.)

2) 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 (see Para. 2.6.3 and Para. 2.6.4).
If the tension is appropriate, mount the arm 2 cover. Now the inspection completes.

3) When adjustment of the tension is required, loosen the flange head bolts (M4x12) 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: M4x16, axis 4: M4x16).

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

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

2.7 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 is turned off with the power supply plug removed. If the work is done while the power is turned on, 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 4.

2.7.1 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 and our drawing number.

Description	Stroke	Our drawing No.	Unit code
Ball screw spline unit	150 mm	H846367	Y610A3EP0
	300 mm	H846387	Y610A3EQ0

* Stroke 300 mm is optional.

2.7.2 Ball Screw Spline Unit Location

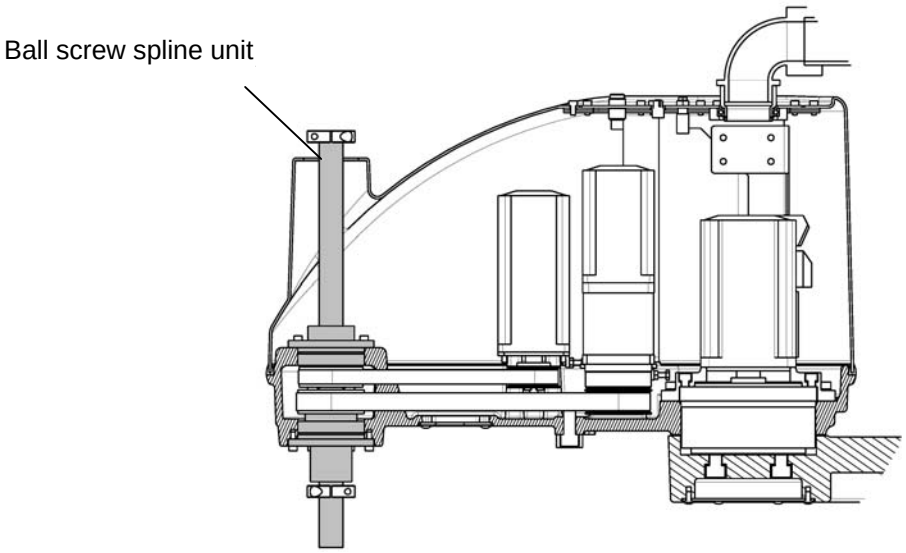


Fig. 2.12 Ball screw spline unit location

2.7.3 Filling Grease to Ball Screw Spline Unit

! 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.

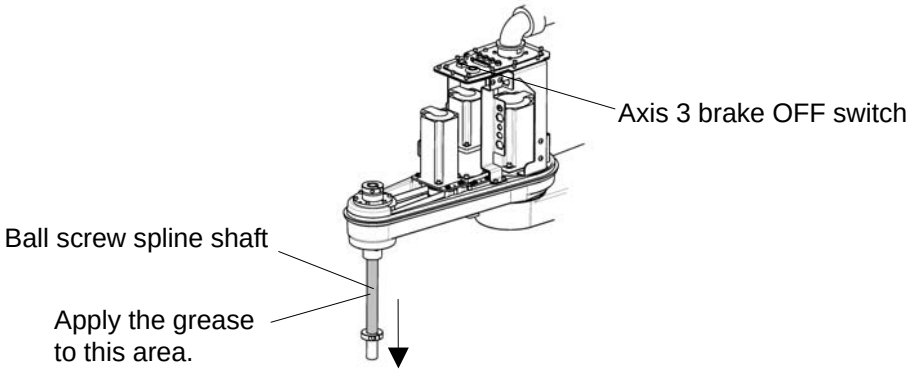
! CAUTION

- 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 Toshiba Machine.

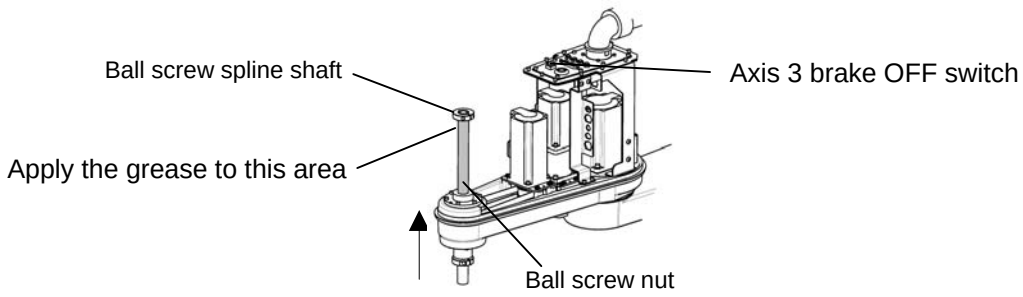
Fill the grease to the ball screw spline unit every three (3) months.
At daily inspection also, make sure that the ball screw spline unit is filled with a sufficient volume of grease.

Recommended grease	Maker
AFF grease	THK

1) Turn on the controller power and turn off the servo system.
2) Move the arm to a position where the axis 3 can be moved over the full stroke.
3) Remove the arm 2 cover (see Para. 2.4.1).
4) Push down the ball screw spline shaft to the lower limit while pressing the axis 3 brake OFF switch.
5) Directly apply the grease to the exposed shaft area by hand or finger.
   Apply the grease to such an extent that the shaft groove can be filled. Wipe out the surplus grease.



6) Push up the shaft up to the upper limit while pressing the axis 3 brake OFF switch.
7) Directly apply the grease by hand or finger 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.



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

2.7.4 Dismounting Ball Screw Spline Unit

DANGER

- The ball screw spline unit should be replaced with a new one only after the controller power is turned off with the power supply plug removed. If the work is done while the power is turned on, 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 is necessary after replacement of the ball screw spline unit. For the home return procedures, see Section 4.

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. 2.5.7, Para. 2.5.9, Para. 2.6.3 and Para. 2.6.4).

1) Remove the arm 2 cover. (See Para. 2.4.1.)

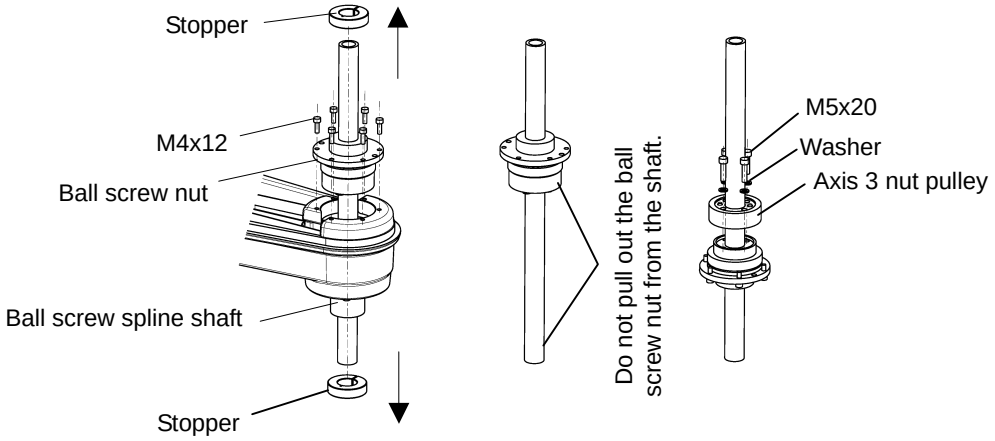
2) Disconnect the hand, tool, etc. followed by the upper and lower stoppers
Once the stoppers are removed, the shaft can slip out in the vertical direction. Take careful precautions not to drop it by its dead weight.

3) Disconnect the axis 3 and 4 motors and timing belts.

4) Remove the six bolts (M4x12) securing the ball screw nut, and lift off the ball screw nut and the ball screw spline shaft all together. Caution should be taken when lifting them off. If they cannot be removed by hand, use a tap for disassembly.

5) Remove the timing belts from the axes 3 and 4.

6) Disconnect the axis 3 nut pulley secured to the ball screw nut.

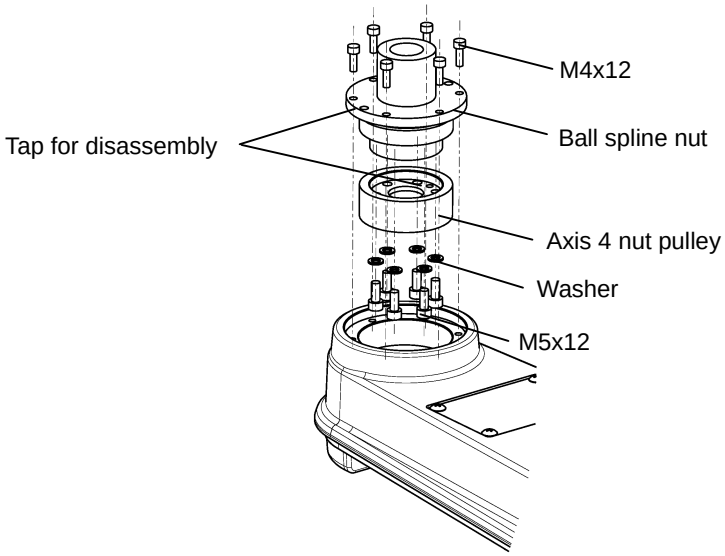


CAUTION

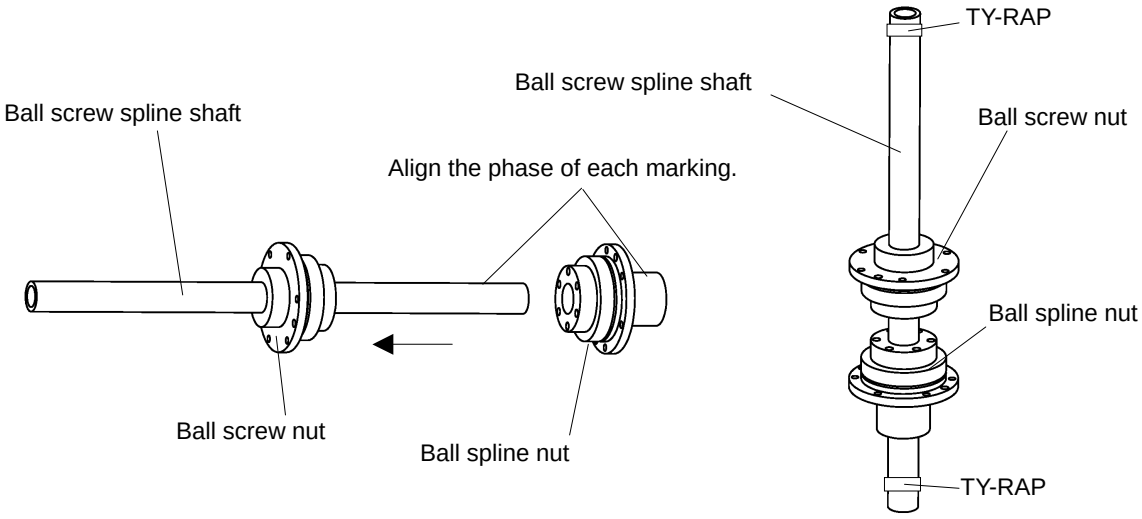
- When the ball screw nut integrated with the ball screw spline shaft is disconnected, take utmost care not to cause the ball screw spline shaft to come off. Otherwise, the ball in the ball screw nut will drop and the ball screw nut integrated with the ball screw spline shaft cannot function any further.

7) Remove the six bolts (M4x12) 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 tap (M4) to remove it.

8) Disconnect the axis 4 nut pulley secured to the ball spline nut with six (6) bolts (M5x12). When it is hard to disconnect, screw the bolt into the tap for disassembly (M4) machined on the pulley and disconnect.



9) 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 TY-RAP around near the top and bottom of the shaft.



2.7.5 Mounting Ball Screw Spline Unit

DANGER

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

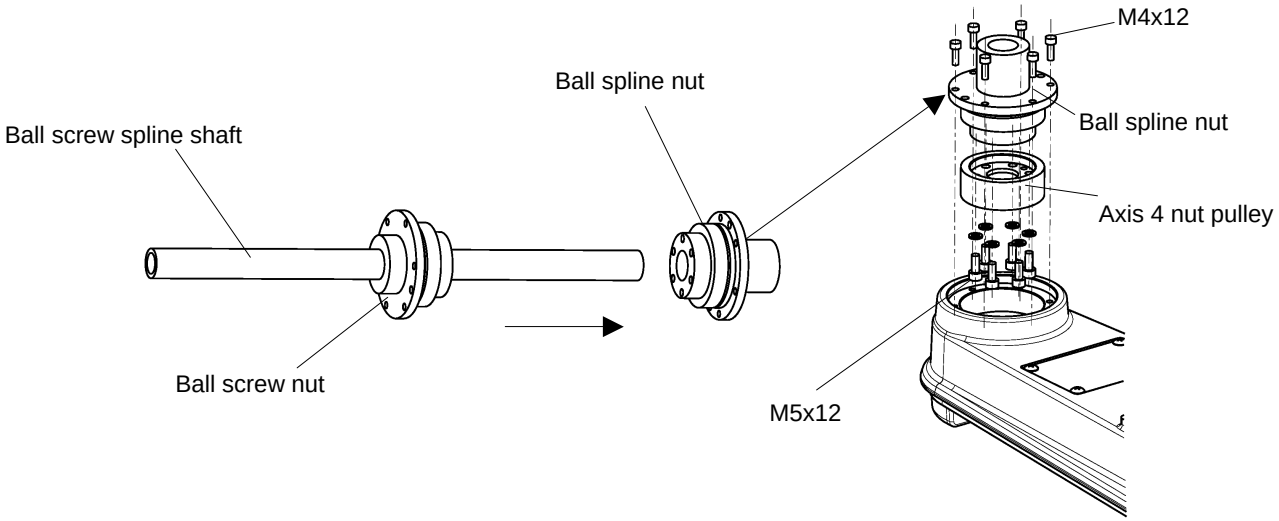
CAUTION

- 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 axes 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 is necessary after replacement of the ball screw spline unit. For the home return procedures, see Section 4.
- 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.

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 six (6) bolts (M5x12). 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 the arm 2 with the six bolts (M4x12).



4) Mount the axis 4 timing belt and axis 4 motor, then adjust the belt tension.

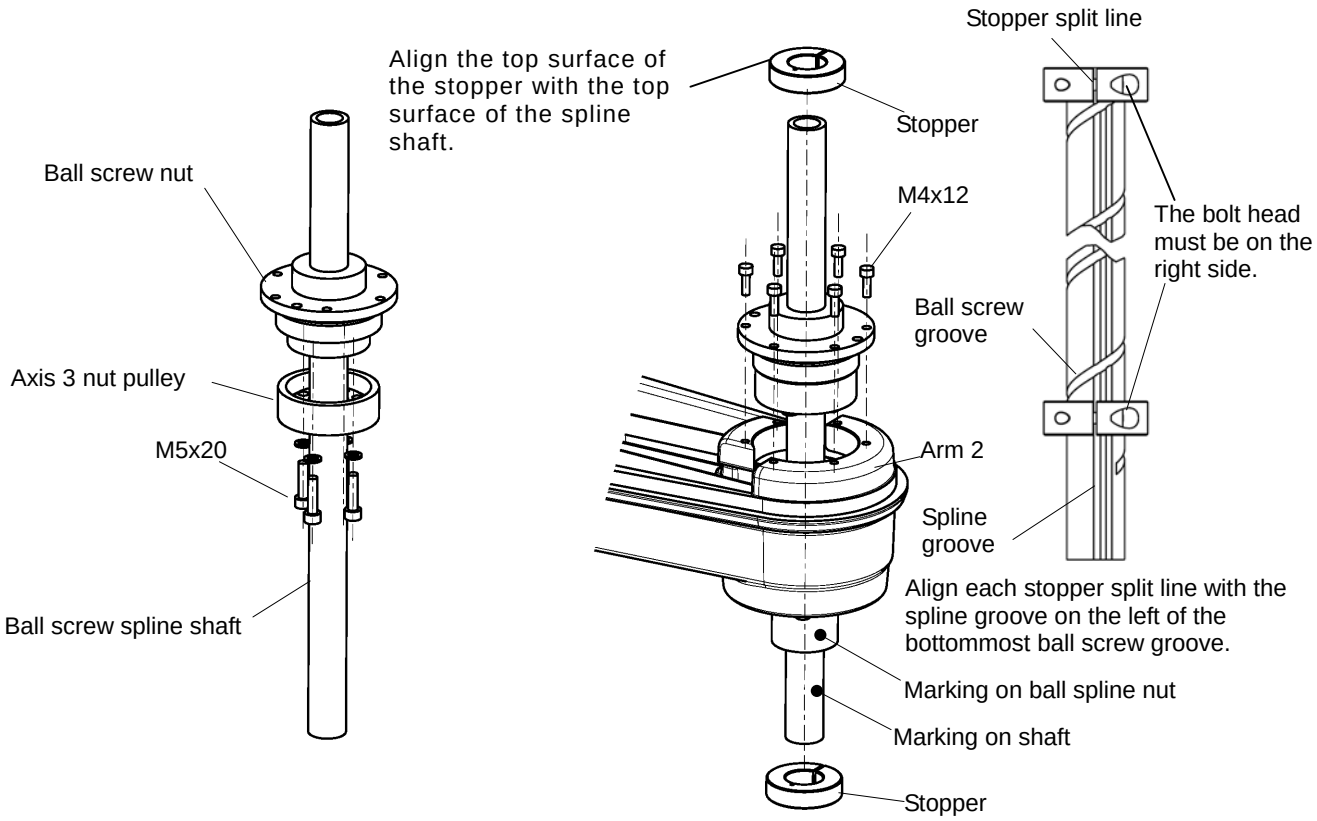
5) Mount the axis 3 nut pulley with the four bolts (M5x20).

6) Put the axis 3 timing belt through the clearance in the fixed surface of the ball screw nut.

7) Mount the ball screw nut integrated with the ball screw spline shaft onto the nut flange, then pass them through the ball spline nut. 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) Secure the ball screw nut to the arm 2 with the six (6) bolts (M4x12).
At first, tighten the bolts temporarily. Move the shaft up and down by hand and make sure that it moves smoothly, then tighten the bolts completely.

9) 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.



10) Mount the axis 3 motor, then adjust the belt tension.

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

12) Perform home setting for the axes 3 and 4.
When performing home setting for the 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) Carry out a test operation of the axes 3 and 4 and make sure that each part operates properly.

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

2.8 Filling Grease to Reduction Gear and 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 is turned off with the power supply plug removed. If the work is done while the power is turned on, 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 4.

2.8.1 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 (THP700), axis name, type and our drawing number.

Description	Axis name	Our drawing No.	Unit code
Reduction gear	Axis 1	S874941	Y610A3JT0
	Axis 2	M147090	Y610A34L0
	Axis 4	S829013	Y610A3JD0

2.8.2 Reduction Gear Locations

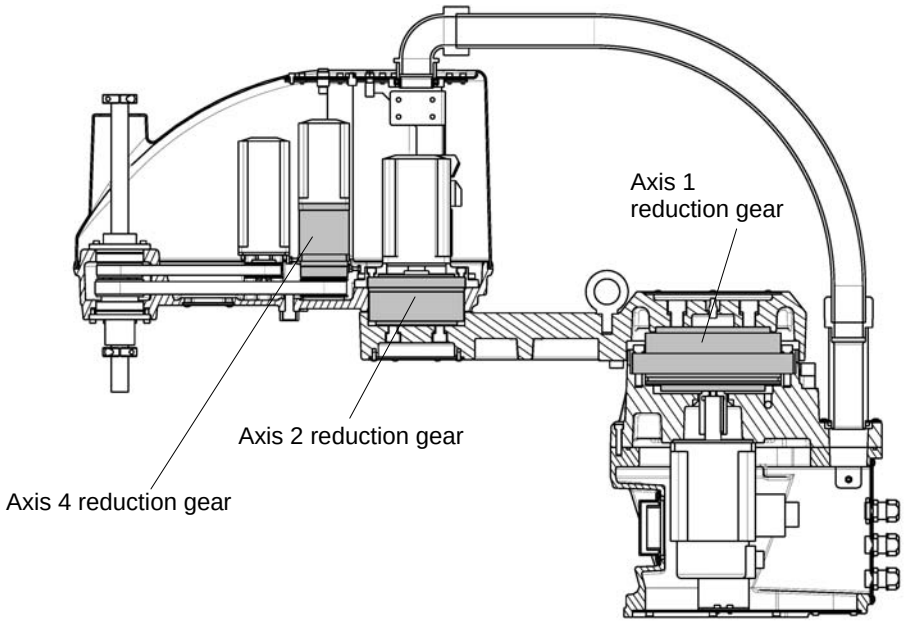


Fig. 2.13 Reduction gear locations

2.8.3 Filling Grease to Reduction Gear

When the reduction gears are used under the normal operating conditions, regular greasing of them is unnecessary. Replace the reduction gears at the time of overhauling. For the axis 1, however, if the reduction gear is used under the conditions of high operation duty and heavy load, fill the grease to it every 10,000 hours (i.e., approximately two (2) years). Greasing of the axes 2 and 4 reduction gears are unnecessary.

! CAUTION

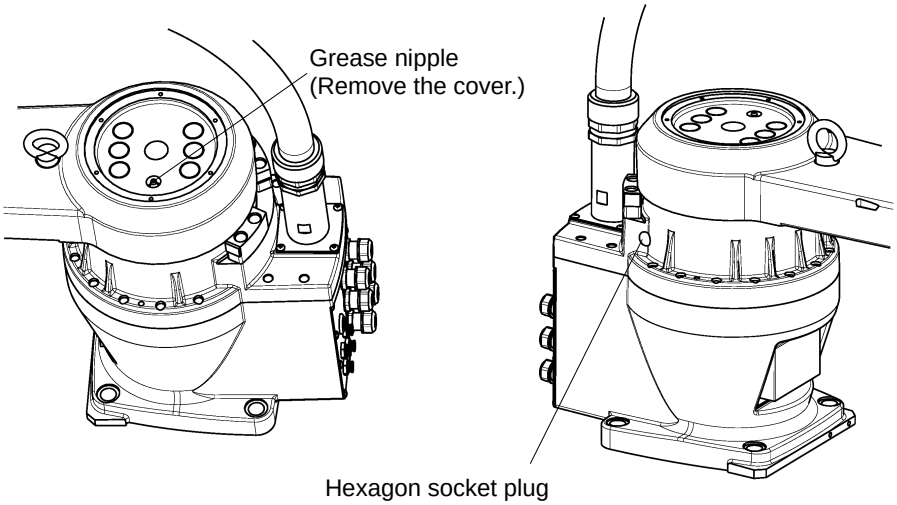
- Shortage of grease causes metallic contact inside the reduction gear unit or of gears, which in turn causes an early failure. Caution should be taken to avoid shortage of grease.
- Be sure to use the grease designated by Toshiba Machine.
  Increase in internal pressure will adversely affect the starting torque and damage the internal seal. To avoid this, be sure to observe the grease filling volume.

Grease filling volume

Grease filling volume for axis 1 reduction gear
246 g

When you wish to place an order for the grease, contact us at the Service Department.

1) Filling grease to axis 1 reduction gear
Remove the top cover of the arm 1, and supply grease through the nipple. Grease of 82 g should be supplied at each of the operating angles +90°, 0°, and -90° of the arm 1. In doing so, remove the hexagon socket plug (Rc1/8) from the side of the base so as to drain old grease. Provide an oil pan or the like to collect old grease.
After supplying the specified amount of grease, let old grease out by rotating the arm 1 several times in a range from +90° to -90°. Attach the hexagon socket plug (Rc1/8) to the side of the base, and wipe off grease on the side of the base and in the area around the grease nipple. After that, mount the cover on the arm 1. This completes the supply of grease.
When attaching the socket plug, be sure to use a seal tape.
To circulate the grease throughout the reduction gear interior, it is recommended to perform running at a low speed for about five (5) minutes.



2.8.4 Dismounting Axis 1 Reduction Gear

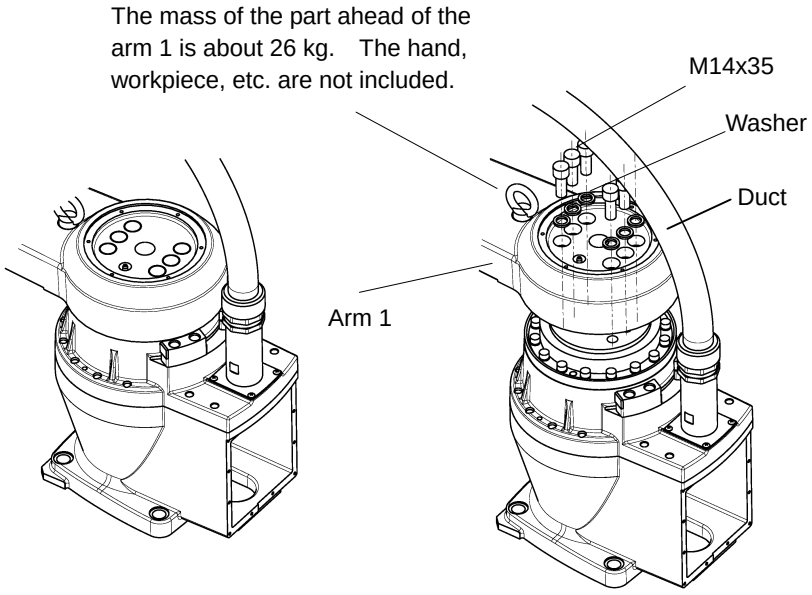
1) Remove the arm 1 top cover. (See Para. 2.4.2.)

2) Remove the base cover and pull out the cables (J1AS and J1BS). (See Para. 2.4.3.)

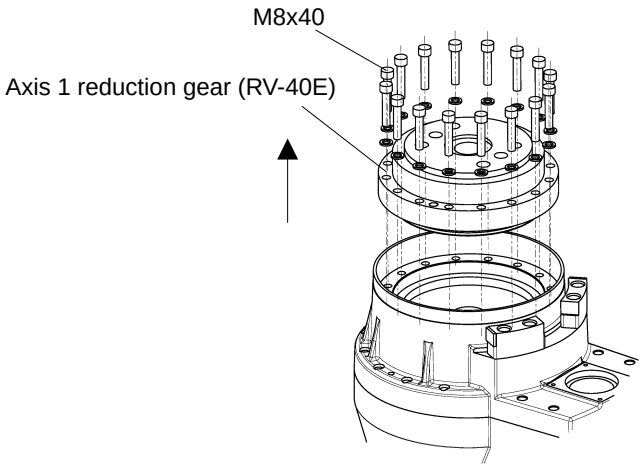
! CAUTION

- The arm should always be mounted and dismounted by three (3) or more persons. When removing the arm set bolts, take careful precautions because the arm will drop. Also, if an excessively large impact is imposed on the arm, the robot will be damaged.

3) While more than one (1) person is holding the arm, another person should remove the six (6) bolts (M14x35) securing the arm 1 and the long type union, then disconnect the arm 1. Connect the disconnected arm to the base through the duct. Provide a cushion near the base, and place the arm sideways on the cushion.



4) Remove the sixteen (16) bolts (M8x40) securing the reduction gear, then draw out the reduction gear upward. If the reduction gear is hard to remove, screw one of the securing bolts into the tap (M8) to remove the reduction gear. Note that a special “O” ring is attached to the side of the reduction gear.



5) Remove the input gear. For the removal of the input gear, see "Para. 2.5.3." The input gear is used in combination with the reduction gear, so it must be replaced when the reduction gear is replaced. An input gear is provided as an accessory with a new reduction gear.

6) Mount the input gear. (See "Para. 2.8.5.")

7) Install the robot at the original location.

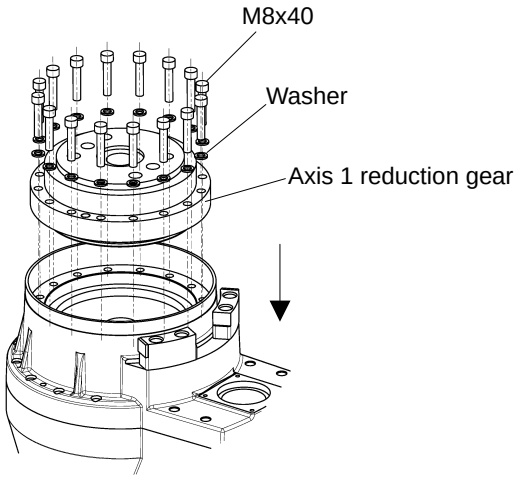
2.8.5 Mounting Axis 1 Reduction Gear

! 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 input gear 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 input gear provided as an accessory with a new reduction gear. For the mounting procedure, see "Para. 2.5.4.")

2) Mount the reduction gear with the sixteen (16) bolts (M8 × 40). Be sure to apply the Loctite adhesives to the threaded area of each bolt. Before mounting the reduction gear, set the “O” ring in the “O” ring groove on the bottom of the reduction gear. The “O” ring is attached to the new reduction gear.

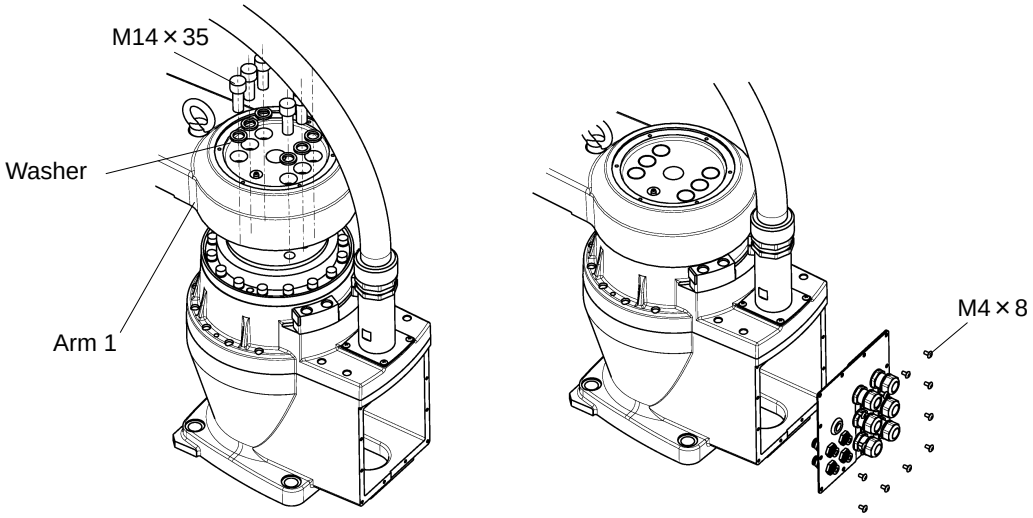


3) Mount the arm 1 with the six (6) bolts (M14 × 35). Be sure to apply the Loctite adhesives to the threaded area of each bolt.

4) Connect the cable connectors (J1AS and J1BS) as originally set.

5) Mount the arm 1 cover and perform home setting for the axes 1 to 4. Now replacement of the axis 1 reduction gear completes.
As all cable connectors are disconnected, home setting of axes 2, 3 and 4 is necessary.

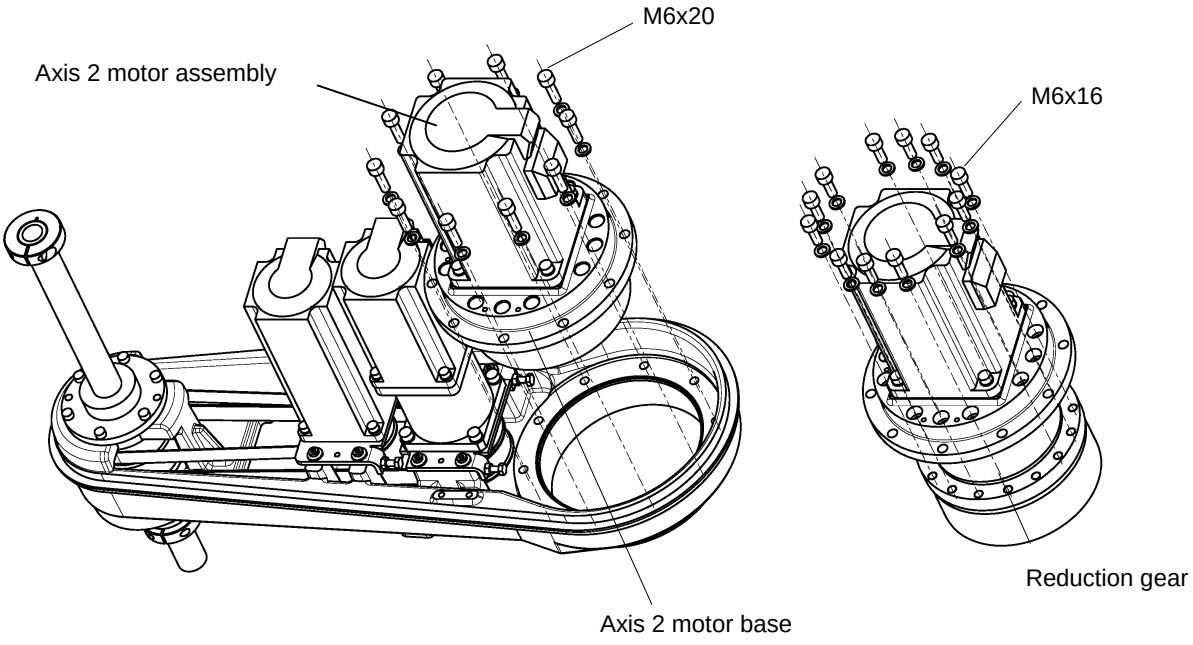
6) Carry out a test operation of the axis 1 and make sure that each part operates properly.



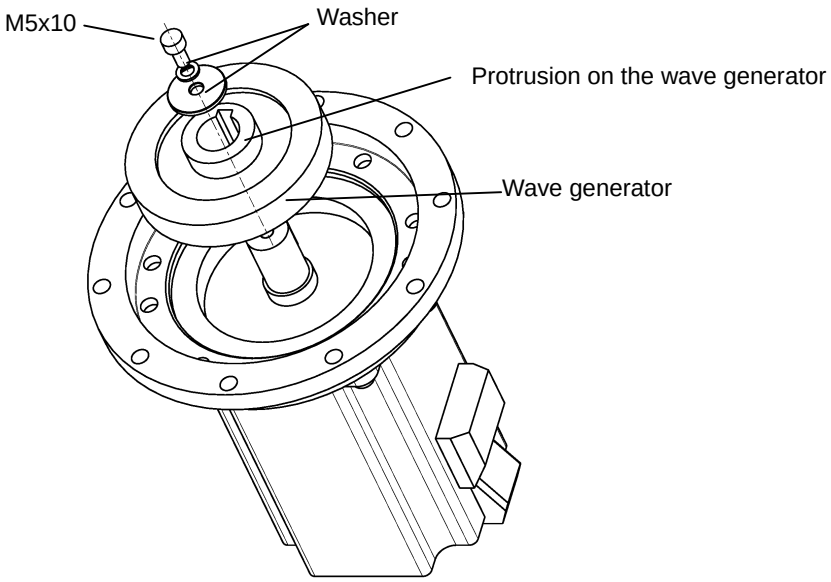
2.8.6 Dismounting Axis 2 Reduction Gear

1) Remove the arm 2 cover. (See Para. 2.4.1.)
Remove the arm 2 from the arm 1.
For the disconnecting procedures, see Steps 1) through 8) of Para. 2.5.5.

2) Remove the ten bolts (M6x20) securing the axis 2 motor base and the arm 2, and pull out the axis 2 motor assembly from the arm 2.
Remove the 12 bolts (M6x16) securing the axis 2 motor base and the reduction gear, and pull out the reduction gear.



3) Remove the bolt (M5x10) from the end of the axis while holding the protrusion on the wave generator with pliers or the likes. In doing so, use a waste cloth (or the like) as a cushion to protect the wave generator from scratches. It is recommended that the wave generator should also be replaced when the reduction gear is replaced. Note that a special “O” ring is attached to the bottom of the reduction gear. See "Para. 2.5.5."



! CAUTION

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

2.8.7 Mounting Axis 2 Reduction Gear

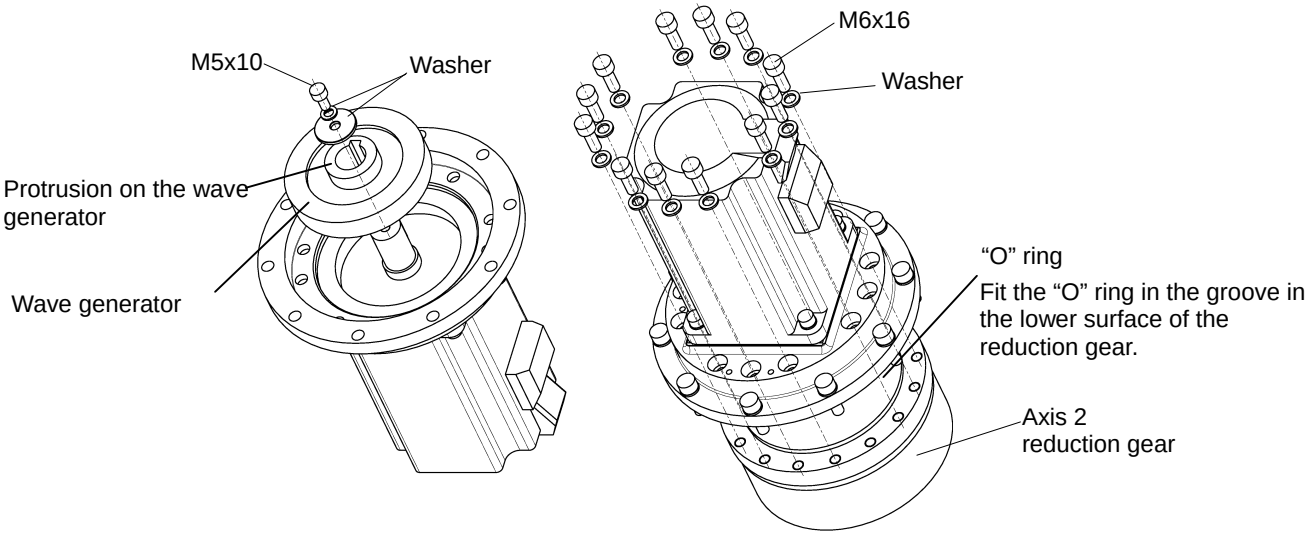
! CAUTION

- 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) A wave generator is provided as an accessory with a new reduction gear. Secure the wave generator to the motor with the bolt (M5x10). Insert the wave generator, holding it with the groove around the circumference on the motor side. The bolt is difficult to tighten because the wave generator rotates. Thus, tighten it while holding the protrusion on the wave generator with pliers or the likes. In doing so, use a waste cloth (or the like) as a cushion to protect the wave generator from scratches.

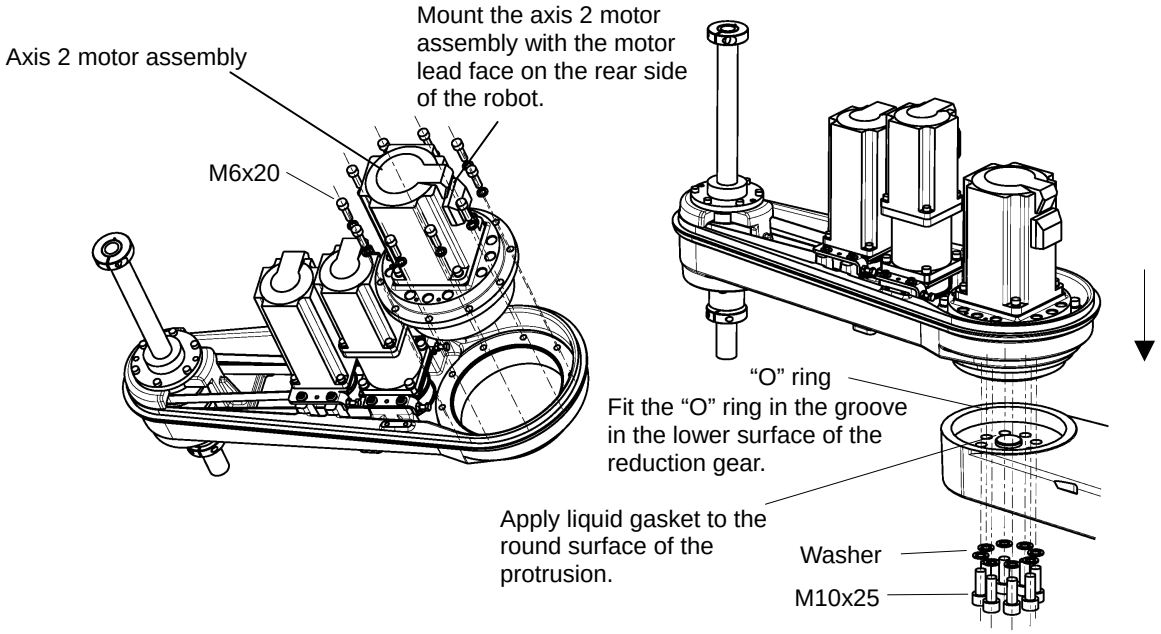
2) Fill the new wave generator and new reduction gear with grease (SK-1A). Supply 22 g of grease to the wave generator, and 28 g to the reduction gear.

3) Mount the new reduction gear with the 12 bolts (M6x16). In doing so, fit the “O” ring in the groove on the reduction gear beforehand. The “O” ring is provided with the reduction gear.



4) Secure the axis 2 motor assembly to the arm 2 with the ten bolts (M6x20). While lifting the cover bracket, secure the axis 2 motor assembly.

5) Secure the arm 2 to the arm 1 with the eight bolts (M10x25). In doing so, fit the "O" ring in the groove on the reduction gear beforehand. If the arm 2 is secured while the "O" ring is out of the groove, the "O" ring can be broken, causing grease leak.
Be sure to apply sufficient Loctite to at least three threads of each bolt.
In addition, apply liquid gasket to the round surface of the protrusion at the end of the arm 1.



6) Mount the cover bracket on the arm 2. For the mounting procedure, see steps 6) to 9) in "Para. 2.5.6."

7) Mount the arm 2 cover and perform home setting for the axes 2, 3 and 4. Now replacement of the axis 2 reduction gear completes.
(Check the axis 1 for the coordinates and perform home setting as necessary.)

8) Carry out a test operation of the axis 2 and make sure that each part operates properly.

2.8.8 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. 2.4.1.)

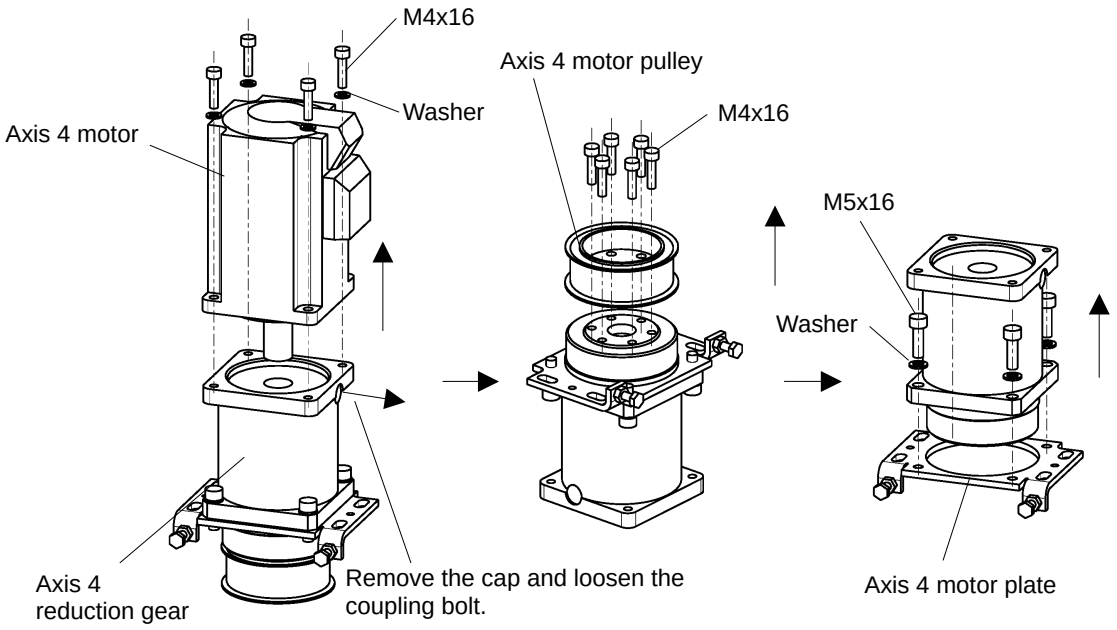
2) Disconnect the axis 3 motor assembly and axes 4 motor assembly from the arm 2, referring to Steps 2) to 5) inclusive of Para. 2.6.4 above.

3) Remove the cap attached to the lateral side of the axis 4 reduction gear, then loosen the coupling bolt (M4x12) securing the axis 4 motor shaft and the input shaft of the axis 4 reduction gear.

4) Remove the four (4) bolts (M4x16) securing the motor, and draw out the motor upward.

5) While holding the axis 4 motor pulley with pliers or the likes, remove the six bolts (M4x16) to remove the pulley. In doing so, use a waste cloth (or the like) as a cushion to protect the pulley from scratches.

6) Remove the four (4) bolts (M5x16) securing the axis 4 motor plate and reduction gear to the motor base, then dismount the reduction gear.



7) Assemble the new reduction gear, motor and pulley in the reverse order of Steps 4), 5) and 6) above.

8) Assemble the axis 4 motor and timing belt according to Steps 11) through 14) of Para. 2.6.4 above, then mount the arm 2 cover.

9) Perform home setting for the axes 3 and 4. Now replacement of the axis 4 reduction gear completes.

2.9 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.

2.9.1 Battery Box Location

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

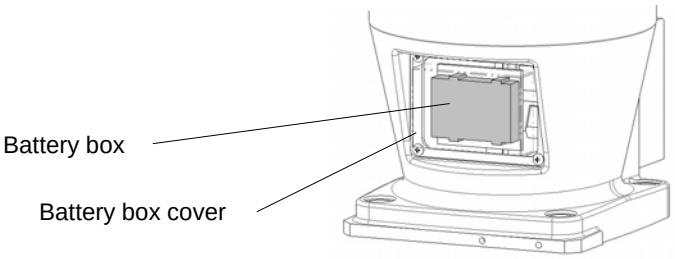


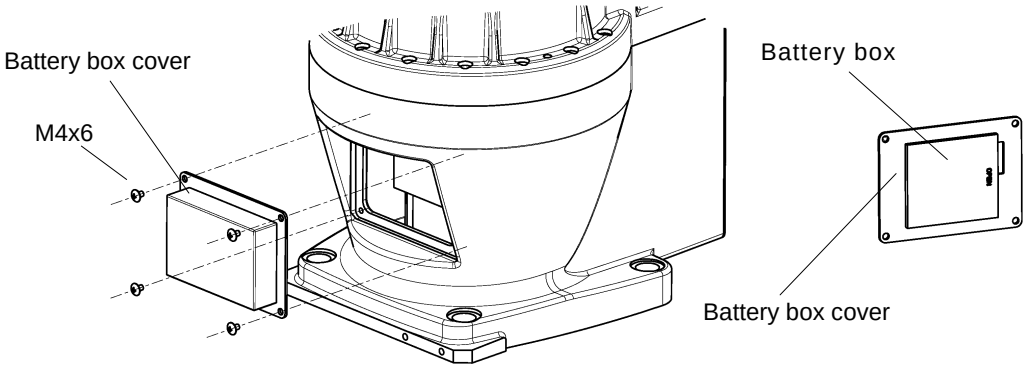
Fig. 2.14 Battery box location

2.9.2 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 effected 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) Disconnect the battery box cover which is secured to the base unit with the four (4) truss head screws (M4x6). As the cables are connected, DO NOT pull them by force.
3) Remove the battery box cover followed by 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.



4) Attach the battery box cover to the base unit. Now replacement of the batteries completes.

2.9.3 Battery Error Code

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

8–401 Axis1 Encoder abnormal
8–402 Axis2 Encoder abnormal
8–403 Axis3 Encoder abnormal
8–404 Axis4 Encoder abnormal
8–405 Axis5 Encoder abnormal

When a battery alarm has occurred, 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.

1–401 Axis1 Battery alarm
1–402 Axis2 Battery alarm
1–403 Axis3 Battery alarm
1–404 Axis4 Battery alarm
1–405 Axis5 Battery alarm

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 4.

3. Maintenance of Controller

3.1 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.

! CAUTION

- Before removing the controller cover for maintenance or inspection, be sure to turn off the main power switch of the controller.
  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 main power switch is turned off. 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.

! DANGER

Be sure to turn off the main power switch. If the main power switch remains ON, 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 turn off the main power switch before starting the work.

3.2 Layout of Controller Parts

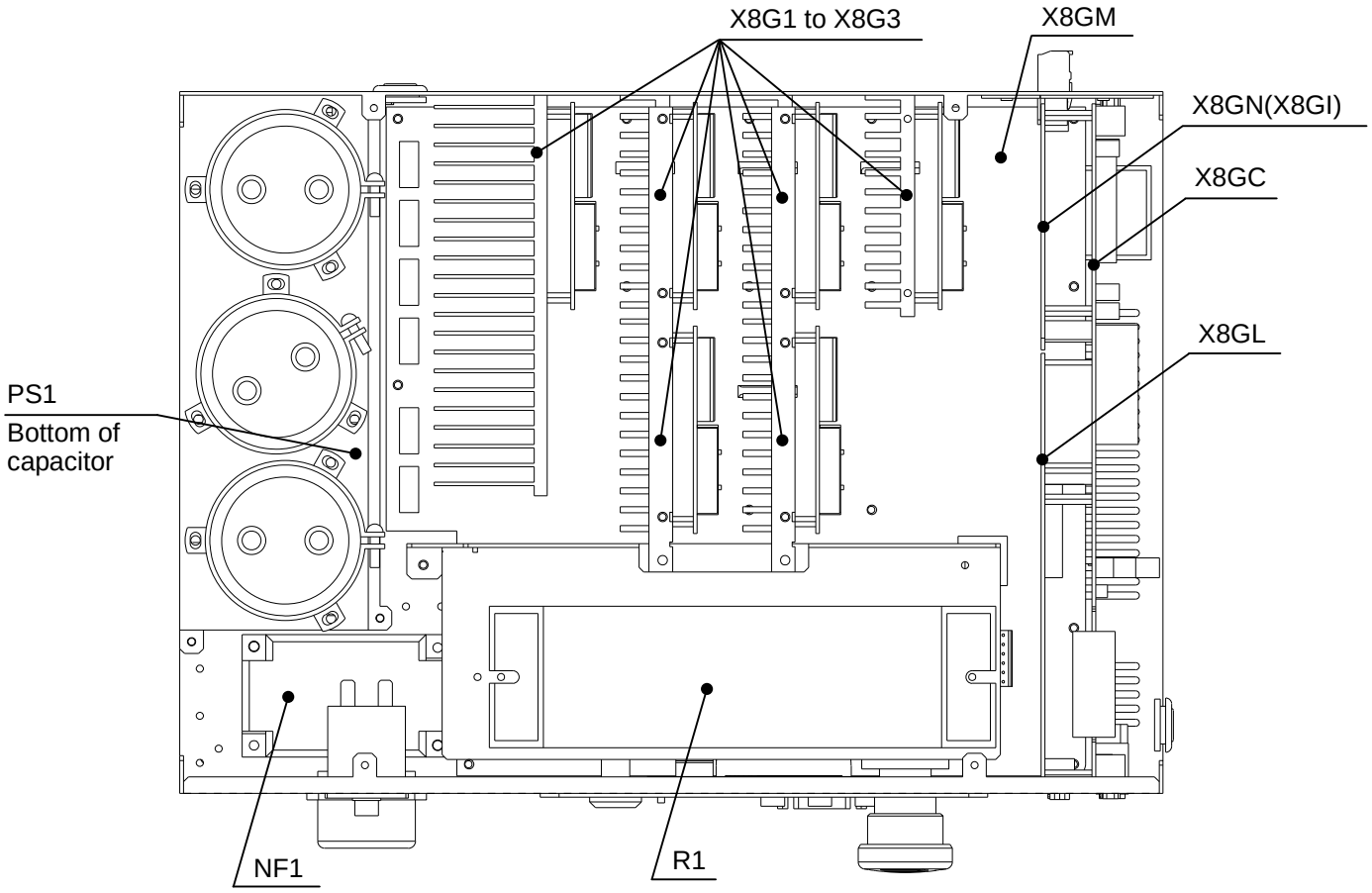


Fig. 3.1 Layout of controller parts

Part name	Descriptions
PS1	P5V, P24V output switching power supply
X8GC	Main control printed board
X8GN (X8GI)	I/O output printed board
X8GL	Servo logic printed board
X8G1 to X8G3	Servo amplifier printed board
X8GM	Mother board
R1	Regenerative resistor
NF1	Noise filter

3.3 Maintenance Procedures

3.3.1 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.

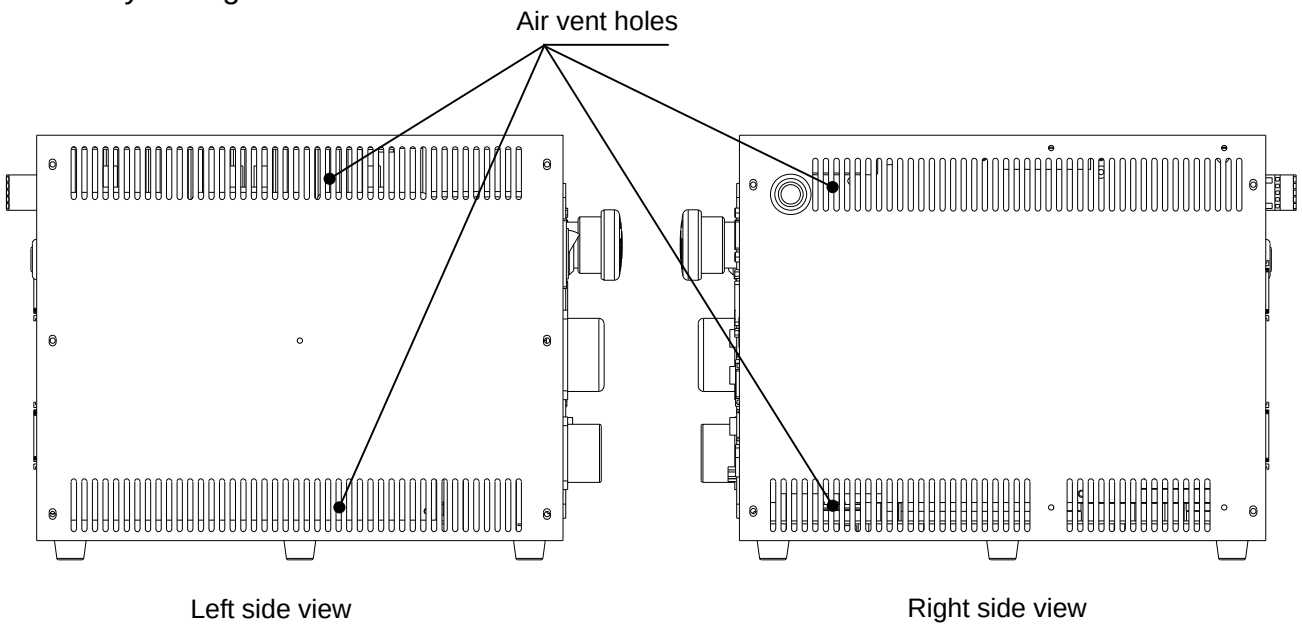


Fig. 3.2 Controller side views

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

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

c) If the controller is placed sideways, make sure that the air vent holes on the bottom surface of the controller are more than 11 mm away from the floor surface. Always keep the space of 11 mm or over. The length of rubber shoe is approximately 11 mm.

3.3.2 Check of Safety Devices for Function

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

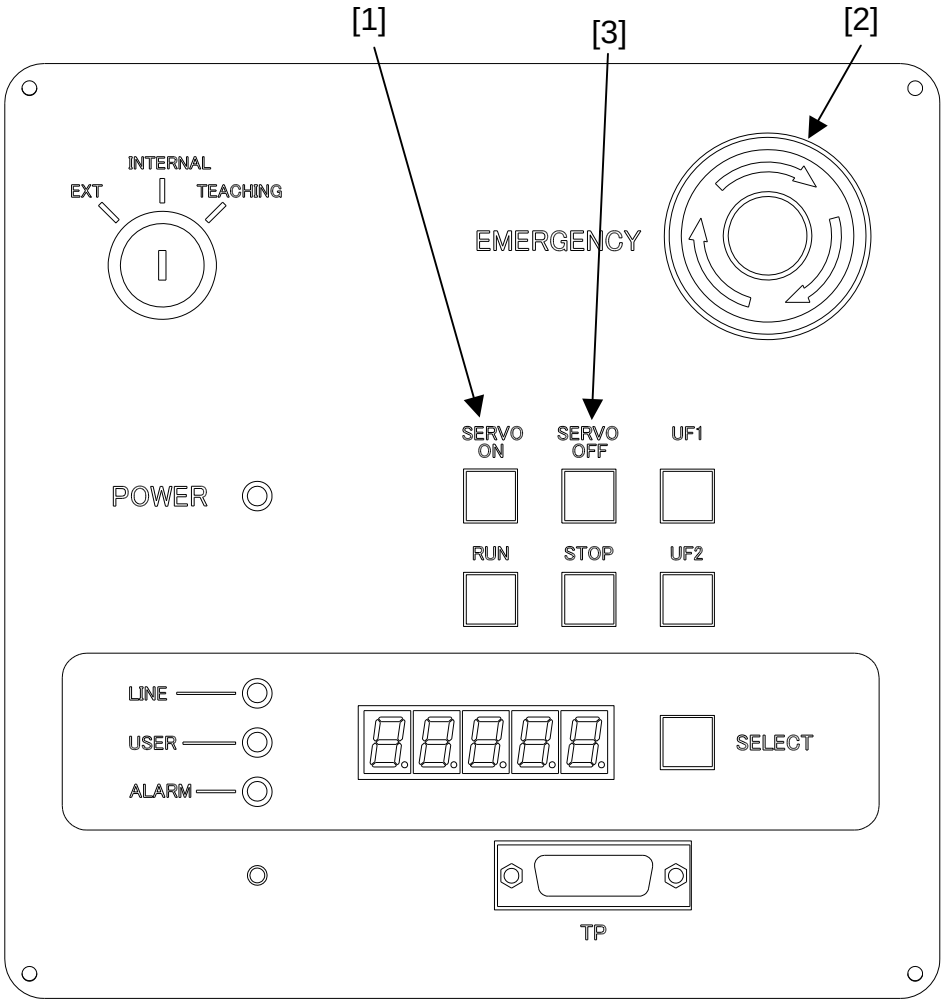


Fig. 3.3 Layout of control panel switches

a) Make sure that the EMERGENCY (emergency stop) switch [2] provided on the control panel functions properly.

1) Press the SERVO ON [1] switch provided on the control panel to turn the servos on and make sure that the SERVO ON LED is illuminated.

2) Press the EMERGENCY switch and make sure that the servos are turned off. The SERVO ON LED goes out and the SERVO OFF switch [3] LED is illuminated. At this time, make sure that the EMERGENCY switch remains depressed.

3) Turn the EMERGENCY switch clockwise and make sure that the same switch turns off.

b) Make sure that the EMERGENCY STOP switch provided on the teach pendant functions properly.

1) Press the SERVO ON switch [4] on the teach pendant to turn on the servo power, and make sure that the SERVO ON LED [5] is illuminated.

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

2) Press the EMERGENCY STOP switch [6] on the teach pendant and make sure that the servos are turned off. The SERVO ON LED [5] goes out.

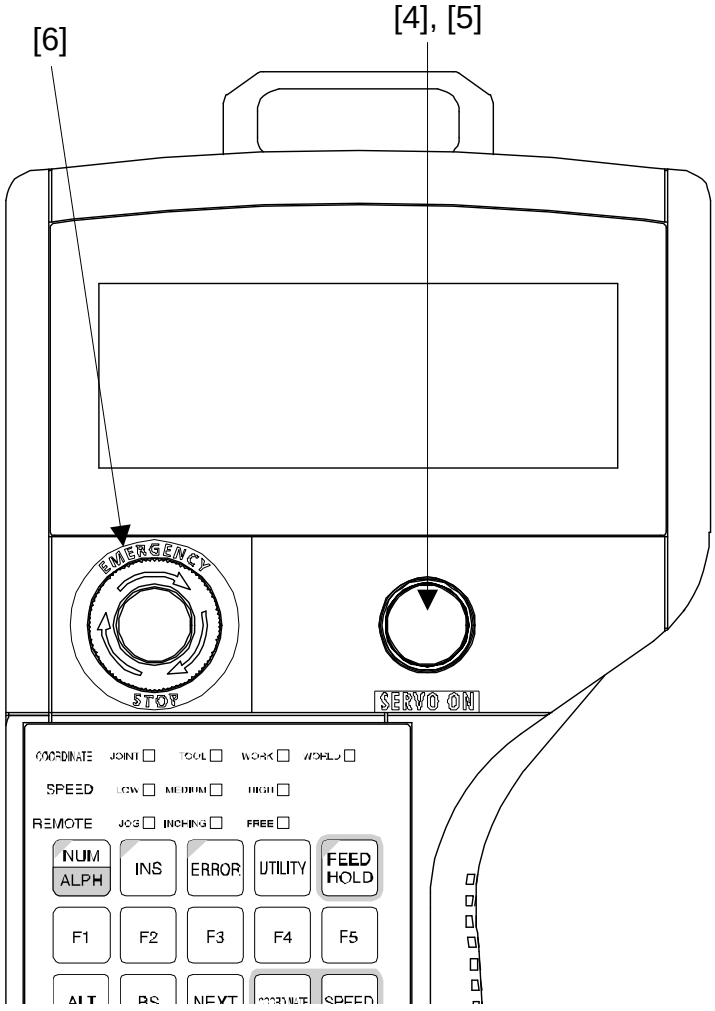


Fig. 3.4 EMERGENCY STOP switch provided on teach pendant

At this time, make sure that the EMERGENCY STOP switch [6] remains depressed.

3) Turn the EMERGENCY STOP switch clockwise and make sure that the same switch turns off.

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

1) Press the SERVO ON switch equipped on the control panel 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.

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

3.3.3 Battery Replacement

The memory equipped on the X8GC 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

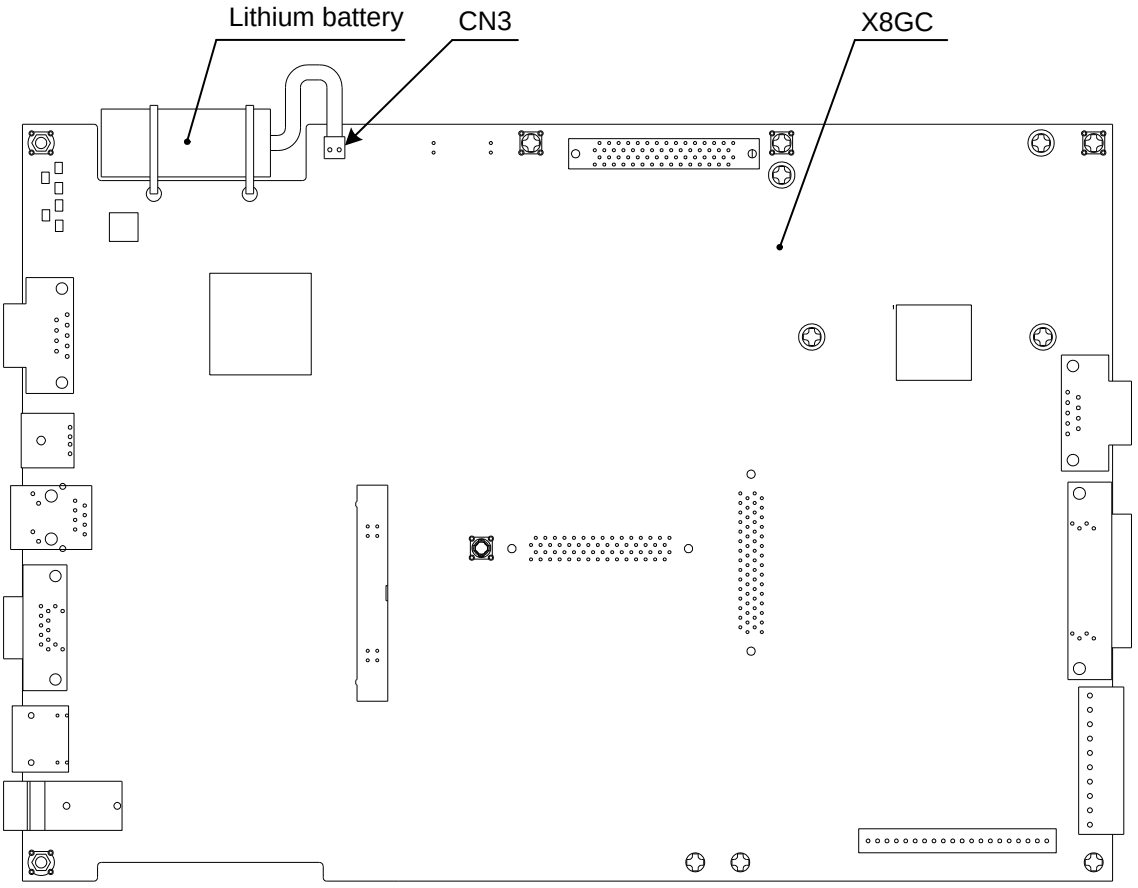


Fig. 3.5 Location of lithium battery

Type of battery	Manufacturer	Battery service life
ER6C WK27	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 Toshiba Machine 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) Set OFF the main power switch.
3) Prepare a new battery, then remove the cover from the controller.
4) Disconnect the battery connector from CN3 of the X8GC printed board, and remove the battery from the TY-RAP securing the battery.
(For the battery position, see Fig. 3.5.)
5) Set the new battery immediately. (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) Mount the cover on the controller.
7) If the battery is kept removed for more than one (1) minute, turn on the main power switch and load the programs and various parameters from the floppy disk unit 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.

CAUTION

- 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.

3.3.4 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 ~ 10 years), replace the power supply unit every five (5) years for preventive maintenance.

[Replacement procedures]

1) Turn off the main power switch.
2) Turn off the power breaker.
3) Remove the cover from the controller.
4) Remove the four screws securing the switching power supply unit (PS1).

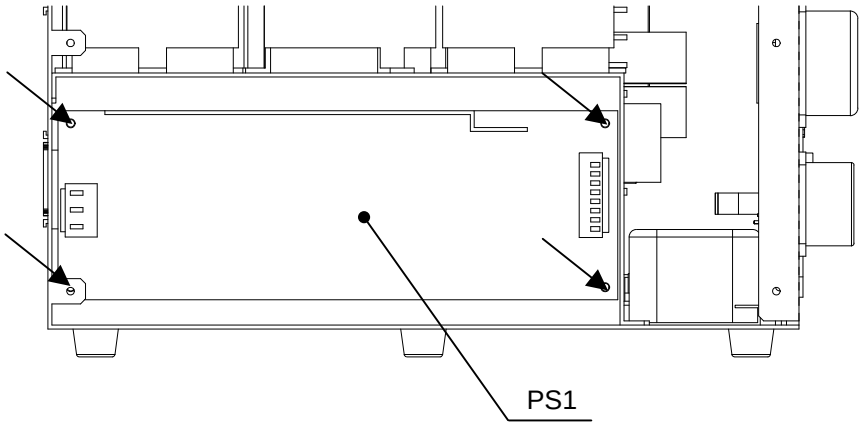
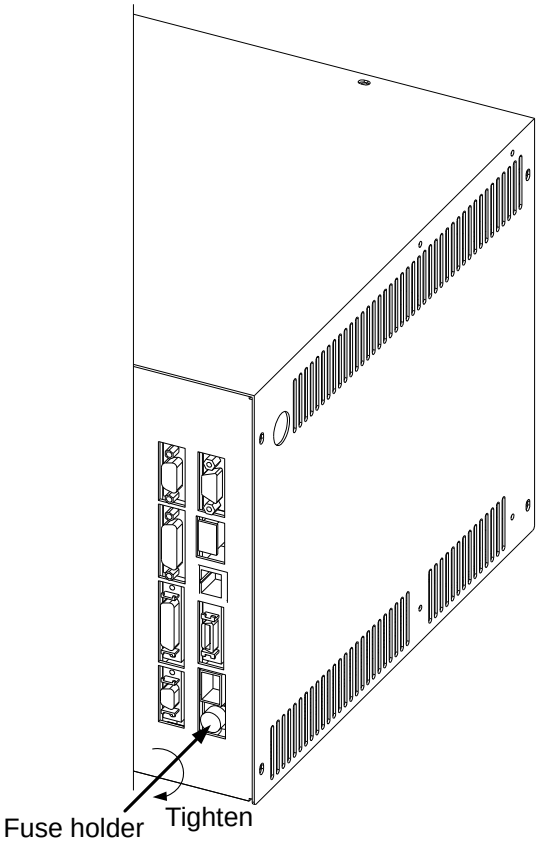


Fig. 3.6 Left-side view of the TS3100 (lower part)

5) Secure the new power supply unit to the robot controller by tightening the four screws.
6) Attach the cover to the controller.

3.3.5 Replacement of Fuse (X8GN, X8GI Printed Board)

If the current exceeding the specified current has run through the I/O unit, the fuse of the front of the TS3100 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 an fault circuit, remedy the cause, then replace the fuse.



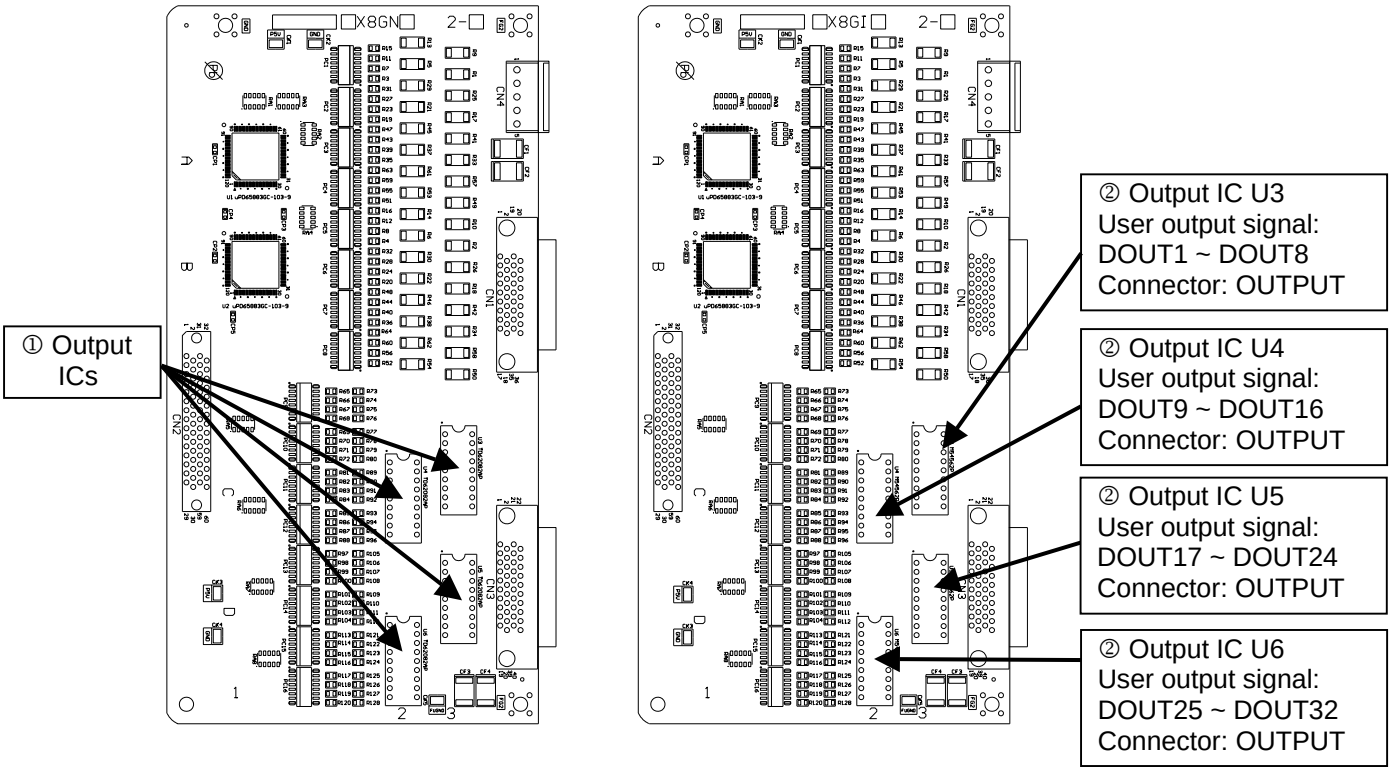
Type of fuse	Manufacturer
51NM030H	PICO

[Replacement procedures]

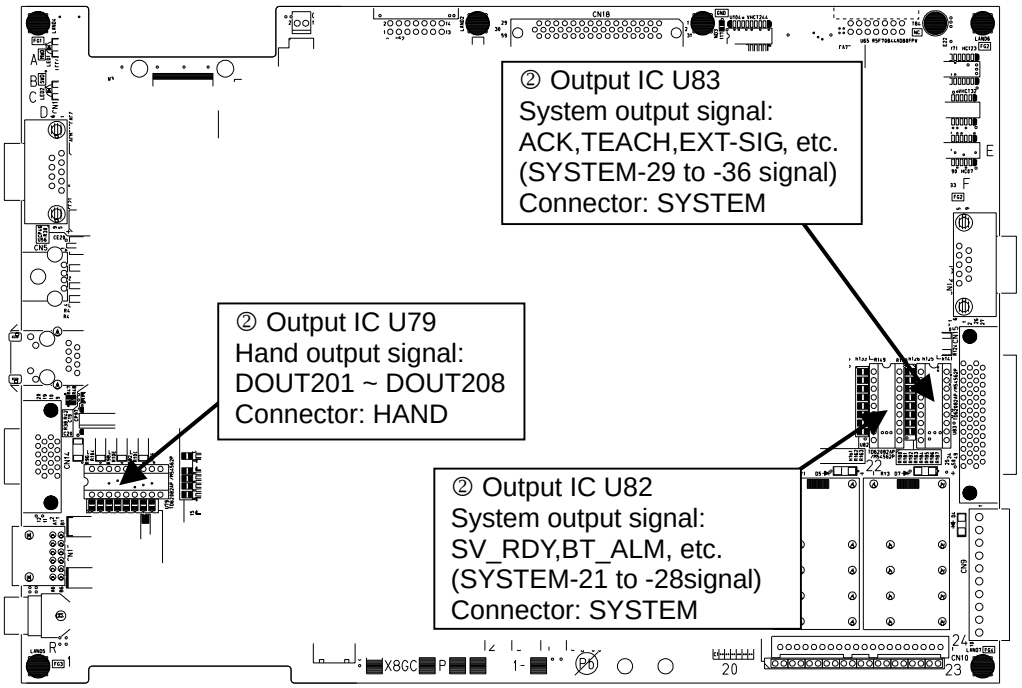
1) Turn off the controller main power.
2) Remove the fuse holder shown in the above figure. (To release the lock, push and turn the holder 90° counterclockwise.)
3) Remove the fuse and set a new fuse.
4) Mount the fuse holder. (To lock the holder, push and turn the holder 90° clockwise.)
5) Turn on the controller main power and make sure that no error will occur.

3.3.6 Replacement of Output ICs (X8GN, X8GI Printed Board)

If the current exceeding the specified current has run through the output unit, the ICs on the X8GC, X8GN (X8GI) printed board is 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 ② and output signals is shown below.



I/O Board (X8GN/X8GI)



Main Board (X8GC)

	Name of board	Type of IC	Manufacturer
①	X8GN	TD62082AP	Toshiba Corp.
②	X8GI	M54562P	Mitsubishi Electric

[Replacement procedures]

1) Turn off the controller main power.
2) Remove the cover from the controller.
3) Disconnect all connectors connected to the X8GC, X8GN (X8GI) printed boards in the controller.
4) Disconnect the X8GC, X8GN (X8GI) printed boards from the controller.
5) Remove the ICs shown above from respective sockets.
6) Attach the new ICs to the sockets.
7) Mount the X8GC, X8GN (X8GI) printed boards on the controller.
8) Connect all disconnected connectors to the X8GC printed board, then attach the controller cover.
9) Turn on the controller main power.

4. Robot Home Point and Position Detector Error

4.1 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 turned on.
The position data of the motor position detector comes in the two (2) types; home position data within one (1) full turn of motor and motor multi-turn data.

Home position data within one (1) full turn of motor:
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.

Motor 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.

4.2 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
8–401	Axis1 Encoder abnormal
8–402	Axis2 Encoder abnormal
8–403	Axis3 Encoder abnormal
8–404	Axis4 Encoder abnormal
8–405	Axis5 Encoder abnormal

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 which occurs most frequently is the battery voltage drop which is caused by the absence of maintenance at specified change intervals (once a year) 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. 2.9.
Also, a heavy vibration should not be exerted on the robot or the robot should not be moved suddenly by hand during power OFF. 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.

[1] Encoder error reset operation: See Para. 4.3.2.
[2] HOME operation: See Para. 4.4.
[3] ZEROP operation: See Para. 4.5.
[4] Multi-turn data reset operation: See Para. 4.6.

(1) 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 “[3] ZEROP operation.” At this time, the contents in the parameter file (i.e., home position data within one (1) full turn of motor) are updated. Rewriting of the data into the system disk is necessary.
3) Make sure that the error has been reset, referring to the error display.
4) In the “[2] HOME operation” and “[3] ZEROP operation”, some error may be caused according to the adjusting method. Re-teaching of the teach points may be required under some circumstances.

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

(2) 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 stroke limit error generates.

! DANGER

- When moving the robot by hand while the power is turned on, 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 OFF 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 OFF switch is kept pressed.
- If the axis 3 motor brake OFF 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.

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

Turn on the controller power only (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 turn off the controller power and turn on again to make sure that the same error will not recur.

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

The position detector has possibly malfunctioned.

2.1.2) **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.”

2.2) **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.

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

Execute the same operation as in Para. 2.1) above.

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

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

4.3 Restoring Operation from Position Detector Error

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.

4.3.1 Encoder Status Display

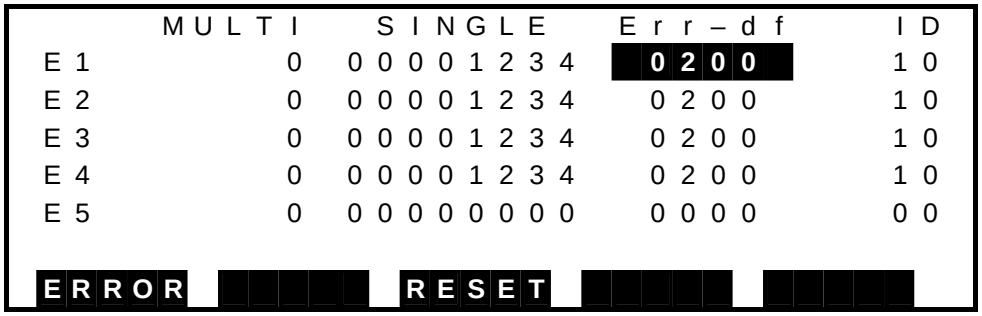
Call the encoder status screen on the teach pendant display, and make sure of the position data and the type of position detector error there. The type of the position detector error (i.e., error status) is expressed as shown below. The motor multi-turn data, home position data within one (1) full turn 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 4.1 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 during power OFF. The multi-turn data has possibly shifted.
0200	Because axis feed was not executed after power ON, 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.



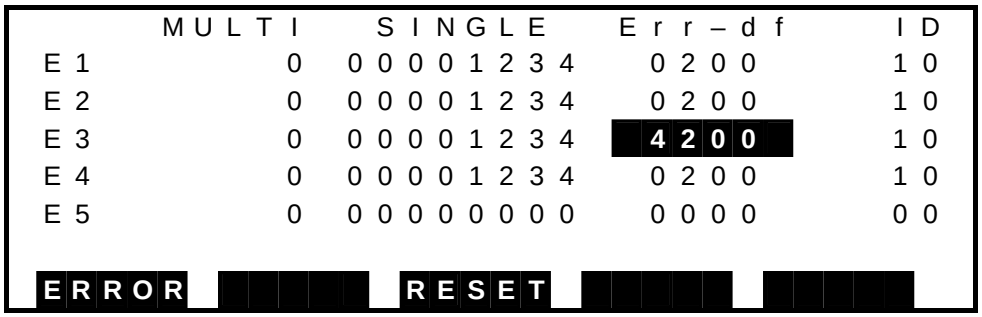
If the error status shown in the error status table above is displayed, you can restore from the position detector error.

4.3.2 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. 4.3.1 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).



[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 "8–403 Axis3 Encoder Abnormal."

4.4 Restoring Home Position Data by HOME Function

Batteries for backing up the position information of the position detector are housed in the base unit of the robot. Unless the robot has been used for a long term, the battery voltage drops and the home position data will be lost. Also, when the battery voltage for backing up the internal memory of the X8GC printed board has dropped, user's set programs, parameters and absolute coordinates will be lost. To avoid this, replace the batteries on a regular basis.

4.4.1 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 the axis 1 to axis 3 plus (+) side mechanical stopper positions are set in HOME3, and the axis 1 to axis 3 minus (–) mechanical stopper positions in HOME4. The 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)

USER	HOME1	HOME2	
(J1)	0	0	[deg]
(J2)	0	0	[deg]
(J3)	0	0	[mm]
(J4)	0	0	[deg]
(J5)	0	0	[mm]

SET TEACH

(Page 2)

SYSTEM	HOME3	HOME4	
(J1)	11834688	–11804744	[deg]
(J2)	14507116	–14507200	[deg]
(J3)	12390920	–36711	[mm]
(J4)	0	0	[deg]
(J5)	0	0	[mm]

SET TEACH

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.

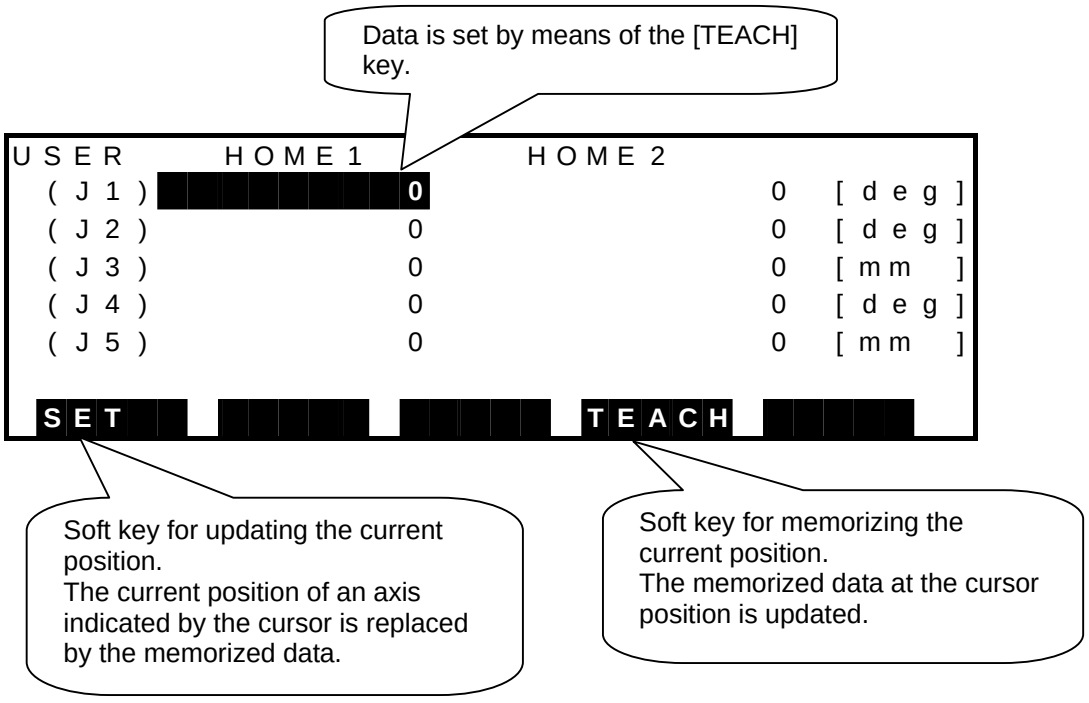
4.4.2 Setting HOME1 and HOME2

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] 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] mode.

4.4.3 How to Restore Data by HOME1 or HOME2

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] menu appears, then press the [REORG] key.
5) Move the cursor to each axis under HOME1 of the REORG screen, then press the [SET] key to update the coordinate value set in HOME1 to the position where the robot was secured. Thus, the machine home position can be restored.

! CAUTION

- The axis 3 and axis 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 the axis 3 (or axis 4) by using the [REORG] function, be sure to restore the home point of the axis 4 (or axis 3) also.

  Operating procedures

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

4.4.4 Locations of Robot Home Point Match-Marks

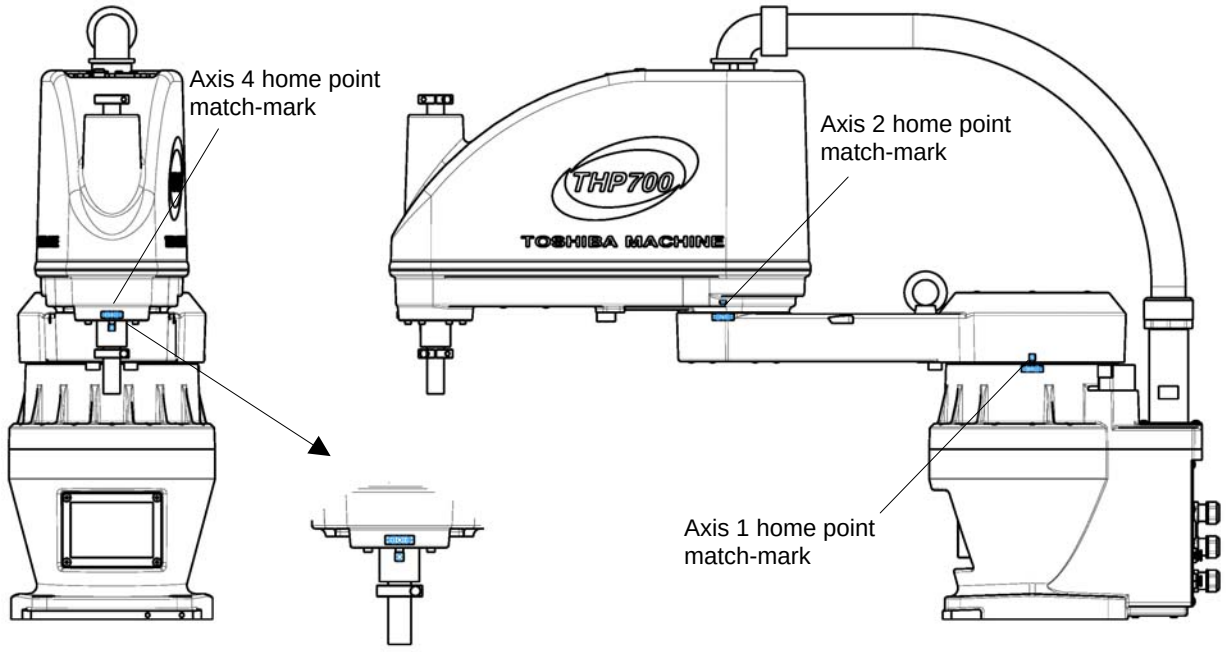
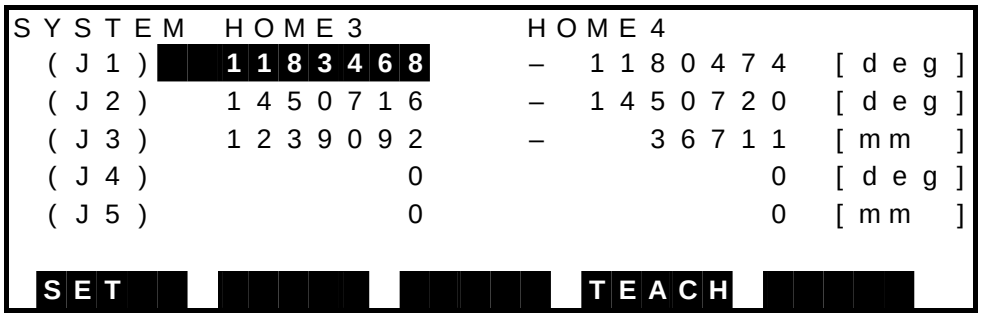


Fig. 4.1 Locations of home point match-marks

4.4.5 How to Restore Data by HOME3 or HOME4

The plus (+) side mechanical stopper positions and minus (–) side mechanical stopper positions of the axes 1 to 3 are factory-set in HOME3 and HOME4, respectively. The axis 4 is set to the home point match-mark.
The machine home point can be restored, using the above.
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] key.
4) Press the [NEXT] key to call Page 2.



5) Contact the 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] key. Now, the machine home point of the axis 1 is restored.

7) Likewise, contact the 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] key. Now, the machine home point of the axis 2 is restored.

9) Press the [ESC] key to escape from the REORG screen once.

10) Turn on the servo power, and set the axes 3 and 4 in the servo-free state.

11) Set the axis 4 to the home point match-mark.

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

13) Turn off the servo power.

14) Repeat Steps [2] to [4] inclusive to call the HOME screen again.

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

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

17) Press the [ESC] key to escape from the HOME screen. Now, the operation has finished.

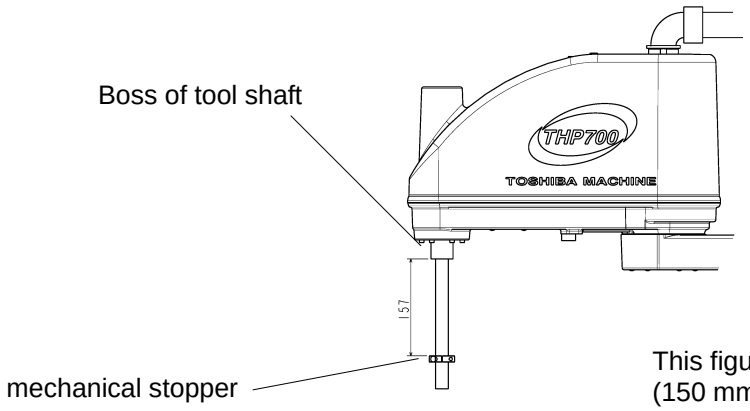
4.5 Restoring Home Position Data by ZEROP Function

Batteries for backing up the position information of the position detector are housed in the base unit of the robot. Unless the robot has been used for a long term, the battery voltage drops and the home position data will be lost. Also, when the battery voltage for backing up the internal memory of the X8GC printed board has dropped, user's set programs, parameters and absolute coordinates will be lost. To avoid this, replace the batteries on a regular basis.

When the robot arm is moved fast during power OFF, the absolute coordinate counter cannot follow the robot motion, resulting in destruction of the home point data.
This paragraph deals with the restoring procedures when the home position data was destroyed by mistake.
This restoring operation may cause some error according to the adjusting method.

4.5.1 Preparation before Restoring Operation

1) Turn on the controller power and align the home point match-marks of each axis in the manual mode.
2) If this is not possible, mark the reference position of each axis and jot down its coordinate beforehand.
3) Move the axis 3 down to near the lower limit, according to the dimension shown in the figure below (i.e., distance between the end face of the boss on the tool shaft and the end face of the mechanical stopper).



This figure shows when the standard axis stroke (150 mm) is used.
When the optional axis stroke (300 mm) is selected, the length is 307 mm.

Fig. 4.2 Dimension of axis 3 home point

4.5.2 Setting New Home Position Data

1) Select the TEACHING mode by means of the master mode switch.

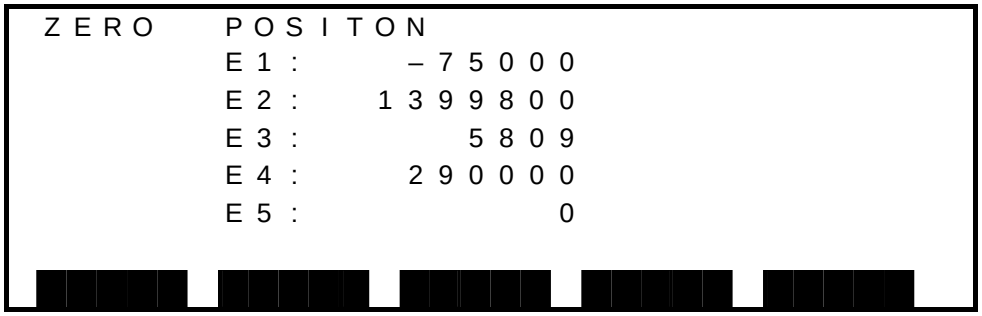
2) Press the “UTILITY” key equipped on the teach pendant.

3) Press the [NEXT] (F6) key on the teach pendant twice.

4) Turn off the servo power.

5) Press the [F3] key on the teach pendant to select the ZEROP mode.

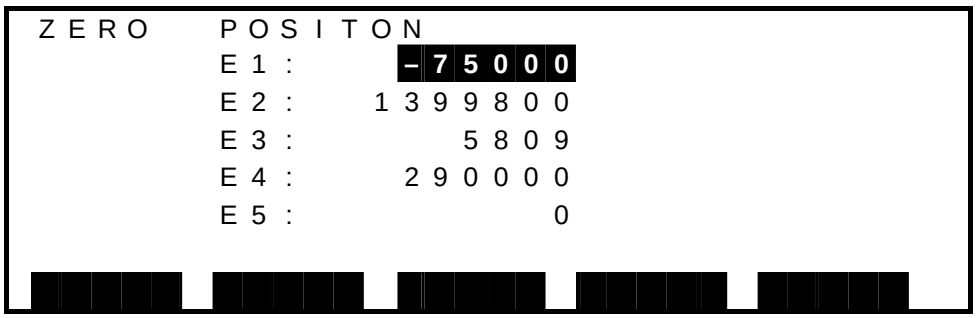
6) The following home point setting screen is called..



7) Press the “ALT” and “0” keys on the teach pendant at the same time.

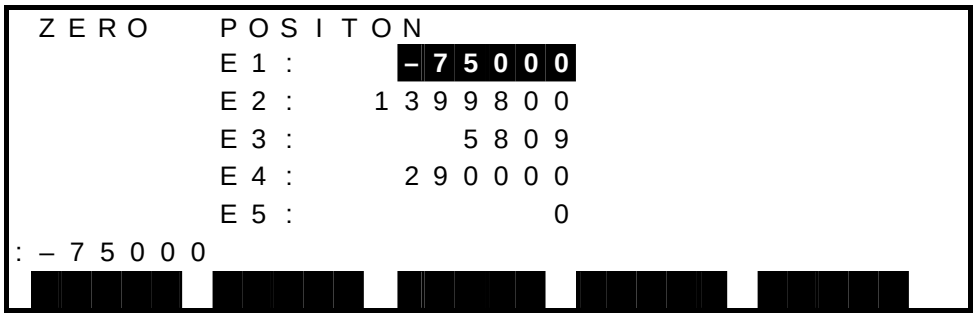
8) The following home point editing screen appears.

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

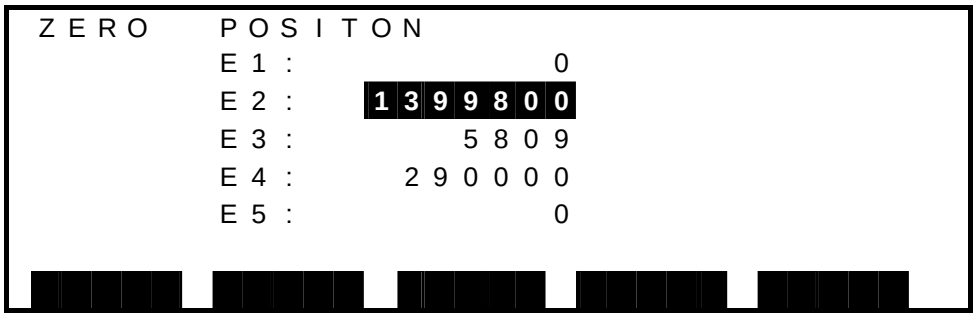


10) Press the “EXE” key on the teach pendant, and the value of “E1” is displayed at the lower left side. Set “0” in lieu of this value and press the “EXE” key. Then the E1 value becomes “0”.

11) Unless the axis could be located at the home point mark, enter the coordinate value registered beforehand.



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

- The axis 3 and axis 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.

4.5.3 Confirming Home Position

1) Make sure of the robot current position according to the POS data of the UTILITY mode. Guide the robot to the approximate home position by manual operation and confirm the position. Unless it could be located at the home point match-mark, make sure that the approximate position is the reference position marked in advance.

2) Execute the following program and make sure of the robot machine home position. Unless the robot could be located at the home point match-mark, DO NOT use the following program.
Create a program in which the robot moves to the position recorded beforehand, referring to the following program. Then make sure that the robot moves to the reference position mark according to the program thus created.

```
PROGRAM ZERO
 SPEED=30
 MOVEA 3,100
 MOVEA 1,0
 MOVEA 2,0
 MOVEA 3,0
 MOVEA 4,0
END
```

4.5.4 Saving Data

Save the system parameters in the system disk.
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 completes.

4.6 Restoring Home Position Data by Multi-Turn Data Clear

1) Home point match-marks are provided for the axes 1, 2 and 4. When only the multi-turn data of these axes has been cleared, move the robot to each home point match-mark. For the axis 3, move it to the position shown in Fig. 4.2 above.
2) Turn off the servo power, select the TEACHING mode by means of the master mode switch, then press the “UTILITY” key equipped on the teach pendant.
3) When the [UTILITY] screen is called, press the [NEXT] key once, then press the [F5] function key corresponding to the [ENC] menu.
4) When the encoder information screen appears, press the “ALT” and “0” keys at the same time to cancel the editing lock mode.
5) 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] menu.
6) 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. Replacement Parts for Maintenance

5.1 List of Replacement Parts – Main Robot

	Part name	Type	Dwg. No.	Unit code	Maker	Q'ty	Remarks
1	AC servo motor		S874940	Y610A3JS0	Toshiba Machine	1	Axis 1
2			S746326	Y610A3400		1	Axis 2
3			S746336	Y610A3420		1	Axis 3
4			S816701	Y610A3950		1	Axis 4
5	Reduction gear		S874941	Y610A3JT0	Toshiba Machine	1	Axis 1
6			M147090	Y610A34L0		1	Axis 2
7			S829013	Y610A3JD0		1	Axis 4
8	Timing pulley		M250006 (ball screw side)	Y610A3JQ0	Toshiba Machine	1	Axis 3
9			M249966 (motor side)			1	Axis 3
10			S854455 (ball screw side)			1	Axis 4
11			M249964 (motor side)			1	Axis 4
12	Timing belt		S860460			1	Axis 3
13			S860461			1	Axis 4
14	Ball screw spline unit		H846367 (Z150)	Y610A3EP0	Toshiba Machine	1	Axis 3
15			H846387 (Z300)	Y610A3EQ0		1	
16	Grease	VIGO grease	For reduction gear		Nabtesco		Axis 1
17		SK-1A			HDS		Axis 2
18		AFF grease (Lithium-based)	For ball screw		THK		Axis 3
19	Encoder backup battery	Size AA alkali battery				3	All axes

! CAUTION

- With the exception of the encoder backup batteries and greases, all parts listed in previous page are custom-made to Toshiba Machine specifications. Contact Toshiba Machine at order entry.
- Parts replacement work must be done by Toshiba Machine service engineer.

  Toshiba Machine's warranty does not cover failures, accidents or any damages.

5.2 List of Replacement Parts – Controller

Part name	No.	Type		Q'ty	Remarks
PS1 (Switching power supply)	1	LEB100F-0524		1	
Main power switch	3	IR-11-A8-25-1BF		1	
Lithium battery	4	ER6C WK27		1	
Fuse	5	51NM030H		1	For X8GC printed board
Printed board	6	X8GC (Main control)	Y610A4000	1	Type N
		X8GC (Main control)	Y610A4020	1	Type P
		X8GN (I/O board)	Y610A40A0	1	Type N
		X8GI (I/O board)	Y610A40B0	1	Type P
		X8G1A(50A) (Servo)	Y610A40C0	1	Axis 1
		X8G1B(30A) (Servo)	Y610A40D0	1	Axis 2
		X8G2B(15A) (Servo)	Y610A40G0	2	Axes 3, 4
		X8GH (Servo power supply)	Y610A4050	1	
		X8GM (Mother board)	Y610A4060	1	
Operation panel unit	7	TS3000CP1	Y610A4080	1	
Teach pendant	8	TP1000	Y610A4300	1	With 5 m-long cable
System disk	9	TS3000SYS	Y610A3HC0	1	CD-ROM

APPROVED BY: 

CHECKED BY: 

PREPARED BY: