EPSON
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Industrial Robot: SCARA ROBOT

RS series

MAINTENANCE MANUAL

Rev.3 ENM226R5366F

Original instructions

Industrial Robot: SCARA ROBOT

RS series Maintenance Manual

Rev.3

FOREWORD

Thank you for purchasing our robot products.
This manual contains the information necessary for the correct use of the manipulator.
Please carefully read this manual and other related manuals before installing the robot system.
Keep this manual handy for easy access at all times.

The robot system and its optional parts are shipped to our customers only after being subjected to the strictest quality controls, tests, and inspections to certify its compliance with our high performance standards. Please note that the basic performance of the product will not be exhibited if our robot system is used outside of the usage conditions and product specifications described in the manuals.

This manual describes possible dangers and consequences that we can foresee. Be sure to comply with safety precautions on this manual to use our robot system safety and correctly.

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The contents of this manual are subject to change without notice.
Please notify us if you should find any errors in this manual or if you have any comments regarding its contents.

MANUFACTURER

SEIKO EPSON CORPORATION

CONTACT INFORMATION

Contact information is described in “SUPPLIERS” in the first pages of the following manual:

Robot System Safety Manual Read this manual first

DISPOSAL

When disposing this product, dispose in accordance with the laws and regulations of each country.

Regarding battery disposal

The battery removal/replacement procedure is described in the following manuals:
Maintenance Manual

For European Union customers only

The crossed out wheeled bin label that can be found on your product indicates that this product and incorporated batteries should not be disposed of via the normal household waste stream. To prevent possible harm to the environment or human health please separate this product and its batteries from other waste streams to ensure that it can be recycled in an environmentally sound manner. For more details on available collection facilities please contact your local government office or the retailer where you purchased this product. Use of the chemical symbols Pb, Cd or Hg indicates if these metals are used in the battery.

This information only applies to customers in the European Union, according to DIRECTIVE 2006/66/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL OF 6 September 2006 on batteries and accumulators and waste batteries and accumulators and repealing Directive 91/157/EEC and legislation transposing and implementing it into the various national legal systems.
For other countries, please contact your local government to investigate the possibility of recycling your product.

For Taiwanese customers only

Please separate used batteries from other waste streams to ensure that it can be recycled in an environmentally sound manner. For more details on available collection facilities please contact your local government office or the retailer where you purchased this product.

Before Reading This Manual

This section describes what you should know before reading this manual.

Structure of Control System

The RS series Manipulators can be used with the following combinations of Controllers and software.

Controller		Software
Name	Structure	
RC700-A	Control Unit Drive Unit	EPSON RC+ 7.0 Ver.7.1.2 or greater

Turning ON/OFF Controller

When you see the instruction “Turn ON/OFF the Controller” in this manual, be sure to turn ON/OFF all the hardware components. For the Controller composition, refer to the table above.

Shape of Motors

The shape of the motors used for the Manipulator that you are using may be different from the shape of the motors described in this manual because of the specifications.

Setting by Using Software

This manual contains setting procedures by using software. They are marked with the following icon.

The Manuals of This Product

The following are typical manual types for this product and an outline of the descriptions.

Safety Manual (book, PDF)

This manual contains safety information for all people who handle this product. The manual also describes the process from unpacking to operation and the manual you should look at next.
Read this manual first.

- Safety precautions regarding robot system and residual risk
- Declaration of conformity
- Training
- Flow from unpacking to operation

RC700 series Manual (PDF)

This manual explains the installation of the entire robot system and the specifications and functions of the controller. The manual is primarily intended for people who design robot systems.

- The installation procedure of the robot system (specific details from unpacking to operation)
- Daily inspection of the controller
- Controller specifications and basic functions

RS series Manual (PDF)

This manual describes the specifications and functions of the Manipulator. The manual is primarily intended for people who design robot systems.

- Technical information, functions, specifications, etc. required for the Manipulator installation and design
- Daily inspection of the Manipulator

Status Code/Error Code List (PDF)

This manual contains a list of code numbers displayed on the controller and messages displayed in the software message area. The manual is primarily intended for people who design robot systems or do programming.

RC700 series Maintenance Manual (PDF)
RS series Maintenance Manual (PDF)

This manual describes the details of maintenance etc. The manual is intended for people who perform maintenance.

- Daily inspection
- Replacement and repair of maintenance parts
- The method of firmware update and controller setting backup etc.

EPSON RC+ 7.0 User's Guide (PDF Manual)

This manual describes general information about program development software.

EPSON RC+ 7.0 SPEL+ Language Reference (PDF Manual)

This manual describes the robot programming language "SPEL+".

Other Manual (PDF Manual)

Manuals for each option are available.

RS Maintenance

RS Maintenance

This volume contains maintenance procedures with safety precautions for RS series Manipulators.

1. Safety Maintenance

Please read this chapter, this manual, and other relevant manuals carefully to understand safe maintenance procedures before performing any routine maintenance.
Only authorized personnel who have taken maintenance training held by the manufacturer or dealer should be allowed to perform the robot maintenance.
When removing the arm from the Manipulator, for such as replacing the reduction gear unit, it must be done by two or more personnel.

For removing the Arm #1 cover, in case that the maintenance window is not installed to the base table, it needs to remove the Manipulator from the base table. Removing the Manipulator must be done by two or more personnel.

 WARNING	■ Do not remove any parts that are not covered in this manual. Follow the maintenance procedure strictly as described in this manual. Improper removal of parts or improper maintenance may not only cause improper function of the robot system but also serious safety problems. ■ Keep away from the Manipulator while the power is ON if you have not taken the training courses. Do not enter the operating area while the power is ON. Entering the operating area with the power ON is extremely hazardous and may cause serious safety problems as the Manipulator may move even it seems to be stopped. ■ When you check the operation of the Manipulator after replacing parts, be sure to check it while you are outside of the safeguarded area. Checking the operation of the Manipulator while you are inside of the safeguarded area may cause serious safety problems as the Manipulator may move unexpectedly. ■ Before operating the robot system, make sure that both the Emergency Stop switches and safeguard switch function properly. Operating the robot system when the switches do not function properly is extremely hazardous and may result in serious bodily injury and/or serious damage to the robot system as the switches cannot fulfill their intended functions in an emergency.

 WARNING	■ To shut off power to the robot system, disconnect the power plug from the power source. Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source. ■ Before performing any replacement procedure, turn OFF the Controller and related equipment, and then disconnect the power plug from the power source. Performing any replacement procedure with the power ON is extremely hazardous and may result in electric shock and/or malfunction of the robot system.

 CAUTION	■ Be sure to connect the cables properly. Do not allow unnecessary strain on the cables. (Do not put heavy objects on the cables. Do not bend or pull the cables forcibly.) The unnecessary strain on the cables may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system. ■ When operating maintenance of manipulator, secure about 50 cm of empty space around the manipulator.

2. General Maintenance

This chapter describes maintenance inspections and procedures. Performing maintenance inspections and procedures properly is essential for preventing trouble and ensuring safety. Be sure to perform the maintenance inspections in accordance with the schedule.

2.1 Maintenance Inspection

2.1.1 Schedule for Maintenance Inspection

Inspection points are divided into five stages: daily, monthly, quarterly, biannual, and annual. The inspection points are added every stage.
If the Manipulator is operated for 250 hours or longer per month, the inspection points must be added every 250 hours, 750 hours, 1500 hours, and 3000 hours operation.

h = hour

	Inspection Point					
	Daily inspection	Monthly inspection	Quarterly inspection	Biannual inspection	Annual inspection	Overhaul (replacement)
1 month (250 h)	Inspect every day	√				
2 months (500 h)		√				
3 months (750 h)		√	√			
4 months (1000 h)		√				
5 months (1250 h)		√				
6 months (1500 h)		√	√	√		
7 months (1750 h)		√				
8 months (2000 h)		√				
9 months (2250 h)		√	√			
10 months (2500 h)		√				
11 months (2750 h)		√				
12 months (3000 h)		√	√	√	√	
13 months (3250 h)		√				
⋮	⋮	⋮	⋮	⋮	⋮	⋮
20000 h						√

2.1.2 Inspection Point

Inspection Item

Inspection Point	Inspection Place	Daily	Monthly	Quarterly	Biannual	Annual
Check looseness or backlash of bolts/screws.	End effector mounting bolts	√	√	√	√	√
	Manipulator mounting bolts	√	√	√	√	√
Check looseness of connectors.	External connectors on Manipulator (on the connector plates etc.)	√	√	√	√	√
Visually check for external defects. Clean up if necessary.	External appearance of Manipulator	√	√	√	√	√
	External cables		√	√	√	√
Check for bends or improper location. Repair or place it properly if necessary.	Safeguard etc.	√	√	√	√	√
Check the brake operation	Break for arm #3	√	√	√	√	√
Check whether unusual sound or vibration occurs.	Whole	√	√	√	√	√

Inspection Method

Inspection Point	Inspection Method
Check looseness or backlash of bolts/screws.	Use a hexagonal wrench to check that the end effector mounting bolts and the Manipulator mounting bolts are not loose. When the bolts are loose, refer to "2.*4 Tightening Hexagon Socket Head Bolts*" and tighten them to the proper torque.
Check looseness of connectors.	Check that connectors are not loose. When the connectors are loose, reattach it not to come off.
Visually check for external defects. Clean up if necessary.	Check the appearance of the Manipulator and clean up if necessary. Check the appearance of the cable, and if it is scratched, check that there is no cable disconnection.
Check for bends or improper location. Repair or place it properly if necessary.	Check that the safeguard, etc. are located properly. If the location is improper, place it properly.
Check the brake operation	Check that the shaft does not fall when in MOTOR OFF. If the shaft falls when in MOTOR OFF and the brake is not released, contact the supplier. Also, if the break is not released even operated release the break, contact the supplier.
Check whether unusual sound or vibration occurs.	Check that there is no unusual sound or vibration when operating. If there is something wrong, contact the supplier.

2.2 Overhaul (Parts Replacement)

CAUTION	■ If you do not overhaul properly, it may have a serious impact on safety. ■ Overhaul timing is based on an assumption that all joints are operated for equal distance. If a particular joint has a high duty or high load, it is recommended to overhaul all joints (as many as possible) before exceeding 20,000 operation hours with the joint as a basis.

The parts for the manipulator joints may cause accuracy decline or malfunction due to deterioration of the manipulator resulting from long term use. In order to use the manipulator for a long term, it is recommended to overhaul the parts (parts replacement).

The time between overhauls is 20,000 operation hours of the Manipulator as a rough indication.

However, it may vary depending on ambient temperature, usage condition and degree of the load (such as when operated with the maximum motion speed and maximum acceleration / deceleration in continuous operation) applied on the Manipulator.

NOTE

For the EPSON RC+ 7.0 Ver. 7.2.x or later (firmware Ver.7.2.x.x or later), the recommended replacement time for the parts subject to maintenance (motors, reduction gear units, and timing belts) can be checked in the [Maintenance] dialog box of the EPSON RC+ 7.0.
For details, refer to the following manual.
RC700 series Maintenance Manual 6. Alarm

Note:
The recommended replacement time for the maintenance parts is when it reaches the L10 life (time until 10% failure probability). In the [Maintenance] dialog box, the L10 life is displayed as 100%.

The manipulator operation hours can be checked in [Controller Status Viewer] dialog - [Motor On Hours].

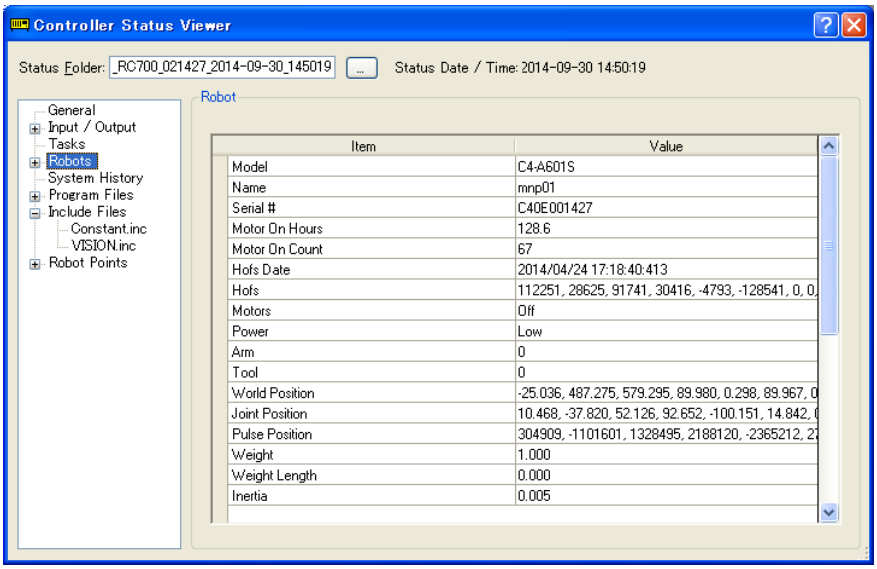
(1) Select EPSON RC+ menu-[Tools]-[Controller] to open the [Controller Tools] dialog.

(2) Click the <View Controller Status> button to open the [Browse For Folder] dialog.

(3) Select the folder where the information is stored.

(4) Click <OK> to view the [Controller Status Viewer] dialog.

(5) Select [Robot] from the tree menu on the left side (Dialog image: EPSON RC+ 7.0)



For the parts subject to overhaul, refer to *14. Maintenance Parts List.*

For details of replacement of each part, refer to each section.

Please contact the supplier of your region for further information.

2.3 Greasing

The ball screw spline and reduction gear units need greasing regularly. Only use the grease specified in the following table.

CAUTION	■ Keep enough grease in the Manipulator. Operating the Manipulator with insufficient grease will damage sliding parts and/or result in insufficient function of the Manipulator. Once the parts are damaged, a lot of time and money will be required for the repairs.

CAUTION	■ If grease gets into your eyes, mouth, or on your skin, follow the instructions below. If grease gets into your eyes : Flush them thoroughly with clean water, and then see a doctor immediately. If grease gets into your mouth : If swallowed, do not induce vomiting. See a doctor immediately. : If grease just gets into your mouth, wash out your mouth with water thoroughly. If grease gets on your skin : Wash the area thoroughly with soap and water.

	Greasing part	Greasing Interval	Grease	Reference
Joint #1 Joint #2	Reduction gear units	Overhaul timing	SK-1A	*5.2 Replacing the Joint #1 Reduction Gear Unit* *6.2 Replacing the Joint #2 Reduction Gear Unit*
Joint #3	Ball screw spline unit	At 100 km of operation (50 km for first greasing)	AFB	*Greasing the Ball Screw Spline Unit* *(See below)*

Joint #1, 2 reduction gear units

As a rough indication, perform greasing at the same timing as overhaul.
However, it may vary depending on ambient temperature, usage condition and degree of the load (such as when operated with the maximum motion speed and maximum acceleration / deceleration in continuous operation) applied on the Manipulator.

Joint #3 Ball screw spline unit

The recommended greasing interval is at 100 km of operation. However, greasing timing also can be checked from the grease condition. Perform greasing if the grease is discolored or becomes dry.

Normal grease

Discolored grease

Perform greasing at 50 km of operation for the first time of greasing.

NOTE

For the EPSON RC+ 7.0 Ver. 7.2.x or later (firmware Ver.7.2.x.x or later), the recommended replacement time for the grease on the ball screw spline unit can be checked in the [Maintenance] dialog box of the EPSON RC+ 7.0.
For details, refer to the following manual.

RC700 series Maintenance Manual 6. Alarm

Greasing the Ball Screw Spline Unit

	Name	Quantity	NOTE
Grease	For Ball Screw Spline Unit (AFB grease)	Proper quantity	
Tools	Wiping cloth	1	For wiping grease (Spline shaft)
	Cross-point screwdriver	1	For clamp band removal Only for Cleanroom-model

Standard-model

NOTE
Cover the surrounding area such as the end effector and peripheral equipment in case the grease drips.

(1) Turn ON the Controller.

(2) Move the shaft to the lower limit by using one of the following methods:

- Move the shaft to the lower limit manually while pressing the brake release switch.

NOTE
Be careful of the shaft falling and rotating while the brake release switch is being pressed because the shaft may be lowered by the weight of the end effector.

- Move the shaft to the lower limit manually while by selecting EPSON RC+ 7.0 menu - [Tools] - [Robot Manager] - [Jog & Teach].

NOTE
Be sure to keep enough space and prevent the end effector hitting any peripheral equipment.

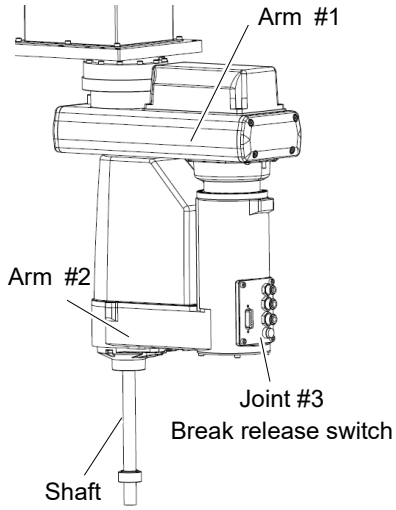
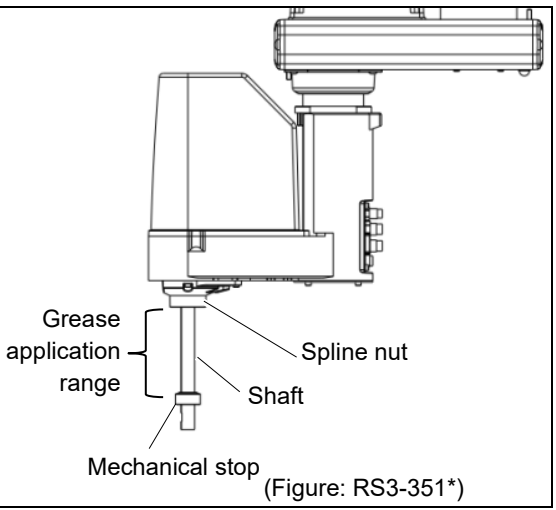


Figure: RS3-351*

(3) Turn OFF the Controller.

(4) Wipe off the old grease from the shaft, and then apply new grease to it.

Grease application range is from the end of the spline nut to mechanical stop.



(Figure: RS3-351*)

(5) Apply new grease evenly to the spiral groove of the ball screw spline unit and the vertical groove so that the groove is filled.

Grease application example

(6) Turn ON the Controller.

(7) Start the robot manager and move the shaft to the origin position. Be careful not to hit peripheral equipment.

(8) After moving to the origin position, reciprocate the shaft. The reciprocating operation is a low power mode operation program that performs from the upper limit to the lower limit. Run for about 5 minutes to spread the grease over the shaft.

(9) Turn OFF the controller.

(10) Wipe off excess grease on the end of the spline nut and mechanical stop.

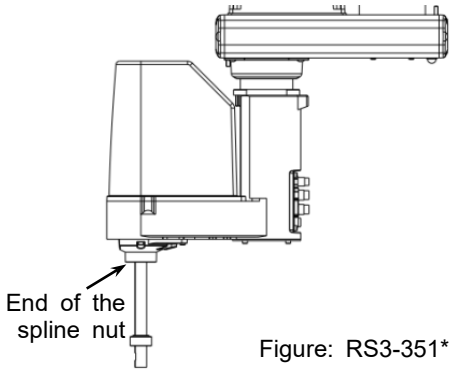


Figure: RS3-351*

Cleanroom-model

NOTE

Dust is emitted when greasing. Take the Manipulator to an outer room such as the room in front of the clean room's entrance, or take the necessary countermeasures to prevent dust emission before greasing. Cover the surrounding area such as the end effector and peripheral equipment in case the grease drips.

(1) Turn ON the Controller.

(2) Move the shaft to the upper limit by using one of the following methods:

- Move the shaft to the upper limit manually while pressing the brake release switch.

NOTE

Be careful of the shaft falling and rotating while the brake release switch is being pressed because the shaft may be lowered by the weight of the end effector.

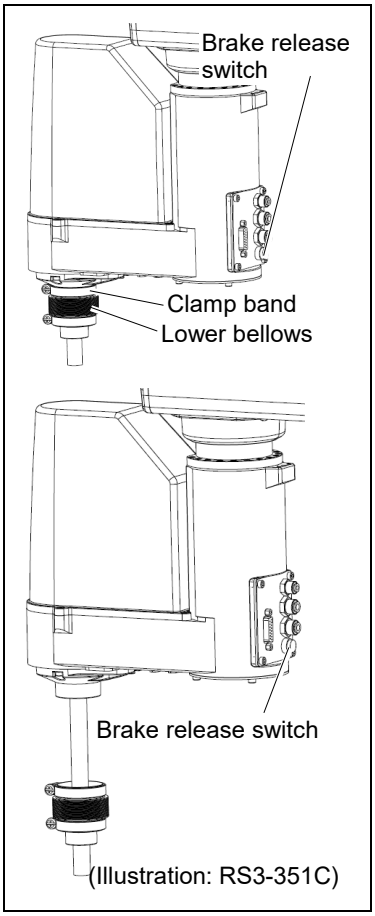
- Move the shaft to the upper limit manually while by selecting EPSON RC+ 7.0 menu - [Tools] - [Robot Manager] - [Jog & Teach].

NOTE

Be sure to keep enough space and prevent the end effector hitting any peripheral equipment.

(3) Loosen the clamp band on the top of the lower bellows, and then move the lower bellows downward.

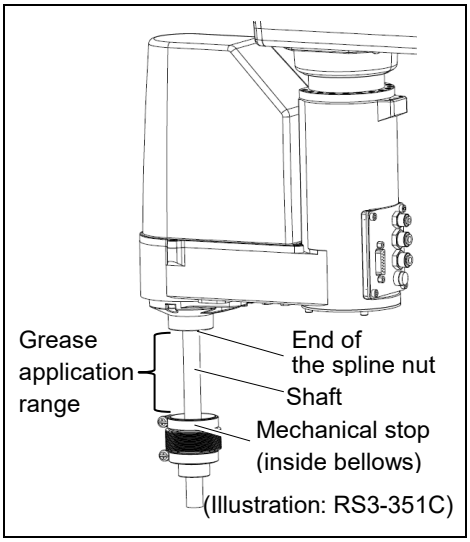
(4) Move the shaft to the lower limit in the same way as in step (2).



(5) Turn OFF the Controller.

(6) Wipe off the old grease from the shaft, and then apply new grease to it.

The range to apply grease is from the end of the spline nut to the mechanical stop.



(7) Apply grease to the spiral groove and vertical groove of the ball screw spline to fill the grooves.

Example of grease application

(8) Turn ON the Controller.

(9) Apply grease to the whole of the shaft.

Move the shaft up and down about 10 times from the upper limit to the lower limit.

When moving the shaft up and down, press and hold the brake release switch on the top of cover.

After moving up and down, wipe off excess grease from the end of the spline nut.

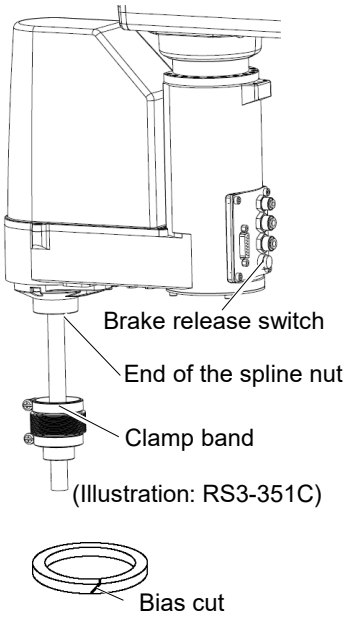
(10) Fix the lower bellows.

Move the shaft to the upper limit.

Insert the bellows mounted part until it touches the cylinder part of the cover.

Fit the rubber sheet. Be sure to fit the rubber sheet so that no space is made between the bias cut.

Fix with the clamp band.



(11) After fitting, move the shaft up and down several times and rotate Joint #4. Make sure that the bellows can expand and contract smoothly without any excessive force.

(12) Start Robot Manager and move the shaft to the origin position.
Be sure to prevent hitting any peripheral equipment.

(13) After moving to the origin position, move the shaft up and down. To move up and down, use an operation program to move from the upper limit to the lower limit in low power mode. Run about 5 minutes to spread grease over the shaft.

(14) Turn OFF the Controller.

2.4 Tightening Hexagon Socket Head Cap Bolts

Hexagon socket head cap bolts are used in places where mechanical strength is required. (A hexagon socket head cap bolt will be called a “bolt” in this manual.) These bolts are fastened with the tightening torques shown in the following table.

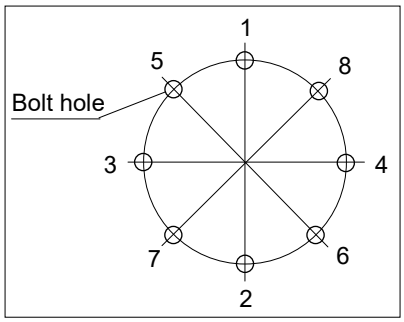
When it is necessary to refasten these bolts in some procedures in this manual (except special cases as noted), use a torque wrench so that the bolts are fastened with the appropriate tightening torques as shown below.

Bolt	Tightening Torque
M3	2.0 ± 0.1 N·m (21 ± 1 kgf·cm)
M4	4.0 ± 0.2 N·m (41 ± 2 kgf·cm)
M5	8.0 ± 0.4 N·m (82 ± 4 kgf·cm)
M6	13.0 ± 0.6 N·m (133 ± 6 kgf·cm)
M8	32.0 ± 1.6 N·m (326 ± 16 kgf·cm)
M10	58.0 ± 2.9 N·m (590 ± 30 kgf·cm)
M12	100.0 ± 5.0 N·m (1,020 ± 51 kgf·cm)

Refer below for the set screw.

Set Screw	Tightening Torque
M4	2.4 ± 0.1 N·m (26 ± 1 kgf·cm)
M5	3.9 ± 0.2 N·m (40 ± 2 kgf·cm)

We recommend that the bolts aligned on a circumference should be fastened in a crisscross pattern as shown in the figure below.



Do not fasten all bolts securely at one time. Divide the number of times that the bolts are fastened into two or three and fasten the bolts securely with a hexagonal wrench. Then, use a torque wrench so that the bolts are fastened with tightening torques shown in the table above.

2.5 Matching Origins

After parts have been replaced (motors, reduction gear units, a brake, timing belts, a ball screw spline unit, etc.), the Manipulator cannot operate properly because a mismatch exists between the origin stored in each motor and its corresponding origin stored in the Controller. After replacing the parts, it is necessary to match these origins.

For calibration, the pulse values for a specific position must be recorded in advance.
Before replacing parts, select easy point (pose) data from the registered point data to check the accuracy. Then, follow the steps below to display the pulse values and record them.

EPSON RC+

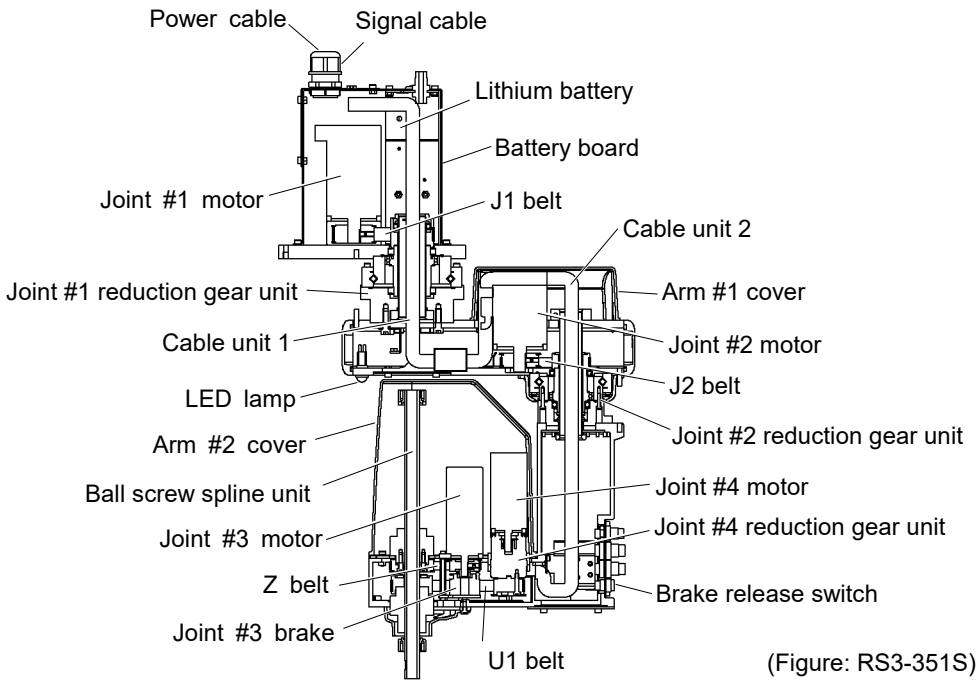
Execute the following command from the [Command Window].

```
>PULSE
```

`PULSE:` [Joint #1 Pulse value] `pls` [Joint #2 Pulse value] `pls` [Joint #3 Pulse value] `pls` [Joint #4 Pulse value] `pls`

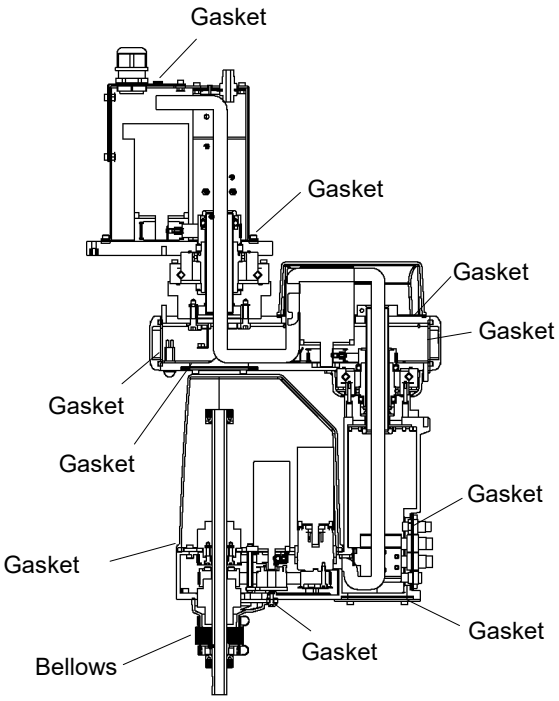
2.6 Layout of Maintenance Parts

Standard-model



(Figure: RS3-351S)

Cleanroom-model



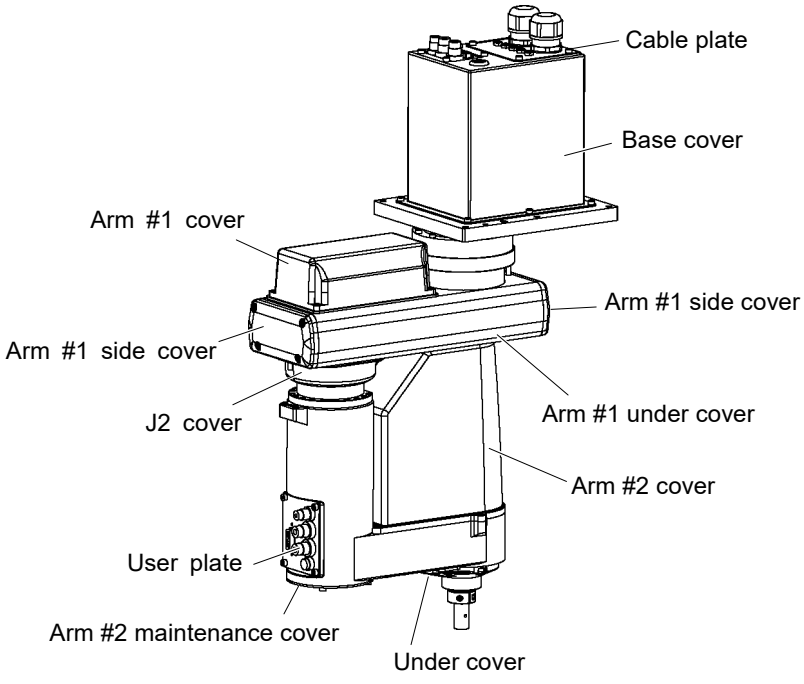
(Figure: RS3-351C)

3. Covers

All procedures for removing and installing covers in maintenance are described in this chapter.

WARNING	■ Do not connect or disconnect the motor connectors while the power to the robot system is turned ON. Connecting or disconnecting the motor connectors with the power ON is extremely hazardous and may result in serious bodily injury as the Manipulator may move abnormally, and also may result in electric shock and/or malfunction of the robot system. ■ To shut off power to the robot system, disconnect the power plug from the power source. Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source. ■ Before performing any replacement procedure, turn OFF the Controller and related equipment, and then disconnect the power plug from the power source. Performing any replacement procedure with the power ON is extremely hazardous and may result in electric shock and/or malfunction of the robot system. ■ Be careful not to get any foreign substances in the Manipulator, connectors, and pins during maintenance. Turning ON the power to the robot system when any foreign substances exist in them is extremely hazardous and may result in electric shock and/or malfunction of the robot system.

	Name	Quantity	Note
Maintenance parts	Gasket unit	1	1514477 (RS3-351C) 1548345 (RS4-551C) Only for Cleanroom-model
Tools	Hexagonal wrench (width across flats: 3 mm)	1	For M4 screw Tightening torque: 0.9 N·m (9.2 kgf·cm)
	Cross-point screwdriver	1	For bellows removal (Only for Cleanroom-model) For M4 truss Tightening torque: 0.9 N·m (9.2 kgf·cm)



3.1 Arm #1

The following covers are mounted to Arm #1.

Arm #1 cover	× 1
Arm #1 under cover	× 1
J2 cover	× 2
Arm #1 side cover	× 2

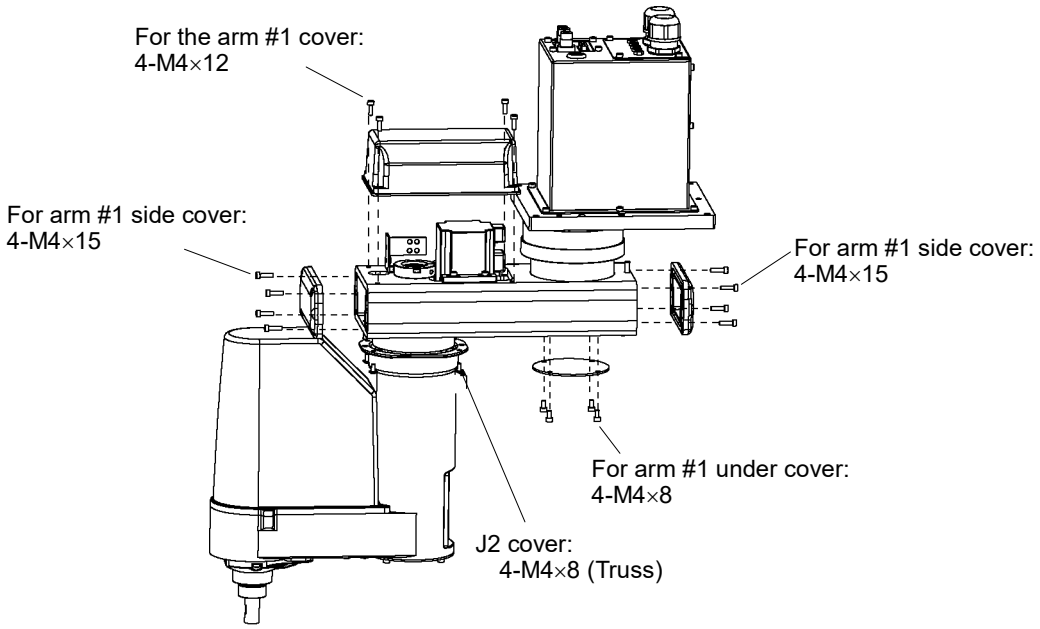
Remove the bolt (or screw) securing the cover to remove the cover.

CAUTION	■ When mounting the cover, do not allow the cables to interfere with the cover mounting or bend these cables forcibly to push them into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure that cause the electric shock and/or improper function of the robot system. When routing the cables, observe the cable locations after removing the cover. Be sure to place the cables back to their original locations.

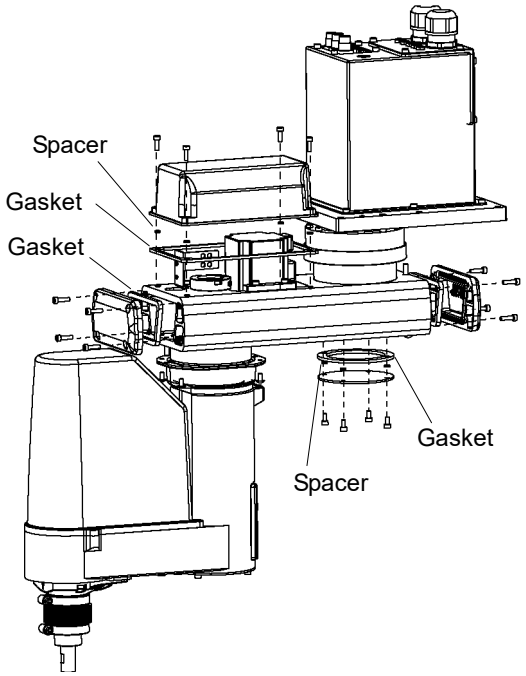
When mounting Arm #1 cover, be sure to check the air tubes and cables are secured as in the figure below. Be careful not to squash the air tubes and cables with the cover.

If the maintenance window is not designed in the base table, the Arm #1 cover cannot be removed. It needs to remove the Manipulator from the base table for the maintenance work. Be sure to remove the Manipulator form the base table by two or more personnel.
For details, refer to *RS series Manual Environments and Installation*.

3.1.1 Standard-model



3.1.2 Cleanroom-model



Gaskets and spacers are installed to Cleanroom-model.

3.2 Arm #2

3.2.1 Arm #2 Cover

⚠ CAUTION	■ When mounting the cover, be careful not to allow the cables to interfere with the cover mounting and do not bend these cables forcibly to push them into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, observe the cable locations after removing the cover. Be sure to place the cables back to their original locations.

Arm Top Cover Removal

(1) Move the Arm #2 to the 180 degree.

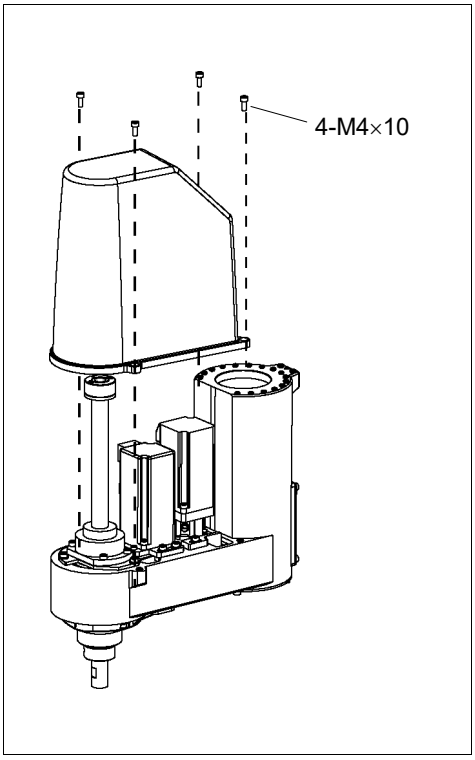
For the arm position, refer to the figure in *3.1 Arm #1*.

(2) Remove the Arm #1 side cover on the Joint #2 side.

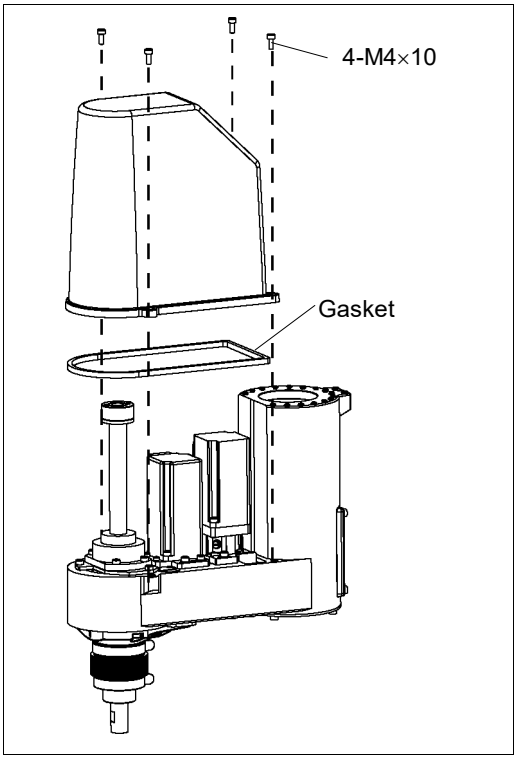
For details, refer to *3.1 Arm #1*.

(3) Remove the Arm #2 cover mounting bolt and hold the cover up.

Standard-model



Cleanroom-model



Arm Top Cover Installation

(1) Set the arm top cover to the arm and secure with the mounting bolts.

Gaskets are installed to the Cleanroom-model.

(2) Mount the Arm #1 side cover.

For details, refer to *3.1 Arm #1*.

3.2.2 Under Cover

Unscrew the under cover mounting bolts, and then pull the cover downward to remove it.

NOTE

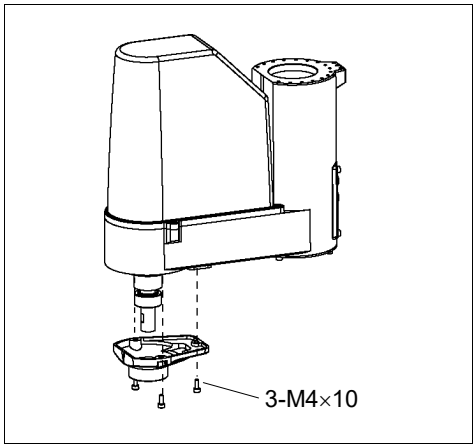
The under cover may not be removed from the shaft because the end effector is installed. If it is necessary to remove the cover completely (for replacement of the ball screw spline unit etc.), remove the end effector.

When the ball screw spline unit need to be replaced, remove the end effector and remove the under cover completely.

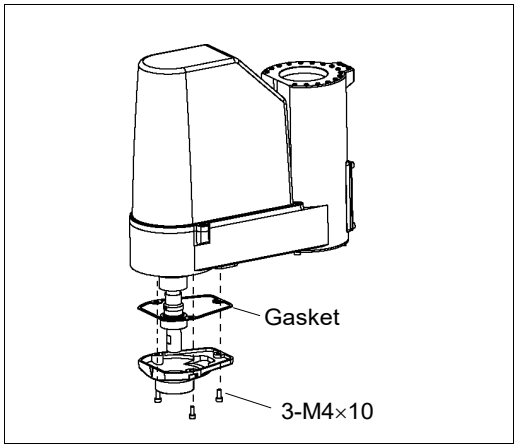
If it is not necessary to remove the cover completely, move the shaft to the lower limit, and lower the under cover. Then, perform maintenance or inspection.

When bellows are installed to the manipulator, remove or pull down the lower bellows and then remove the under cover. For bellows removal, refer to *9. Bellows*.

Standard-model



Cleanroom-model

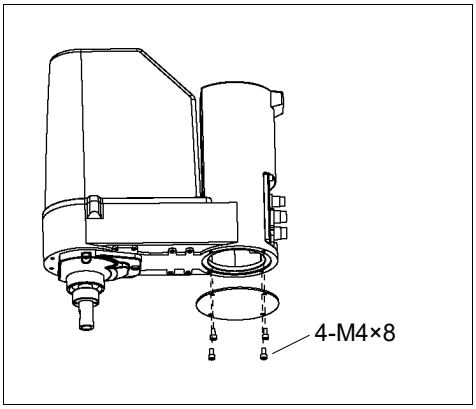


A gasket is installed to Cleanroom-model.

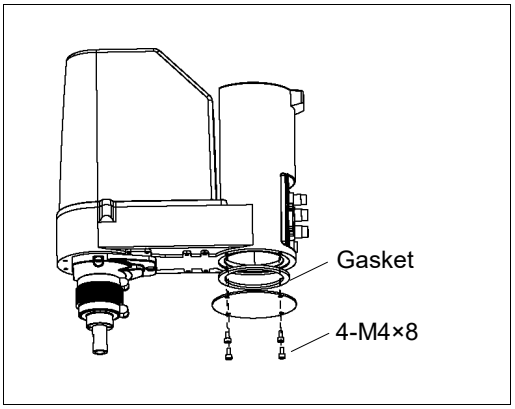
3.2.3 Arm #2 Maintenance Cover

Unscrew the bolts securing the Arm #2 maintenance cover, and then pull the cover downward to remove it.

Standard-model



Cleanroom-model



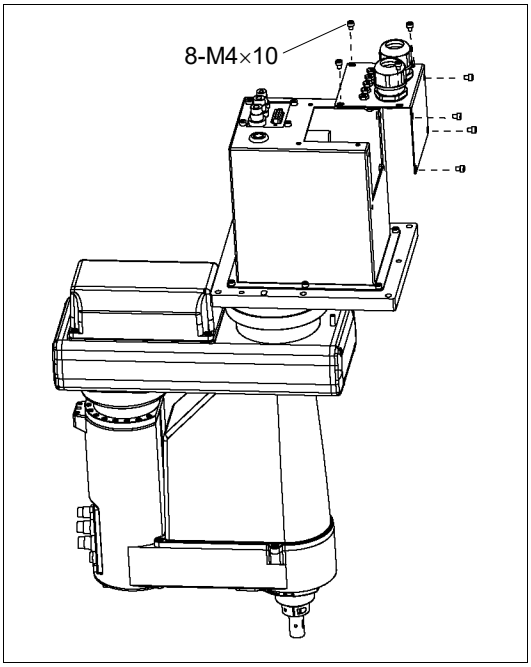
Gasket is installed to the Cleanroom-model.

3.3 Connector Plate

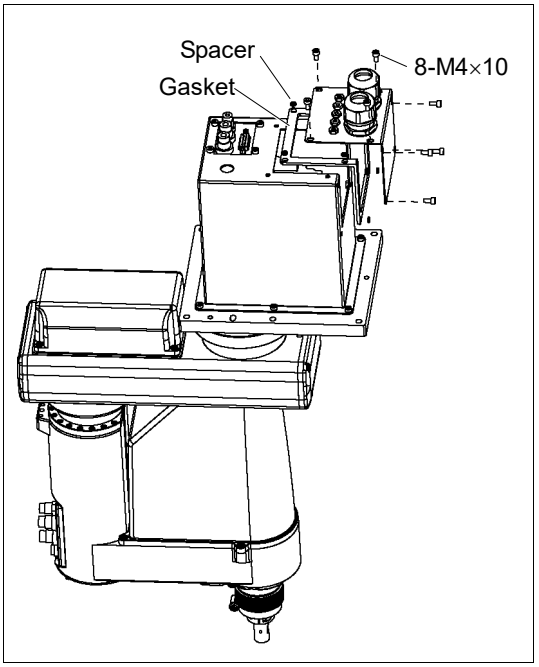
CAUTION	■ Do not remove the connector plate forcibly. Removing the connector plate forcibly may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system. ■ When installing the connector plate, be careful not to allow the cables to interfere with the plate mounting and do not bend these cables forcibly to push them into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, observe the cable locations after removing the connector plate. Be sure to place the cables back to their original locations.

Unscrew the connector plate mounting bolts and remove the plate.

Standard-model



Cleanroom-model



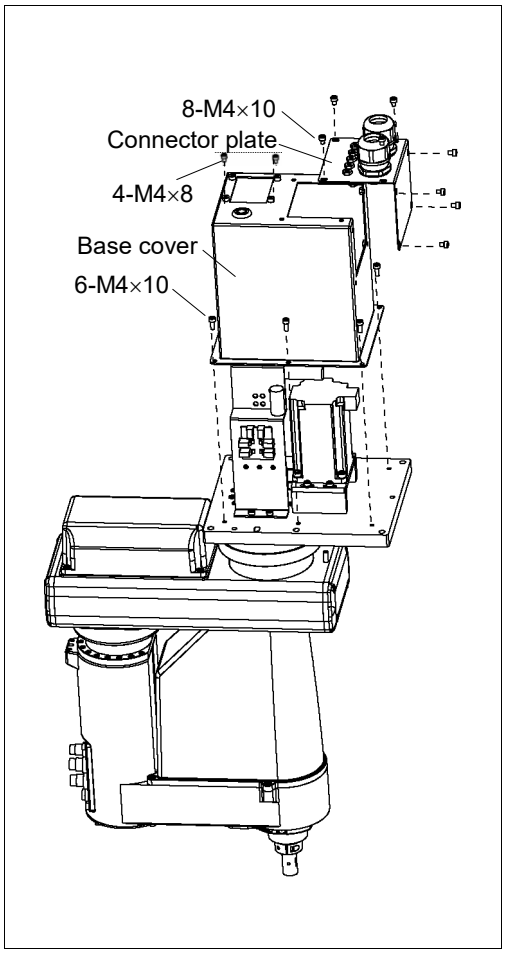
A gasket and spacer are installed to Cleanroom-model.

3.4 Base Cover

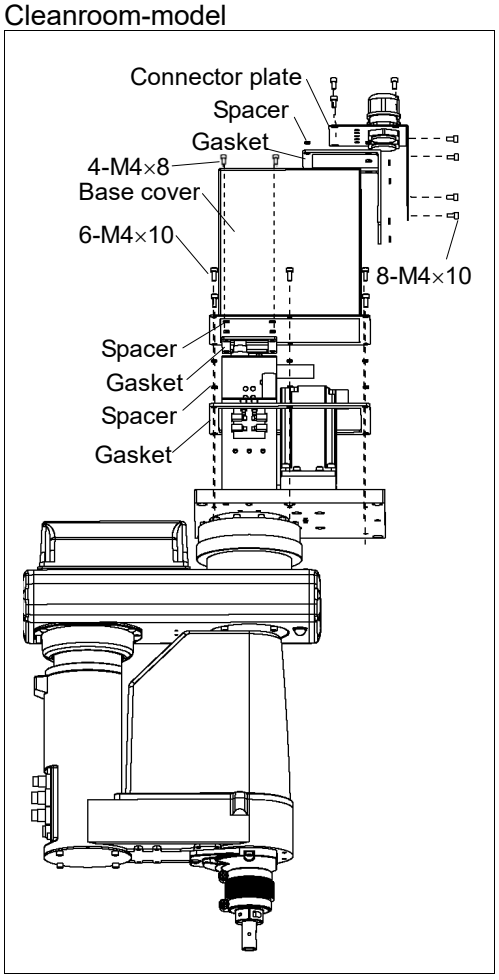
Before removing the base cover, remove the connector plate and disconnect the connectors.

Unscrew the bolts securing the base cover to remove the base cover.

Standard-model



Cleanroom-model

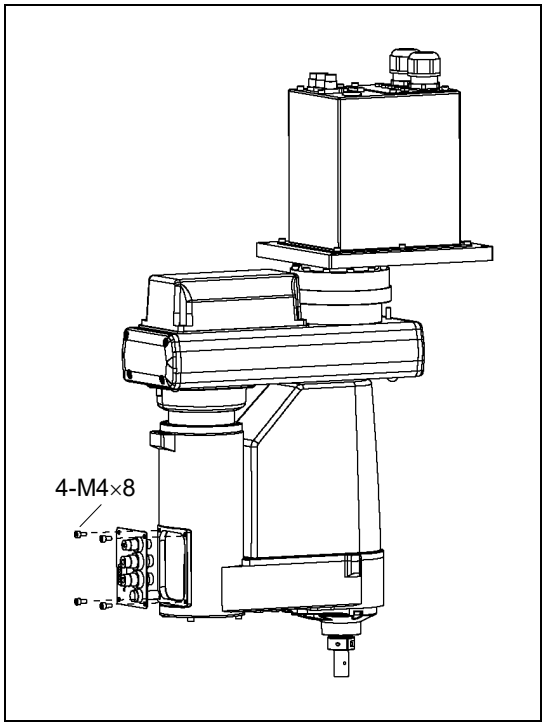


Gaskets and spacers are installed to the Cleanroom-model.

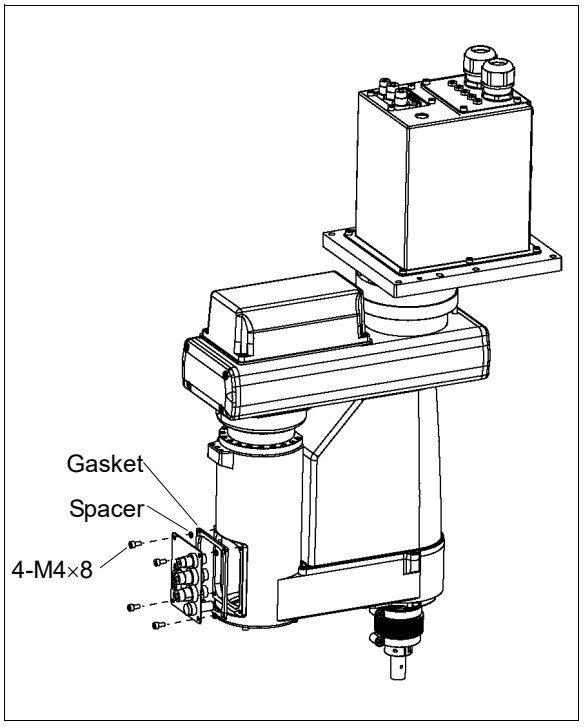
3.5 User Plate

Unscrew the user plate mounting bolts and remove the plate.

Standard-model



Cleanroom-model



A gasket and spacer are installed to Cleanroom-model.

4. Cable Unit

 WARNING	■ Do not connect or disconnect the motor connectors while the power to the robot system is turned ON. Connecting or disconnecting the motor connectors with the power ON is extremely hazardous and may result in serious bodily injury as the Manipulator may move abnormally, and also may result in electric shock and/or malfunction of the robot system. ■ To shut off power to the robot system, disconnect the power plug from the power source. Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source. ■ Before performing any replacement procedure, turn OFF the Controller and related equipment, and then disconnect the power plug from the power source. Performing any replacement procedure with the power ON is extremely hazardous and may result in electric shock and/or malfunction of the robot system. ■ Be careful not to get any foreign substances in the Manipulator, connectors, and pins during maintenance. Turning ON the power to the robot system when any foreign substances exist in them is extremely hazardous and may result in electric shock and/or malfunction of the robot system. ■ Be sure to remove the Manipulator with two or more people. The Manipulator weight is as follows. Be careful not to get hands, fingers, or feet caught and/or have equipment damaged by a fall of the Manipulator. RS3-351* : approx. 17 kg: 38 lb. RS4-551* : approx. 19 kg: 42 lb. ■ When installing the Manipulator to the ceiling, support the Manipulator, and then secure the anchor bolts. Removing the support without securing the anchor bolts properly is extremely hazardous and may result in fall of the Manipulator.

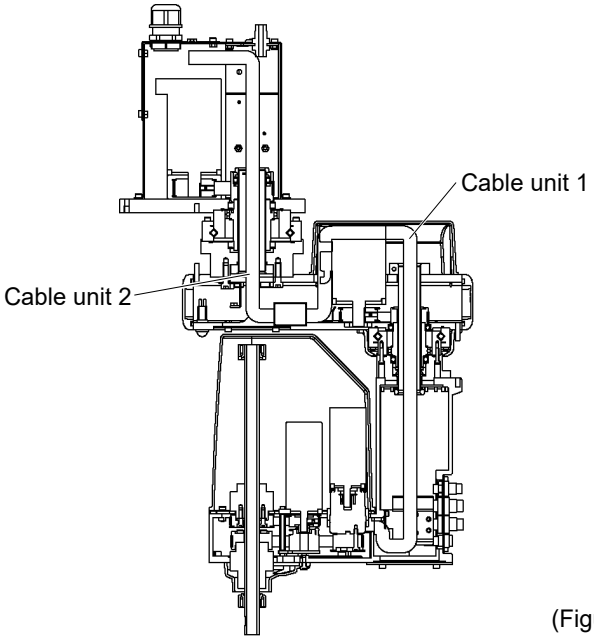
 CAUTION	■ Be sure to connect the cables properly. Do not allow unnecessary strain on the cables. (Do not put heavy objects on the cables. Do not bend or pull the cables forcibly.) The unnecessary strain on the cables may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system.

4.1 Replacing Cable Unit

Since the power is supplied to each motor from the lithium battery installed on the battery board via the battery connector, the position data will not be lost when the Controller is turned OFF. When the battery connectors are disconnected, the position data will be lost, and EPSON RC+ will display an error when the Controller is turned ON.

If the error occurs, execute the calibration of all joints and axes.

	Name	Quantity	Note
Maintenance parts	Cable unit	1	Each manipulator model *(Refer to 14. Maintenance parts)*
	Battery Unit (Lithium battery)	3	2117879
Tools	Hexagonal wrench (width across flats: 3 mm)	1	For M4 screw
	Hexagonal wrench (width across flats: 4 mm)	1	For M5 screw
	Hexagonal wrench (width across flats: 5 mm)	1	For M6 screw
	Spanner (width across flats: 5 mm)	1	For D-sub connector removal
	Nut screwdriver (width across flats: 5 mm)	1	For D-sub connector removal
	Nippers	1	For cutting wire tie
	Alcohol	Proper quantity	For wiping grease
	Wiping cloth	1	For wiping grease
Material	Wire tie	20	
Grease	Grease for cable (GPL-224)	10 g	



(Figure: RS3-351S)

CAUTION	■ If the connectors have been disconnected during the replacement of the cable unit, be sure to reconnect the connectors to their proper positions. Refer to the block diagrams. Improper connection of the connectors may result in improper function of the robot system. For details on the connections, refer to *4.2 Wiring Diagrams.* ■ When mounting the cover, be careful not to allow the cables to interfere with the cover mounting and do not bend these cables forcibly to push them into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, observe the cable locations after removing the cover. Be sure to place the cables back to their original locations. ■ Be sure to connect the cables properly. Do not allow unnecessary strain on the cables. (Do not put heavy objects on the cables. Do not bend or pull the cables forcibly.) The unnecessary strain on the cables may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system.

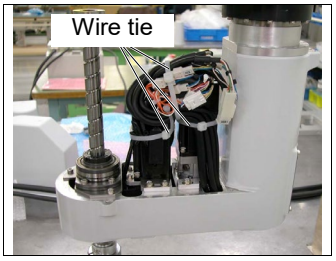
Cable unit Removal

(1) Turn OFF the Controller.

(2) Disconnect the power cable and signal cable connectors from thee controller.

(3) Remove the Arm #2 cover.
For details, refer to *3.2 Arm #2*.

(4) Cut off the wire ties bundling cables.



(5) Connect the spare batteries to connector XB13, XB14 (in Arm #2 side).
- The position of motors of Joints #3 and #4 are stored by the battery in the base. Connect the batteries to prevent the position data from losing.

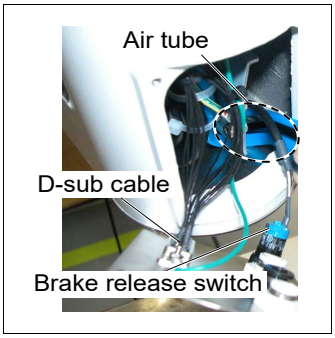
(6) Disconnect the connectors.

Connectors X31, X32, X33, X41, XB33, XB34, X331, X341

(7) Remove the user plate, and it draws it out forward.
For details, refer to *3.5 User Plate*.

(8) Disconnect the air tubes, ground wire, connecter of the D-sub cable (XU11, XU21), and connector of the brake release switch from the user plate.

Press the ring on the fitting and pull out the air tube. (ø6×2, ø4×1)



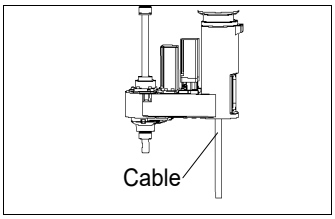
NOTE Be sure to remember the cable location to connect them to the original position.

(9) Remove the ground wire from the cable mounting jig.

Cut off two wire ties bundling the cables.

(10) Remove the Arm #2 maintenance cover.
For details, refer to *3.2 Arm #2*.

(11) Draw out the cables connected to the motor side forward in order of size with the thinnest one first.

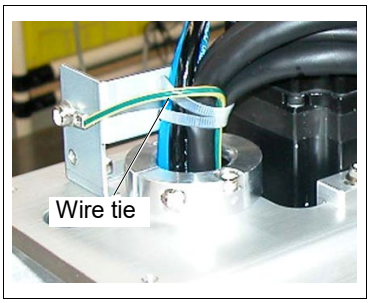


(12) Remove the Arm #1 cover.

For details, refer to *3.1 Arm #1*.

(13) Cut off two wire ties bundling the cables.

(14) Disconnect the ground wire.



(15) Pull out the tubes and cables upward in order of size with the thinnest one first. (Be careful about the connectors not to be caught.)

(16) Remove the Arm #1 side cover and Arm #1 under cover.

For details, refer to *3.1 Arm #1*.

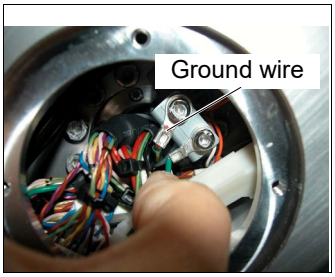
(17) Connect the spare batteries to connector XB12 (in Arm #2 side).
- The position of motor of Joint #2 is stored by the battery in the base. Connect the batteries to prevent the position data from losing.

(18) Push the cables and tubes drawn out before and disconnect the connectors from the hole of the under cover.

(19) Disconnect the connectors except the battery connector.

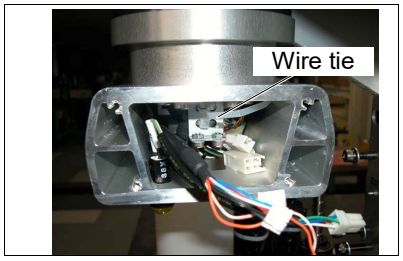
Connectors X21, X22, X23, X30, XB22, XB23, X221, X231, XU10, XU20

(20) Remove the ground wire.



(21) Cut off two wire ties bundling the cables

Pull out the cable unit 2.



(22) Remove the Connector plate.

For details, refer to *3.3 Connector plate.*

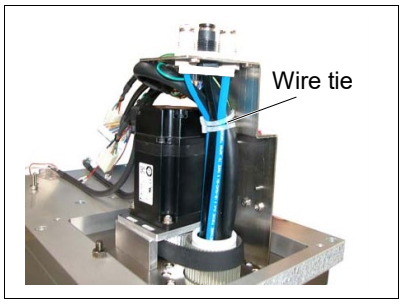
(23) Remove the Base cover.

For details, refer to *3.4 Base cover.*

(24) Remove the D-sub connector from the plate securing the cables.

(25) Remove three air tubes.

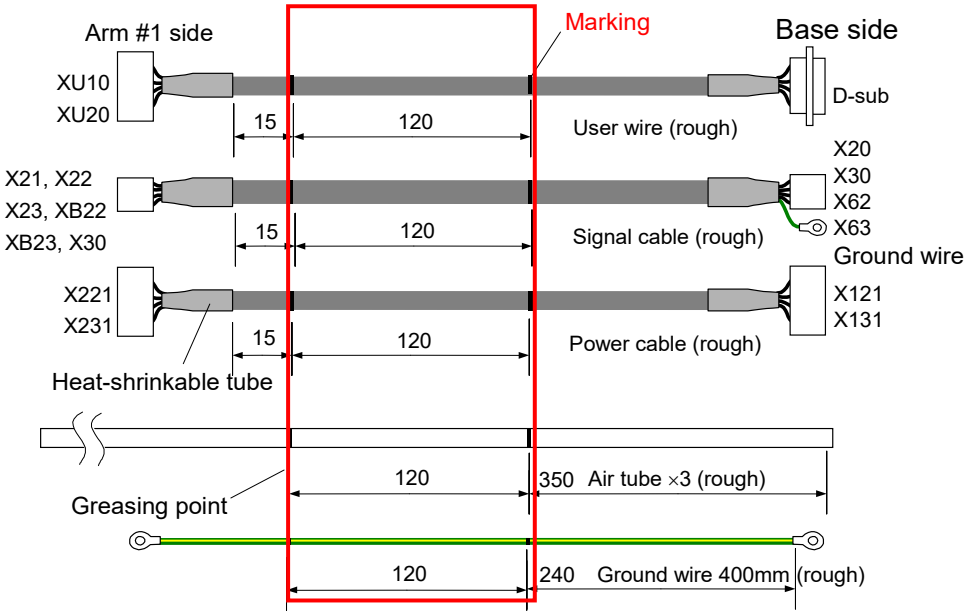
Cut off two wire ties bundling the cables.



(26) Pull out the cable unit 2 and air tubes.
(Be careful about the connector not to be caught.)

Cable unit Installation

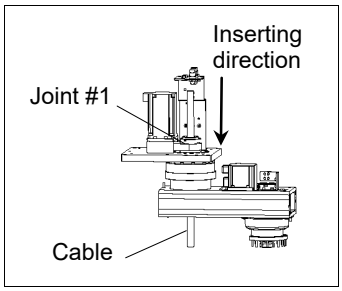
(1) Mark the position of the cable unit 1 using a permanent marker.



(2) Cover both ends of the cables with plastic bags.
(The photo shows the one end covered with plastic bags.)

The plastic bags prevent grease adhesion to the ends of connectors/air tubes during the cable drawing.

(3) Insert the cables to the Joint #1 from the base side. Be careful about the cable direction.
Refer to *the connector label* in *Step (1)*.

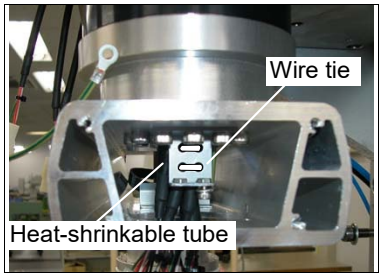


Insert the connectors in order of size with the largest one first, and then, the air tube and ground wire.
To prevent the cables and tube from falling off, pull them out from the bottom side temporarily and apply grease (GPL-224) to the marked point.
For the greasing point, refer to *Step (1)*.

(4) Put two wire ties to the cable mounting jig in Arm #1.

Secure cables, tube, and ground wire loosely.

Secrure the bottom of the tube and ground wire where the grease (GPL-224) is applied.



(5) Connect the connectors to the battery baord of the base side.

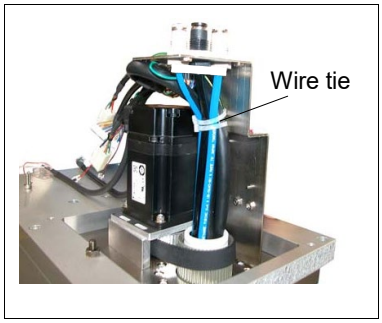
Connectors X62, X63

(6) Draw out the connectors of Arm #1 side (X21, X22, XB22, X221) forward in the arm.

(7) Connect the D-sub cable and air tubes connected to the J1 cable plate (inner side).

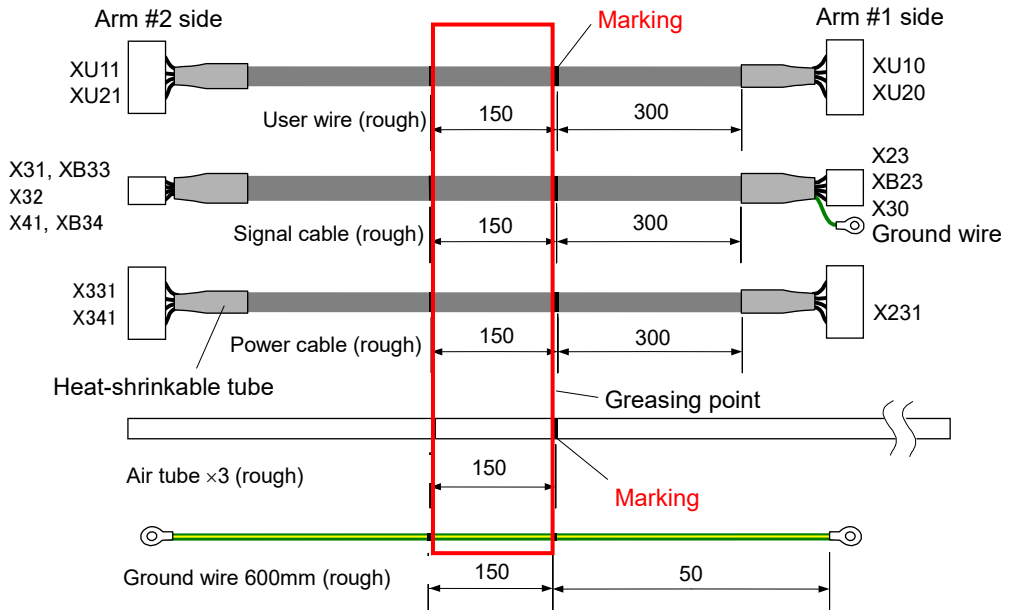
(8) Push the wires, tubes, and ground wire downward and secure them to the cable mounting plate with the wire tie.

When bundling the cables, untangle the cables and put Arm #1 to the position of 90 degree (end of the arm faces to the other side to the J1 motor.)



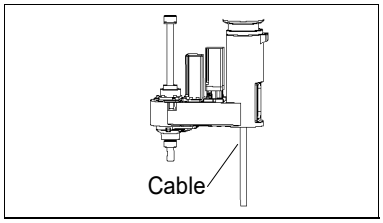
(9) Install the ground wire.

(10) Mark the position of the cable unit 2 using a permanent marker.



(11) Insert the cables to the Arm #1.

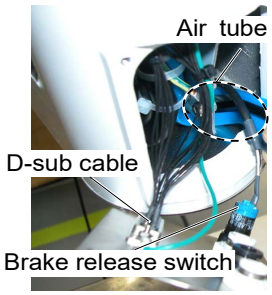
Be careful about the cable direction.
Refer to *the connector label* in S*tep (1)*.



(12) Secure the cables with the wire tie.

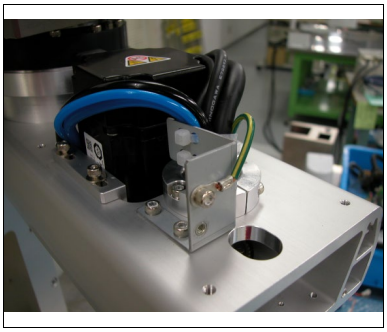
The wire tie should be a little away from the greasing part of the cables.

Untangle the cables and bundle them at the position of calibration point of Arm #2 (where Arm #1 overlaps with Arm #2).



(13) Connect the ground wire.

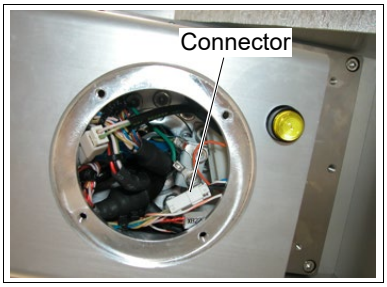
(14) Secure the air tubes and cables to both sides of the motor.



(15) Connect the ground wire.

(16) Connect the connectors.

Connectors X21, X22, X23, X30, XB22, XB23, X221, X231, XU10, XU20.

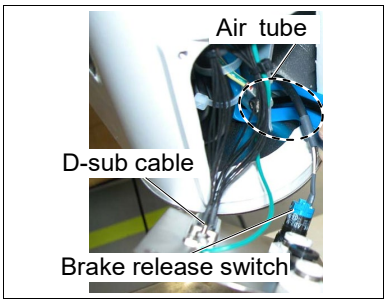


(17) Remove the spare battery from XB12.

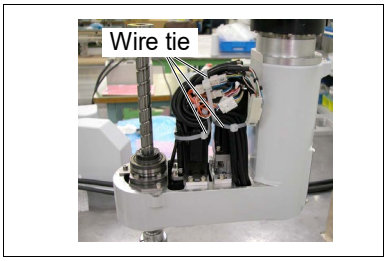
(18) Secure the cables with the wire tie.

(19) Install the ground wire to the connector plate.

(20) Connect the D-sub cable connectors (XU11, XU21) and air tubes connected to the inner side of connector plate.



(21) Put the cable unit 2 to the wire hole of Arm #2 and bundle the cables with the wire tie.



(22) Connect the connectors.

Connectors X31, X32, X33, X41, XB33, XB34, X331, X341.

For details, refer to *4.2 Wiring Diagrams*.

(23) Remove the spare batteries from XB13 and XB14.

(24) Mount the user plate to the Arm #2 cover.
For details, refer to *3.5 User Plate*.

(25) Set and secure the Arm #2 cover and Arm #2 maintenance cover without the cables being stuck.

For details, refer to *3.2 Arm #2*.

(26) Mount the Arm #1 cover, Arm #1 side cover, and Arm #1 under cover.

For details, refer to *3.1 Arm #1*.

(27) Install the Base cover.

For details, refer to *3.4 Base Cover*.

(28) Connect the connector and install the connector plate.

For derails, refer to *3.3 Connector Plate*.

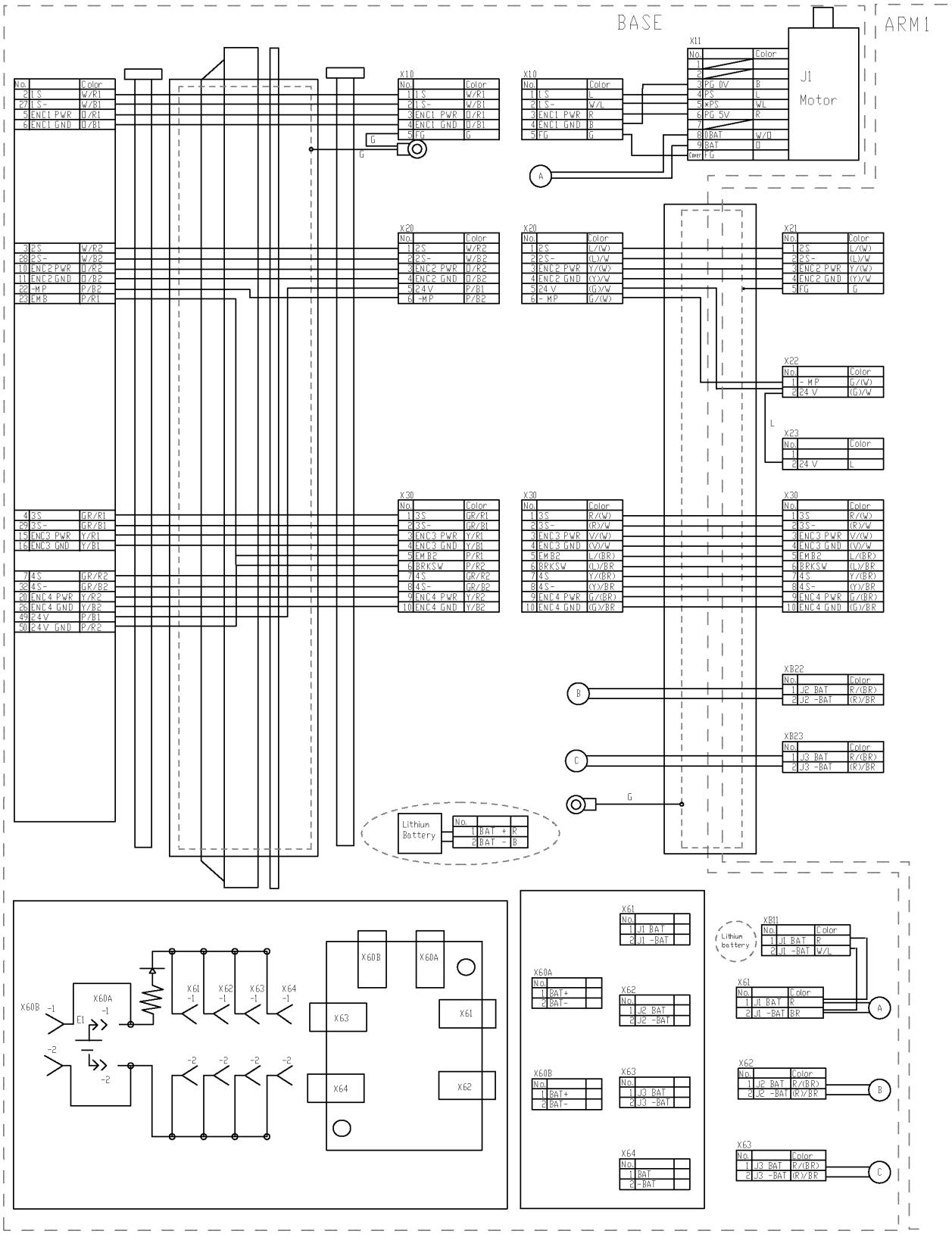
(29) Perform the calibration of all axis.

4.2 Wiring Diagrams

4.2.1 Signal Cable

For the colors and symbols of the cables, refer to *4.2.2 Power Cable*.

Continues to the next page



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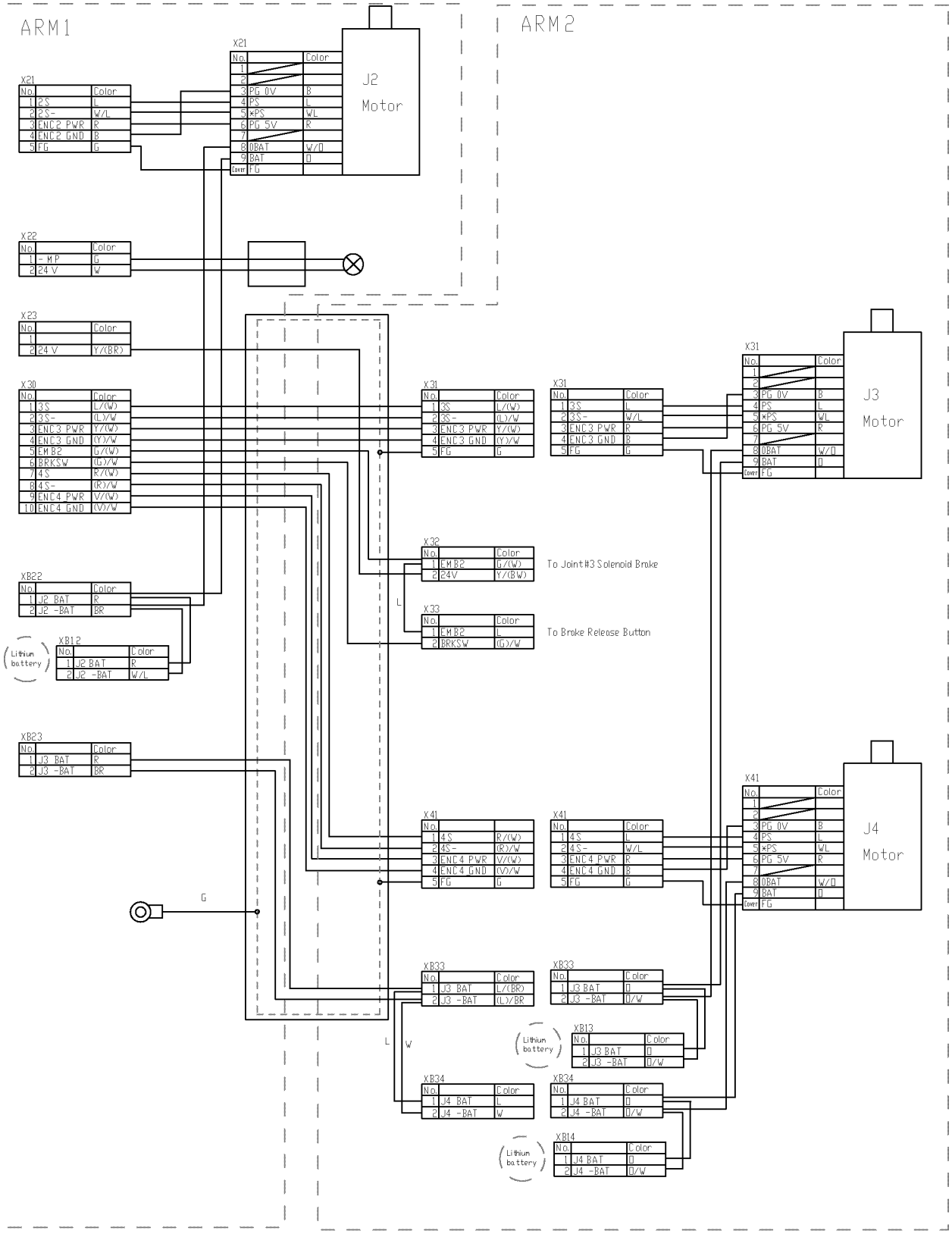

4.2.2 Power Cable

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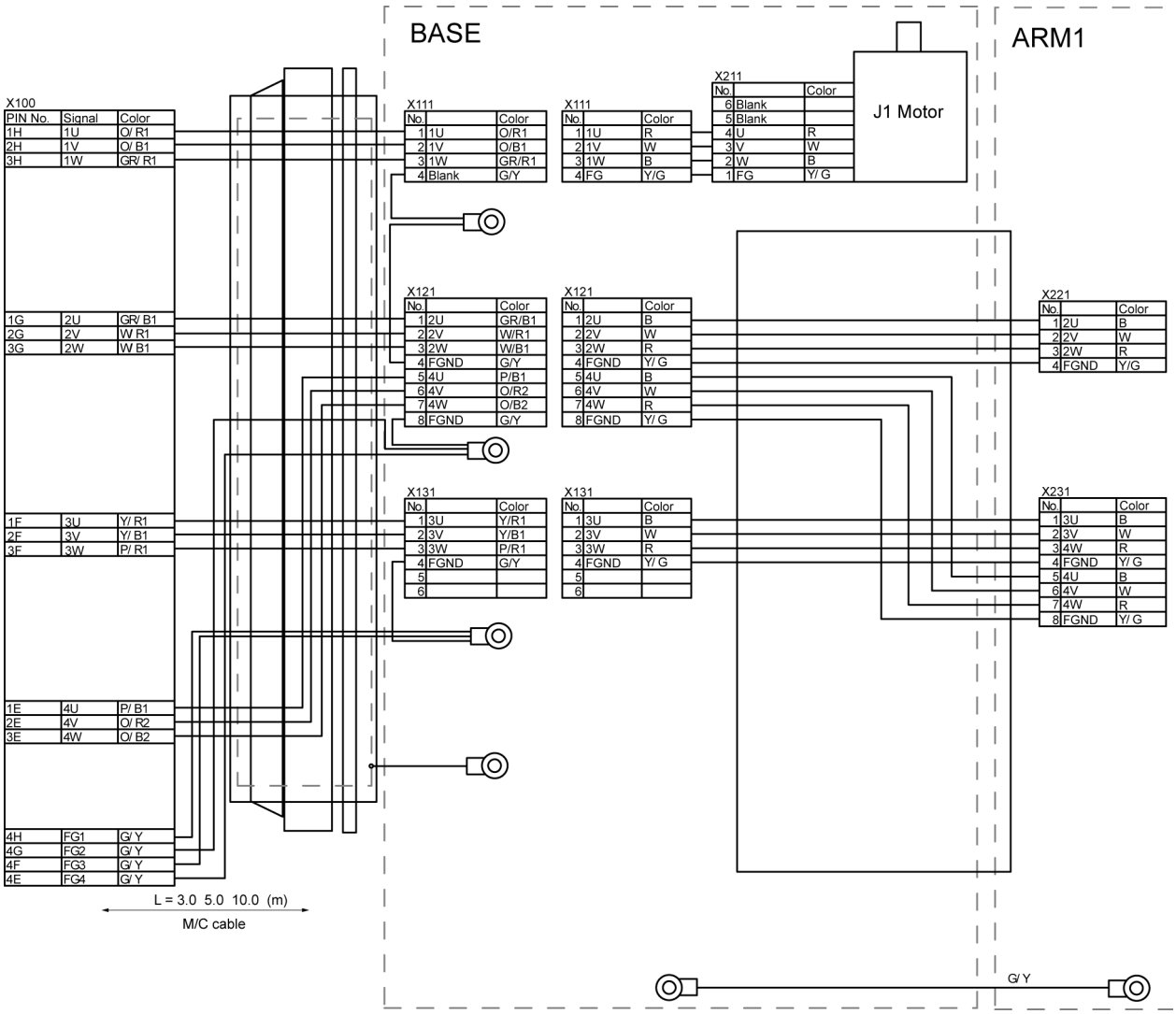

Code	Cable color	Code	Cable color
B	Black	P	Pink
BR	Brown	R	Red
G	Green	V	Violet
L	Blue	W	White
O	Orange	Y	Yellow

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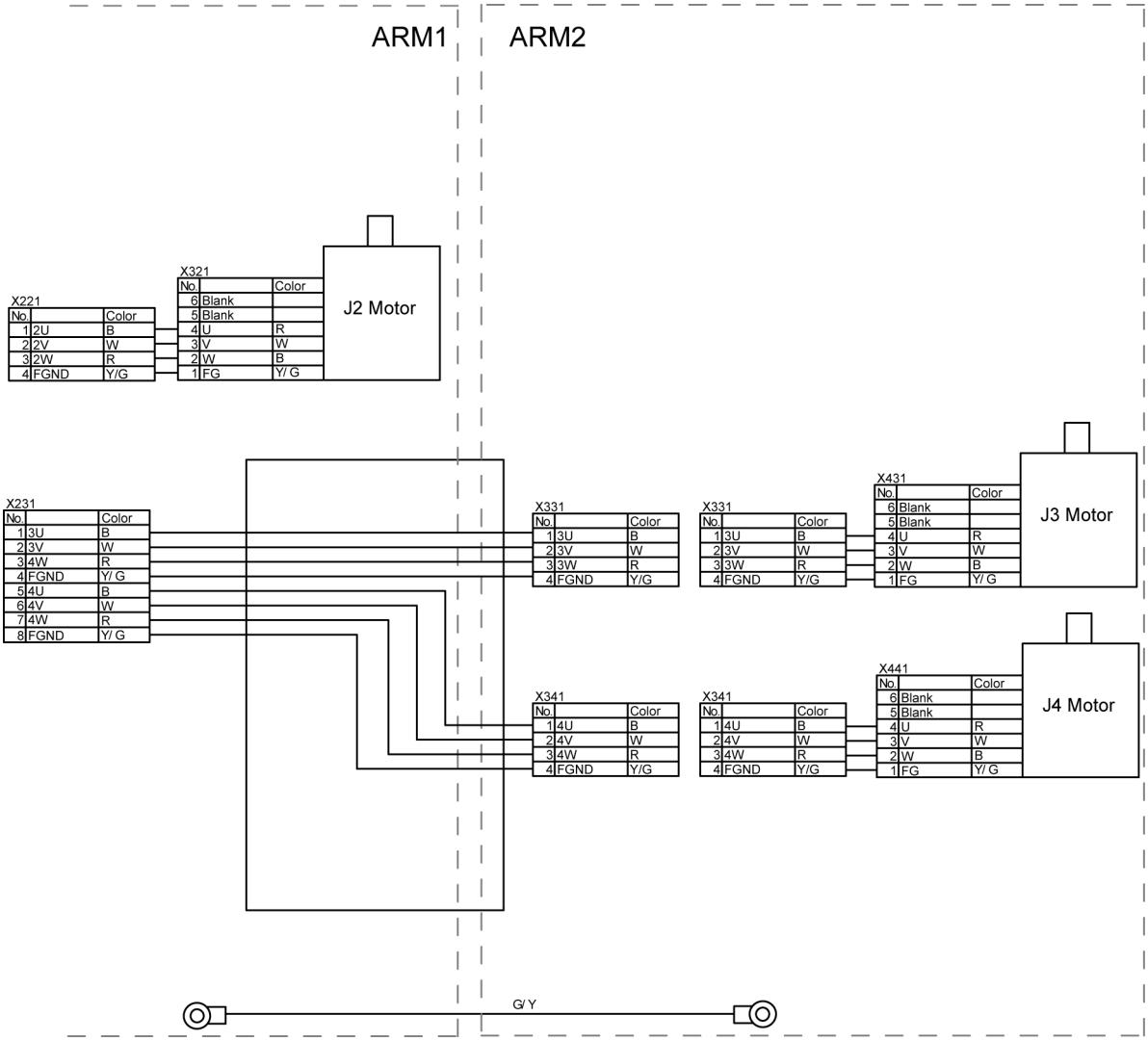
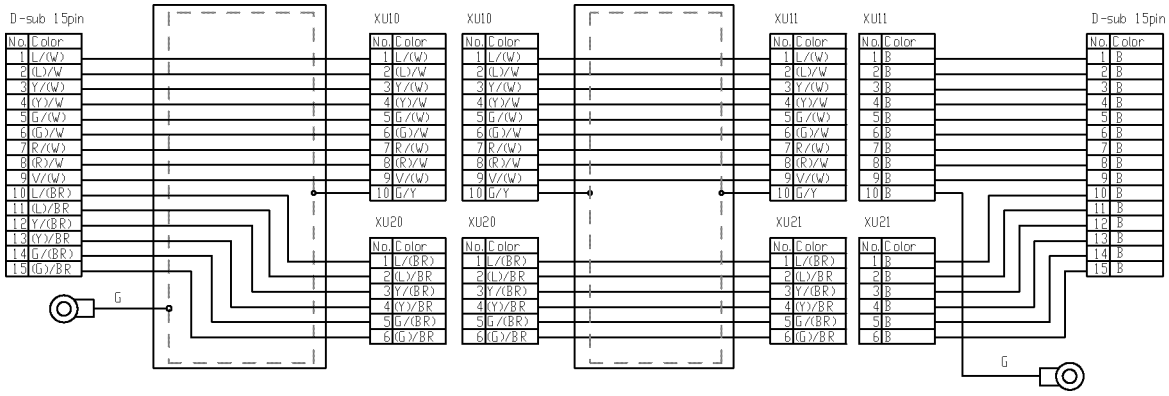


4.2.3 User Cable



Code	Cable color	Code	Cable color
B	Black	R	Red
BR	Brown	V	Violet
G	Green	W	White
L	Blue	Y	Yellow

The following table shows the types of the cable unit.

Environment	Model name	Code	Note
S	RS3-351*	1514474	
	RS4-551*	1547166	
C	RS3-351*	1514475	Waterproof connector : D-sub
	RS4-551*	1548346	

4.3 Replacing M/C Cable

Since the power is supplied to each motor from the lithium battery installed on the battery board via the battery connector, the position data will not be lost when the Controller is turned OFF. When the battery connectors are disconnected, the position data will be lost, and EPSON RC+ will display an error when the Controller is turned ON.

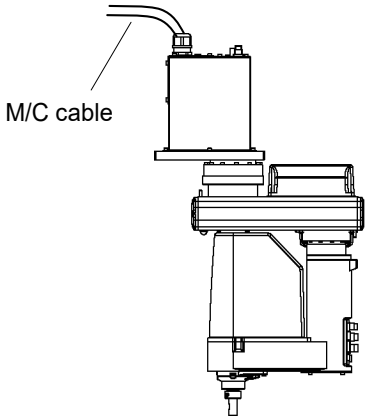
NOTE

If the connector connected to the battery was disconnected during cable replacement, execute calibration.
For details, refer to *13. Calibration.*

	Name	Quantity	Note
Maintenance parts	M/C Cable	1	Each manipulator model (Refer to *14. Maintenance parts*)
Tools	Hexagonal wrench (width across flats: 3 mm)	1	For M4 screw
	Torque wrench	1	

CAUTION

- If the connectors have been disconnected during the replacement of the cable unit, be sure to reconnect the connectors to their proper positions. Refer to the block diagrams.
  Improper connection of the connectors may result in improper function of the robot system.
  For details on the connections, refer to *4.2 Wiring Diagrams.*
- When mounting the cover, be careful not to allow the cables to interfere with the cover mounting and do not bend these cables forcibly to push them into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system.
  When routing the cables, observe the cable locations after removing the cover. Be sure to place the cables back to their original locations.
- Be sure to connect the cables properly. Do not allow unnecessary strain on the cables. (Do not put heavy objects on the cables. Do not bend or pull the cables forcibly.) The unnecessary strain on the cables may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system.



M/C Cable Removal

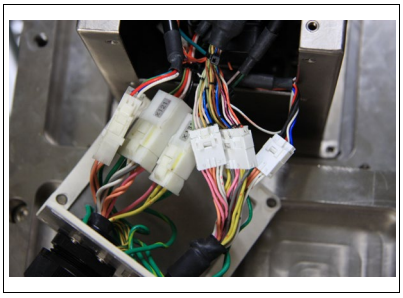
(1) Turn OFF the Controller.

(2) Disconnect the power cable and signal cable connectors from the controller.

(3) Remove the Connector Plate.
For details, refer to *3.3 Connector Plate*.

NOTE
Do not pull the Connector plate forcibly.
The M/C cables are still attached to the plate.

(4) Disconnect the connectors.
Connector: X10, X20, X30, X111, X121, X131



NOTE
Each connector has a unique number.
Each connector has a different shape.

NOTE
Do not disconect the battery connectors (X61, X62, X63). Otherwise, the calibration must be executed.

M/C Cable Installation

(1) Connect new M/C cable connectors to those of the Cable Unit.
(Connect to the connectors of the Cable Unit with the same number.)

(2) Mount the Connector Plate.
For details, refer to *3.3 Connector Plate*.

(3) Connect the power cable and signal cable connectors to the controller.

(4) Turn ON the Controller.

(5) If the connectors (X61, X62, X63) fall off from the battery, execute the calibration for Joint #1.
For details, refer to *13 Calibration*.

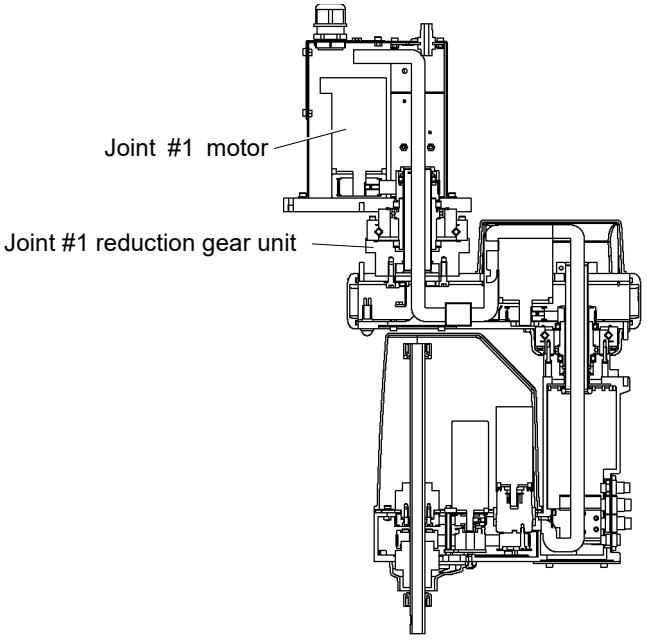
5. Joint #1

WARNING	■ Do not connect or disconnect the motor connectors while the power to the robot system is turned ON. Connecting or disconnecting the motor connectors with the power ON is extremely hazardous and may result in serious bodily injury as the Manipulator may move abnormally, and also may result in electric shock and/or malfunction of the robot system. ■ To shut off power to the robot system, disconnect the power plug from the power source. Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source. ■ Before performing any replacement procedure, turn OFF the Controller and related equipment, and then disconnect the power plug from the power source. Performing any replacement procedure with the power ON is extremely hazardous and may result in electric shock and/or malfunction of the robot system.

CAUTION	■ Be careful not to apply excessive shock to the motor shaft when replacing the motors. The shock may shorten the life cycle of the motors and encoder and/or damage them. ■ Never disassemble the motor and encoder. A disassembled motor and encoder will cause a positional gap and cannot be used again.

After parts have been replaced (motors, reduction gear units, brakes, timing belts, ball screw spline unit, etc.), the Manipulator cannot operate properly because a mismatch exists between the origin stored in each motor and its corresponding origin stored in the Controller. After replacing the parts, it is necessary to match these origins.
The process of aligning the two origins is called “Calibration”.

Refer to *13. Calibration* to perform the calibration.



(Figure : RS3-351S)

5.1 Replacing Joint #1 Motor

	Name		Quantity	Note
Maintenance parts	AC Servo Motor (400 W)		1	1514468
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M5 set screw, M3 screw
		width across flats: 3 mm	1	For M4 screw
	Torque wrench (M4)		1	
	Force gauge		1	Belt tension 150 N (15.3 kgf)
	Suitable cord (Length about 800 mm)		1	For belt tension
	Wiping cloth		1	For wiping grease
Grease	Grease (SK-1A)		13 g	

NOTE

When tightening hexagon socket head cap bolts, refer to the *2.4 Tightening Hexagon Socket Head Cap Bolts.*

Joint #1 motor Removal

(1) Turn ON the Controller.

(2) Move the Manipulator Joint #1 to the origin.

(3) Turn OFF the Controller.

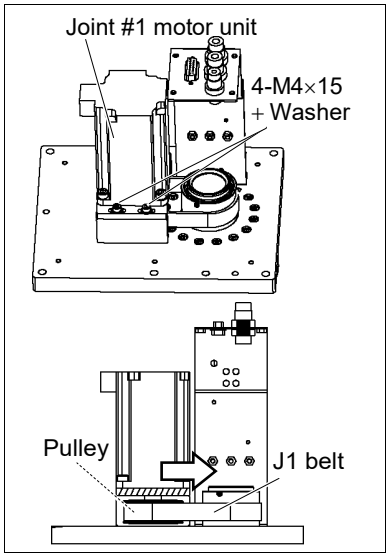
(4) Remove the connector plate.
For details, refer to *3.3 Connector Plate*.

(5) Disconnect the following connectors.
Connectors X10, X20, X30, X111, X121, X131 (Hold the clip to remove.)
Connector X61

(6) Remove the base cover.
For details, refer to *3.4 Base Cover*.

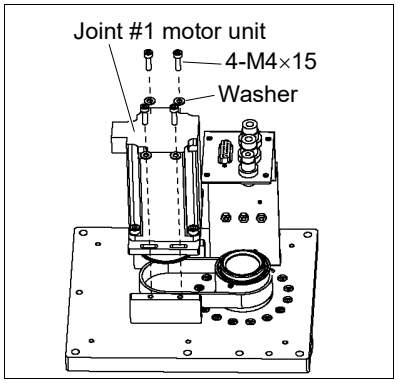
(7) Loosen the J1 belt.

Loosen four bolts on the Joint #1 motor unit.
Slide the Joint #1 motor unit toward the Joint #1 side.

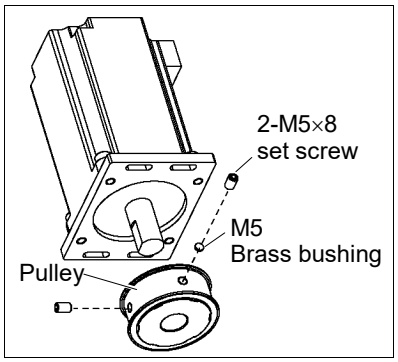


(8) Remove the Joint #1 motor unit from the base.

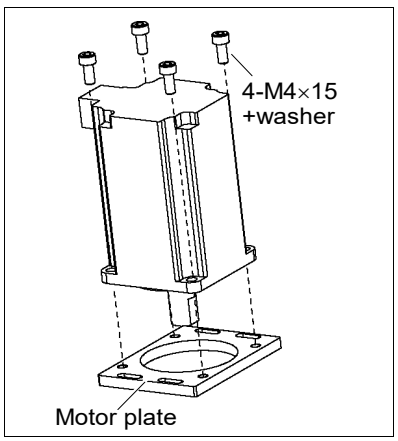
Unscrew the bolts securing the Joint #1 motor plate and pull it upward to remove.



(9) Remove the pulley from the Joint #1 motor.

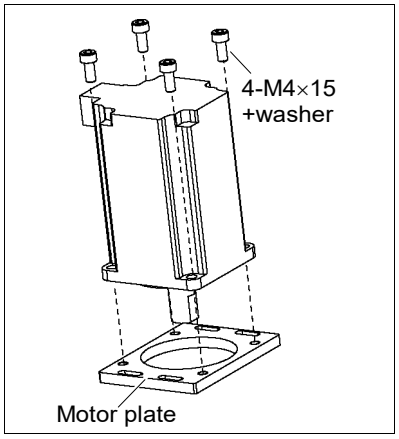


(10) Remove the motor plate from the Joint #1 motor.



Joint #1 motor Installation

(1) Mount the motor plate on the Joint #1 motor.

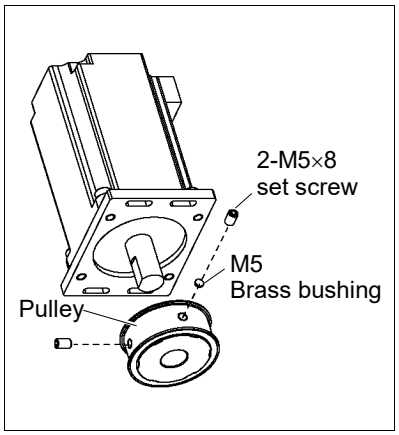


(2) Mount the pulley to the Joint #1 motor.

Fit the end face of the pulley with the end face of the motor shaft.

Tighten one of the set screws on the flat face of the motor shaft until the screw just touches the surface.
Insert a bushing into the other set screw hole to prevent damage to the motor shaft.

Then, tighten both set screws.



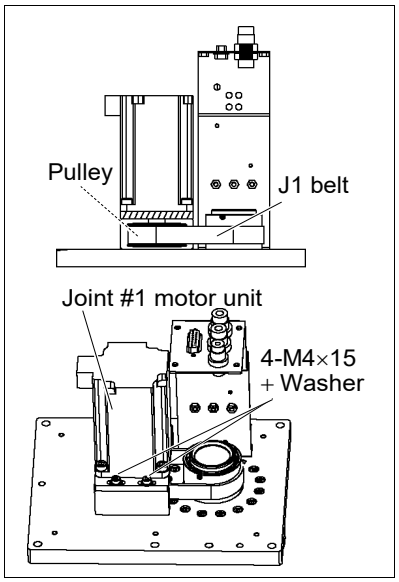
(3) Place the J1 belt around the pulley of the Joint #1 motor unit to secure the unit loosely.

NOTE

Make sure that the gear grooves of the belt are fit into those of the pulleys completely.

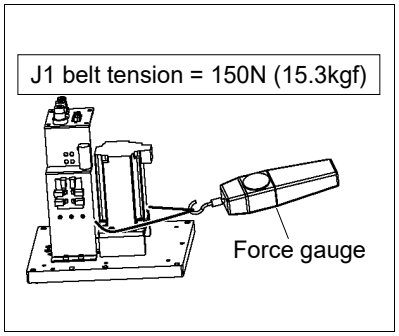
Put the motor cable facing toward the other side of Joint #1.

When securing the motor unit, make sure the unit can be moved by hand, and it will not tilt when pulled. If the unit is secured too loose or too tight, the belt will not have the proper tension.



(4) Apply the proper tension to the J1 belt and secure the Joint #1 motor unit.

To do so, pass a suitable cord or string around the Joint #1 motor unit near its mounting plate.
Then, pull the cord using a force gauge or similar tool to apply the specified tension shown in the figure on the right.



(5) Connect the connector to the battery board

Connector X61

(6) Mount the base cover.

For the details, refer to *3.4 Base Cover*.

(7) Connect the following connectors.

Connectors X10, X20, X30, X111, X121, X131

(8) Mount the connector plate.

For details, refer to *3.3 Connector Plate*.

(9) Perform the calibration of Joint #1.

For details refer to *13. Calibration*.

5.2 Replacing Joint #1 Reduction Gear Unit

	Name		Quantity	Note
Maintenance Parts	Reduction Gear Unit		1	1514470 (RS3-351*) 1547165 (RS4-551*)
Tools	Hexagonal wrench	width across flats: 1.5 mm	1	For M2 screw
		width across flats: 3 mm	1	For M4 screw
		width across flats: 5 mm	1	For M6 screw
	Torque wrench	M4	1	
		M6	1	
	Nippers		1	
	Spatula		1	For applying grease
	Force gauge		1	Belt tension 150 N (15.3 kgf)
	Suitable cord (Length about 800 mm)		1	For belt tension
	Wiping cloth		1	For wiping grease (Flange)
			1	For wiping grease (Bolt)
Material	Wire tie		4	
Grease	Grease (SK-1A)		40 g	

NOTE

When tightening hexagon socket head cap bolts, refer to the *2.4 Tightening Hexagon Socket Head Cap Bolts.*

WARNING

- When removing the Manipulator from the base table, the Manipulator with two or more people.
  The Manipulator weights are as follows. Be careful not to get hands, fingers, or feet caught and/or have equipment damaged by a fall of the Manipulator.
  RS3-351* : approx. 17 kg: 38 lb.
  RS4-551* : approx. 19 kg: 42 lb.
- When removing the Manipulator from the base table, support the Manipulator, and then remove the anchor bolts. Removing the anchor bolts without supporting is extremely hazardous and may result in fall of the Manipulator.

Joint #1 reduction gear unit Removal

(1) Remove the Manipulator from the base table.

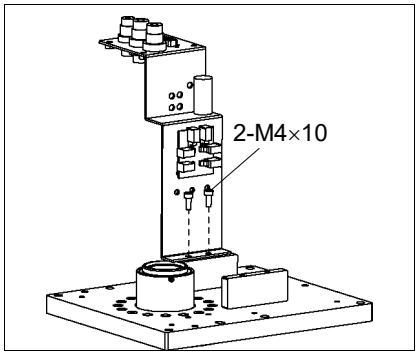
To remove the Manipulator, please observe the WARNING above.

(2) Remove the Joint #1 motor unit.

Execute the removal steps from (1) to (5) in *5.1 Replacing Joint #1 Motor.*

(3) Remove the air tube, D-sub cable, ground wire on the J1 cable plate. Cut off the wire tie.

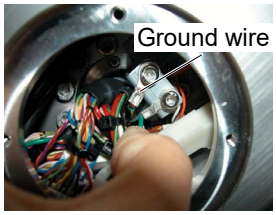
(4) Remove the J1 cable plate.



(5) Remove the Arm #1 under cover.

For details, refer to *3.1 Arm #1*.

(6) Remove the ground wire and connectors in the Joint #1 side of Arm #1.

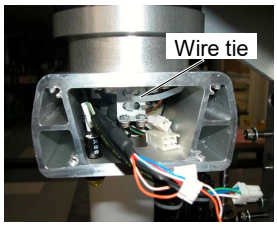


(7) Cut off two wire tie bundling the cables.

Pull out the Cable unit 1 (except air tubes) from the base side.

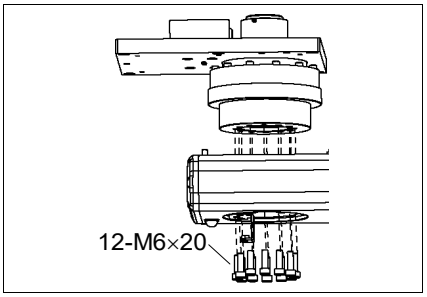
When pulling out the cables, first, pull out the air tubes from the Arm #1 side (the other side to the cables).

And pull out from smaller connectors in order from the base side.



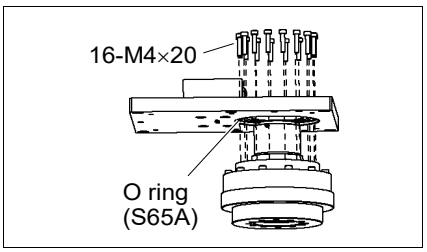
Do not try to pull out the cables forcibly. Otherwise, connectors may be stuck, disconnected, or connector pins may fall off.

(8) Remove the Arm #1.



(9) Remove the reduction gear unit from the base.

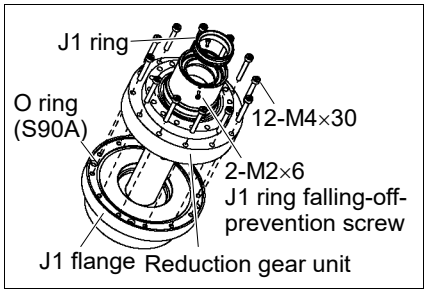
Be sure to keep the O ring (S65A).



(10) Remove the J1 ring falling-off-prevention screws and remove the J1 ring.

(11) Remove the J1 flange (with Metallic pipe).

Be sure to keep the O ring (S90A).



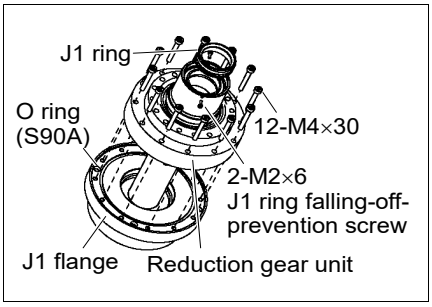
Joint #1 reduction gear unit Installation

(1) Unpack the new reduction gear unit.

(2) Set the O ring to the O ring (S90A) groove in the J1 flange.

(3) Set the hole on the reduction gear and the tap hole on the J1 flange.

Loosely secure all bolts in a crisscross pattern so that the bolts will be secured evenly. Then, using a torque wrench, tighten each bolt securely in a crisscross pattern at the torque specified in the table below.



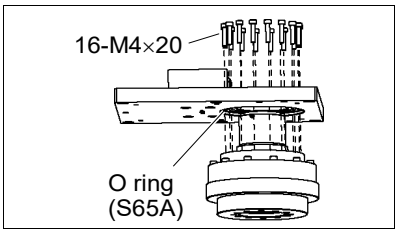
(4) Set the J1 ring and secure the J1 ring falling-off-prevention screws.

Item	Bolt type	Number of bolts	Tightening torque
Joint #1 reduction gear unit	M4×30	12	6.0 N·m (61.2 kgf·cm)
	M6×15	8	22.0 N·m (224.3 kgf·cm)

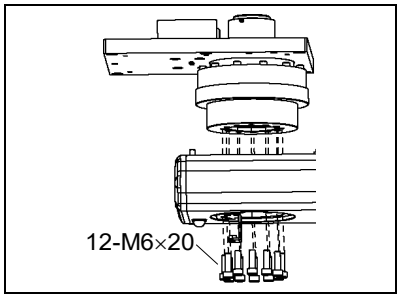
(5) Set the O ring to the O ring (S65A) groove in the Base.

(6) Mount the reduction gear unit to the base.

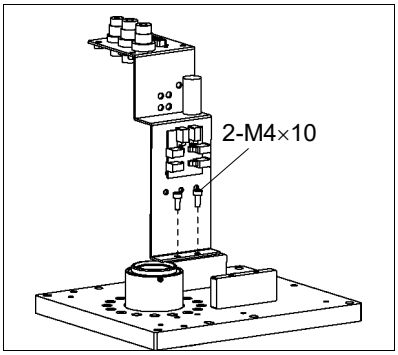
Be sure to keep the O ring.



(7) Mount the Arm #1.



(8) Mount the Joint #1 cable plate.



(9) Insert the cable unit to the Arm #1.

Follow the steps in *4.1 Cable Unit - Installation (1) - (9)*.

(10) Secure the Joint #1 motor and mount the cover.

Follow the steps in *5.1 Replacing Joint #1 Motor - Installation (4) - (8)*.

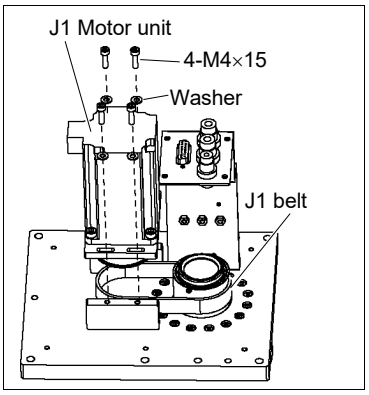
(11) Mount the Manipulator to the base table.

5.3 Replacing J1 Belt

J1 belt Removal

(1) Remove the J1 motor unit.

Follow the steps in *5.1 Replacing Joint #1 Motor - Removal (1) - (8)*.



(2) Remove the J1 belt.

J1 belt Installation

(1) Mount the J1 belt to the pulley of the Joint #1 side.

(2) Mount the J1 motor unit.

Follow the steps in
5.1 Replacing Joint #1 Motor - Installation (3) - (9).

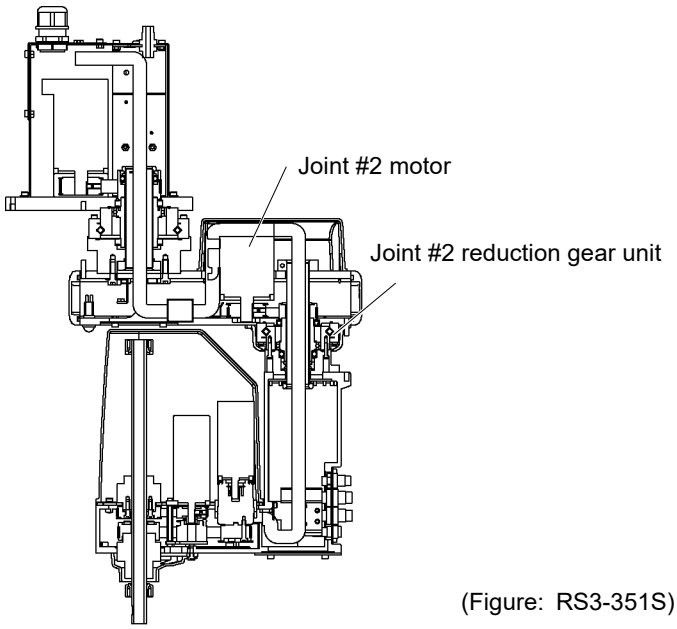
6. Joint #2

WARNING	■ Do not connect or disconnect the motor connectors while the power to the robot system is turned ON. Connecting or disconnecting the motor connectors with the power ON is extremely hazardous and may result in serious bodily injury as the Manipulator may move abnormally, and also may result in electric shock and/or malfunction of the robot system. ■ To shut off power to the robot system, disconnect the power plug from the power source. Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source. ■ Before performing any replacement procedure, turn OFF the Controller and related equipment, and then disconnect the power plug from the power source. Performing any replacement procedure with the power ON is extremely hazardous and may result in electric shock and/or malfunction of the robot system.

CAUTION	■ Be careful not to apply excessive shock to the motor shaft when replacing the motors. The shock may shorten the life cycle of the motors and encoder and/or damage them. ■ Never disassemble the motor and encoder. A disassembled motor and encoder will cause a positional gap and cannot be used again.

After parts have been replaced (motors, reduction gear units, brakes, timing belts, ball screw spline unit, etc.), the Manipulator cannot operate properly because a mismatch exists between the origin stored in each motor and its corresponding origin stored in the Controller.

After replacing the parts, it is necessary to match these origins.
The process of aligning the two origins is called “Calibration”.
Refer to *13. Calibration* to perform the calibration.



(Figure: RS3-351S)

6.1 Replacing Joint #2 Motor

	Name		Quantity	Note
Maintenance Parts	AC Servo Motor	200 W (RS3-351*)	1	1514451
		400 W (RS4-551*)	1	1514468
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M5 set screw
		width across flats: 3 mm	1	For M4 screw
		width across flats: 4 mm	1	For M5 screw
	Nippers		1	For cutting wire tie
	Force gauge		1	Belt tension 100 N (10.2 kgf)
	Suitable cord (Length about 800 mm)		1	For belt tension
	Wiping cloth		1	For wiping grease
Material	Wire tie		4	
Grease	Grease (SK-1A)		6 g	

NOTE

When tightening hexagon socket head cap bolts, refer to the *2.4 Tightening Hexagon Socket Head Cap Bolts.*

Joint #2 motor Removal

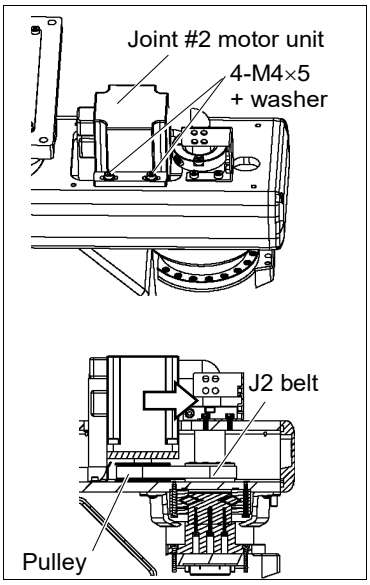
(1) Remove the Arm #1 cover.
For details, refer to *3.1 Arm #1.*

(2) Remove the Arm #1 under cover.
For details, refer to *3.1 Arm #1.*

(3) Disconnect the following connectors.
Connectors X21, X221, XB22 (Hold the clip to remove.)

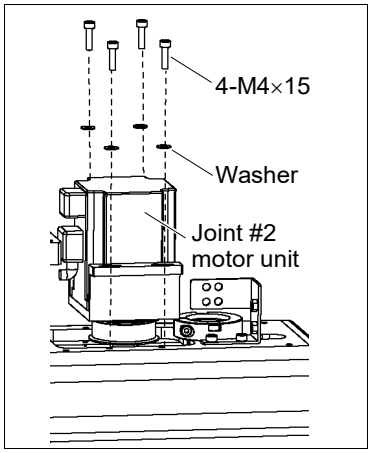
(4) Loosen the J2 belt.

Loosen four bolts securing the Joint #2 motor unit. Slide the Joint #2 motor unit toward the Joint #2 side.

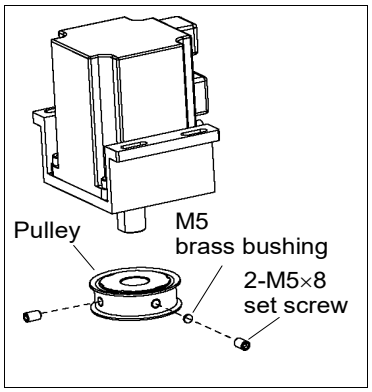


(5) Remove the Joint #2 motor unit from the Arm #1.

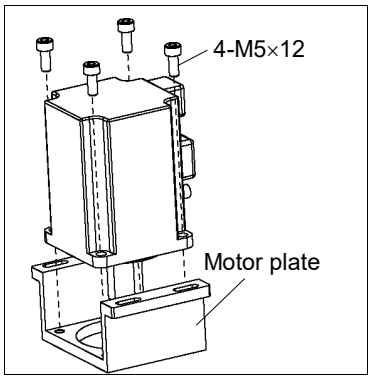
Unscrew the bolts securing the Joint #2 motor plate and pull the plate upward to remove.



(6) Remove the pulley from the Joint #2 motor.

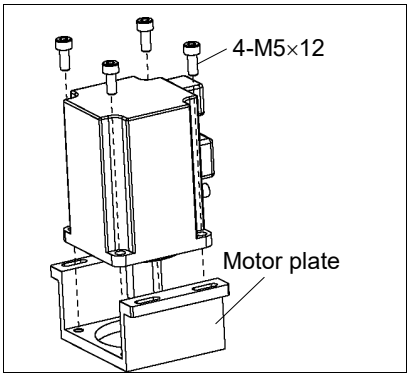


(7) Remove the motor plate from the Joint #2 motor.



Joint #2 motor Installation

(1) Mount the motor plate to the Joint #2 motor.



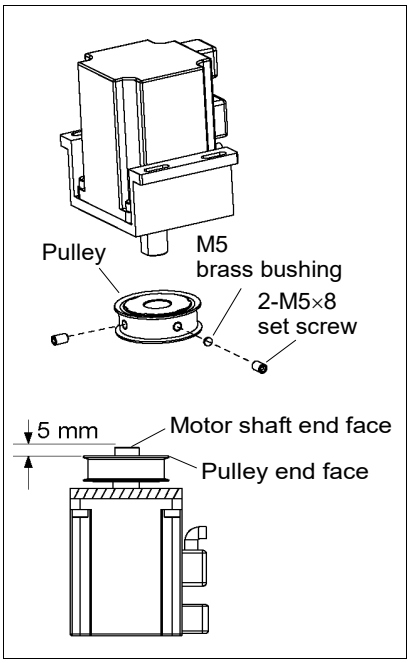
(2) Mount the pulley to the Joint #2 motor.

Secure the pulley to the distance of 5 mm from the end of the motor shaft.

Tighten one of the set screws on the flat face of the motor shaft until the screw just touches the surface.

Insert a bushing into the other set screw hole to prevent damage to the motor shaft.

Then, tighten both set screws.



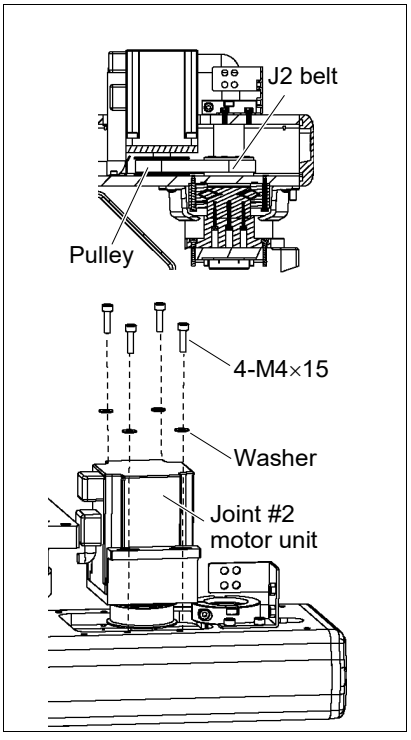
(3) Set the J2 belt around the pulley of the Joint #2 motor unit and secure the unit loosely.

NOTE

Make sure the gear grooves of the belt are fit into those of the pulleys completely.

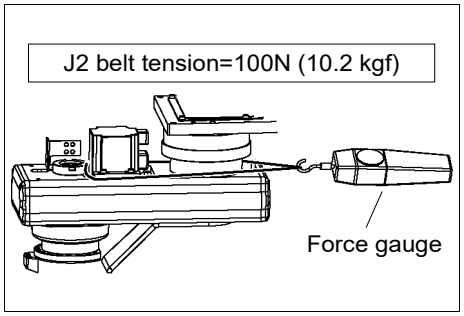
Set the motor cable facing toward the other side to J2 axis.

When securing the unit, make sure that the motor unit can move by hand, and it will not tilt when pulled. If the unit is secured too loose or too tight, the belt will not have the proper tension.



(4) Apply the proper tension to J2 belt and secure the Joint #2 motor unit.

To do so, pass a suitable cord or string around the Joint #2 motor unit near its mounting plate. Then, pull the cord using a force gauge or similar tool to apply the specified tension shown in the figure on the right.



(5) Insert the cables to Arm #1.

(6) Connect the connectors.

Connectors X21, X221, XB22

(7) Mount the Arm #1 cover.

For details, refer to *3.1 Arm #1*.

(8) Mount the Arm #1 under cover.

For details, refer to *3.1 Arm #1*.

(9) Perform the calibration of Joint #2.

For details refer to *13. Calibration*.

6.2 Replacing Joint #2 Reduction Gear Unit

	Name		Quantity	Note
Maintenance parts	Reduction Gear Unit		1	1514471
Tools	Hexagonal wrench	width across flats: 2 mm	1	
		width across flats: 2.5 mm	1	For M3 screw
		width across flats: 3 mm	1	
		width across flats: 4 mm	1	For M5 screw
	Torque wrench	M3	1	
		M5	1	
	Nipper		1	
	Spatula		1	For applying grease
	Force gauge		1	Belt tension 100 N (10.2 kgf)
	Suitable cord (Length about 800 mm)		1	For belt tension
	Wiping cloth		1	For wiping grease (Flange)
			1	For wiping grease (Bolt)
Material	Wire tie		4	
Grease	Grease (SK-1A)		12 g	

NOTE

When tightening hexagon socket head cap bolts, refer to the *2.4 Tightening Hexagon Socket Head Cap Bolts.*

Joint #2 reduction gear unit Removal

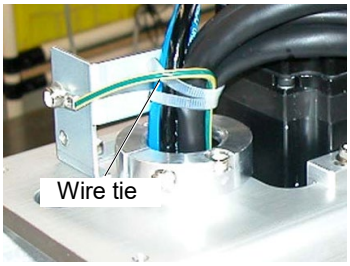
(1) Remove the Arm #1 cover.
For details, refer to *3.1 Arm #1.*

(2) Remove the Arm #1 under cover.
For details, refer to *3.1 Arm #1.*

(3) Disconnect the connectors:
Connectors X30, X23, XB23, X231, XU10, XU20 (Hold the clip to remove.)

(4) Put the cables over the J2.

(5) Cut off two wire ties bundling the cables.



(6) Disconnect the ground wire.

(7) Remove the user plate.

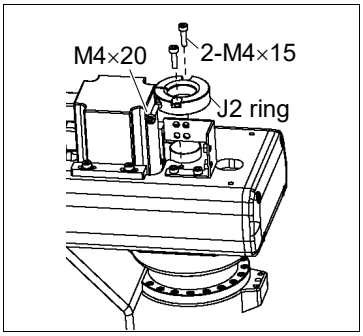
For details, refer to *3.5 User plate*.

(8) Remove the air tubes from the user plate. Press the ring of fittings of the air tube to pull it out (ø6×2, ø4×1).

Be sure to remember the cable location to connect them to the original position.

(9) Pull out the air tubes from the upper side of Joint #2.

(10) Remove the J2 ring.



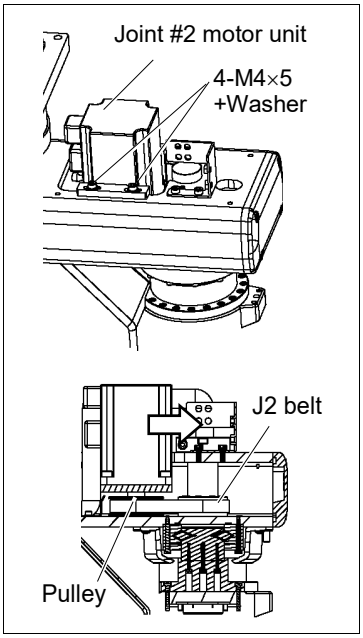
(11) Remove the J2 cover.

For details, refer to *3.1 Arm #1*.

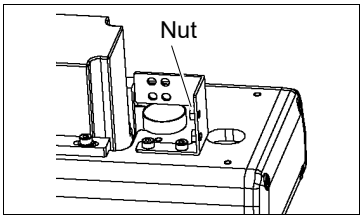
(12) Loosen the J2 belt.

Unscrew four bolts securing the Joint #2 motor unit.

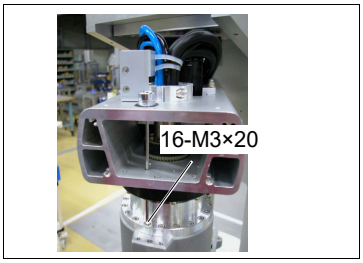
Slide the Joint #2 motor unit toward the Joint #2 side.



(13) Remove the screws secured with nuts.



(14) Use the holes and rotate the Arm #2 to remove the screws.



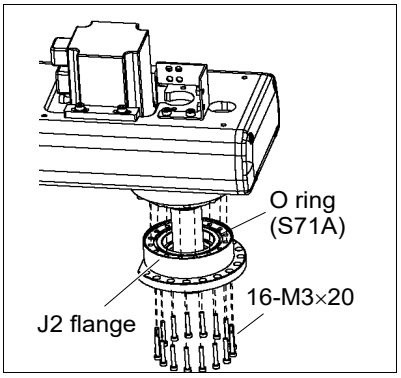
(15) Pull out the cables (except air tube) to downward from Joint #1.

Pull out cables in order of size (smaller cables first).

Do not try to pull out the cables forcibly. Otherwise, connectors may be stuck, disconnected, or connector pins may fall off.

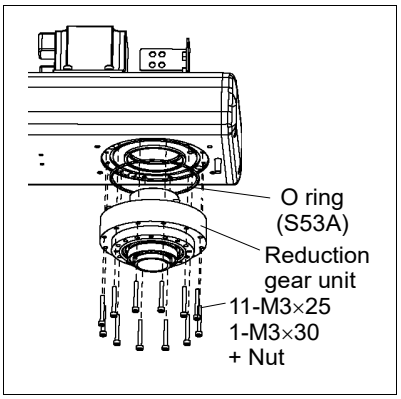
(16) Remove the J2 flange.

Be sure to keep the O ring (S71A).



(17) Remove the reduction gear unit.

Be sure to keep the O ring (S53A).

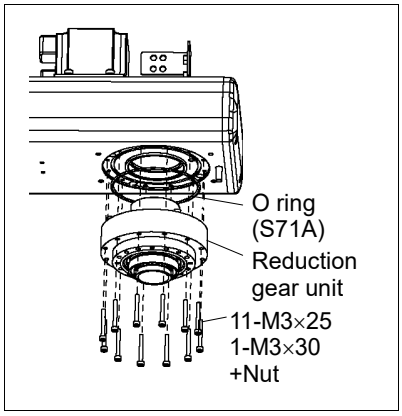


Joint #2 reduction gear unit Installation

(1) Unpack the new reduction gear unit.
Apply the grease on the gear.

(2) Set the O ring to the O ring (S71A) groove under the Arm.

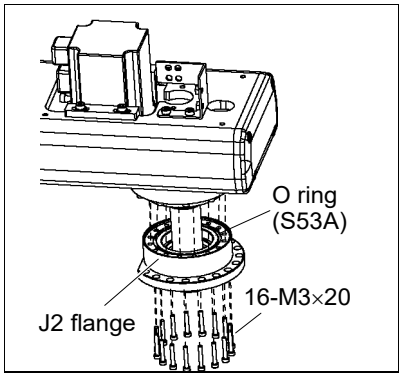
(3) Secure the reduction gear unit to the Arm #1.
Be sure to keep the O ring.



Item	Bolt type	Number of bolts	Tightening torque
Joint #2 reduction gear unit	M3×25	11	3.0 N·m (30.5 kgf)
	M3×30	1	
	M3×20	16	

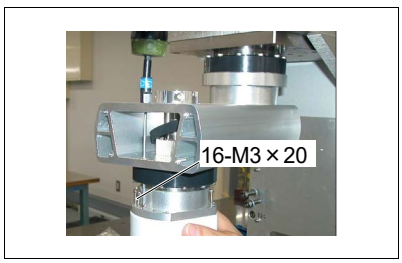
(4) Set the O ring (S53A) to the O ring groove in the J2 flange.

(5) Mount the J2 flange.
Be sure to keep the O ring.



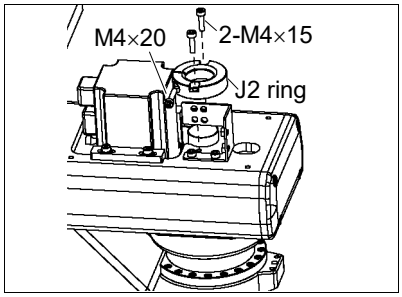
(6) Insert the cables to the Arm.

(7) Mount the Arm #2.



(8) Mount J2 ring.

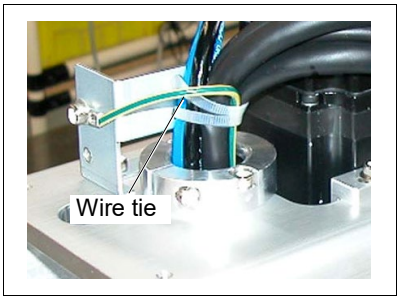
(9) Insert the air tube to Arm #2 upper side.
Put the cables from above.



(10) Connect the air tube to the user plate and mount the user plate.
For details, refer to *3.5 User Plate*.

(11) Secure the cables with wire tie and connect the ground wire.

(12) Along both sides of the motor, insert the cables and tube in the Arm #1.



(13) Connect the connector.

(14) Mount the Arm #1 under cover and J2 cover.

For details, refer to *3.1 Arm #1*.

(15) Secure the Joint #2 motor and mount the cover.

Follow the steps in *6.1 Replacing Joint #2 Motor - Installation (4) - (8)*.

6.3 Replacing J2 Belt

J2 belt Removal

(1) Remove the Joint #2 motor unit.

Follow the steps in *6.1 Replacing Joint #2 Motor- Removal (1) - (5)*.

(2) Pull out the cables.

Follow the steps in *6.2 Replacing Joint #2 Reduction Gear Unit - Removal* (2) - (10).

(3) Push the metal pipe for the cable.

(4) Remove the J2 belt.

J2 belt Installation

(1) Mount the J2 belt.

(2) Pull out the pipe for cables to the upper part of the arm.

Follow the steps in *6.2 Replacing Joint #2 Reduction Gear Unit - Installation (8) - (10)*.

(3) Install the Joint #2 motor unit.

Follow the steps in *6.1 Replacing Joint #2 Motor - Installation (3) - (6)*.

(4) Follow the steps in *6.2 Replacing Joint #2 Reduction Gear Unit - Installation (11) - (13)*.

(5) Follow the steps in *6.1 Replacing Joint #2 Motor - Installation (7) - (9)*.

7. Joint #3

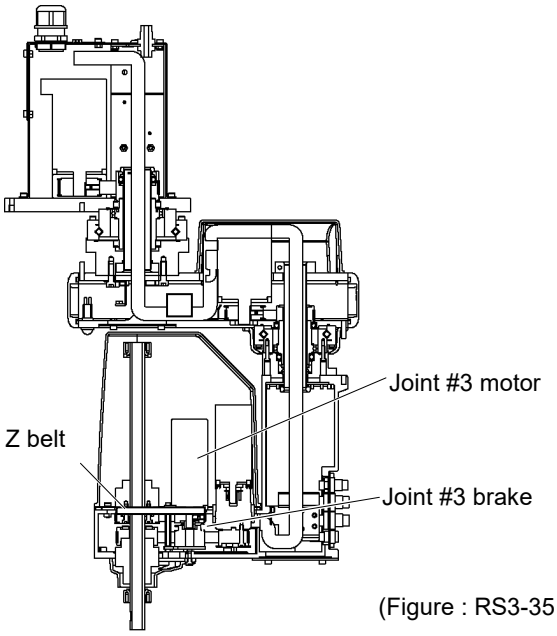
WARNING	■ Do not connect or disconnect the motor connectors while the power to the robot system is turned ON. Connecting or disconnecting the motor connectors with the power ON is extremely hazardous and may result in serious bodily injury as the Manipulator may move abnormally, and also may result in electric shock and/or malfunction of the robot system. ■ To shut off power to the robot system, disconnect the power plug from the power source. Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source. ■ Before performing any replacement procedure, turn OFF the Controller and related equipment, and then disconnect the power plug from the power source. Performing any replacement procedure with the power ON is extremely hazardous and may result in electric shock and/or malfunction of the robot system.

CAUTION	■ Be careful not to apply excessive shock to the motor shaft when replacing the motors. The shock may shorten the life cycle of the motors and encoder and/or damage them. ■ Never disassemble the motor and encoder. A disassembled motor and encoder will cause a positional gap and cannot be used again.

After parts have been replaced (motors, reduction gear units, brakes, timing belts, ball screw spline unit, etc.), the Manipulator cannot operate properly because a mismatch exists between the origin stored in each motor and its corresponding origin stored in the Controller. After replacing the parts, it is necessary to match these origins.

The process of aligning the two origins is called “Calibration”.

Refer to *13. Calibration* to perform the calibration.



(Figure : RS3-351S)

7.1 Replacing Joint #3 Motor

	Name		Quantity	Note
Maintenance parts	AC Servo Motor	150W	1	1514453
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M5 set screw
		width across flats: 3 mm	1	For M4 screw
		width across flats: 4 mm	1	For M5 screw
	Torque wrench	M5	1	
	Nippers		1	For cutting wire tie
	Force gauge		1	Belt tension 75 N (7.7 kgf)
	Suitable cord (Length about 800 mm)		1	For belt tension
Material	Wire tie		4	

A brake is mounted on Joints #3 to prevent the shaft from moving down due to the weight of the end effector while the power to the Controller is OFF or while the motor is in OFF status (MOTOR OFF).

Note that the brake will not work during the replacement procedure.
Move the shaft down to its lower limit before starting the replacement procedure by following the removal steps from (1) to (4).

NOTE

When tightening hexagon socket head cap bolts, refer to the *2.4 Tightening Hexagon Socket Head Cap Bolts.*

Joint #3 motor Removal

(1) Turn ON the Controller.

(2) Push down the shaft to its lower limit while pressing the brake release switch. Be sure to keep enough space and prevent the end effector hitting any peripheral equipment.

Be careful of the shaft falling while the brake release switch is being pressed because the shaft may be lowered by the weight of an end effector.

(3) Turn the Arm #2 to the 180 degree position.

(4) Turn OFF the Controller.

(5) Remove the Arm #1 side cover of the Joint #2 side.

For details, refer to *3.1 Arm #1 Covers*.

(6) Remove the Arm #2 cover.

For details, refer to *3.2 Arm #2 Covers*.

(7) Cut off the wire tie bundling the motor cables to the Joint #3 motor.

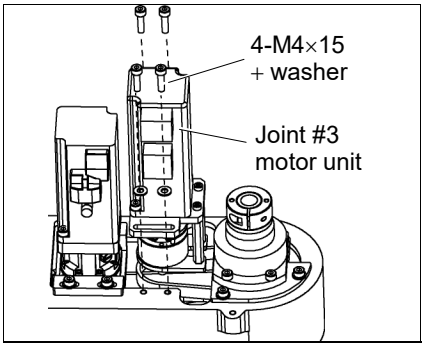
Remember the cable layout so that the cables can be reconnected correctly after replacement.

(8) Disconnect the following connectors.
Connectors X331, X31, X32 (Hold the clip to remove.)
Connector XB33

(9) Loosen the Z belt.

Loosen four bolts on the Joint #3 motor unit.

Slide the Joint #3 motor unit to the end of the arm.

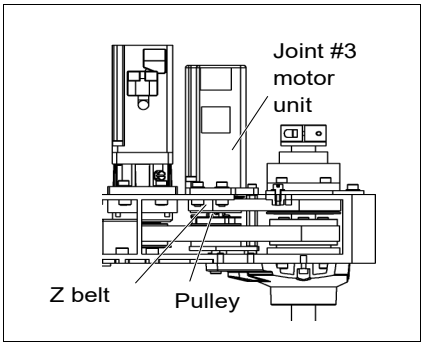


(10) Remove the Joint #3 motor unit from Arm #2.

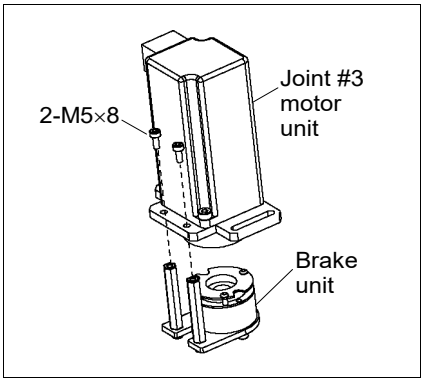
Unscrew the bolts securing the Joint #3 motor unit.

Remove the Z pulley from the Z belt.

Pull the Joint #3 motor unit upward to remove.



(11) Remove the brake unit from the Joint #3 motor unit.

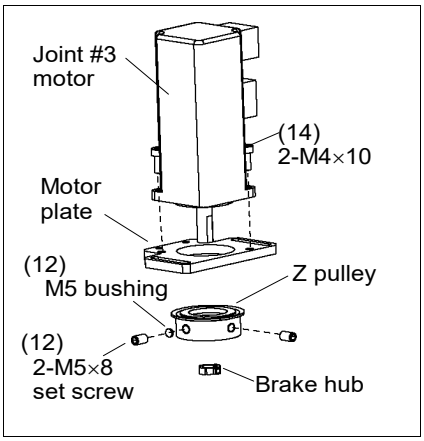


(12) Unscrew the screws securing the pulley to the Joint #3 motor. Press the pulley toward the plate.

Remove the brake hub.

Remove the pulley and motor plate.

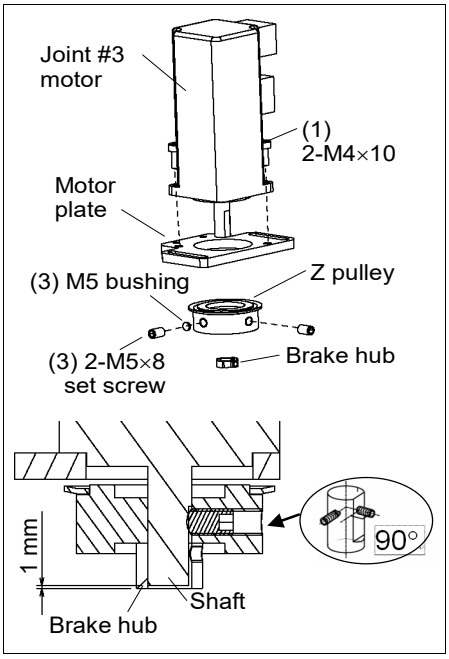
There is a brass bushing in one of the set screw holes. Be careful not to lose it.



Joint #3 motor Installation

(1) Mount the motor plate to the Joint #3 motor. (Be careful of the mounting direction.)

Screw: 2-M4×10
Tightening torque: 3.5 N·m (35.7 kgf·cm)



(2) Insert the pulley and brake hub into the motor shaft. Then, tighten both at a distance of 1 mm from the shaft.

(3) Secure the pulley to the position touching the hub.

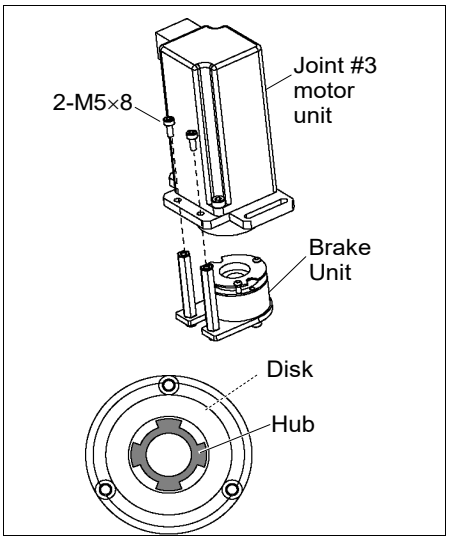
Put the one of the set screws and the flatly chamfered surface of motor shaft to touch vertically.

Insert the bushing into the other screw.
Secure the bushing to prevent damage from the motor shaft.

(4) Install the brake to the Joint #3 motor.

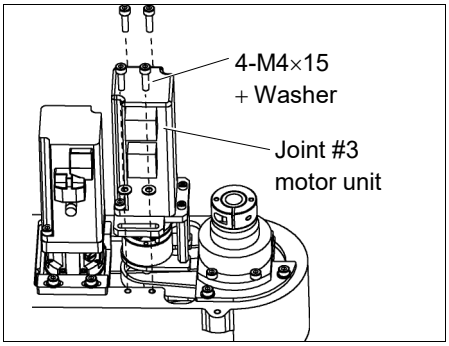
Align the position of the disk on the brake and the hub.

When the brake disk is not aligned, connect the connector X32. Press the brake release switch and release the brake to manually adjust the position.

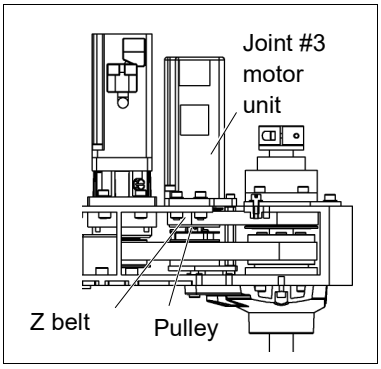


(5) Put the Joint # 3 motor unit in the arm.

Motor cable must face to the right side of the arm.



(6) Place the Z belt around the Z pulley so that the gear grooves of the belt are fit into those of the pulley completely.



(7) Loosely secure the Joint #3 motor unit to Arm #2.

NOTE Loosely secure the Joint #3 motor unit to Arm #2 so that the motor unit can be moved by hand, and it will not tilt when pulled. If the unit is secured too loose or too tight, the belt will not have the proper tension.

(8) Apply the proper tension to the Z belt, and then secure the Joint #3 motor unit.

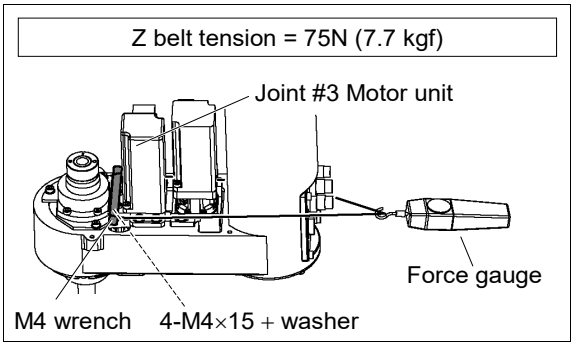
Hexagonal wrench (Stubby type) makes it easier to tighten / remove screws.

Put the M4 wrench to the Joint #3 motor unit, near its mounting plate.

And pass a suitable cord or string around the motor unit.

Then, pull the cord using a force gauge or similar tool to apply the specified tension shown in the figure.

Make sure that the brake cables do not touch the pulley.



(9) Connect the following connectors.

Connectors X331, X31, X32, XB33

(10) Re-bundle the cables in their original positions with a wire tie removed in step (7).

Do not allow unnecessary strain on the cables.

(11) Install the Arm #2 cover.

For details, refer to *3.2 Arm #2*.

(12) Install the Arm #1 side cove.

For details, refer to *3.1 Arm #1.*

(13) Perform the calibration of Joint #3.

For details on the calibration method, refer to *13. Calibration*.

7.2 Replacing the Timing Belt

	Name	Quantity	Note
Maintenance parts	Z belt (width 9 mm)	1	1510526
Tools	Hexagonal wrench (width across flats: 3 mm)	1	For M4 screw
	Nippers	1	For cutting wire tie
	Force gauge	1	Belt tension 75 N (7.7 kgf)
	Suitable cord (Length about 800 mm)	1	For belt tension
Material	Wire tie	2	

A brake is mounted on the motor of Joint #3 to prevent the shaft from moving down due to the weight of the end effector while the power to the Controller is OFF or while the motor is in OFF status (MOTOR OFF).

Note that the brake will not work during the replacement procedure.
Move the shaft down to its lower limit before the replacement procedure following the removal steps.

NOTE

When tightening hexagon socket head cap bolts, refer to the *2.4 Tightening Hexagon Socket Head Cap Bolts.*

Z belt Removal

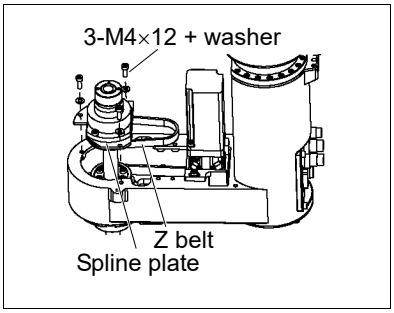
(1) Remove the Joint #3 motor.

Follow the steps in *7.1 Replacing Joint #3 Motor - Removal (1) - (10)*.

(2) Remove the Z belt.

Remove the volts securing the spline plate.

Hold up the spline plate and pull out the Z belt upward.



Z belt Installation

(1) Pass a new Z belt through the shaft from above, and then place it under the spline plate.

(2) Loosely secure the spline plate to Arm #2.

After moving the shaft up and down several times, secure the spline plate to Arm #2.

(3) Set the Joint #3 motor unit in the arm so that motor cable faces toward the right side of arm.

Secure the Joint #3 motor unit and mount the cover.

Follow the steps in *7.1 Replacing Joint #3 Motor - Installation (5) - (13)*.

7.3 Replacing the Brake

	Name		Quantity	Note
Maintenance parts	Electromagnetic brake		1	1497639
Tools	Hexagonal wrench	width across flats: 1.5 mm	1	For M3 set screw
		width across flats: 2.5 mm	1	For M3 screw
		width across flats: 3 mm	1	For M4 screw
		width across flats: 4 mm	1	For M5 screw
	Nippers		1	For cutting wire tie
	Force gauge		1	Belt tension 75 N (7.7 kgf)
	Suitable cord (Length about 800 mm)		1	For belt tension
Material	Wire tie		3	

A brake is mounted on the motor of Joint #3 to prevent the shaft from moving down due to the weight of the end effector while the power to the Controller is OFF or while the motor is in OFF status (MOTOR OFF).

Note that the brake will not work during the replacement procedure.
Move the shaft down to its lower limit before the replacement procedure following the removal steps.

NOTE

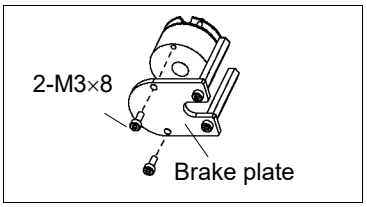
When tightening hexagon socket head cap bolts, refer to the *2.4 Tightening Hexagon Socket Head Cap Bolts.*

Electromagnetic Brake Removal

(1) Remove the Joint #3 motor.

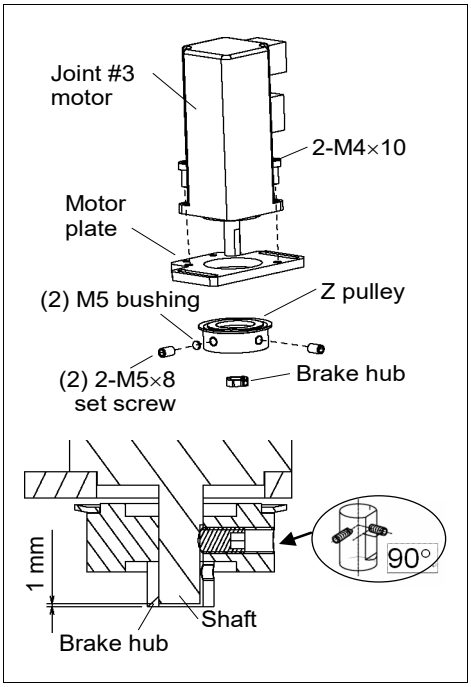
Follow the steps in *7.1 Replacing Joint #3 Motor - Removal (1) - (13)*.

(2) Remove the brake from the brake plate.



Electromagnetic Brake Installation

(1) Mount the brake hub to the motor shaft.
Secure the hub to the distance of 1 mm from the shaft.

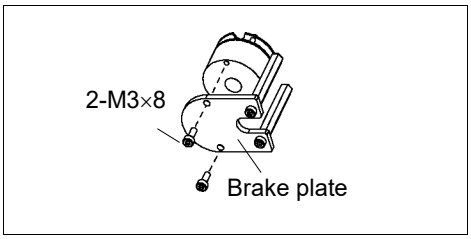


(2) Secure the pulley so that it touches the hub.

Put one of the set screws and the flatly chamfered surface of the motor shaft to touch vertically.

Insert the bushing into the other screw to prevent the damage from the motor shaft.

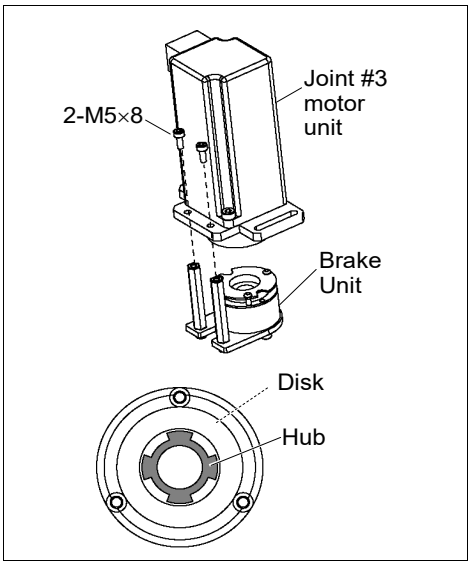
(3) Install the electromagnetic brake to the brake plate.



(4) Install the brake to the Joint #3 motor.

Align the position of the disk on the brake and the hub.

When the brake disk is not aligned, connect the connector X32. Press the brake release switch and release the brake to manually adjust the position.



(5) Secure the Joint #3 motor unit and mount the cover.

Follow the steps in *7.1 Replacing Joint #3 Motor - Installation (5) - (13)*.

8. Joint #4

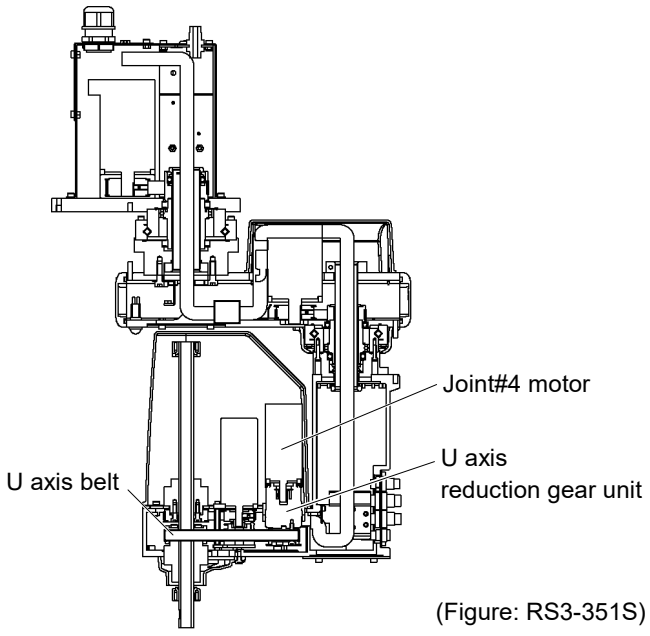
WARNING	■ Do not connect or disconnect the motor connectors while the power to the robot system is turned ON. Connecting or disconnecting the motor connectors with the power ON is extremely hazardous and may result in serious bodily injury as the Manipulator may move abnormally, and also may result in electric shock and/or malfunction of the robot system. ■ To shut off power to the robot system, disconnect the power plug from the power source. Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source. ■ Before performing any replacement procedure, turn OFF the Controller and related equipment, and then disconnect the power plug from the power source. Performing any replacement procedure with the power ON is extremely hazardous and may result in electric shock and/or malfunction of the robot system.

CAUTION	■ Be careful not to apply excessive shock to the motor shaft when replacing the motors. The shock may shorten the life cycle of the motors and encoder and/or damage them. ■ Never disassemble the motor and encoder. A disassembled motor and encoder will cause a positional gap and cannot be used again.

After parts have been replaced (motors, reduction gear units, brakes, timing belts, ball screw spline unit, etc.), the Manipulator cannot operate properly because a mismatch exists between the origin stored in each motor and its corresponding origin stored in the Controller. After replacing the parts, it is necessary to match these origins.

The process of aligning the two origins is called “Calibration”.

Refer to *13. Calibration* to perform the calibration.



(Figure: RS3-351S)

8.1 Replacing Joint #4 Motor

	Name		Quantity	Note
Maintenance parts	AC Servo Motor (100W)		1	1514469
Tools	Hexagonal wrench	width across flats: 2 mm	1	For M4 set screw
		width across flats: 3 mm	1	For M4 screw
	Nippers		1	For cutting wire tie
	Force gauge		1	Belt tension 120 N (12.2kgf)
	Suitable cord (Length about 800 mm)		1	For belt tension

A brake is mounted on the motor of Joint #3 to prevent the shaft from moving down due to the weight of the end effector while the power to the Controller is OFF or while the motor is in OFF status (MOTOR OFF).

Note that the brake will not work during the replacement procedure.

Move the shaft down to its lower limit before starting the replacement procedure by following the removal steps (1) - (4).

NOTE

When tightening hexagon socket head cap bolts, refer to the *2.4 Tightening Hexagon Socket Head Cap Bolts.*

Joint #4 Motor Removal

(1) Turn ON the Controller.

(2) Push down the shaft to its lower limit while pressing the brake release switch. Be sure to keep enough space and prevent the end effector hitting any peripheral equipment.

Be careful of the shaft falling while the brake release switch is being pressed because the shaft may be lowered by the weight of an end effector.

(3) Move Arm #2 to the position of 180 degree.

(4) Turn OFF the Controller.

(5) Remove the Arm #1 side cover in the Joint #2 side.

For details, refer to *3.1 Arm #1*.

(6) Remove the Arm #2 cover.

For details, refer to *3.2 Arm #2*.

(7) Cut off the wire tie used for binding the motor cables to the Joint #4 motor.

Remember the cable location to connect them to the original position.

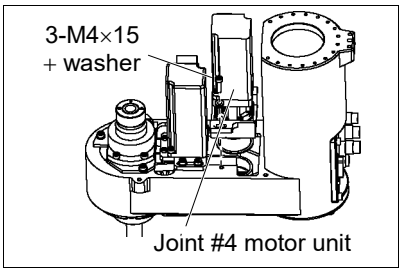
(8) Remove the following connectors:

Connector X341, X41 (Hold the clip to remove.)
Connector XB34

(9) Remove the U belt.

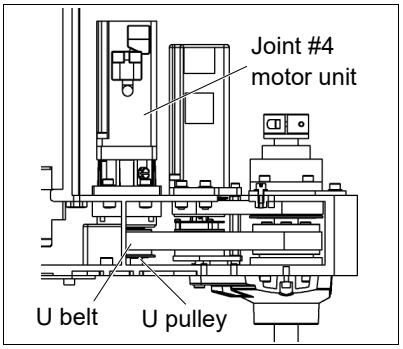
Remove four bolts securing the Joint #4 motor unit.

Slide the motor unit toward the end of arm.



(10) First, remove the bolts securing the Joint #4 motor unit.

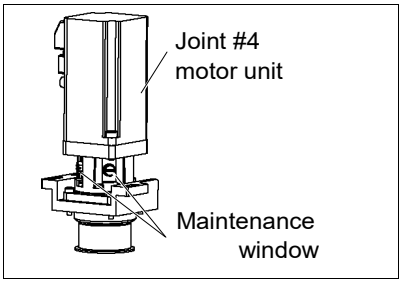
Next, remove the U pulley from the U belt and pull out the motor unit to remove.



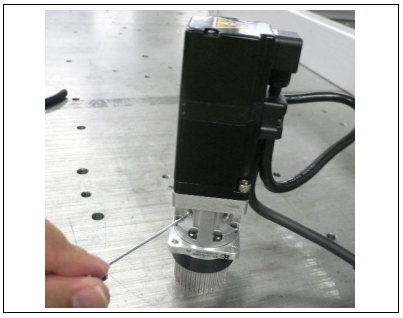
(11) Open the maintenance windows of the Joint #4 reduction gear unit.

Remove the set screw.

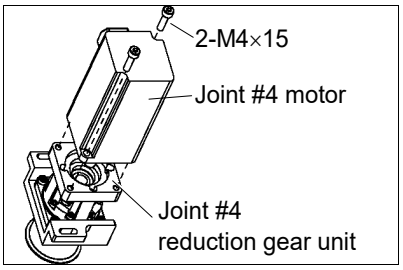
Rotate the pulley until the screws fit into the holes.



Remove two set screws.



(12) Remove the Joint #4 motor.



If the motor cannot be removed easily, put a washer between the motor and reduction gear and use the motor mounting screws to press the motor equally from the reduction gear side to remove the motor.

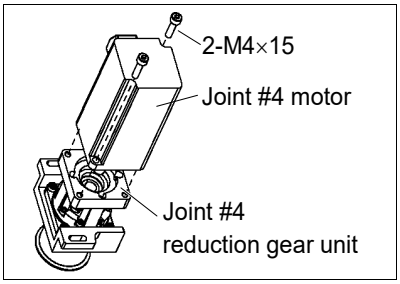
(Use two diagonal holes from the motor mounting holes. See the photo.)

Joint #4 Motor Installation

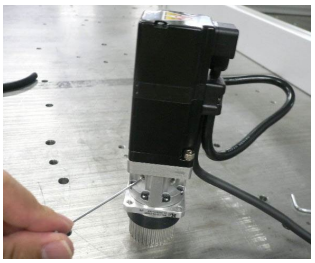
(1) Mount the Joint #4 motor to the Joint #4 reduction gear unit.

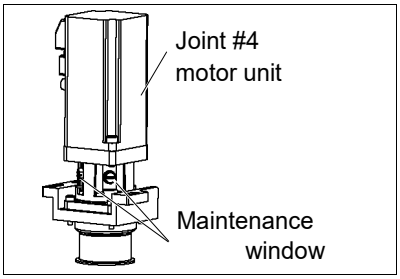
Align the flat face of the shaft with the hole of the maintenance window.

Screw: 2-M4 × 15
Tightening torque: 3.5 N·m (35.7 kgf·cm)



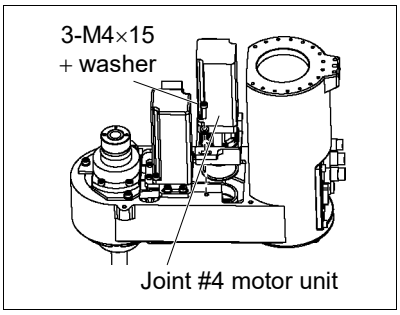
(2) Align the maintenance holes and screws position by turning the pulley and secure with the set screws.



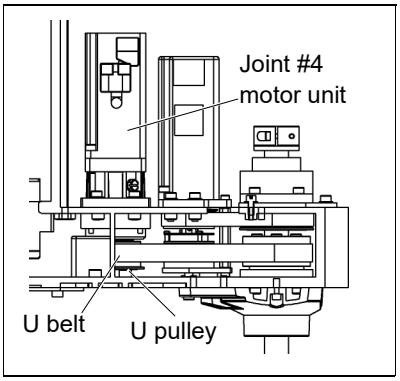


Close the maintenance windows.

(3) Place the Joint #4 motor unit in the arm so that the motor cable faces toward the right side of arm.



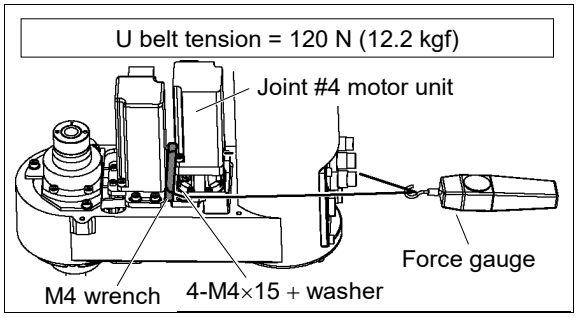
(4) Place the U belt around the U pulley so that the gear grooves of the belt are fit into those of the pulley completely.



(5) Loosely secure the Joint #4 motor unit to Arm #2.

NOTE
Loosely secure the Joint #4 motor unit to Arm #2 so that the motor unit can be moved by hand, and it will not tilt when pulled. If the unit is secured too loose or too tight, the belt will not have the proper tension.

(6) Apply the proper tension to the U belt, and then secure the Joint #4 motor unit.
Hexagonal wrench (Stubby type) makes it easier to tighten / remove the screws.
Put M4 wrench to the Joint #4 motor unit near it mounting plate.
And pass a suitable cord or string around the motor unit.
Then, pull the cord using a force gauge or similar tool to apply the specified tension shown in the figure.



(7) Connect the connectors X341, X41, XB34

(8) Re-bundle the cables in their original positions with a wire tie removed in step (7).

Do not allow unnecessary strain on the cables.

(9) Install the Arm #2 cover.

For details, refer to *3.2 Arm #2*.

(10) Install the Arm #1 side cover.

For details, refer to *3.1 Arm #1*.

Perform the calibration of Joint #4.

For details on the calibration method, refer to *13. Calibration*.

8.2 Replacing the Timing Belt

	Name	Quantity	Note
Maintenance parts	U belt (width 12 mm)	1	1510527
Tools	Hexagonal wrench (width across flats: 3 mm)	1	For M4 screw
	Force gauge	1	Belt tension : 75 N (7.6 kgf), 120 N (12.2 kgf)
	Nippers	1	For cutting wire tie
	Suitable cord (Length about 800 mm)	1	For belt tension
Material	Wire tie	2	

A brake is mounted on the motor of Joint #3 to prevent the shaft from moving down due to the weight of the end effector while the power to the Controller is OFF or while the motor is in OFF status (MOTOR OFF).

Note that the brake will not work during the replacement procedure.

Move the shaft down to its lower limit before starting the replacement procedure by following the removal steps (1) - (4).

NOTE

When tightening hexagon socket head cap bolts, refer to the *2.4 Tightening Hexagon Socket Head Cap Bolts*.

U belt Removal

(1) Turn ON the Controller.

(2) Push down the shaft to its lower limit while pressing the brake release switch. Be sure to keep enough space and prevent the end effector hitting any peripheral equipment.

Be careful of the shaft falling while the brake release switch is being pressed because the shaft may be lowered by the weight of an end effector.

(3) Move Arm #2 to the position of 180 degree.

(4) Turn OFF the Controller.

(5) Remove the Arm #1 side cover.

For details, refer to *3.1 Arm #1*.

(6) Remove the Arm #2 cover.

For details, refer to *3.2 Arm #2*.

(7) Cut off the wire tie used for binding the motor cables to the Joint #3, #4 motor.

Remember the cable location to connect them to the original position.

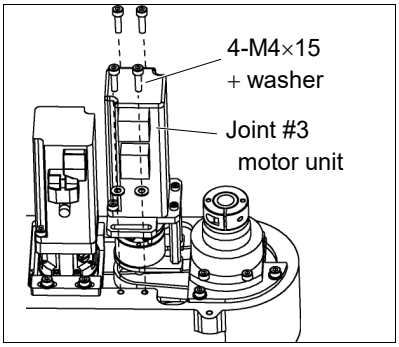
(8) Remove the following connectors:

Connector X331, X31, X32, X341, X41 (Hold the clip to remove.)
Connector XB33, XB34

(9) Loosen the Z belt.

Loosen four blots securing the Joint #3 motor unit.

Slide the motor unit toward the end of arm.

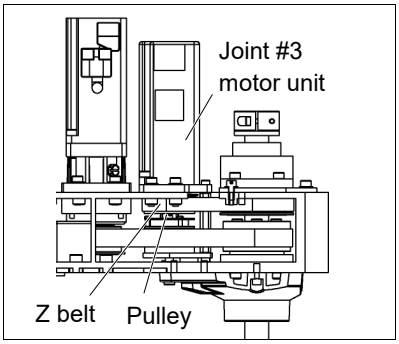


(10) Remove the Joint #3 motor unit from Arm #2.

Remove the bolts securing the Joint #3 motor unit.

Remove the Z1 pulley from the Z belt.

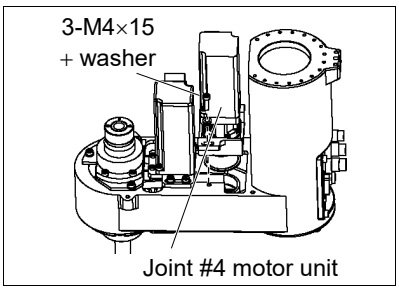
Pull out the motor unit to remove.



(11) Loosen the U belt.

Loosen the four bolts securing the Joint #4 motor unit.

Slide the Joint #4 motor unit toward the end of arm.

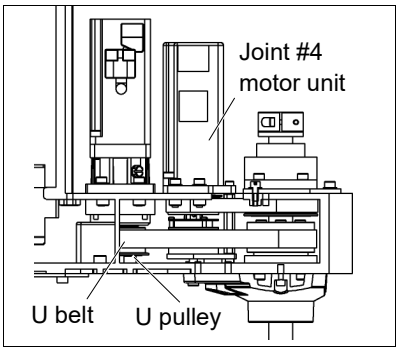


(12) Remove the Joint #4 motor unit from Arm #2.

First, remove the bolts securing the Joint #4 motor unit.

Next, remove the U pulley from the U belt.

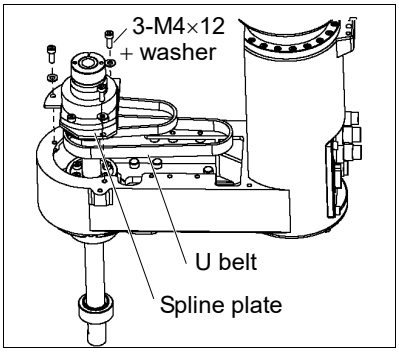
Pull out the Joint #4 motor unit to remove.



(13) Remove the belt.

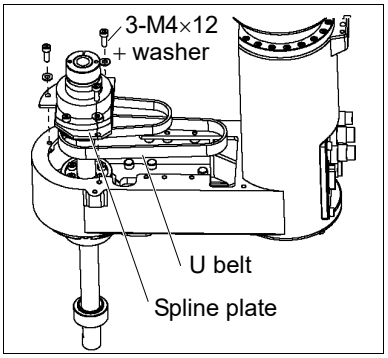
Remove the bolts securing the spline plate.

Hold up the spline plate and pull the U belt upward from the shaft.



U belt Installation

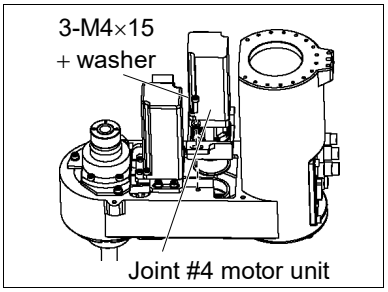
(1) Pass the U belt through the shaft and under the spline plate.



(2) Loosely secure the Spline plate to Arm #2.

Move the shaft up/down several times and secure it.

(3) Set the Joint #4 motor unit to Arm #2 so that the motor cables face to the right side of arm.



(4) Place the U belt around the U pulley so that the gear grooves of the belt are fit into those of the pulley completely.

(5) Loosely secure the Joint #4 motor unit to Arm #2.

NOTE

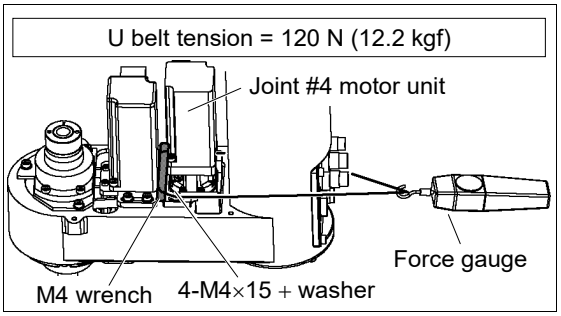
Check that the motor unit can be moved by hand, and it will not tilt when pulled. If the units are secured too loose or too tight, the belt will not have the proper tension.

(6) Apply the proper tension to the U belt, and then secure the Joint #4 motor unit.

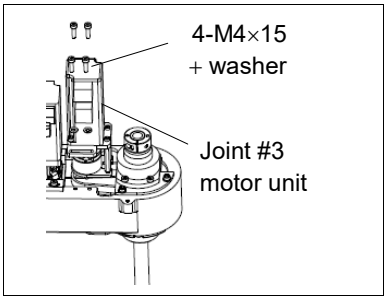
Hexagonal wrench (Stubby type) makes it easier to tighten / remove the screws.

To do so, pass a suitable cord or string around the Joint #4 intermediate shaft unit near its mounting plate.

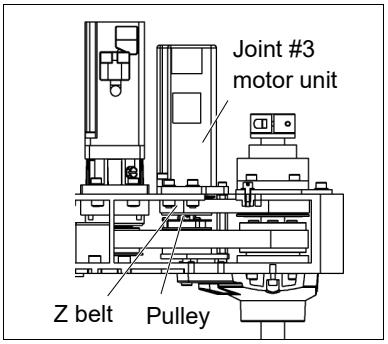
Then, pull the cord using a force gauge or similar tool to apply the specified tension shown in the figure.



(7) Set the Joint #3 motor unit to Arm #2 so that the motor cables face to the right side of arm.



(8) Place the Z belt around the Z pulley so that the gear grooves of the belt are fit into those of the pulley completely.



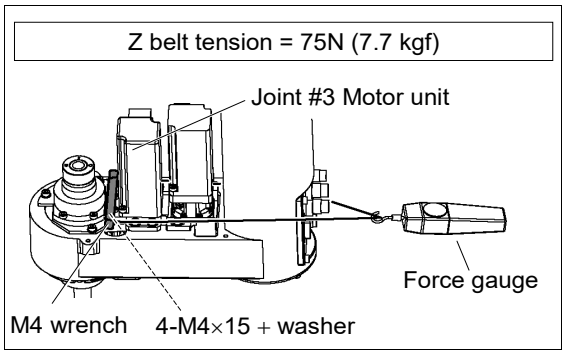
(9) Loosely secure the Joint #3 motor unit to Arm #2.

NOTE Check that the motor unit can be moved by hand, and it will not tilt when pulled. If the units are secured too loose or too tight, the belt will not have the proper tension.

(10) Apply the proper tension to the Z belt, and then secure the Joint #3 motor unit.

To do so, pass a suitable cord or string around the Joint #4 intermediate shaft unit near its mounting plate. Then, pull the cord using a force gauge or similar tool to apply the specified tension shown in the figure on the right.

Make sure the brake cable not to touch the pulley.



(11) Connect the connectors.
Connector X331, X31, X32, X341, X41, XB33, XB34

(12) Re-bundle the cables in their original positions with a wire tie removed in step (7).

Do not allow unnecessary strain on the cables.

(13) Install the Arm #2 cover.

For details, refer to *3.2 Arm #2*.

(14) Install the Arm #1 side cover.

For details, refer to *3.1 Arm #1*.

(15) Perform the calibration of Joint #4.

For details on the calibration method, refer to *13. Calibration*.

8.3 Replacing the Reduction Gear Unit

	Name		Quantity	Note
Maintenance parts	Reduction Gear Unit		1	1510322
Tools	Hexagonal wrench	width across flats: 1.3 mm	1	For M2.5 set screw
		width across flats: 2 mm	1	For M2.5 screw
	Nippers		1	For cutting wire tie
Material	Wire tie		1	

NOTE

When tightening hexagon socket head cap bolts, refer to the *2.4 Tightening Hexagon Socket Head Cap Bolts.*

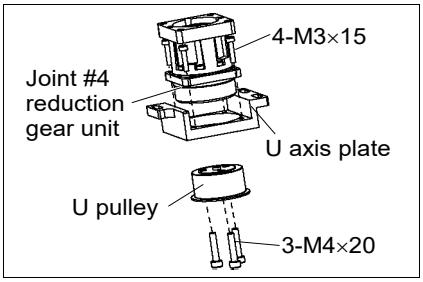
Joint #4 reduction gear unit Removal

(1) Remove the Joint #4 motor unit from Arm #2 and remove the motor.

Follow the steps in *8.1 Replacing Joint #4 Motor – Removal (1)-(12)*.

(2) Remove the reduction gear unit.

Remove the U pulley, and remove the Joint #4 reduction gear unit from U axis plate.



Joint #4 reduction gear unit Installation

(1) Mount the reduction gear unit.

At this point, the maintenance window hole should come to the front of the Arm (the side with no cutout to U axis plate).

(2) Mount the reduction gear unit to the Joint #4 motor and secure to Arm #2.

Follow the steps in 8.1 Replacing Joint #4 Motor – Installation *(1)-(12)*.

9. Bellows

NOTE

The bellows are provided in a unit of one piece.
A large amount of dust is emitted when replacing the bellows.
Take the Manipulator to an outer room such as the room in front of the clean room's entrance, or take the necessary countermeasures to prevent dust emission before removing the bellows.

	Name	Quantity	Note
Maintenance parts	Bellows (100 mm)	1	1510547
Tools	Cross-point screwdriver	1	For clamp band removal
Material	Liquid gasket	1	

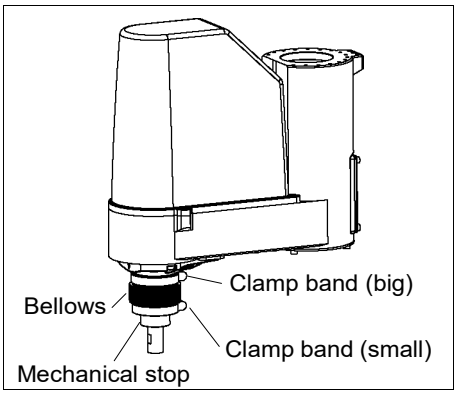
Bellows Removal

(1) Remove the end effector.

(2) Remove the wires and tubes from the end effector.

(3) Turn ON the controller. Stop motor excitation. (MOTOR OFF)

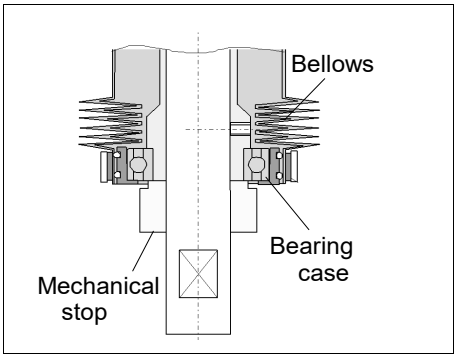
(4) Remove the mechanical stop.



(5) Loosen the cramp band securing above and below the bellows.

(6) Push up the bellows,
and remove the bearing case and the baring from the shaft.

(7) Pull the bellows, rubber sheet and clamp band from the shaft.



Bellows Installation

(1) To attach the bellows, move the shaft to its upper limit.

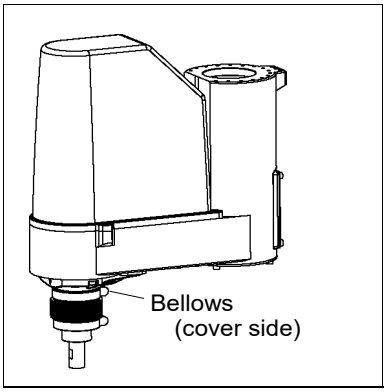
To move the shaft up/down, press and hold the brake release switch.
Be sure to keep enough space and prevent the end effector hitting any peripheral equipment.

Be careful of the shaft falling while the brake release switch is being pressed because the shaft may be lowered by the weight of an end effector.

(2) Pass the shaft through the bellows from the larger joint.

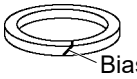
(3) Secure the cover side of the bellows.

The bellows has two joints:
The larger joint must be attached to the cover side.
The smaller joint must be attached to the end face side of the shaft.
Be careful not to misplace the clamp bands. The clamp band has two sizes; small and large.

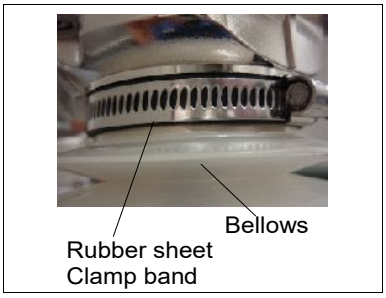


Attach the mounting part of the bellows until the end touches the cylindrical part of the cover.

Attach the rubber sheet. Be sure to attach the rubber sheet so that no space is made between the bias cut.



Then, secure them with clamp bands.

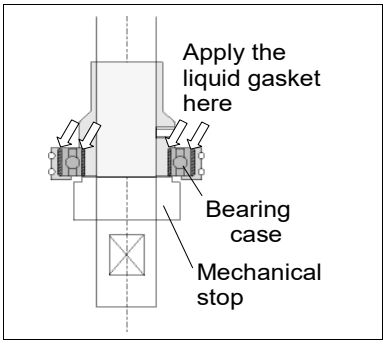


(4) Apply the liquid gasket uniformly.

- Mating point of the bearing inner race
- Inside of the bearing base

(5) Mount the bearing and the bearing case.

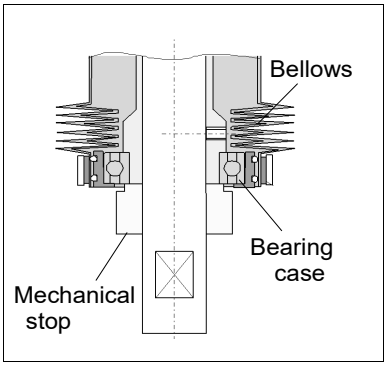
(6) Mount the mechanical stop.



(7) Secure the end face side of the bellows to the shaft.

Cover the bearing case (black) on the end face of the shaft with the bellows mounting part.

Attach the rubber sheet. Be sure to attach the rubber sheet so that no space is made between the bias cut.



Then, secure them with clamp bands.

(8) After completing the attachment of the bellows, move the shaft up/down by hand several times and rotate Joint #4. Make sure that the bellows can expand and contract smoothly without any excessive force.

(9) Turn OFF the Controller and peripheral equipment.

(10) Attach the end effector.

(11) Connect the wires and tubes to the end effector.

10. Ball Screw Spline Unit Replacement

WARNING	■ Do not connect or disconnect the motor connectors while the power to the robot system is turned ON. Connecting or disconnecting the motor connectors with the power ON is extremely hazardous and may result in serious bodily injury as the Manipulator may move abnormally, and also may result in electric shock and/or malfunction of the robot system. ■ To shut off power to the robot system, disconnect the power plug from the power source. Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source. ■ Before performing any replacement procedure, turn OFF the Controller and related equipment, and then disconnect the power plug from the power source. Performing any replacement procedure with the power ON is extremely hazardous and may result in electric shock and/or malfunction of the robot system.

NOTE

After parts have been replaced (motors, reduction gear units, brakes, timing belts, ball screw spline unit, etc.), the Manipulator cannot operate properly because a mismatch exists between the origin stored in each motor and its corresponding origin stored in the Controller. After replacing the parts, it is necessary to match these origins.

The process of aligning the two origins is called “Calibration”.

Refer to *13. Calibration* to perform the calibration.

	Name	Quantity	Note
Maintenance parts	Ball Screw Spline Unit	1	Standard-model: 1514472 Cleanroom-model: 1514473
Grease	For Ball Screw Spline Unit (AFB grease)	Proper quantity	
Tools	Hexagonal wrench (width across flats: 3 mm)	1	For M4 screw
	Nippers	1	For cutting wire tie
	Force gauge	1	Belt tension 75N (7.6 kgf) / 120 N (12.2 kgf)
	Suitable cord (Length about 1000 mm)	1	For belt tension
	Wiping cloth	1	For wiping grease (Spline shaft)
Material	Wire tie	2	

A brake is mounted on Joints #3 to prevent the shaft from moving down due to the weight of the end effector while the power to the Controller is OFF or while the motor is in OFF status (MOTOR OFF).
Note that the brake will not work during the replacement procedure. Move the shaft down to its lower limit before starting the replacement procedure by following the removal steps from (1) to (3).

NOTE

When tightening hexagon socket head cap bolts, refer to the *2.4 Tightening Hexagon Socket Head Cap Bolts.*

Ball screw spline unit Removal

(1) Turn ON the Controller.

(2) Push down the shaft to its lower limit while pressing the brake release switch. Be sure to keep enough space and prevent the end effector hitting any peripheral equipment.

Be careful of the shaft falling while the brake release switch is being pressed because the shaft may be lowered by the weight of an end effector.

(3) Move Arm #2 to the position of 180 degree.

(4) Turn OFF the Controller.

(5) Detach the wires/tubes from the end effector, and remove the end effector.

(6) This step is only for Cleanroom-model.

Remove the bellows. For details, refer to *9. Bellows*.

(7) Remove the Arm #1 side cover and Arm #2 cover.

For details, refer to *3. Covers*.

(8) Cut off the wire tie banding motor cables to the motors of Joints #3, #4.

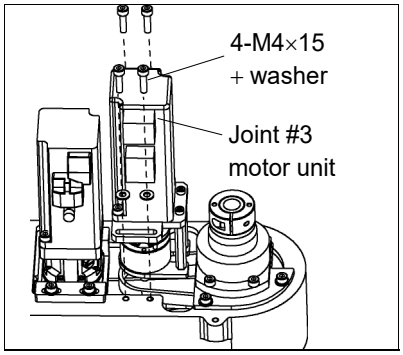
Be sure to remember the cable layout to connect the cables to the original position.

(9) Disconnect the following connectors.
Connectors X331, X31, X32, X341, X41 (Hold the clip to remove.)
Connector XB33, XB34

(10) Loosen the Z belt.

Loosen four bolts securing the Joint #3 motor.

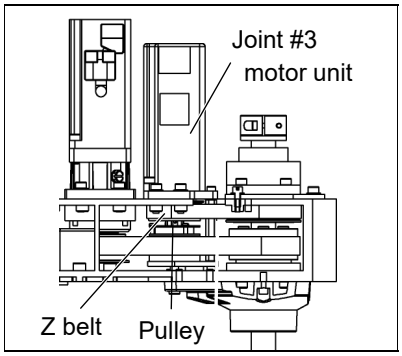
Slide the Joint #3 motor unit toward the arm end.



(11) Remove the Joint #3 motor unit from Arm #2.

Remove the bolts securing the Joint #3 motor.

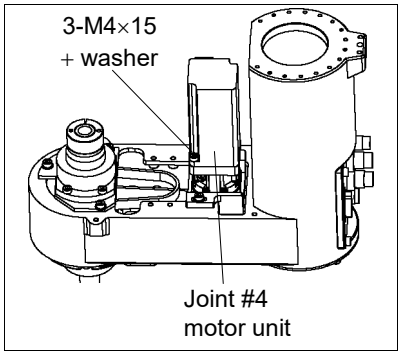
Remove the pulley from the Z belt and pull out the Joint #3 motor unit.



(12) Loosen the U belt.

Loosen four bolts securing the Joint #4 motor.

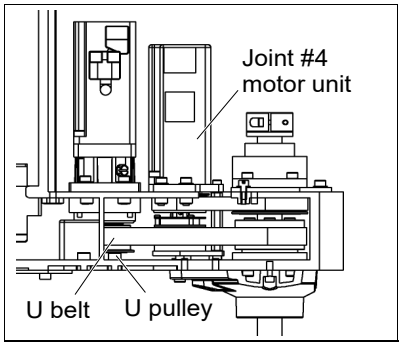
Slide the Joint #4 motor unit toward the arm end.



(13) Remove the Joint #4 motor unit from Arm #2.

First, remove the bolts securing the Joint #4 motor.

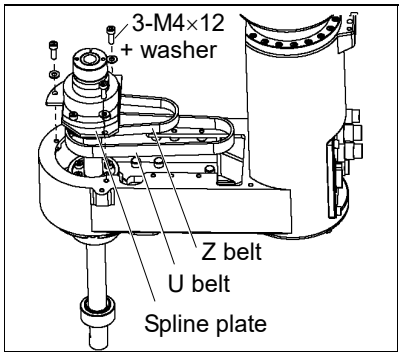
Next, remove the U pulley from the U belt and pull out the Joint #4 motor unit.



(14) Remove the U belt and Z belt.

Remove the bolts securing the spline plate.

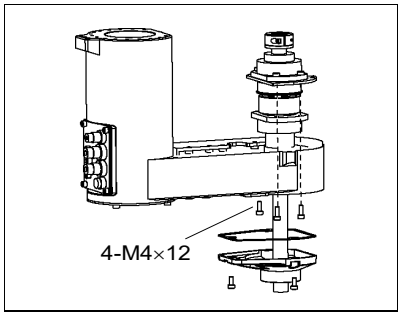
Hold the spline plate upward and pull the U belt and Z belt out of the shaft.



(15) Remove the under cover.

For details, refer to *3.2.Arm #2*.

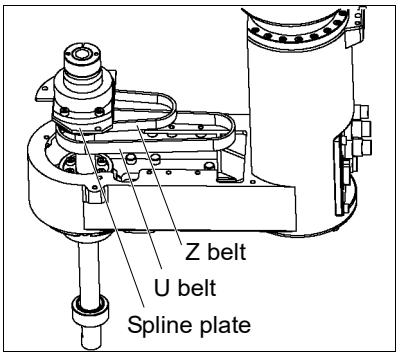
(16) Remove the nut mounting screws of the ball screw spline shaft on the underside of Arm #2.



(17) Pull the ball screw spline unit out of Arm #2.

Ball screw spline unit Installation

(1) Pass the U belt and Z belt through the shaft and mount the ball screw spline unit to Arm #2.

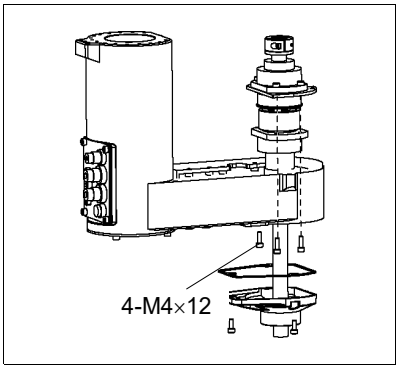


(2) Secure the nut mounting screws of the ball screw spline shaft on lower side of Arm #2.

Be sure to keep the timing belt from being stuck between the nut and Arm #2.

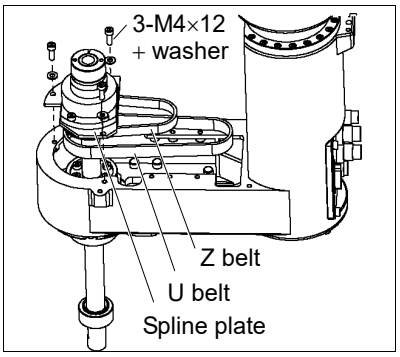
(3) Secure the under cover.

For details, refer to *3.2. Arm #2*.



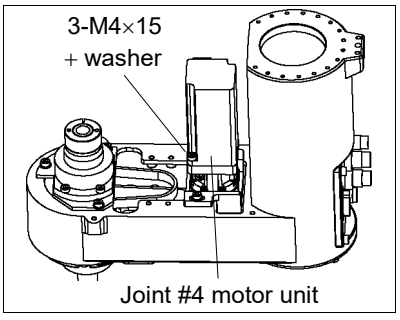
(4) Loosely secure the spline plate to Arm #2.

Secure the spline plate to Arm #2 after moving the shaft up and down several times.



(5) Place the Joint #4 motor unit back to Arm #2.

(6) Set the U belt around the U pulley so that the gear grooves of the belt are fit into those of the pulleys completely.



(7) Loosely secure the Joint #4 motor unit to Arm #2.

NOTE

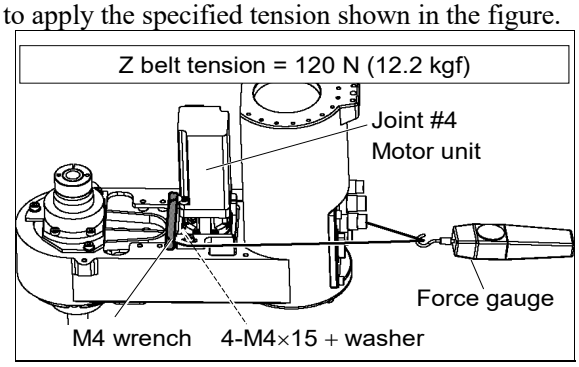
Check that the motor unit can be moved by hand, and it will not tilt when pulled. If the unit is secured too loose or too tight, the belt will not have the proper tension.

(8) Apply the proper tension to the U belt, and then secure the Joint #4 motor unit.

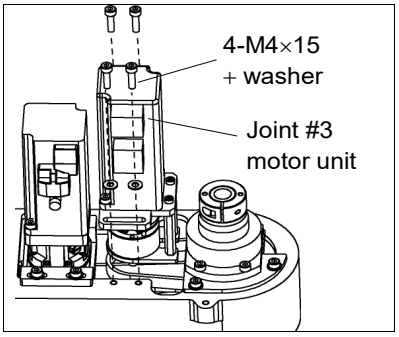
Hexagonal wrench (Stubby type) makes it easier to tighten / remove the screws.

Put M4 wrench to the Joint #4 motor unit near its mounting plate.

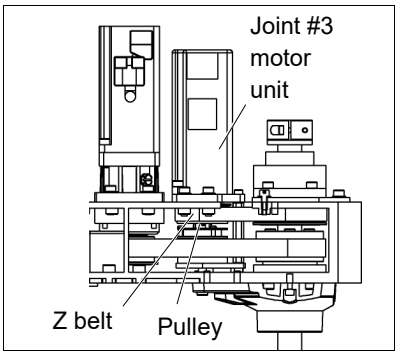
Pass a suitable cord or string around the Joint #4 motor unit. Then, pull the cord using a force gauge or similar tool to apply the specified tension shown in the figure.



(9) Place the Joint #3 motor unit back to Arm #2 so that the motor cable faces toward the right side of arm.



(10) Put the Z belt around the Z pulley so that the gear grooves of the belt are fit into those of the pulleys completely.



(11) Loosely secure the Joint #3 motor unit to Arm #2.

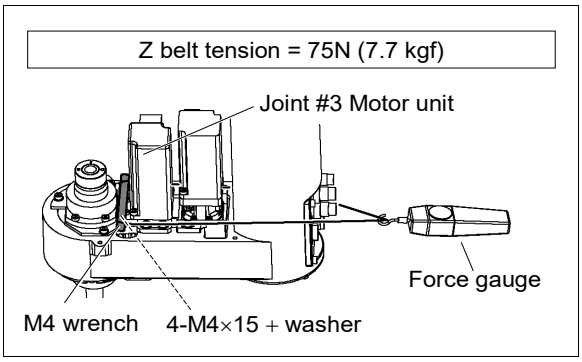
NOTE

Check that the motor unit can be moved by hand, and it will not tilt when pulled. If the unit is secured too loose or too tight, the belt will not have the proper tension.

(12) Apply the proper tension to the U belt, and then secure the Joint #3 motor unit.

To do so, pass a suitable cord or string around the Joint #3 motor unit near its mounting plate.　Then, pull the cord using a force gauge or similar tool to apply the specified tension shown in the figure.

Make sure that the brake cables do not touch the pulley.



(13) Connect the following connectors;
Connector X331, X31, X32, X341, X41
Connector XB33, XB34

(14) Re-bundle the cables in their original positions with a wire tie removed in Removal step (8).

Do not allow unnecessary strain on the cables.

(15) If the position of the lower limit mechanical stop was changed for area limit, secure it to the proper position.

(16) Grease the shaft.

For details, refer to *10.1. Greasing the Ball Screw Spline Unit*.

(17) Install the Arm #2 cover and Arm #1 side cover.

For details, refer to *3. Covers*.

(18) Turn OFF the Controller and peripheral equipment.

(19) Install the end effector, and connect wires and tubes to the end effector.

(20) This step is only for Cleanroom-model.

Install the bellows.　For details, refer to *9. Bellows*.

(21) Perform the calibration of Joints #3 and #4.

For details, refer to *13. Calibration*.

11. Lithium Battery

 WARNING	■ Do not connect or disconnect the motor connectors while the power to the robot system is turned ON. Connecting or disconnecting the motor connectors with the power ON is extremely hazardous and may result in serious bodily injury as the Manipulator may move abnormally, and also may result in electric shock and/or malfunction of the robot system. ■ To shut off power to the robot system, disconnect the power plug from the power source. Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source. ■ Before performing any replacement procedure, turn OFF the Controller and related equipment, and then disconnect the power plug from the power source. Performing any replacement procedure with the power ON is extremely hazardous and may result in electric shock and/or malfunction of the robot system.

 WARNING	■ Use meticulous care when handling the lithium battery. Improper handling of the lithium battery as mentioned below is extremely hazardous, may result in heat generation, leakage, explosion, or inflammation, and may cause serious safety problems. <Improper Handling> ・Battery Charge ・Disassembly ・Incorrect Installation ・Exposing to Fire ・Forced Discharge ・Deformation by Pressure ・Short-circuit (Polarity; Positive/Negative) ・Heating (85°C or more) ・Soldering the terminal of the lithium battery directly ■ When disposing of the battery, consult with the professional disposal services or comply with the local regulation. Spent battery or not, make sure the battery terminal is insulated. If the terminal contacts with the other metals, it may short and result in heat generation, leakage, explosion, or inflammation.

In case of the low lithium battery power, the error to warn the voltage reduction occurs at the Controller startup (the software startup). All position data will be lost and you will need to calibrate all joints.

The life span of the lithium battery varies depending on the energizing hours and installation environment of the Controller. It is about 3 years as a rough guide (when the Controller is connected to power for 8 hours a day). When the Controller is not connected to power, the battery consumption will significantly increase compared to when the Controller is energized. If warnings of voltage reduction occur, replace the lithium metal battery even if it has not reached the above product life.

NOTE

For the EPSON RC+ 7.0 Ver. 7.2.x or later (firmware Ver.7.2.x.x or later), the recommended replacement time for the battery can be checked in the [Maintenance] dialog box of the EPSON RC+ 7.0.
For details, refer to the following manual.
RC700 series Maintenance Manual 6. Alarm

The battery may run out if it passes the recommended replacement time.

If no warnings of voltage reduction occur, the calibration for all joints is not necessary. You need to perform calibration if the position moves from the originals after replaced the battery.

Always use the lithium battery and battery board designated by us.
(Refer to *14. Maintenance Parts List*.)

Be careful of the battery polarity to connect it correctly.

	Name	Quantity	Note
Maintenance parts	Battery unit (Lithium battery)	1	2117879
	Battery board	1	2126750
Tools	Nippers	1	For cutting wire tie
	Hexagonal wrench (width across flats: 3 mm)	1	For M4 screw
Material	Wire tie	1	For fixing battery unit (battery)
		2	For fixing cable

11.1 Replacing the Battery Unit (Lithium Battery)

Battery unit (lithium battery) Removal

(1) Turn OFF the Controller.

(2) Remove the connector plate and base cover.

For details, refer to *3.3 Connector Plate and 3.4 Base Cover*.

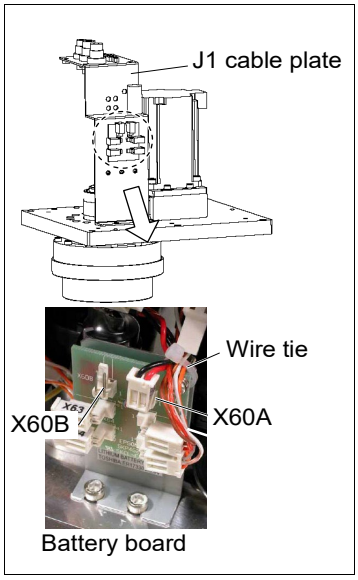
(3) Connect the connectors of the new lithium battery to the battery board.

User the unused connector of the two connectors X60A, X60B on the upper part of the battery board.

Be sure to connect the connector of the new battery before disconnecting the old battery. If the current battery is disconnected before connecting the new battery, the robot will lose the home position data and the calibration must be executed again.

(4) Cut off the wire tie banding the cables of lithium battery.

(5) Cut off the wire tie banding the lithium battery, Remove the battery.



Battery unit (lithium battery) Installation

(1) Mount the new lithium battery to the battery board.

(2) Fix the cable of lithium battery and connector cable connecting to battery board with wire tie. Refer to the procedure (3).

(3) Mount the base cover and connector plate.
For details, refer to *3.3 Connector Plate* and *3.4 Base Cover*.

(4) Turn ON the Controller.

(5) Check if the Manipulator moves to points (poses) correctly.

To do so, select 2 points (poses) or more from the registered points (poses) and move the Manipulator to the points (poses).

(6) If the Manipulator does not move to the points (poses) correctly, perform the calibration of all joints and axes.

For details, refer to *13. Calibration*.

11.2 Replacing the Battery Board

After battery board and parts have been replaced (motors, reduction gear units, brakes, timing belts, ball screw spline unit, etc.), the Manipulator cannot operate properly because a mismatch exists between the origin stored in each motor and its corresponding origin stored in the Controller.
After replacing the parts, it is necessary to match these origins.

The process of aligning the two origins is called “Calibration”.

Refer to *13. Calibration* to perform the calibration.

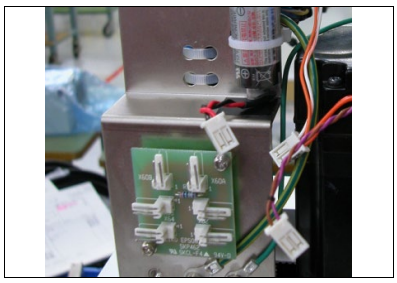
Battery board Removal

(1) Turn OFF the Controller.

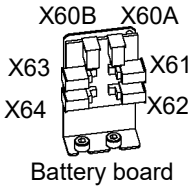
(2) Remove the connector plate and base cover.

For details, refer to *3.3 Connector Plate* and *3.4 Base Cover*.

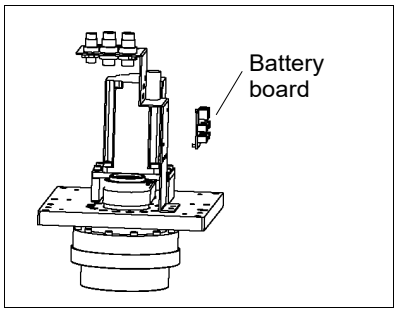
(3) Disconnect the following connectors from the battery board.



Connectors
X60, X61, X62,
X63, X64



(4) Loosen the screws securing the battery board and remove the battery board.

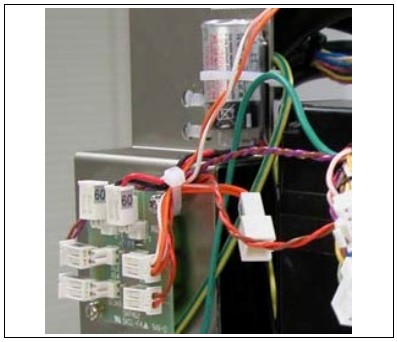


(5) Cut the wire tie securing the battery and remove the battery.

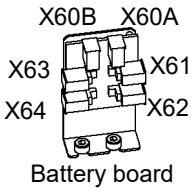
Battery board Installation

(1) Mount the new battery board and secure it with screws.

(2) Connect the following connectors to the battery board.



Connectors
X60, X61, X62,
X63, X64



(3) Mount the battery to Arm #1 cable plate and secure it.

(4) Mount the base cover and connector plate.
For details, refer to *3.3 Connector Plate* and *3.4 Base Cover*.

(5) Turn ON the Controller.

(6) Perform the calibration of all joints.
For details, refer to *13. Calibration*.

12. LED Lamp

WARNING	■ Do not connect or disconnect the motor connectors while the power to the robot system is turned ON. Connecting or disconnecting the motor connectors with the power ON is extremely hazardous and may result in serious bodily injury as the Manipulator may move abnormally, and also may result in electric shock and/or malfunction of the robot system. ■ To shut off power to the robot system, disconnect the power plug from the power source. Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source. ■ Before performing any replacement procedure, turn OFF the Controller and related equipment, and then disconnect the power plug from the power source. Performing any replacement procedure with the power ON is extremely hazardous and may result in electric shock and/or malfunction of the robot system.

	Name	Quantity	Note
Maintenance parts	LED Lamp	1	1661726
Tools	Hexagonal wrench (width across flats: 3 mm)	1	For M4 screw

NOTE

When tightening hexagon socket head cap bolts, refer to the *2.4 Tightening Hexagon Socket Head Cap Bolts*.

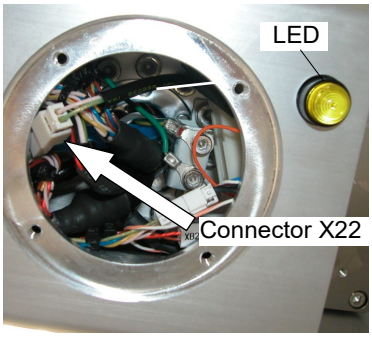
LED Lamp Removal

(1) Remove the Arm #1 under cover.

For details, refer to *3.1 Arm #1 Cover*.

(2) Disconnect the connector X22 from the LED.

(3) Remove the LED. Turn it counterclockwise to remove.



LED Lamp Installation

(1) Pass the cable with connector X22 through the LED mounting hole.

Pass the cable through the LED mounting hole and connect the following connector.

Connector X22

(2) Secure the LED to the Arm #1.

(3) Connect connector X22.

(4) Mount the Arm #1 under cover.

For details, refer to *3.1 Arm #1 Cover*.

13. Calibration

13.1 About Calibration

After parts have been replaced (motors, reduction gear units, timing belts, etc.), the Manipulator cannot execute the positioning properly because a mismatch exists between the origin stored in each motor and its corresponding origin stored in the Controller.
After replacing the parts, it is necessary to match these origins.

The process of aligning the two origins is called “Calibration”. Note that calibration is not the same as teaching*.

*: “Teaching” means to teach the Controller coordinate points (including poses) anywhere in the operating area of the Manipulator.

 WARNING	■ To ensure safety, a safeguard must be installed for the robot system. For details on the safeguard, refer to EPSON RC+ User’s Guide: *2.3 Installation and Design Precautions.* ■ Before operating the robot system, make sure that no one is inside the safeguarded area. The robot system can be operated in the mode for teaching even when someone is inside the safeguarded area. The motion of the Manipulator is always in restricted (low speeds and low power) status to secure the safety of an operator. However, operating the robot system while someone is inside the safeguarded area is extremely hazardous and may result in serious safety problems in case that the Manipulator moves unexpectedly.

Command Input

Calibration procedures include the process to input commands. Select EPSON RC+ menu-[Tools]-[Command Window] to use the command window.

The information above is omitted in the calibration procedure.

Jog Motion

The process to set the jog motion is included in the [Jog & Teach] page of the Robot Manager. Select EPSON RC+ menu-[Tools]-[Robot Manager] and select the [Jog & Teach] tab to use the [Jog & Teach] page.

The page above is indicated as [Jog & Teach] in the calibration procedure.

When the procedure is different for each type of software, see your software type.

13.2 Calibration Procedure

EPSON RC+ has a wizard for calibration.

This section indicates the calibration using the calibration wizard of EPSON RC+.

The same calibration procedure is used for each joint.
The follow the steps below are calibration using Joint #1. Follow the steps below to calibrate other joints.

When coordinates for the Manipulator working point require calculation, it is important for Joint #2 to be calibrated accurately. Execute the procedure in "Calibration Using Right / Left Arm Orientations" to accurately calibrate Joint #2. For details, refer to *13.3 Accurate Calibration of Joint #2*.

When calibrating Joint #4, you must calibrate Joint #3 and #4 at the same time. You cannot calibrate Joint #4 alone because of the structure of the Manipulator.

NOTE
The reference point (a point to identify the position of the manipulator) needs to be specified for calibration.

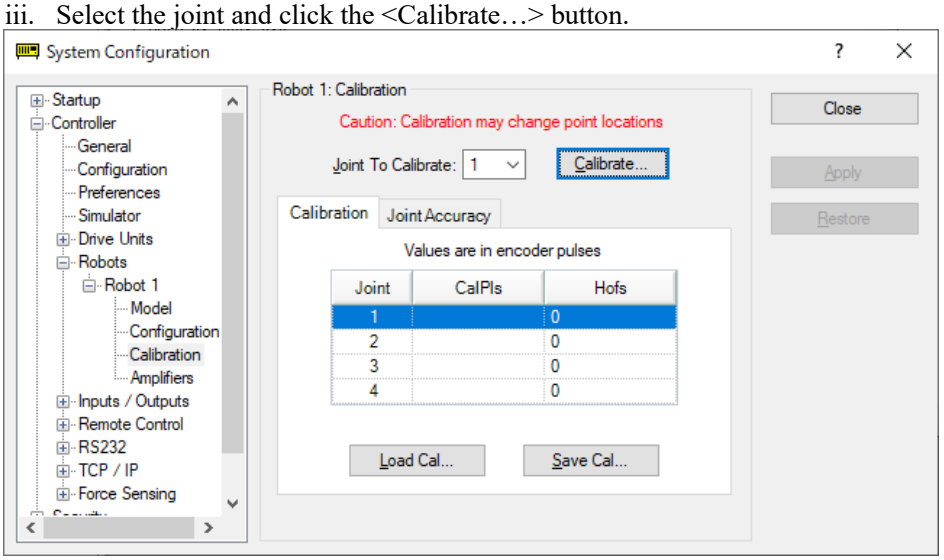
(1) Start the calibration wizard.

i. Select EPSON RC+ menu-[Setup]-[System Configuration].

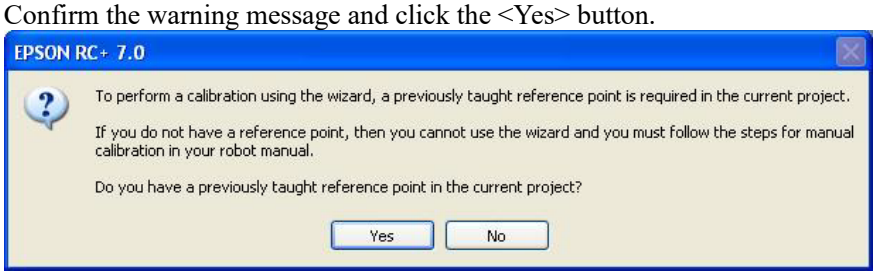
ii. Select the [Robot]-[Robot**]-[Calibration].

NOTE
Only selected robot can be calibrated.

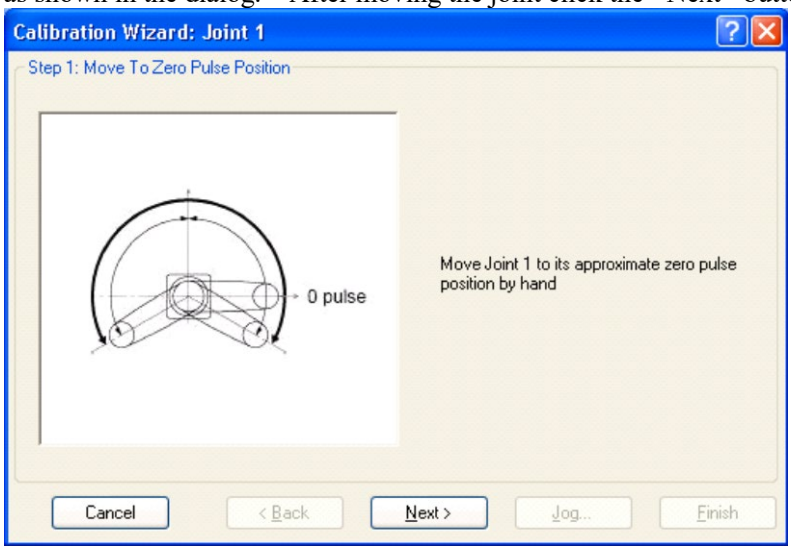
iii. Select the joint and click the <Calibrate…> button.



(2) Confirm the warning message and click the <Yes> button.

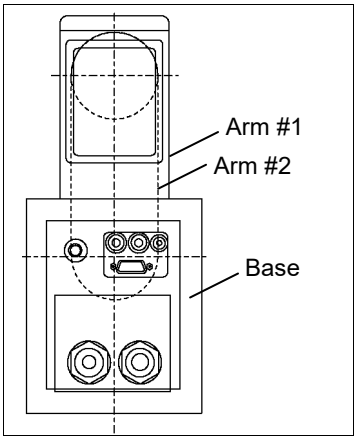


(3) Move the joint to calibrate manually to approximate zero position (Joint #1: 90 deg.), as shown in the dialog. After moving the joint click the <Next> button.



90 deg. position of Joint #1:

position aligned with Y-axis in Robot coordinate system



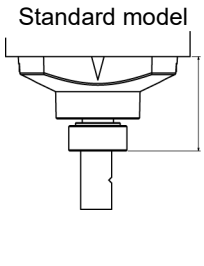
0 pulse position of Joint #2:

position where Arm #2 is inner side of Arm #1 (Regardless of the Joint #1 direction)

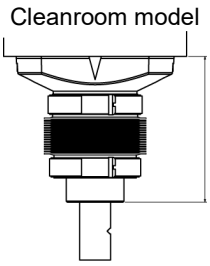
0 pulse position of Joint #3:

upper limit position in motion range

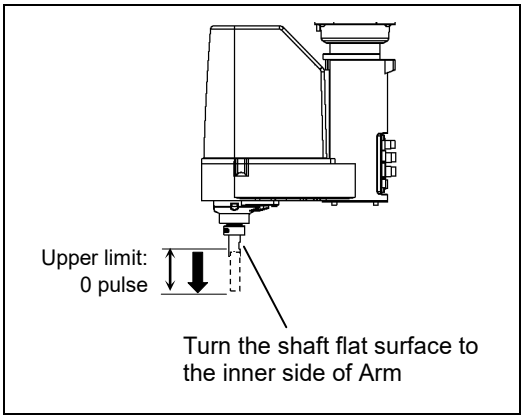
The height of Joint #3 depends on manipulator model.



RS3-351S: 48.5 mm
RS4-551S: 45.5 mm

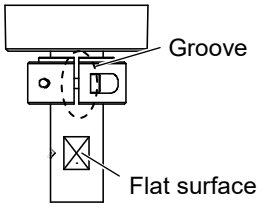


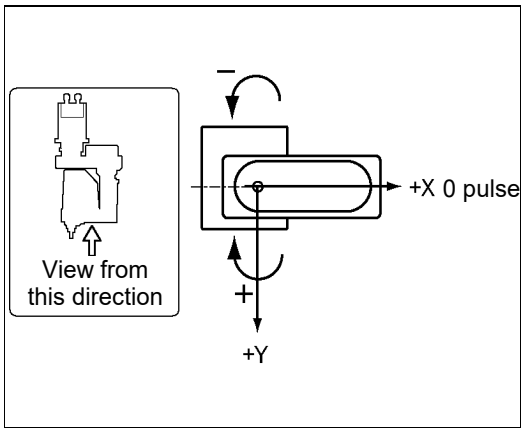
RS3-351C: 74.5 mm
RS4-551C: 73.5 mm



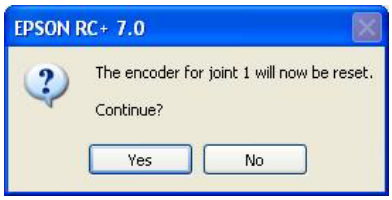
0 pulse position of Joint #4:

position where the flat surface (or groove in mechanical stop) on the shaft faces toward the inside of Arm #2

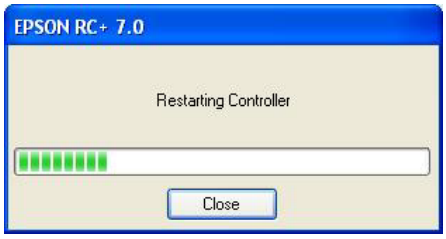




(4) Click the <Yes> button to reset the encoder.



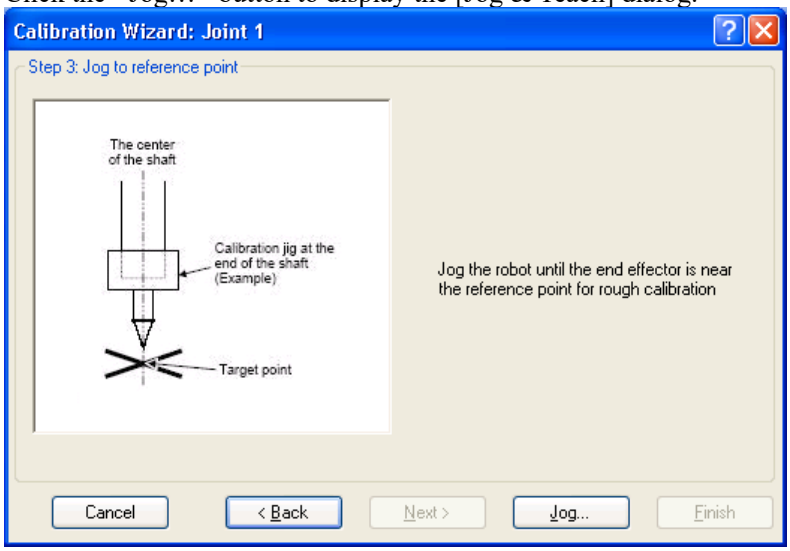
(5) Reboot the Controller.



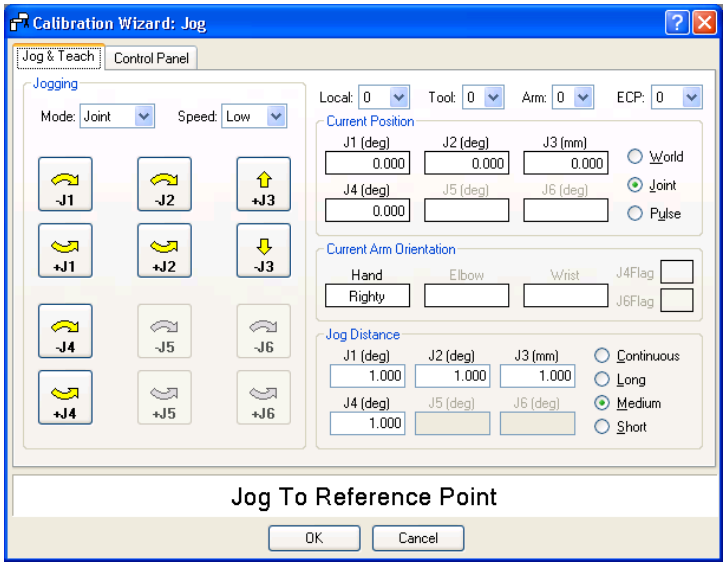
* This window will disappear when the Controller starts up.

(6) Select the reference point to use for calibration, and click the <Next> button.

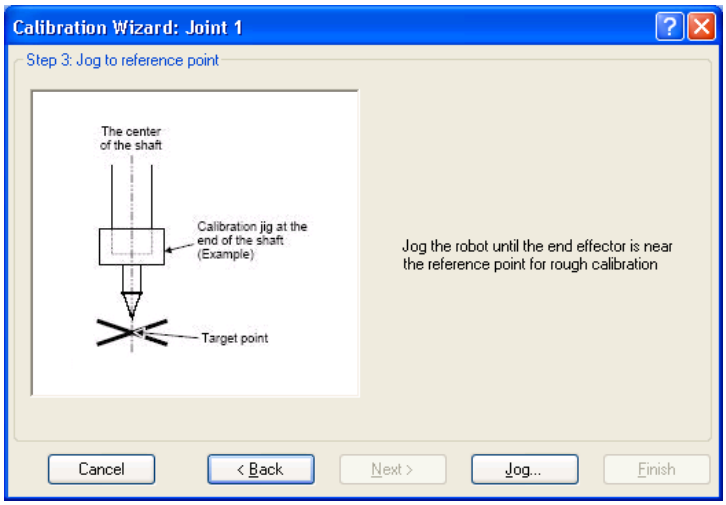
(7) Click the <Jog…> button to display the [Jog & Teach] dialog.



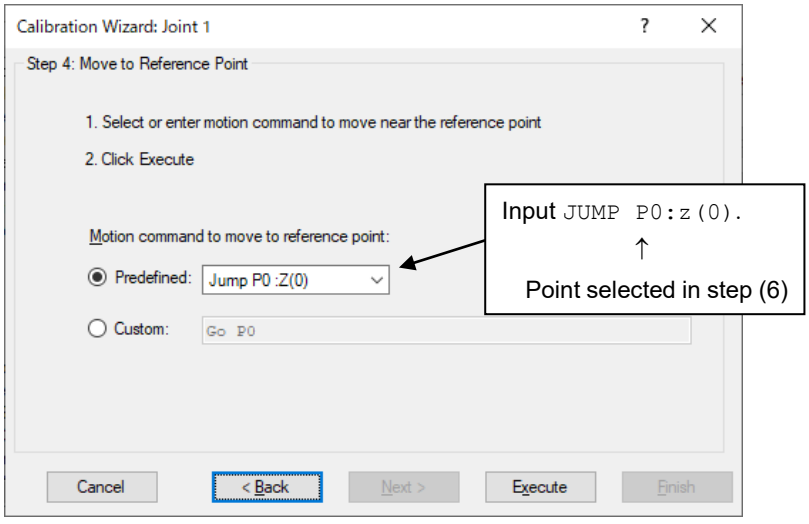
(8) Jog the end effector to approximate reference point in the [Jog & Teach] dialog for rough calibration.
Then click the <OK> button.



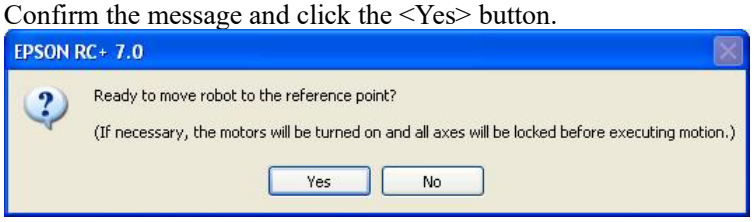
(9) Click the <Next> button.



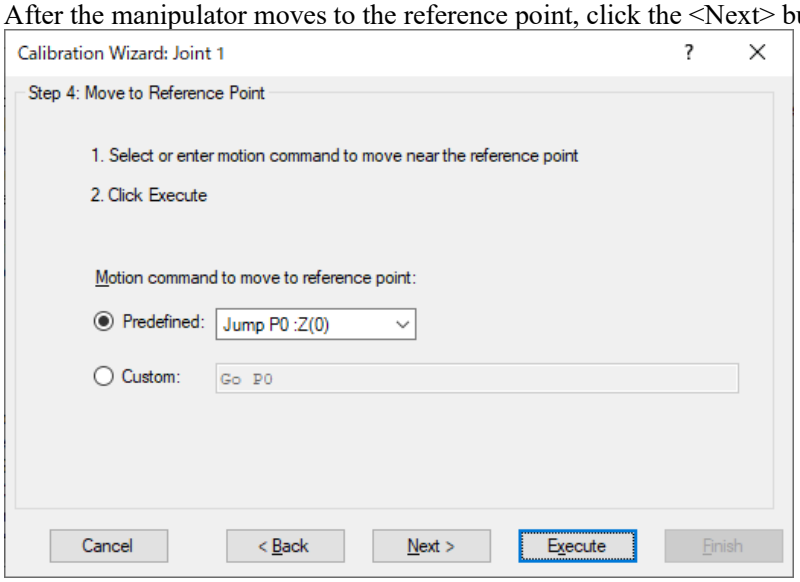
(10) The manipulator moves to the reference point.
Click the <Execute> button.



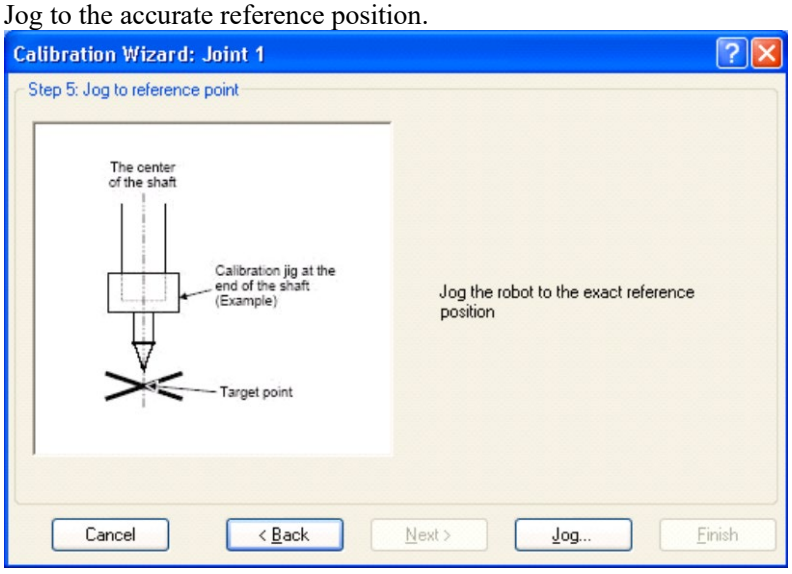
(11) Confirm the message and click the <Yes> button.



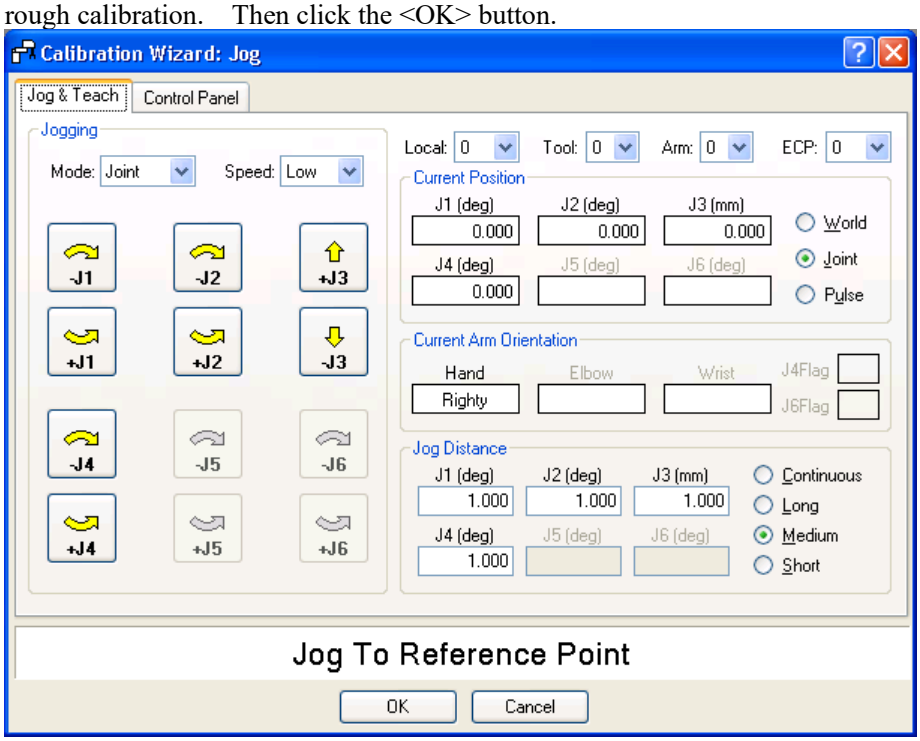
(12) After the manipulator moves to the reference point, click the <Next> button.



(13) Jog to the accurate reference position.

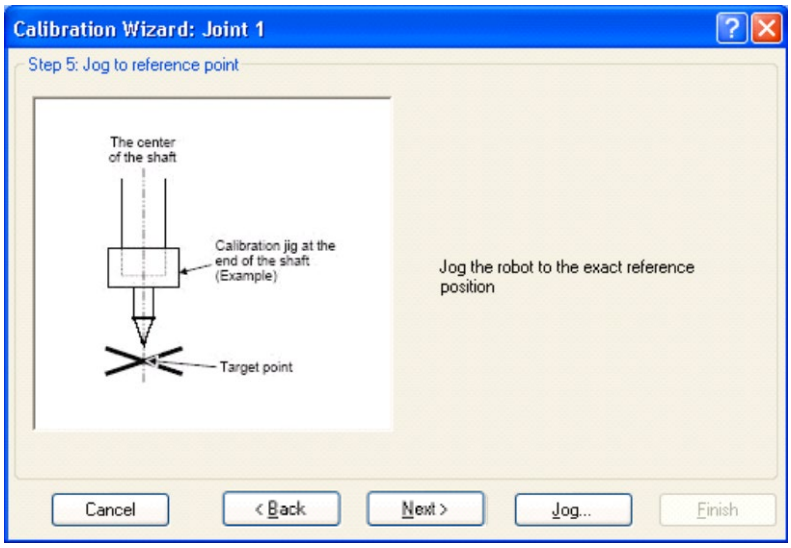


(14) Jog the end effector to approximate reference point in the [Jog & Teach] dialog for rough calibration. Then click the <OK> button.



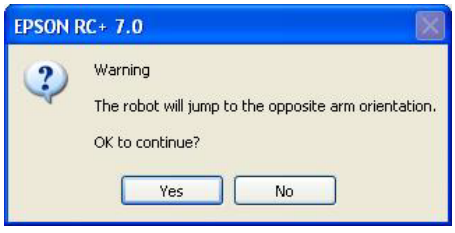
* Position Joint #2 only and move Joint #3 to around 0 pulse.

(15) Click the <Next> button.

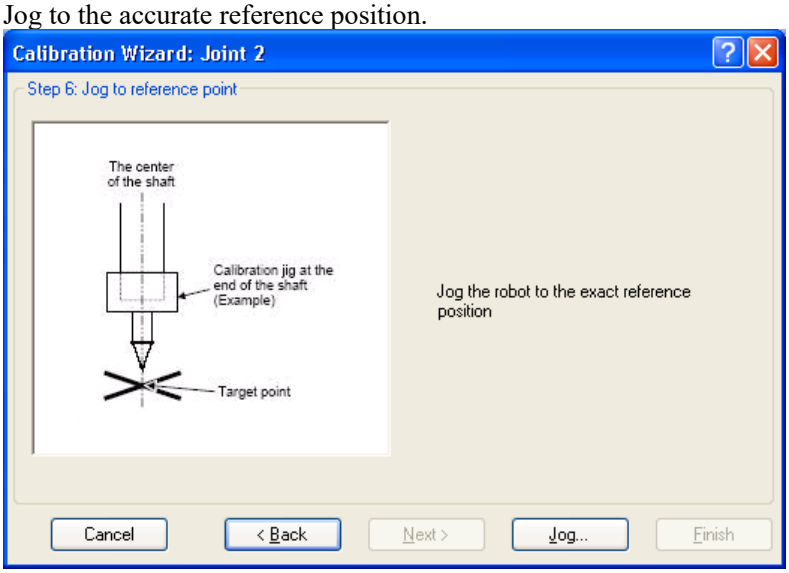


(16) Execute the procedures in “Calibration Using Right / Left Arm Orientations” to accurately calibrate Joint #2.
Go on to the step (17) for the other joints calibration.

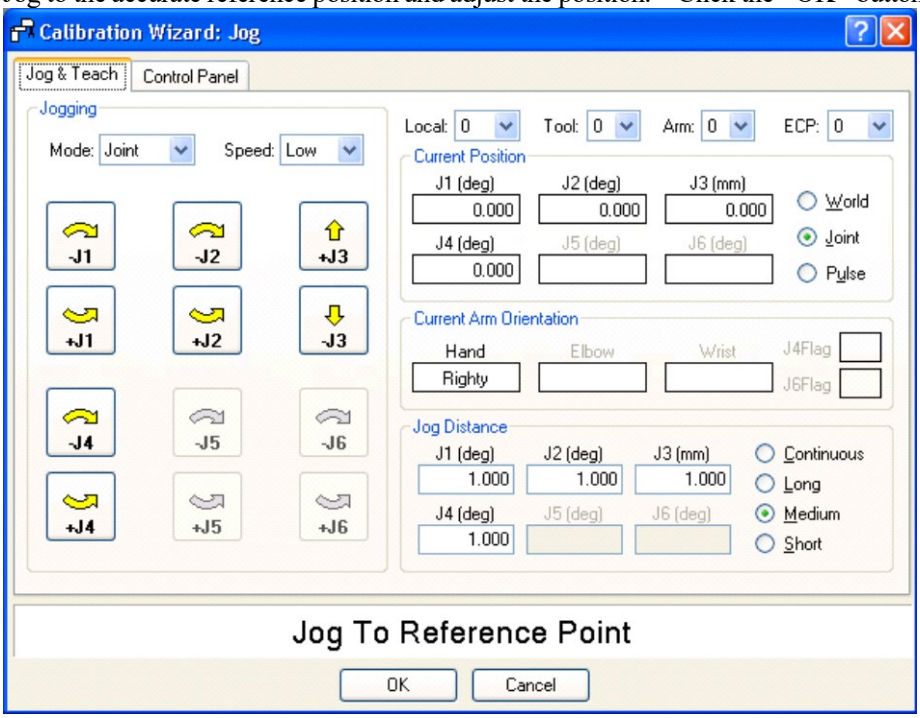
i. Move to another point that has different pose (from righty to lefty) using Jump command. Click the <Yes> button.



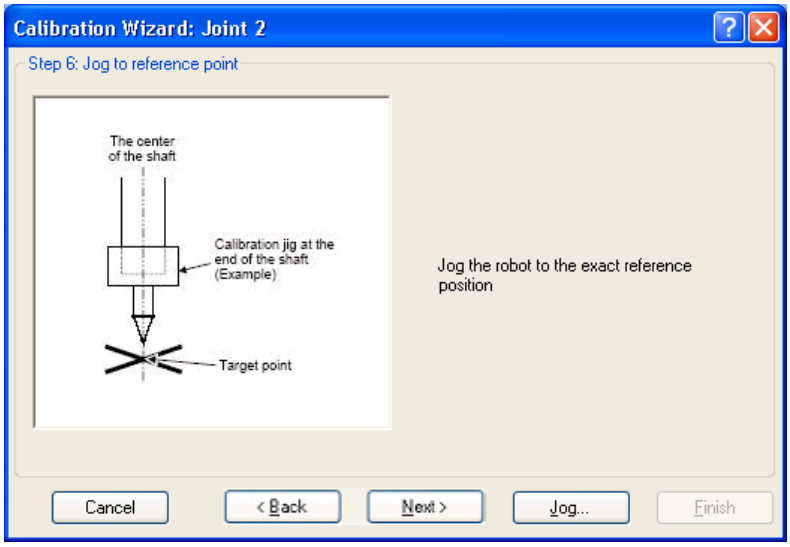
ii. Jog to the accurate reference position.



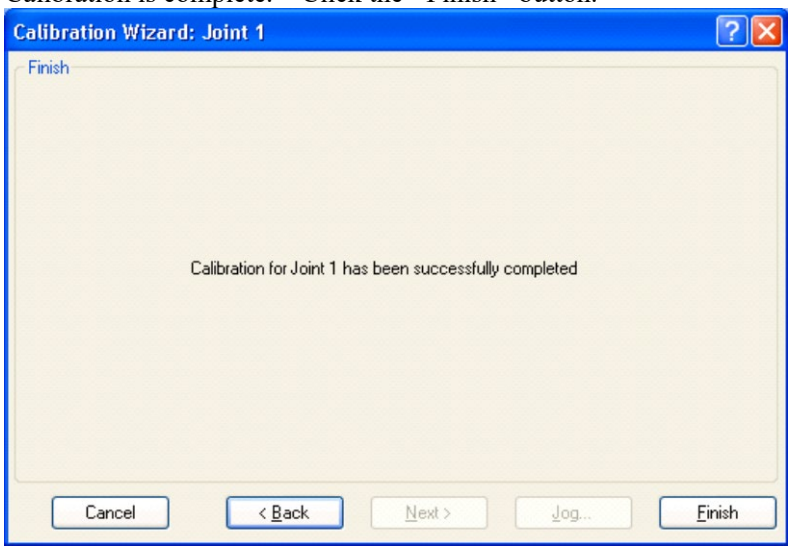
iii. Jog to the accurate reference position and adjust the position. Click the <OK> button.



iv. Click the <Next> button.



(17) Calibration is complete.　Click the <Finish> button.



(18) Move the manipulator to other points and check if it can move without problems.Teach points where appropriate.

13.3 Accurate Calibration of Joint #2

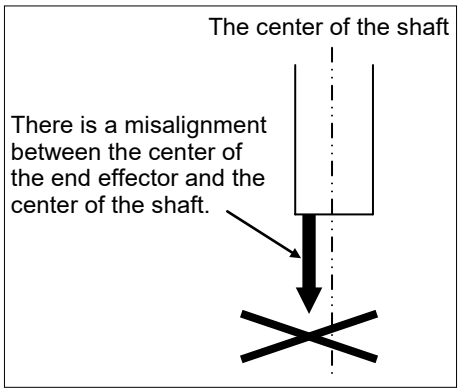
When coordinates for the Manipulator working point require calculation, it is important for Joint #2 to be calibrated accurately.

NOTE

IF the calibration of Joint #2 is performed in *13.2 Calibration Procedure*, configure "Calibration Using Right / Left Arm Orientations" by the wizard.

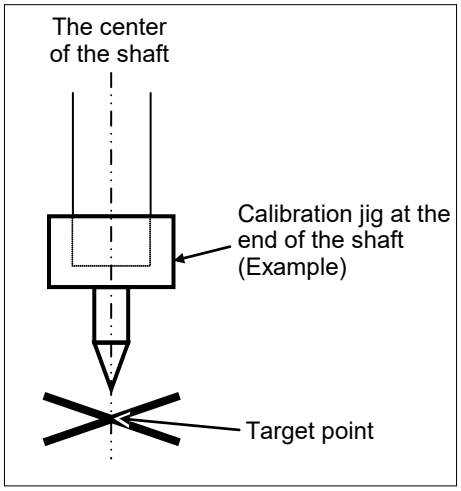
The reference point is the center of the ball screw spline shaft during this calibration.

When there is a misalignment between the center of the end effector and the center of the ball screw spline shaft, remove the end effector and perform the calibration of the shaft.



Make a calibration jig as shown in the right figure and attach it on the end of the shaft to make the center of the shaft clear.

Decide a target point and mark a cross (×) on it so that you can easily verify the center of the shaft after switching the arm pose between right and left.



After removing the end effector and performing the calibration, install the end effector and move the Manipulator to the teaching point to verify whether there is a positional gap. If there is a positional gap, fine-tune the installation position of the end effector and teach the point again.

Coordinates for the working point requires calculation in the following cases:

- Teaching the working point by entering the coordinate values (MDI teaching)
- Switching the arm orientation between right and left at a given point
- Using the Pallet command
- Executing CP control (such as liner or circular interpolation)
- Using the Local command
- Pose data specified with relative coordinates <Example: P1+X(100) >
- Vision Guide camera calibrations

Calibration Using Right / Left Arm Orientations

(1) Check the point data for calibration

Use a pose (point) you can easily verify the accuracy within the work envelop of both right and left arm. Then, check the number of pose (point) you want to use.

(2) Open [Tools menu]-[Robot Manager]-[Control Panel] and turn ON the motor.

(3) Click the <Free All> button in the [Control Panel] to free all joints. Now, you can move arms by hands.

(4) Move the arms to the position of point data for calibration in rightly arm orientation.

(5) From the current position, teach any point data number unused.
This point is now called P1.

Specify the point number “1” and click the <Teach> button in the [Jog & Teach].

(6) Click the <Lock All> button in the [Control Panel] to lock all joints.

(7) Switch to the lefty arm orientation. Then, move the arm to the same point.

```
>Jump P1/L:Z(0)   ' Change the arm orientation from righty to lefty
                    Z is the maximum position
```

* If there is interference on the way from right to lefty, click the <Free All> button in the [Control Panel] and change the arm orientation to lefty by hands. Then, go to the step (6), (7).

(8) The joints are slightly out of position.

Adjust the gap with the –Z in the Jogging group in the [Jog & Teach]. Then, teach another point data number unused. This point is now called P2.

Specify point number “P2” and click the <Teach> button in [Jog & Teach].

(9) Input the new Hofs value.

```
> Hofs Hofs (1), Hofs (2) + (Ppls(P1,2) + Ppls(P2,2)) /
2, Hofs(3), Hofs(4)
```

(10) From the current lefty arm orientation (the position in the step (8)), teach the point data number used in the step (8). This point is called P2.

Specify point number “P2” and click the <Teach> button in [Jog & Teach].

(11) Switch to the righty arm orientation. Then, make sure the manipulator move to the correct position.

```
>Jump P2/R      ' Change the arm orientation from lefty to righty
```

* If there is any interference on the way from lefty to righty, click the <Free All> button in the [Control Panel] and change the arm orientation to righty by hands. Then, go to the step (6), (11).

(12) Move the manipulator to other point data and make sure it moves to the correct position. Teach some more points if required.

* Delete the two points taught for the Joint #2 calibration.

13.4 Calibration Procedure without using Calibration Wizard

NOTE

This section indicates the calibration without using the calibration wizard of EPSON RC+. For details of calibration using the calibration wizard, refer to *13.2 Calibration Procedure*.

When coordinates for the Manipulator working point require calculation, it is important for Joint #2 to be calibrated accurately. Execute the procedure in "Calibration Using Right / Left Arm Orientations" to accurately calibrate Joint #2. For details, refer to *13.3 Accurate Calibration of Joint #2*.

You cannot calibrate Joint #4 alone because of the structure of the Manipulator. When calibrating Joint #4, you must calibrate Joint #3 and #4 at the same time.

NOTE

The reference point (a point to identify the position of the manipulator) needs to be specified for calibration.

Follow steps 1 to 6 described below in order to calibrate the origin.

1. Basic Pose Confirmation

   (1)-1 After the part replacement, perform the calibration using the point data currently registered.
   Confirm the point data number (P*) to reconstruct the correct manipulator position.

   * Point data before the parts replacement (motor, reduction gear, belt, etc.) is necessary for the calibration.

2. Part Replacement

   (2)-1 Replace parts as dictated by this manual.
   Be careful not to injure yourself or damage parts during part replacement.

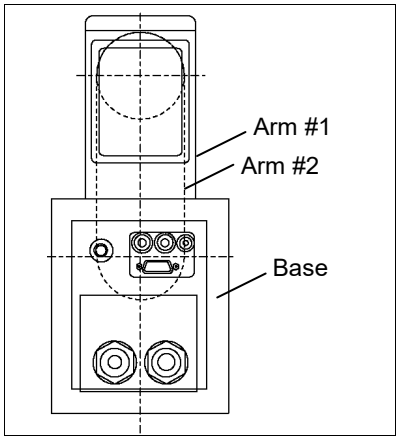
3. Encoder Initialization

   (3)-1 Turn ON the Controller when all joints are in the motion range.

   (3)-2 Manually move the joint that needs origin alignment to its approximate 0 pulse position.

90 deg. position of Joint #1:

position aligned with Y-axis in Robot coordinate system



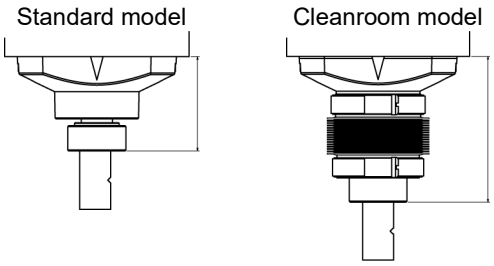
0 pulse position of Joint #2:

position where Arm #2 is inner side of Arm #1 (Regardless of the Joint #1 direction)

0 pulse position of Joint #3:

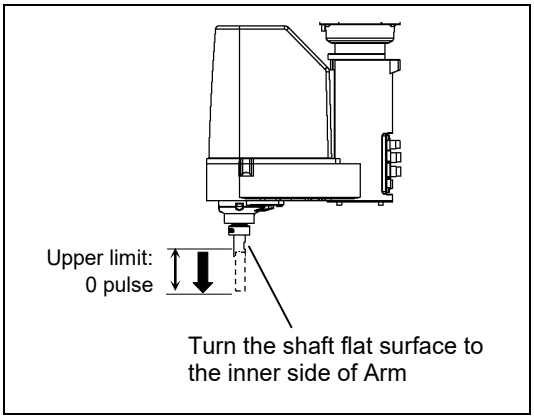
upper limit position in motion range

The height of Joint #3 depends on manipulator model.



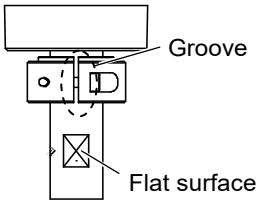
RS3-351S: 48.5 mm
RS4-551S: 45.5 mm

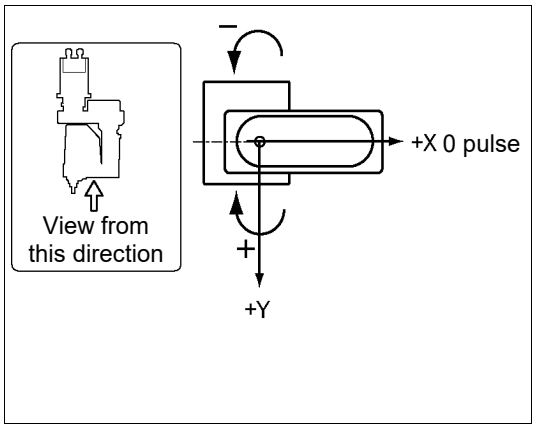
RS3-351C: 74.5 mm
RS4-551C: 73.5 mm



0 pulse position of Joint #4:

position where the flat surface (or groove in mechanical stop) on the shaft faces toward the inside of Arm #2





(3)-3 Connect EPSON RC+ to the Controller.

Select a robot to be calibrated. Input as below in the [Command Window] and execute it.
(This example uses “robot 1”.)

```
> robot 1
```

(3)-4 Execute the absolute encoder initialization command.

Input one of the following commands to [Command Window] according to the joint being calibrated.

Joint #1: `>EncReset 1`
Joint #2: `>EncReset 2`
Joint #3: `>EncReset 3`
Joint #4: `>EncReset 3, 4`

(3)-5 Reboot the Controller.

Select EPSON RC+ menu-[Tools]-[Controller] and click the <Reset Controller> button.

* This window will be disappeared when the Controller starts up.

4. Rough Calibration

(4)-1 Execute the following command from the menu-[Tools]-[Command Window].

```
>calpls 0,0,0,0
```

* Manipulator does not move.

(4)-2 Execute one of the following commands according to the joint you want to calibrate from the menu-[Tools]-[Command Window].

Joint #1 `>calib 1`
Joint #2 `>calib 2`
Joint #3 `>calib 3`
Joint #4 `>calib 3, 4`

5. Calibration (Accurate Positioning)

(5)-1 Turn ON the motors from the EPSON RC+ menu -[Tools] -[Robot Manager]-[Control Panel].

(5)-2 Click the <Free All> button in the [Control Panel] to free all joints. Now, you can move arms by hands.

(5)-3 Move the Manipulator by hand to a rough position/posture of the calibration point data.

(5)-4 Create the data from the calibration point data.

Enter and execute the following command in [Command Window].
(In this example, P1 is used as the calibration point data.)

```
> Calpls Ppls(P1,1), Ppls(P1,2), Ppls(P1,3), Ppls(P1,4)
```

(5)-5 Move the joint to the specified point using a motion command.

For example, when the specified point data is “P1”,
execute “Jump P1:Z(0)” from [Jog & Teach].

* The joint NOT being calibrated moves to the original position.

(5)-6 Accurately align the joint* being calibrated to the specified point using jog commands.

* You must move Joint #3 and #4 to the position when calibrating Joint #4.

Select the jog mode [Joint] from [Jog & Teach] to execute the jog motion.

(5)-7 Execute the calibration.

Enter and execute one of the following commands in [Command Window] according to the joint being calibrated.

Joint #1: `>Calib 1`
Joint #2: `>Calib 2`
Joint #3: `>Calib 3`
Joint #4: `>Calib 3, 4`

6. Accuracy Testing

(6)-1 Move the Manipulator to another point to confirm that it moves to the same position. If it does not move to the same position, re-calibrate using another point. You must set the point again if reproducibility cannot be assured through calibration.

14. Maintenance Parts List

14.1 Common Parts

Part Name		Code	Old Code	Note	Reference	Over-haul*
AC Servo Motor	Joint #1	1514468	R13B000616	400 W	5.1	✓
	Joint #2	1514451	R13B000614	200 W / RS3-351*	6.1	✓
		1514468	R13B000616	400 W / RS4-551*		
	Joint #3	1514453	R13B000615	150 W	7.1	✓
	Joint #4	1514469	R13B000617	100 W	8.1	✓
Reduction Gear Unit	Joint #1	1514470	R13B010018	RS3-351*	5.2	✓
		1547165	R13B010029	RS4-551*		
	Joint #2	1514471	R13B010019		6.2	✓
	Joint #4	1510322	R13B010020		8.3	✓
Electromagnetic Brake	Joint #3	1497639	R13B030501		7.3	✓
Timing Belt	Joint #1	1510524	R13B030216	Width 15 mm Length 270 mm	5.3	✓
	Joint #2	1510525	R13B030217	Width 10 mm Length 246 mm	6.3	✓
	Joint #3	1510526	R13B030218	Width 9 mm Length 246 mm	7.2	✓
	Joint #4	1510527	R13B030219	Width 12 mm Length 339 mm	8.2	✓
Battery Board		2126750	R13B041203	No lithium battery Installed in Base	11.2	
Battery Unit		2117879	R13ZA00600300	Spare lithium battery ER17330V (TOSHIBA)	11.1	
O-ring	Joint #1	1213269	R13B031206	S90A	5.2	
		1510529	R13B031236	S65A		
		1510530	R13B031237	S30A		
	Joint #2	1213267	R13A031200700	S71A	6.2	
		1510531	R13B031238	S53A		
Grease **	AFB (Ball Screw Spline)	—	—	For purchasing the grease, please contact the supplier of your region.	2.3	
	SK-1A (Reduction Gear Unit)	—	—		2.3	
	GPL-224 (Cable)	—	—		2.3	
Oil seal unit (Arm #2)		1514476	R13B031239			

Part Name			Code	Old Code	Note	Reference	Over-haul*
M/C cable	3 m	For RC180	R12NZ9007C	R12B020434	(For RC620)	3.4	
		For RC700-A, Straight	R12NZ900KN	－			
		For RC700-A, L-shaped	R12NZ900KR	－			
	5 m	For RC180	R12NZ9002F	R12B020435	(For RC620)		
		For RC700-A, Straight	R12NZ900KP	－			
		For RC700-A, L-shaped	R12NZ900KT	－			
	10 m	For RC180	R12NZ9002G	R12B020436	(For RC620)		
		For RC700-A, Straight	R12NZ900KQ	－			
		For RC700-A, L-shaped	R12NZ900KU	－			
	15 m	For RC700-A, Straight	R12NZ900Y7	－			
		For RC700-A, L-shaped	R12NZ900Y9	－			
	20 m	For RC700-A, Straight	R12NZ900Y8	－			
		For RC700-A, L-shaped	R12NZ900YA	－			
LED Lamp			1661726	R13B030004		12	
Brake Release Switch			2117817	R13Z702640100		－	

* As a rough indication, perform the overhaul (parts replacement) before reaching 20,000 operation hours of the Manipulator. The operation hours can be checked in [Controller Status Viewer] dialog - [Motor On Hours].
For details, refer to 2.2 Overhaul (Parts Replacement).

** Regarding purchase of grease

Due to the chemicals regulations of individual countries (the UN GHS), we are requesting our customers to purchase the grease required for maintenance from the manufacturers listed in the table below as of April 2015. Regarding purchase of the grease, please contact the following manufacturers. If there is anything unclear, please contact the supplier of your region.

Product name	Manufacturer	URL
THK AFB-LF Grease	THK CO., LTD.	https://www.thk.com/
Harmonic Grease SK-1A	Harmonic Drive Systems Inc.	https://www.harmonicdrive.net/
Krytox®GPL-224	Chemours	https://www.chemours.com/en/brands-and-products

14.2 Parts by Environment Model

14.2.1 S: Standard-model

Part Name	Code	Old Code	Note	Reference	Overhaul *
Ball Screw Spline	1514472	R13B010222		10.2	✓
Cable Unit	1514474	R13B020028	RS3-351*	4	
	1547166	R13B020054	RS4-551*		
Arm #2 Cover	1509821	R13B030425		3.2.1	

* As a rough indication, perform the overhaul (parts replacement) before reaching 20,000 operation hours of the Manipulator. The operation hours can be checked in [Controller Status Viewer] dialog - [Motor On Hours].
For details, refer to *2.2 Overhaul (Parts Replacement)*.

14.2.2 C: Cleanroom-model

Part Name	Code	Old Code	Note	Reference	Overhaul *
Ball Screw Spline	1514473	R13B010223		10.2	✓
Cable Unit	1514475	R13B020029	RS3-351*	4	
	1548346	R13B020055	RS4-551*		
Arm #2 Cover	1509828	R13B030426		3.2.1	
Bellows	1510547	R13B030705	**	9	
Gasket Unit	1514477	R13B031240	RS3-351*	3	
	1548345	R13B031254	RS4-551*		
Liquid gasket KE3497W ***	—	—	For purchasing the liquid gasket, please contact the supplier of your region.	9	

* As a rough indication, perform the overhaul (parts replacement) before reaching 20,000 operation hours of the Manipulator. The operation hours can be checked in [Controller Status Viewer] dialog - [Motor On Hours].
For details, refer to *2.2 Overhaul (Parts Replacement)*.

** The bellows are provided in a unit of one piece.

*** Regarding purchase of liquid gasket

Due to the chemicals regulations of individual countries (the UN GHS), we are requesting our customers to purchase liquid gasket required for maintenance from the manufacturers listed in the table below as of April 2015. Regarding purchase of liquid gasket, please contact the following manufacturers. If there is anything unclear, please contact our suppliers.

Product name	Manufacturer	URL
KE-3497-W	Shin-Etsu Chemical Co., Ltd.	https://www.shinetsusilicone-global.com/