EPSON
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Industrial Robot: 6-Axis Robots

C series

Maintenance Manual

Rev.4 ENM231R5680F

Original instructions

Industrial Robot: 6-Axis Robots

C series Maintenance Manual

Rev.4

FOREWORD

Thank you for purchasing our robot products.
This manual contains the information necessary for the correct use of the robot controller.
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.

TRADEMARKS

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NOTICE

No part of this manual may be copied or reproduced without authorization.
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 Users in Taiwan region

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 Robot System

The C4 series Manipulators can be used with the following combinations of software.

Controllers : RC700, RC700-A

Software : EPSON RC+ 7.0

The C8 series Manipulators can be used with the following combinations of software.

Controllers : RC700-A

Software : EPSON RC+ 7.0 Ver.7.1.3 or later (C8XL)
EPSON RC+ 7.0 Ver.7.1.4 or later (C8, C8L)
EPSON RC+ 7.0 Ver.7.2.0 or later (Wall mounting)

The C12 series Manipulators can be used with the following combinations of software.

Controllers : RC700-A

Software : EPSON RC+ 7.0 Ver.7.4.6 or later

Setting by Using Software

This manual contains setup procedures using the software.
Those sections are indicated by the symbol on the left.

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.

Photos and Illustrations Used in This Manual

The appearance of some parts may differ from those on an actual product depending on when it was shipped or the specifications. The procedures themselves, however, are accurate.

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

C 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)
C series Maintenance Manual (PDF) (xx: Manipulator series name)

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)

This manual describes general information about program development software.

EPSON RC+ 7.0 SPEL+ Language Reference (PDF)

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

Other Manual (PDF)

Manuals for each option are available.

C4 Series Maintenance

C8 Series Maintenance

C12 Series Maintenance

C4 Maintenance

This volume contains maintenance procedures with safety precautions for C4 series Manipulators.

1. Safety Maintenance

Please read this chapter, this manual, and other relevant manuals carefully to understand safe maintenance procedures before performing any maintenance.

Only authorized personnel who have taken maintenance training held by the manufacturer or dealer should be allowed to perform the robot maintenance.

 WARNING	■ Do not remove any parts unless otherwise instructed by this manual. Follow the maintenance procedure strictly as described. Improper removal of parts or improper maintenance may cause not only malfunction of the robot system but serious safety problems. ■ If you have not received training, keep away from the Manipulator while the power is ON. 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. ■ When connecting / replacing the brake release unit or the external short connector, turn OFF the power to the Controller and the brake release unit. Inserting and removing the connector while the power is ON may result in electrical shock.

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.) It may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. ■ If the Manipulator is operated without connecting the brake release unit or the external short connector, the brakes cannot be released and it may cause damage on them. After using the brake release unit, be sure to connect the external short connector to the Manipulator, or check connection of the connector for the brake release unit. ■ When operating maintenance of manipulator, secure about 50 cm of empty space around the manipulator.

2. General Maintenance

This chapter describes maintenance inspection procedures. Performing maintenance inspection properly is essential to prevent trouble and ensure 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.

	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						√

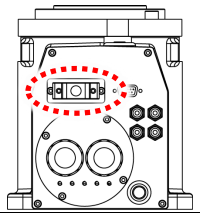
h = hour

2.1.2 Inspection Point

Inspection Point

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.	External appearance of Manipulator	√	√	√	√	√
Clean up if necessary.	External cables		√	√	√	√
Check for bends or improper location. Repair or place it properly if necessary.	Safeguard etc.	√	√	√	√	√
Check either the external short connector or the brake release unit connector is connected.	The external short connector on the back side of the Manipulator, or the brake release unit connector.	√	√	√	√	√
Check the break operation	Joint #1 to 6 break	√	√	√	√	√
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 either the external short connector or the brake release unit connector is connected.	Check whether external short connector or break release connector is connected. When neither is connected, connect either one. 
Check the break operation	Check that the arm does not fall when in MOTOR OFF. If the arm falls when in MOTOR OFF and the brake is not released, 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 box-[Motor On Hours].

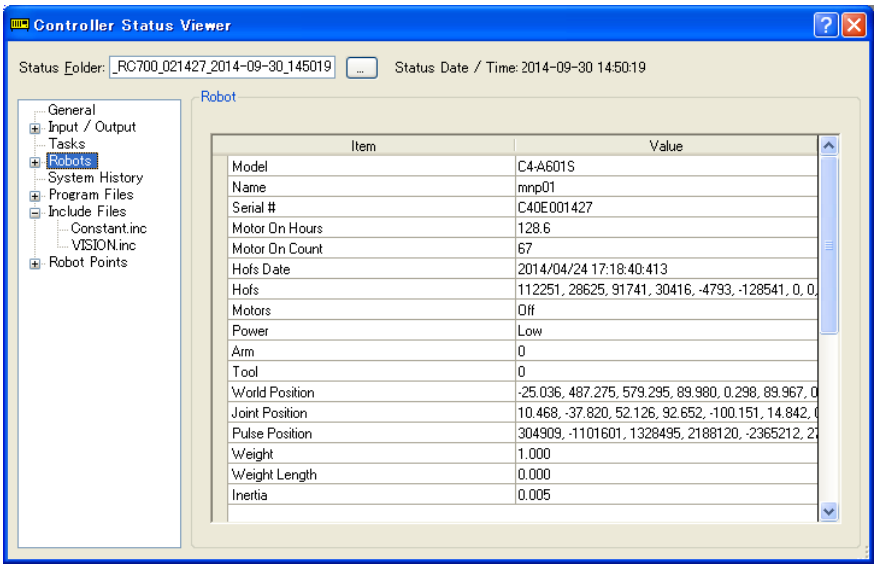
(1) Select EPSON RC+ menu-[Tools]-[Controller] to open the [Controller Tools] dialog box.

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

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

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

(5) Select [Robot] from the tree menu on the left side.



For the parts subject to overhaul, refer to *C4 Maintenance 17. C4 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 reduction gear units and the bevel gear need greasing regularly. Only use the grease specified in the following table.

 WARNING	■ 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	■ Keep enough grease in the Manipulator. Operating the Manipulator with insufficient grease will cause the noise or 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. ■ 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	Greasing method
Joint #1, 2, 3, 4	Reduction gear units	Overhaul timing	SK-1A	Refer to *C4 Maintenance*: *5.2, 6.2, 7.2, 8.2 Replacing the Reduction Gear Unit*
Joint #5, 6			SK-2	Refer to *Maintenance*: *9.2, 10.2 Replacing the Reduction Gear Unit*
Joint # 6	Bevel gear	Overhaul timing	SK-2	Refer to the next page.

Joint #1, 2, 3, 4, 5, 6 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.

Greasing Joint #6 bevel gear

	Name	Quantity	Note
Maintenance Part	Grease (SK-2)	Proper quantity	-
Tools	Screw M4×15 (length: 15 mm or more)	1	For unplugging
	Wiping cloth	1	For wiping grease

(1) Secure Arm #5 in the direction you can unplug the plug easily.

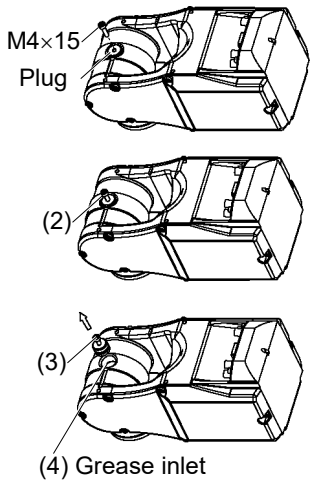
(2) Insert the screw into the screw part (M4 depth 5) of the plug.
Screw : M4 length 15 mm or more (easy-to-unplug)

(3) Hold the screw inserted in the step (2) and unplug the plug.

(4) Apply the grease.
Grease: SK-2
Grease amount : 2 g

(5) Insert the plug unplugged in the step (3) to the original position.
To prevent the grease leaking or unplugging, be sure to insert the plug all the way seated.

(6) Pull out the screw inserted in the step (2).



2.4 Tightening Hexagon Socket Head Bolts

Hexagon socket head cap bolts (hereinafter, “bolts”) are used in places where mechanical strength is required. These bolts are fastened with the tightening torque shown in the following tables.

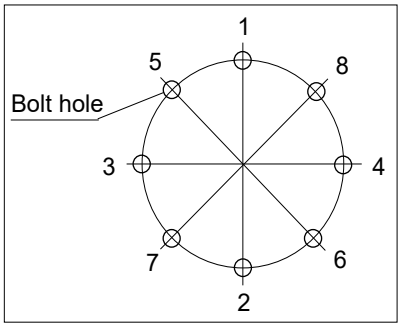
When it is required to refasten the bolts in some procedures in this manual (except special cases as noted), use a torque wrench so that the bolts are fastened with appropriate tightening torque as shown below.

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)

See below for the set screw.

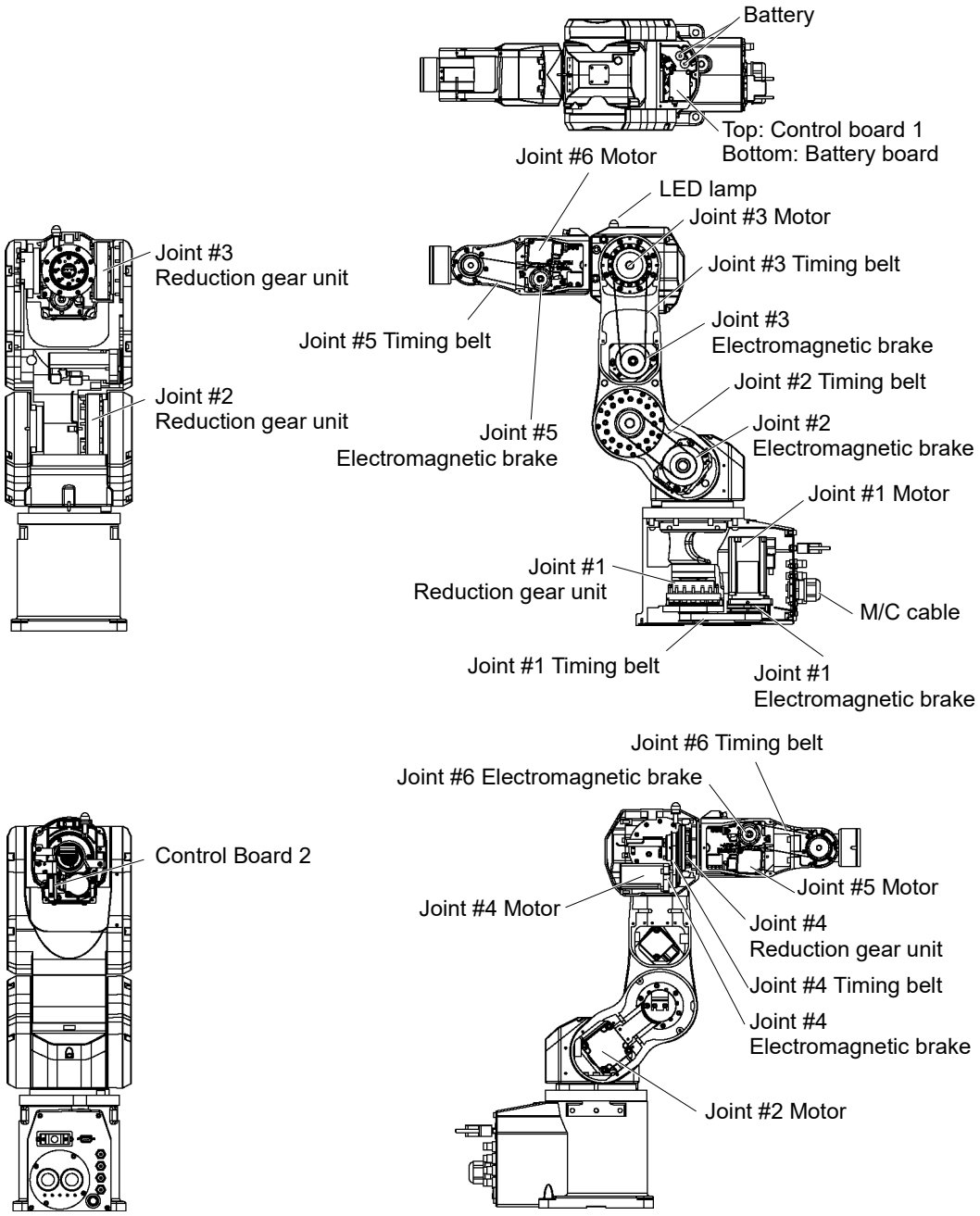
Set Screw	Tightening Torque
M4	2.4 ± 0.1 N·m (26 ± 1 kgf·cm)
M5	3.9 ± 0.2 N·m (40 ± 2 kgf·cm)

It is recommended to fasten the bolts aligned on a circumference in a crisscross pattern as shown in the figure below.



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

2.5 Layout of Maintenance Parts

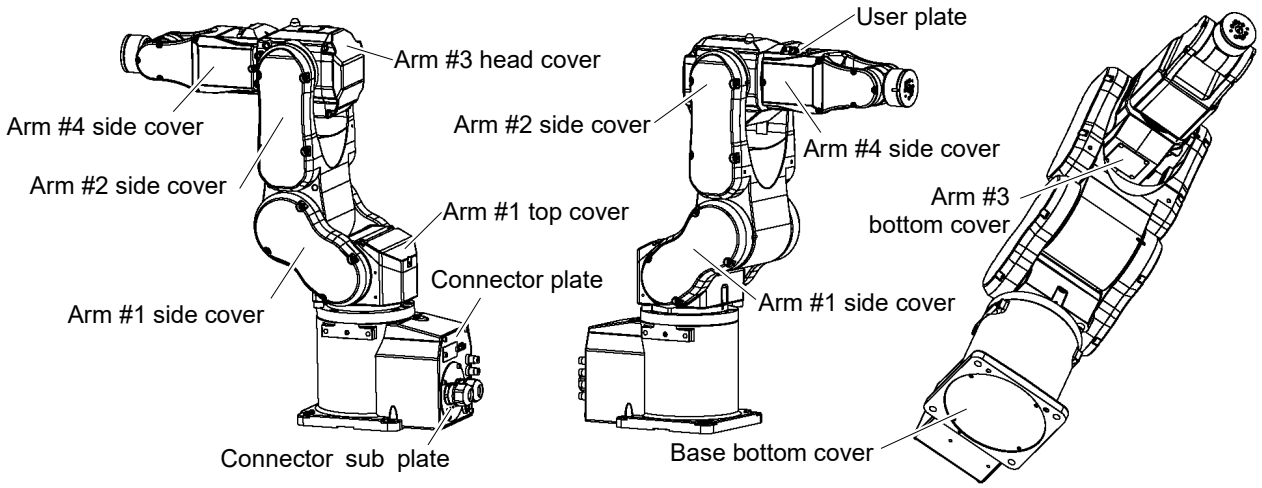


3. Covers

This chapter describes procedures for removing and installing covers and arm spacers in maintenance.

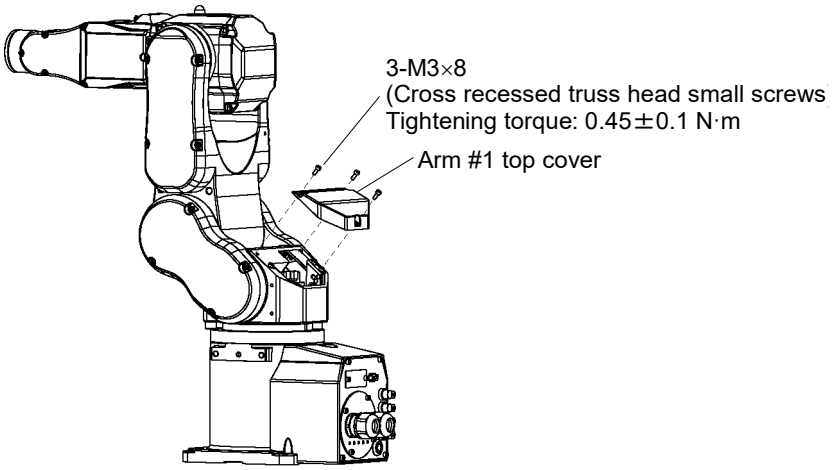
WARNING	■ Do not connect or disconnect the motor connectors while the power to the robot system is turned ON. Connecting or disconnecting the motor connectors with the power ON is extremely hazardous and may result in serious bodily injury as the Manipulator may move abnormally, and also may result in 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
Tools	Hexagonal wrench (width across flats: 2.5 mm)	1	For M3 hexagon socket head cap bolts
	Hexagonal wrench (width across flats: 3 mm)	1	For M4 hexagon socket head cap bolts
	Cross-point screwdriver	1	For covers



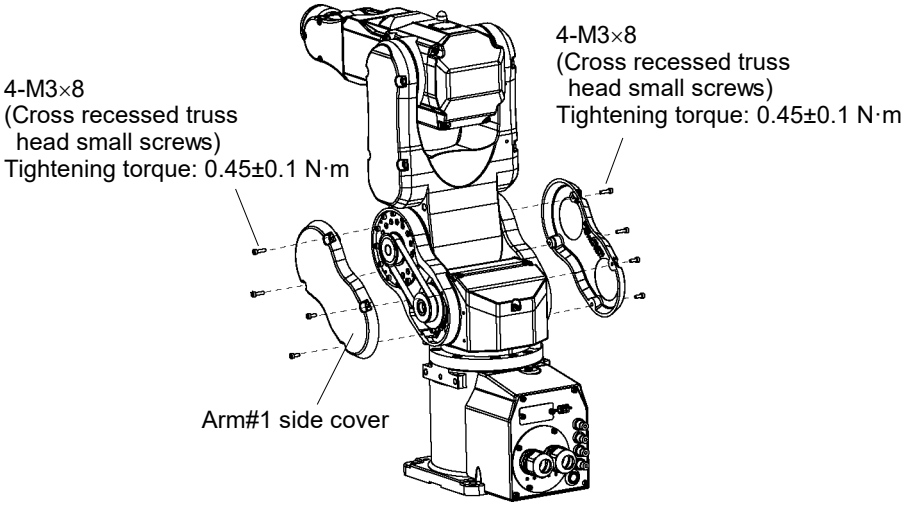
3.1 Arm #1 Top Cover

CAUTION	■ When mounting the cover, be careful not to get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the cover. Be sure to place the cables back to their original locations.



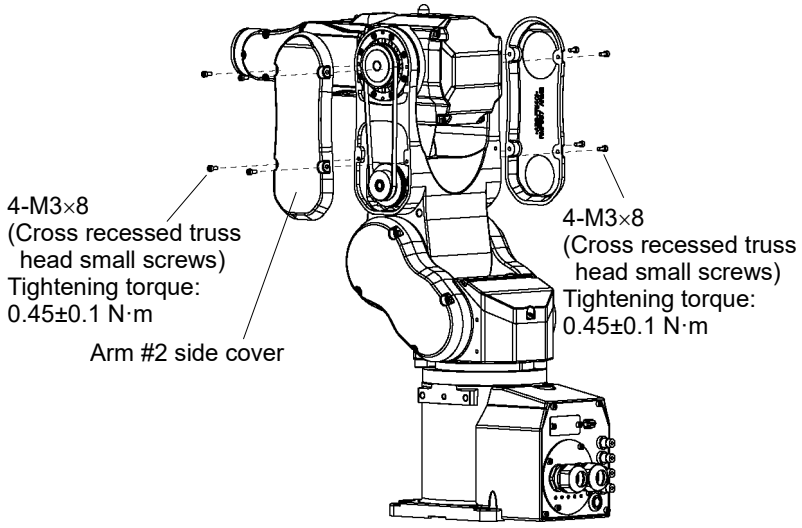
3.2 Arm #1 Side Cover

CAUTION	■ When mounting the cover, be careful not to get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the cover. Be sure to place the cables back to their original locations.



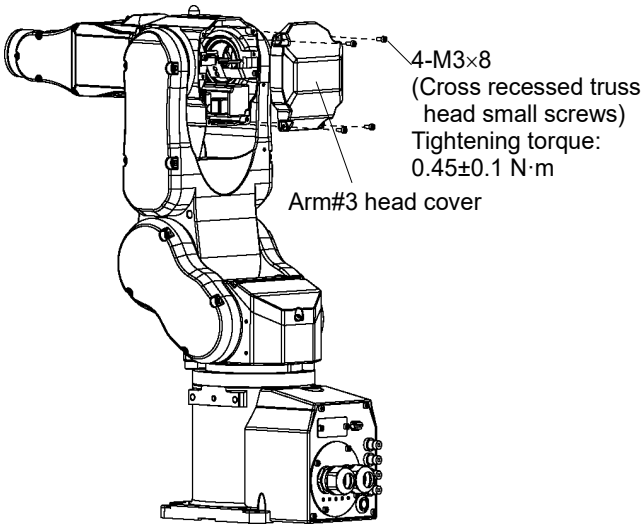
3.3 Arm #2 Side Cover

CAUTION	■ When mounting the cover, be careful not to get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the cover. Be sure to place the cables back to their original locations.



3.4 Arm #3 Head Cover

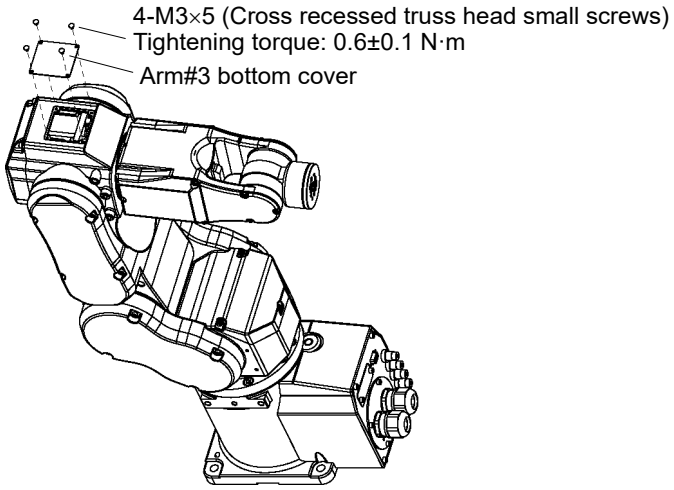
CAUTION	■ When mounting the cover, be careful not to get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the cover. Be sure to place the cables back to their original locations.



3.5 Arm #3 Bottom Cover

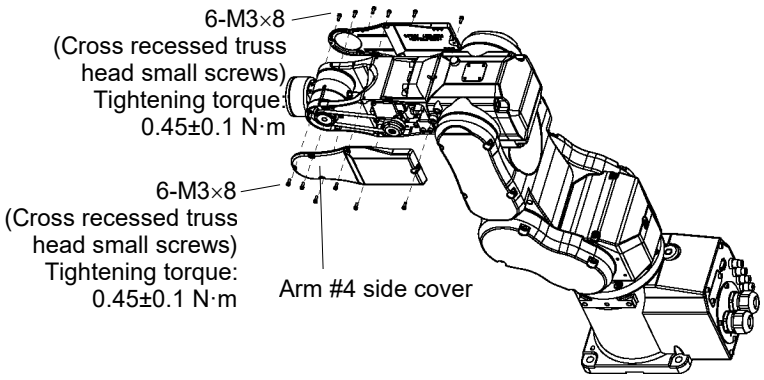
CAUTION	■ When mounting the cover, be careful not to get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the cover. Be sure to place the cables back to their original locations.

Before removing the Arm #3 bottom cover, move the arm to the position where you can remove the cover easily.



3.6 Arm #4 side cover

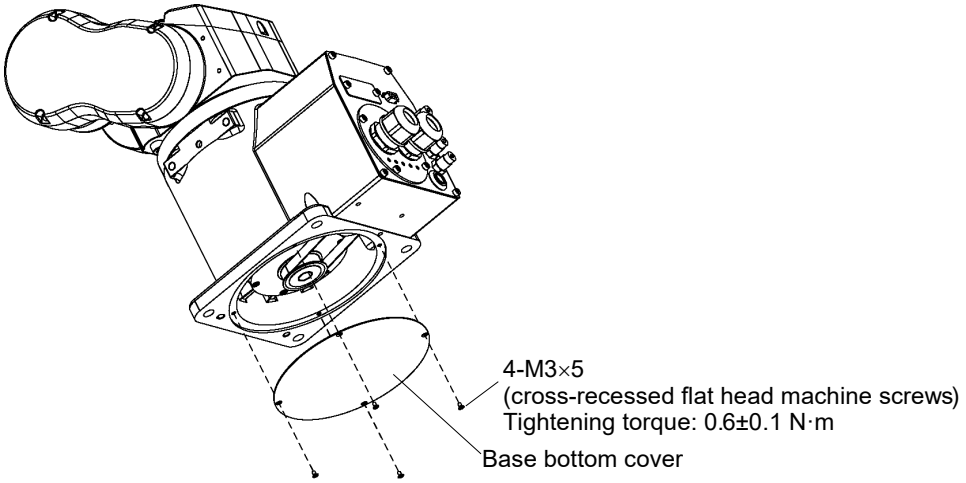
CAUTION	■ When mounting the cover, be careful not to get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the cover. Be sure to place the cables back to their original locations.



3.7 Base Bottom Cover

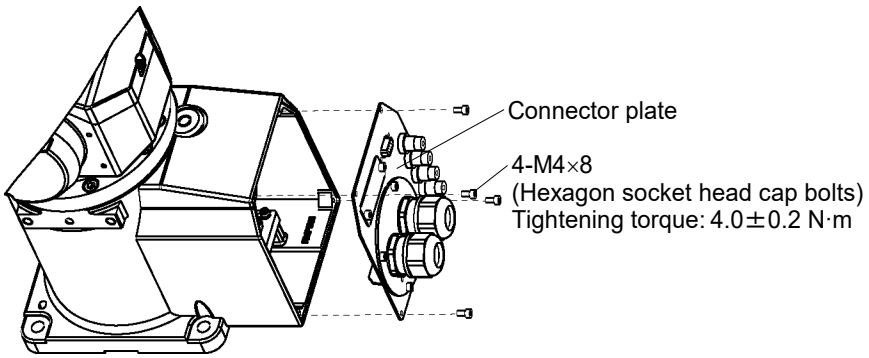
CAUTION	■ When mounting the cover, be careful not to get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the cover. Be sure to place the cables back to their original locations.

Remove the screws (cross-recessed flat head machine screws) securing the cover and remove the cover.
If you use the other screws than the screws indicated here, the screw head will protrude from the base surface and it will make it difficult to mount the Manipulator firmly. We recommend using our attached screws or equivalent ones.



3.8 Connector Plate

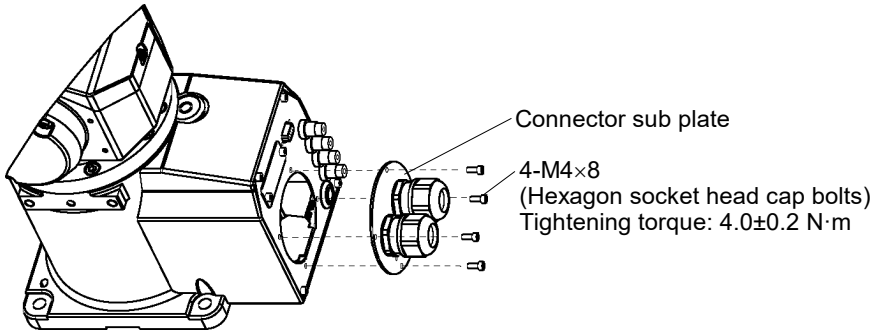
CAUTION	■ Do not remove the connector plate forcibly. Removing the connector plate forcibly may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system. ■ When installing the connector plate, be careful not to get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the connector plate. Be sure to place the cables back to their original locations.



3.9 Connector Sub Plate

CAUTION

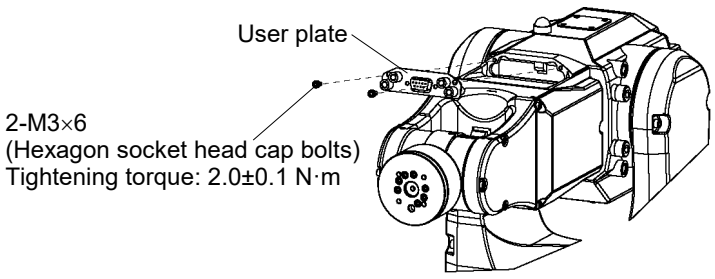
- Do not remove the connector sub plate forcibly. It may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system.
- When installing the connector sub plate, be careful not to get the cables caught in it or bend them forcibly to push into the cover.
  Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system.
  When routing the cables, check the cable locations at removing the connector sub plate. Be sure to place the cables back to their original locations.



3.10 User Plate

CAUTION

- Do not remove the connector plate forcibly. It may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system.
- When installing the user plate, be careful not to get the cables caught in it or bend them forcibly to push into the cover.
  Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system.
  When routing the cables, check the cable locations at removing the user plate. Be sure to place the cables back to their original locations.



4. Cable Unit

4.1 Replacing the Cable Unit

 WARNING	■ 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. ■ 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. ■ Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source. To shut off power to the robot system, disconnect the power plug from the power source. Performing any work while connecting the AC power cable to a factory power source 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 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.) Unnecessary strain on the cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. ■ When installing 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.

 CAUTION	■ When disconnecting the connectors during the replacement of the cable unit, be sure to reconnect the connectors to their proper positions. Improper connection of the connectors may result in improper function of the robot system. For details on the connections, refer to the *C4 Maintenance 4.2 Connector Pin Assignments.*

CAUTION	■ Carefully use alcohol and adhesive following respective instructions and also instructions below. Otherwise, it may cause a fire and/or safety problems. - Never put alcohol or adhesive close to fire. - Use alcohol or adhesive while ventilating the room. - Wear protective gear including a mask, protective goggles, and oil-resistant gloves. - If alcohol or adhesive gets on your skin, wash the area thoroughly with soap and water. - If alcohol or adhesive gets into your eyes or mouth, flush your eyes or wash out your mouth with clean water thoroughly, and then see a doctor immediately. ■ Wear protective gear including a mask, protective goggles, and oil-resistant gloves during grease up. 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.

	Name		Quantity	Note
Maintenance Parts	Cable unit	for C4-A601**	1	For part code, refer to the *17. C4 Maintenance Part List*
		for C4-A901**	1	
		for C4-A601**-UL	1	
		for C4-A901**-UL	1	
	Battery relay cable unit		1	1653173 (Reusable See “Note” below)
Tools	Hexagonal wrench (width across flats: 2.5 mm)		1	For M3 hexagon socket head cap bolt
	Hexagonal wrench (width across flats: 3 mm)		1	For M4 hexagon socket head cap bolt
	Box wrench (width across flats: 5 mm)		1	For D-Sub connector
	Long nose pliers		1	For removing air connector
	Nippers		1	
	Cross-point screwdriver		1	
	Brush		1	For applying grease
	Force gauge		1	For belt tension
	Torque rench		1	
Material	Alcohol		Proper quantity	
	Wire tie	AB100	9	
		AB150	11	
		AB250	2	

Note: The battery relay cable unit is reusable. If the cable or the connector clip is broken during replacement of the cable unit and battery, replace the cable unit. For details on the replacement, refer to Removal step (10) and Installation step (55) in *C4 Maintenance 4. Cable Unit.*

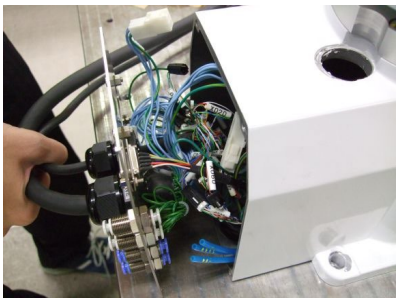
Removal: Cable unit

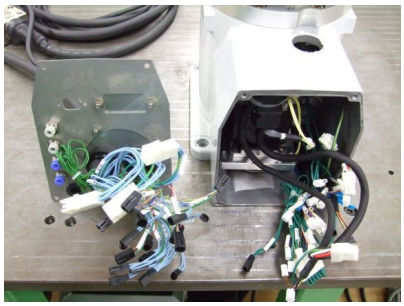
1. Move the Manipulator to the origin (0 pulse position).
2. Turn OFF the Controller power.
3. Remove the following covers and plates.
   For details, refer to *C4 Maintenance: 3. Covers*.

Arm #4 side cover (Both sides)	User plate
Arm #3 head cover	Arm #3 bottom cover
Arm #2 side cover (Both sides)	Arm #1 side cover (Both sides)
Arm #1 top cover	Connector plate

   When removing the user plate and the connector plate, remove the following parts together.
   - D-sub 9-pin connector
   - D-sub 15-pin connector
   - Air tube × 4

4. Disconnect the connectors inside the base.
   Connectors:
   X010, X020, X030, X040, X050, X060,
   LED, BR010, BR011, BR020, BR030,
   BR040, BR050, BR060, BT1,
   X11, X12, X13, X14, X15, X16, XGND,
   GS01,GS02





5. Remove the connector connected to the control board 1.
   Connector: GS01

6. Remove the control board 1 inside the Arm #1.

   Cross recessed head screws: 3-M3×8

7. Cross recessed head screws: 3-M3×8

   Connectors: 2 connectors for the batteries, BT-CN1, BT-CN2

8. Remove the battery board.

   Hexagon socket head cap bolts: 2-M3×8

9. Remove the battery unit.

   Hexagon socket head cap bolts: 2-M4×8

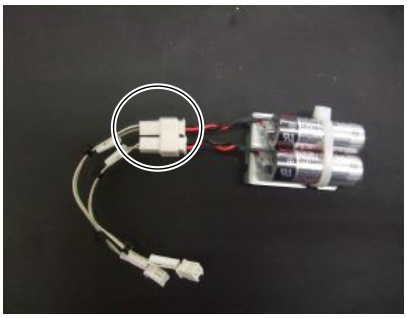
   The battery unit and battery relay cable will be used again.
   Be careful not to lose them.

   If you are replacing the battery relay cable, follow the step (10).

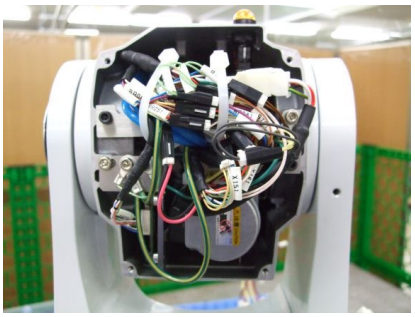
10. If replacing the battery relay cable:
    Remove the connectors connected to the battery.

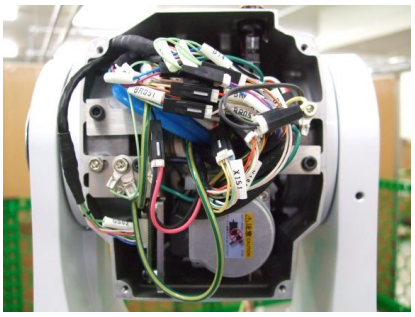
    Connectors: 2 connectors for the batteries, BT

    The battery unit will be used again.
    Be careful not to lose it.



11. Cut off the wire ties binding the cables inside the Arm #3.

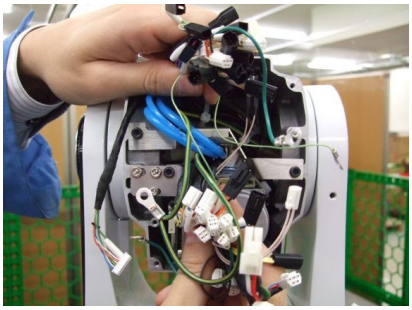




12. Remove the connectors inside the Arm #3.

    Connectors:
    X71, X72*, X041, X051, X061*,
    LED, BR041, BR051, BR061*,
    BT4, BT51, BT61*, X141, X151, X161*, XGND,
    GS02

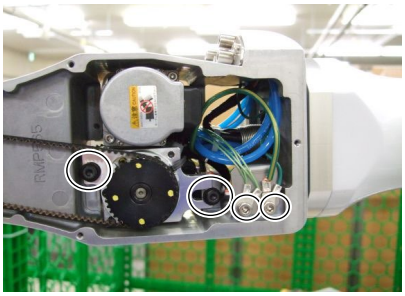
    *: X72, X061, BR061, BT61, and X161 may not be existed.



13. Remove the Arm #4 cable fixing plate (with the ground wires) from the Arm #4.

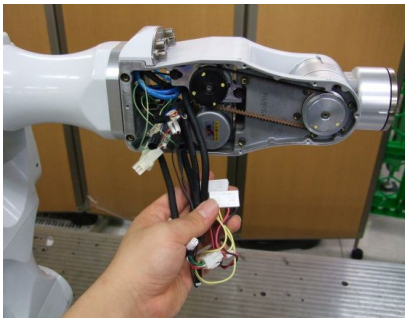
    Hexagon socket head cap bolts: 2-M4×8

    The Arm #4 cable fixing plate will be used again.
    Be careful not to lose it.



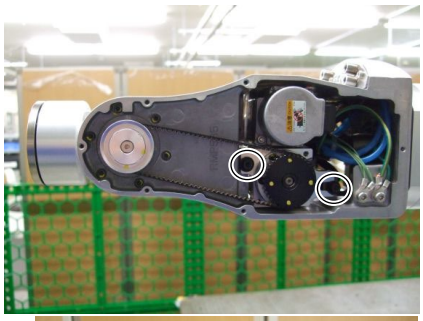
14. Remove the connectors inside the Arm #4.

    Connectors:
    X052, X152, BT52, BR052,
    X062, X162, BT62, BR062



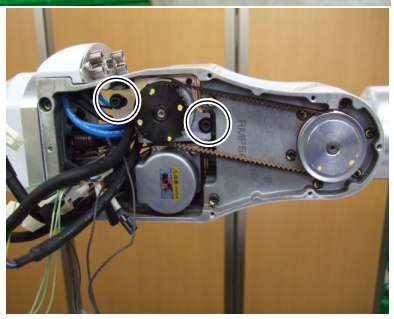
15. Remove the Joint #5 motor unit and the Joint #5 belt from the Arm #4.

    Hexagon socket head cap bolts: 2-M4×15 (with a plain washer)



16. Remove the Joint #6 motor unit and the Joint #6 belt from the Arm #4.

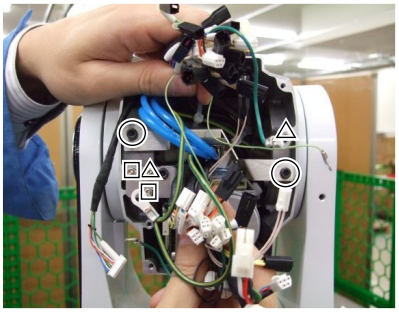
    Hexagon socket head cap bolts: 2-M4×15 (with a plain washer)



17. Cut off the following bands from the Arm #4 cable fixing plate.

    Cable band
    Coil plate fixing band

18. Remove the following parts from the Arm #3.



    Arm #3 cable fixing plate (circle)
      Hexagon socket head cap bolts: 2-M4×8

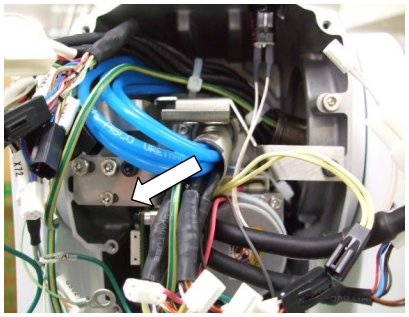
    Ground wire fixing bolts (triangle)
      Hexagon socket head cap bolts: 2-M4×8

    Control board 2 (square)
      Hexagon socket head cap bolt: 1-M4×10
      Hexagon socket head cap bolt: 1-M3×8

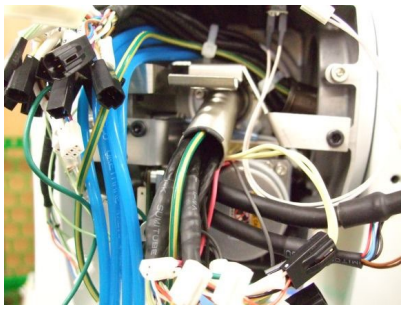
19. Cut off wire ties of the Arm #3 cable fixing plate.

    Cable band
    Coil plate fixing band

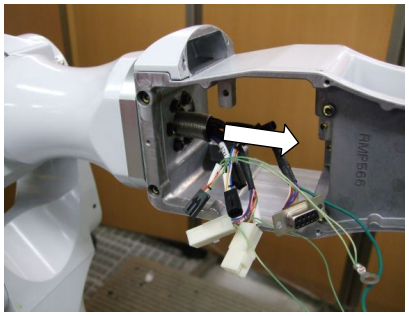
20. Pull out four air tubes and a ground wire from the Arm #3.
(See an arrow in the photo for pulling direction.)



The Arm #3 cable fixing plate will be used again.
Be careful not to lose it.



21. Pull out the following cables and a small diameter spring from the Arm #4. (See an arrow in the photo for pulling direction.)



Joint #5 motor cable and brake cable
Joint #6 motor cable, brake cable
Cable for installed wire for customer use

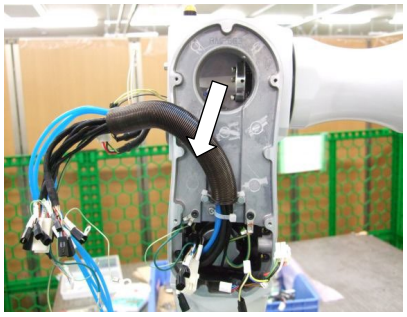
Connector:
X051, X061*, X151, X161*, XGND,
BR051, BR061*, BT51, BT61*

*: X061, X161, BR061, and BT61 may not be existed.

When pulling out the cables, carefully treat cables and connectors to prevent damage to them.

Pull out the cables in the order of connector size, from smallest to largest.

22. Pull out the Arm #3 cable unit from the Arm #2.
(See an arrow in the photo for pulling direction.)

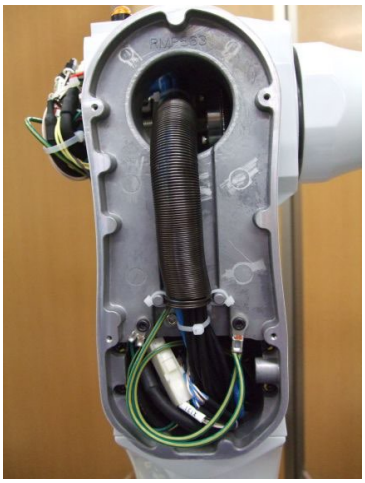


23. Disconnect the connectors of the Joint #3 motor and remove the Joint #3 motor.

    Connectors: X031, X131, BT3, BR031, D

    Hexagon socket head cap bolts: 2-M4×15 (with a plain washer)

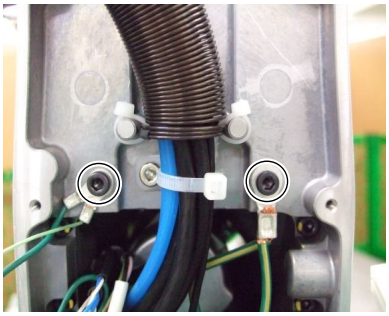
    Arm #3, #4, #5 and #6 lean when the motor is removed. Remove the motor after pushing the Arm to the stopper.
    Connector D will be used again. Be careful not to lose it.



24. Cut off the wire tie of the Arm #2.

25. Remove two ground wires.

    Hexagon socket head cap bolts: 2-M4×8



26. Remove the Arm #2 cable fixing plate.

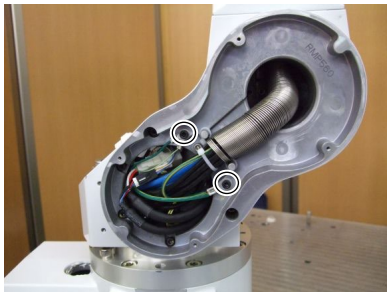
    Hexagon socket head cap bolts: 2-M4×8

    It is not necessary to remove the fixing bolts completely.
    Remaining the bolts on the Arm #2 makes it easy to mount the cable unit.
    Pull out the cables from the Arm #1.

27. Cut off the binding tie of the Arm #1.

28. Remove two ground wires.

    Hexagon socket head cap bolts: 2-M4×8



29. Disconnect the connectors of the Joint #2 motor and remove the Joint #2 motor.
    Connectors: X021, X121, BT2, BR021, D
    Hexagon socket head cap bolts: 3-M4×15 (with a plain washer)

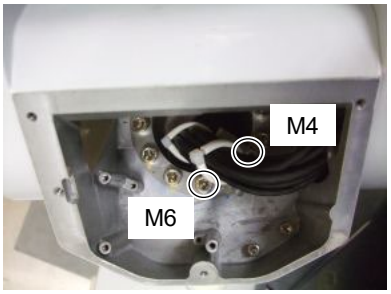
    Arm #3, #4, #5, and #6 lean when the motor is removed.

    Remove the motor after pushing the Arm to the stopper.

    Connector D will be used again. Do not lose it.

30. Remove the Arm #1 cable fixing plate.

    Hexagon socket head cap bolt: M4×8, M6×20

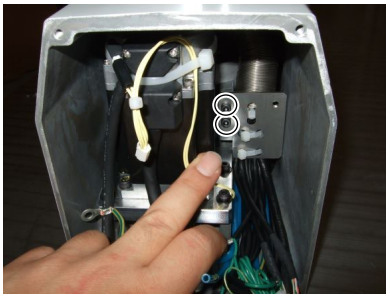


31. Cut off the wire tie of the Arm #1 cable fixing plate.
    The Arm #1 cable fixing plate will be used again.
    Be careful not to lose it.

32. Be careful not to lose it.

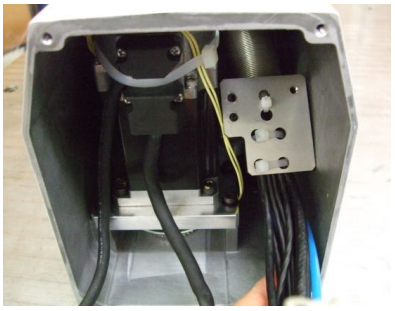
    Base cable fixing plate
    Hexagon socket head cap bolt: 2-M4×8

    Ground wire
    Hexagon socket head cap bolt: 4-M4×8

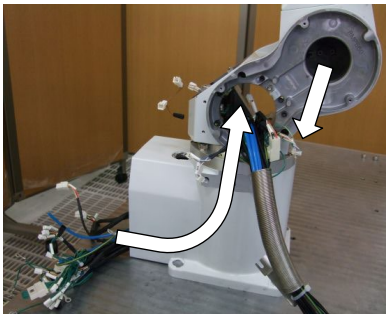


33. Cut off the wire tie of the base cable fixing plate.

    The base cable fixing plate will be used again.
    Be careful not to lose it.

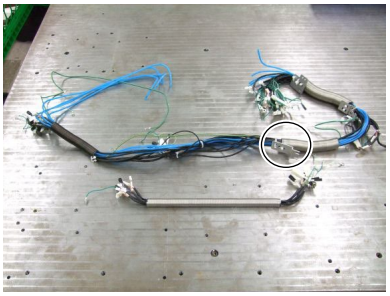


34. Pull out the cables in the Arm #2 and the base from the Arm #1.
    (See an arrow in the photo for pulling direction.)



35. Remove the Arm #2 cable fixing plate from the cables.

    The Arm #2 cable fixing plate will be used again.
    Be careful not to lose it.

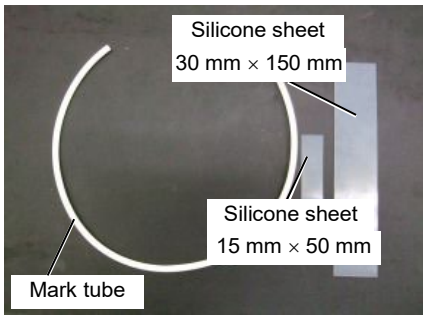


Installation: Cable unit

NOTE

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

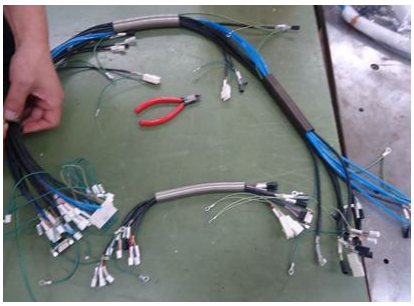
1. Check if the cable unit contains the following parts.
   Silicone sheet: 30 mm × 150 mm
   Silicone sheet: 15 mm × 50 mm
   Mark tube
   Wire tie: AB100, AB150, AB200



2. Separate the cable unit.

   Connectors:
   X051, X061, X151, X161, XGND, BR051, BR061,
   BT51, BT61, X71, X72, SW1

   This operation is not necessary if the cable unit is separated from the beginning.



3. Cut the mark tube into following length.
   68 mm × 2 (for fixing the J1 wire tie)
   65 mm (for fixing the J2 wire tie)
   23 mm × 2 (for fixing the J2 wire tie)
   21 mm × 2 (for fixing the J3 wire tie)
   57 mm × 2 (for fixing the J3 wire tie)
   46 mm (for fixing the J4 wire tie)

4. Grease the inside of the cable protection spring.

C4-A601**:		C4-A901**:	
Grease : Krytox 18 g		Grease : Krytox 19 g	
Spring : ø17.5 (Length: 130 mm)	: 3 g	Spring : ø17.5 (Length: 280 mm)	: 4 g
ø25 (Length: 130 mm)	: 5 g × 2	ø25 (Length: 130 mm)	: 5 g × 2
ø29 (Length: 130 mm)	: 5 g	ø29 (Length: 130 mm)	: 5 g

5. Secure the Arm #2 cable fixing plate and the cable unit.

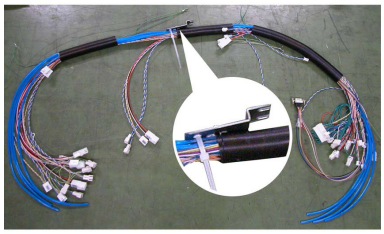


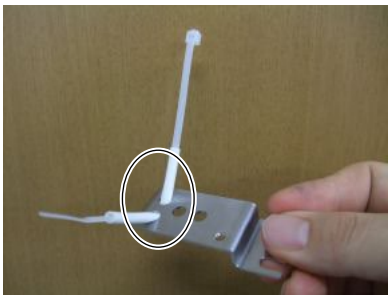
Plate and spring : Wire tie AB100

Cable unit and plate : Wire tie AB150, Mark tube 65 mm

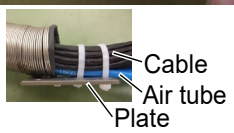
NOTE

Precautions for cable unit fixation to the plate:

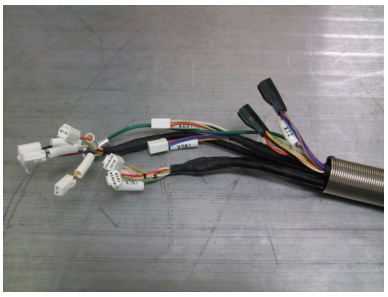
Pass the mark tube and the wire tie through the hole of the plate as shown in the photo on the right.



When installing the cable unit, place the plate, the air tube, and the cables as shown in the photo on the right (example), and then fix the plate and the cable unit with a wire tie.



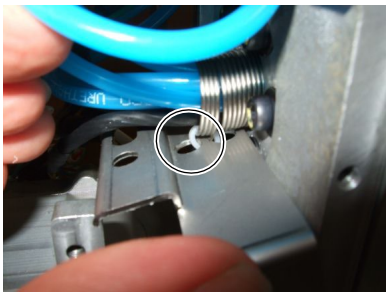
6. Insert the cable unit with the cable protection spring (ø 17.5) from the Arm #4.



7. Wrap the end of the spring to the Arm #4 cable fixing plate with a wire tie.

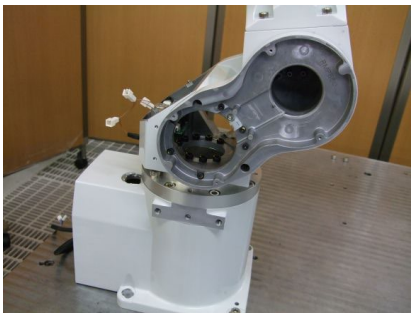
Wire tie: AB100 × 1

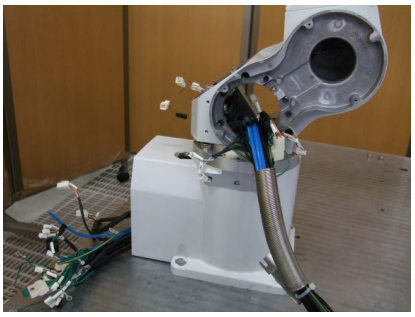
Number of turns of spring to fix: 3 turns



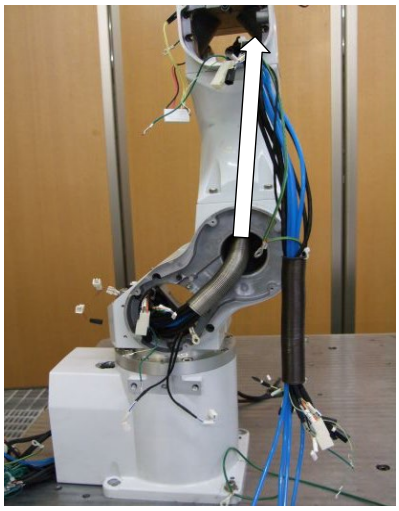
8. Insert the cable unit with the cable protection spring (ø 29) from the Arm #1 to the base side.

   Connectors to be passed through to the base:
   X12, X020, X030, X13, X040, X050, X060,
   X14, X15, X16, XGND, BR011, BR010, BT1,
   BR020, BR030, BR040, BR050, BR060,
   LED, SW1, GS01, GS02

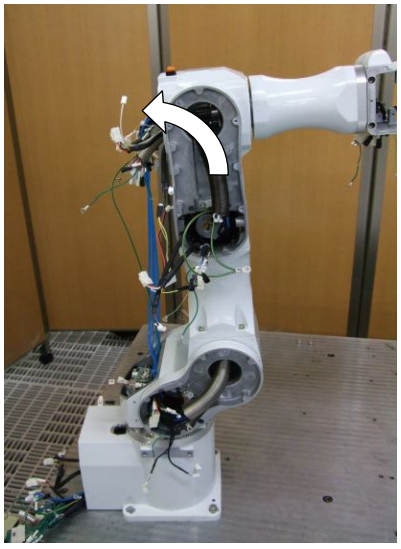




9. Pull the wrapped cables from the Arm #2.



10. Pass the cable unit to the Arm #3.



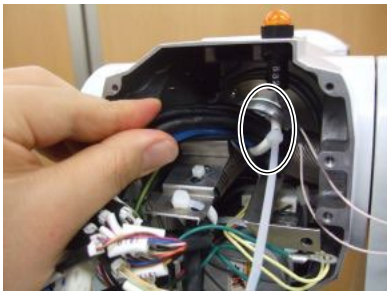
11. Fix the Arm #2 cable fixing plate to the Arm #2.
    Hexagon socket head cap bolt: 2-M4×8

12. Fix the cable protection spring (ø25, 130mm) of the Arm #2 to the Arm #3 cable fixing plate.

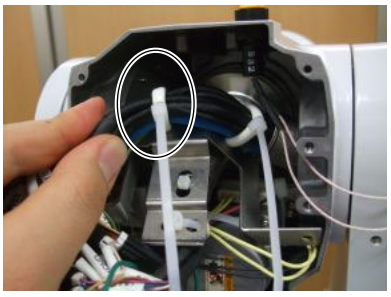
    Wire tie: AB100
    Number of turns of spring to fix: 3 turns

13. Temporally bind two cables.

    Wire tie: AB150 × 2
    Mark tube: 57 mm × 2

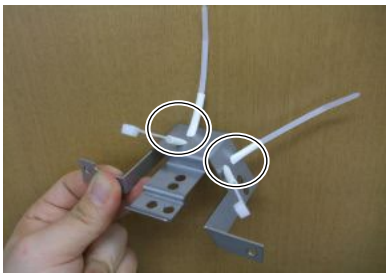


    Temporarily bind the cables so that their position can be adjusted later.

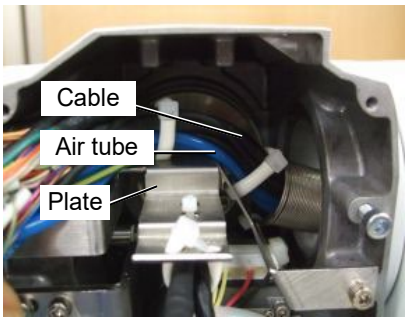


    Precautions for cable unit fixation to the plate:

NOTE ☞ Pass the mark tube and the wire tie through the hole of the plate as shown in the photo on the right.



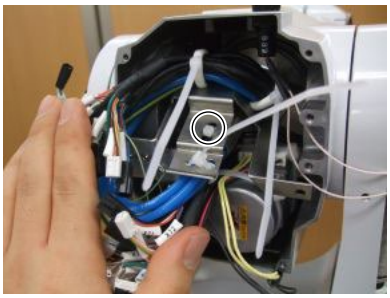
When installing the cable unit, place the plate, the air tube, and the cables as shown in the photo on the right (example), and then fix the plate and the cable unit with a wire tie.



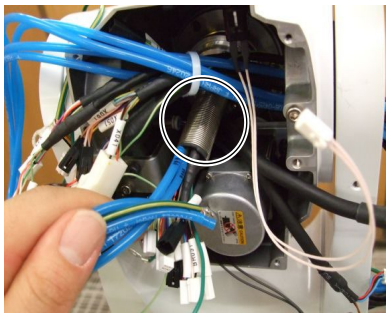
14. Fix the cable protection spring (ø17.5) to the Arm #3 cable fixing plate.

    Wire tie: AB100

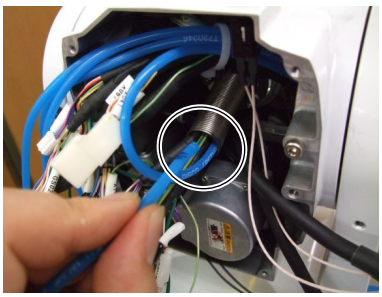
    Number of turns of spring to fix: 3 turns

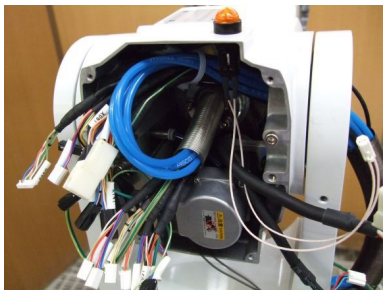


15. Pass the four air tubes and the ground wire of the cable unit through the cable protection spring (ø 17.5) and pull them out from the Arm #4.



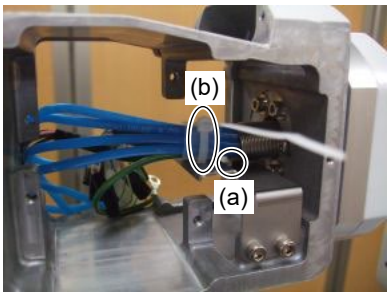
Pass the air tubes through the space on the upper side of the spring.





16. Wrap the end of the spring to the fixing plate with a wire tie. (a)
Temporally bind the cables to the Arm #4 cable fixing plate. (b)

Wire tie: AB150
Silicone sheet: 15 mm × 50 mm

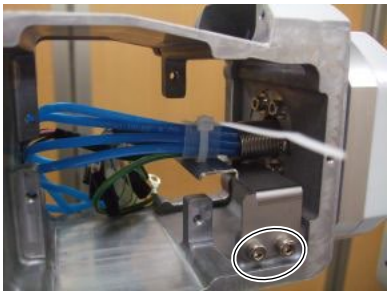


Precautions for cable unit fixation to the plate

NOTE Place the silicone sheet on the plate as shown in the photo on the right (example). Fix the wire tie at the center of the silicone sheet.

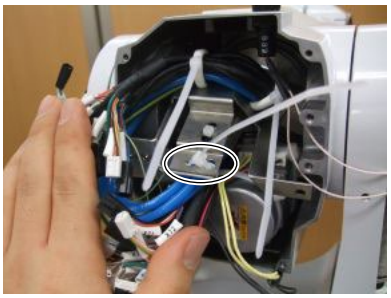
17. Temporarily fix the Arm #4 cable fixing plate to the Arm #4.

Hexagon socket head cap bolt: 2-M4×10



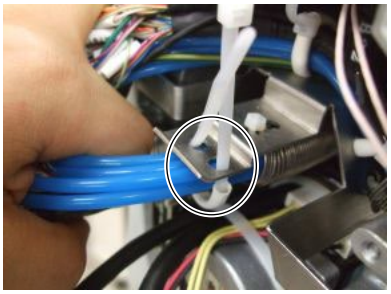
18. Temporarily bind the cables coming from the Arm #4.

Wire tie: AB150
Mark tube: 46 mm

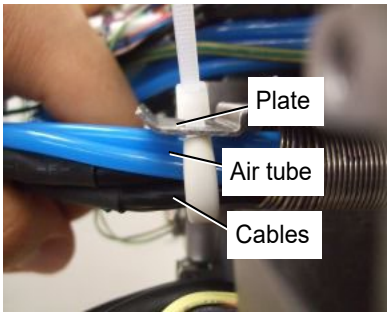


Precautions for cable unit fixation to the plate:

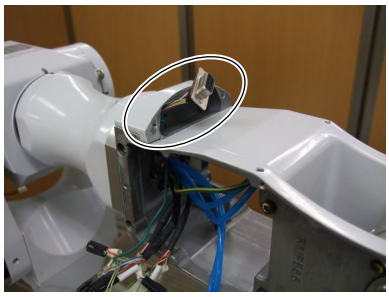
NOTE Pass the mark tube and the wire tie through the hole of the plate as shown in the right photo.



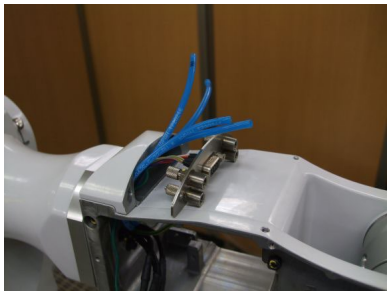
When installing the cable unit, place the plate, the air tube, and the cables as shown in the right photo (example), and then fix the plate and the cable unit with a wire tie.



19. Disconnect the D-sub connector to the user plate installation part.

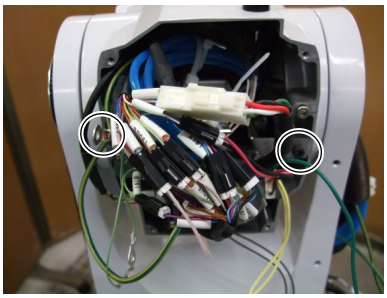


20. Install the D-sub connector to the user plate.



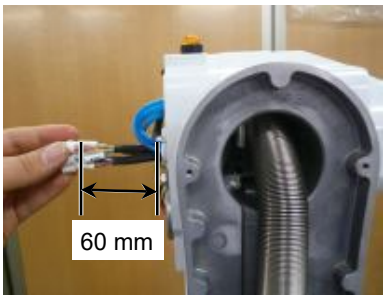
21. Temporarily fix the Arm #3 cable fixing plate to the Arm #3.

    Hexagon socket head cap bolt: 2-M4×8



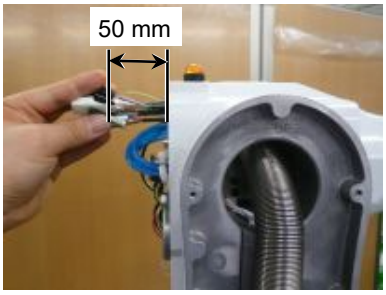
22. Adjust length of each cable and air tube inside the Arm #3.

Length of the cable passed through the Arm #4:
From the Arm #3 cable fixing plate to each connector: 60 mm



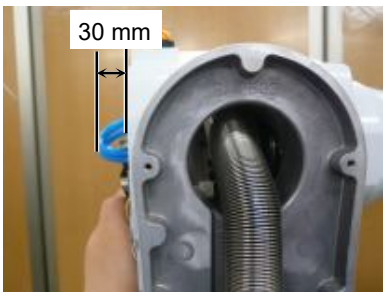
Connector: X151, X161*, XGND, X051, X061*, BR051, BR061*, BT51, BT61*, X71, X72*
*: X161, X061, BR061, BT61, and X72 may not be existed.

Length of the cable passed through the Arm #3:
From the Arm #3 cable fixing plate to each connector: 50 mm

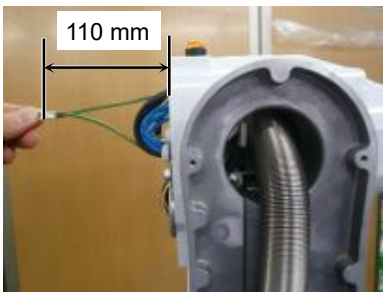


Connector: X141, X151, X161*, XGND, X041, X051, X061*, BR041, BR051, BR061*, LED, BT4 (BT51, BT61*), X71, X72*
*: X161, X061, BR061, BT61, and X72. may not be existed.

Air tube length:
From the Arm #3 to the air tube: 30 mm

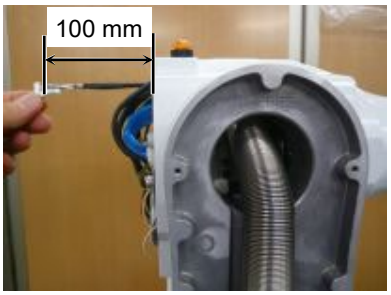


Ground wire length:
From the Arm #3 cable fixing plate
To the ground terminal: 110 mm

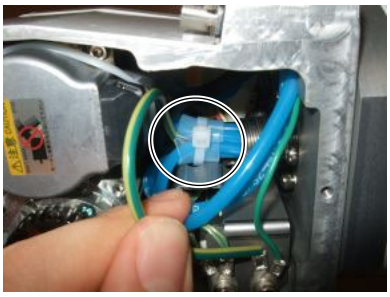


Length of the control board 2 cable passed through the Arm #3:
From the Arm #3 to the control board 2 connector: 100 mm

Connector: GS02

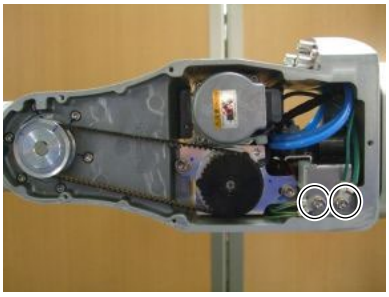


23. Fix the cables temporarily fixed with a wire tie.



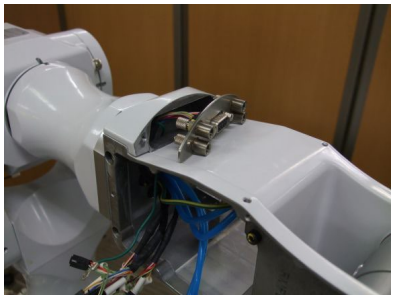
24. Install the ground wires to the fixing screws on the Arm #4 cable fixing plate, and tighten the temporarily fixed screws.
Adjust orientation of terminals as shown in the photo.

Circle (right): Ground terminal, user wire's ground terminal
Circle (left): X052/X062 ground terminal,
X152/X162 ground terminal

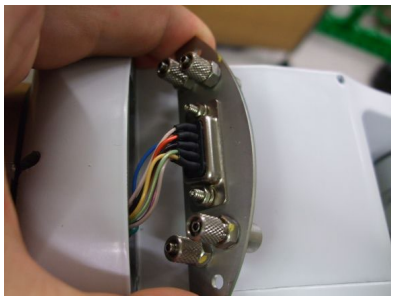


25. Fix the cables temporarily fixed to the Arm #3 cable fixing plate.

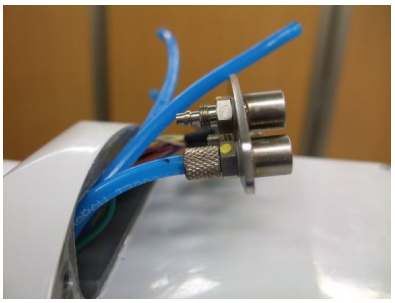
26. Install the D-sub connector to the user plate.



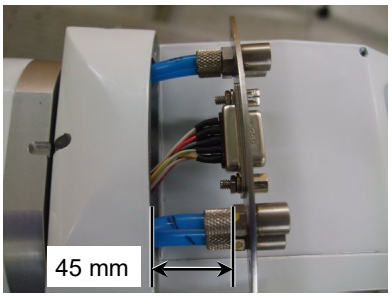
Be careful of the direction of the user plate.



27. Install the air tubes to the user plate fittings.



Air tube projection length: 45 mm

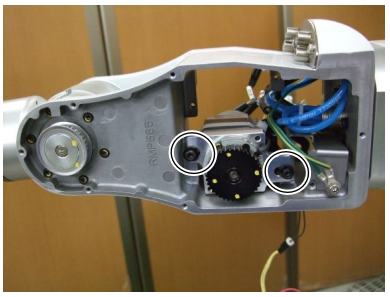


28. Install the user plate to the Arm #4.

Hexagon socket head cap bolt: 2-M3×6

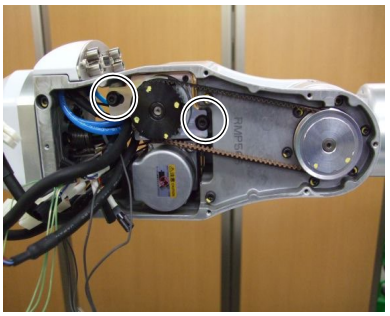
29. Fix the Joint #5 motor unit to the Arm #4 temporarily and place the Joint #5 timing belt on the pulleys.

Hexagon socket head cap bolts: 2-M4×15 (with a plain washer)



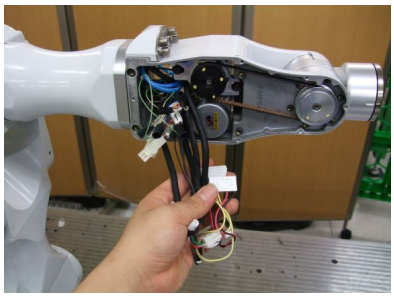
30. Fix the Joint #6 motor unit to the Arm #4 temporarily and place the Joint #5 timing belt on the pulleys.

Hexagon socket head cap bolts: 2-M4×15 (with a plain washer)

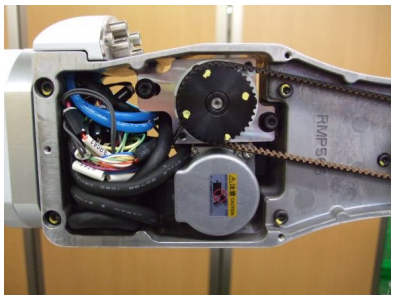


31. Connect the Joint #5 and Joint #6 motor connectors.

    Connectors:
    X052, X062, X152, X162, BR052, BR062, BT52, BT62



32. Put the connected connectors in the Arm #4.

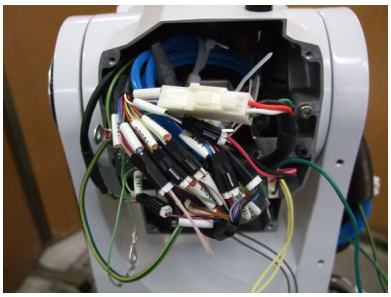


33. Connect the connectors inside the Arm #3.

    Hexagon socket head cap bolts: 2-M4×8

    Connectors:
    X71, X72*, X041, X051, X061*, LED, BR041, BR051, BR061*, BT4, BT51, BT61*, X141, X151, X161*, XGND

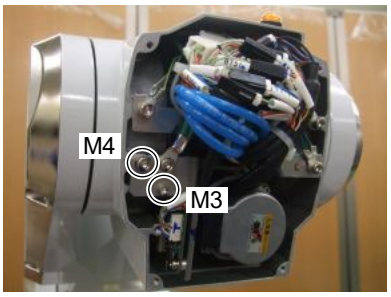
    *: X72, X061, BR061, BT61, and X161 may not be existed.



34. Fix the control board 2 to the Arm #3 and connect the connectors.

    Control board 2
    Hexagon socket head cap bolt: 1-M4×10
    Hexagon socket head cap bolt: 1-M3×8

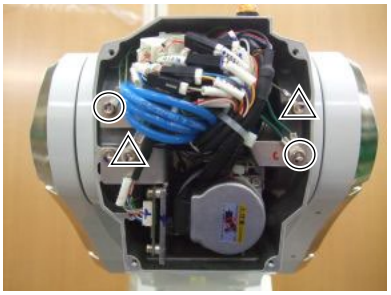
    Connector: GS02



35. Fix the ground wires.
    Install the following ground terminals to the parts marked with circles, and fix together with the Arm #3 cable fixing plate. Then, tighten the temporarily fixed bolts.

    Circle (right): X71/X72 ground terminals (J3),
    X71/X72 ground terminals (J4)

    Circle (left): X061* ground terminal, X041 ground terminal
    *: Use X051 ground terminal if X061 is not existed.



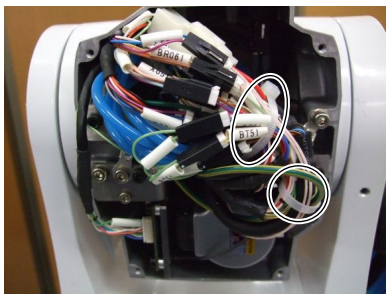
    Install the following ground terminals to the parts marked with triangles.
    Hexagon socket head cap bolt: 2-M4×8
    Triangle (right): X141 ground terminal
    Triangle (left): Ground wire terminal

    Adjust the orientation of terminals as shown in the photo on the right.

36. Put the cables temporarily fixed to the Arm #3 cable fixing plate together and fix them.

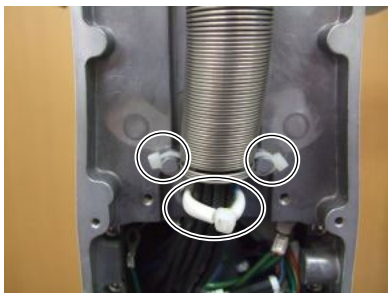
    Bind the Arm #3 cables and the connectors with a wire tie.

    Wire tie: AB200 (2 ties)



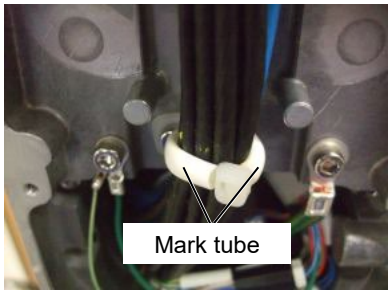
37. Fix the cable protection spring (ø25 Length: 130 mm) to the Arm #2.

    Wire tie: AB100 (2 ties)



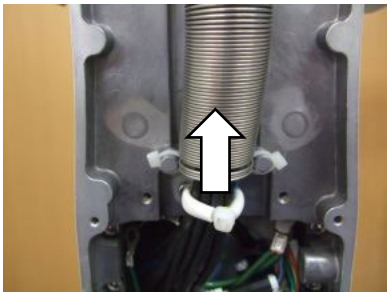
38. Temporarily fix the cables to the cable binder.

    Wire tie: AB150
    Mark tube: 21 mm (2 tubes)



39. Push the cables in the direction of an arrow in the photo on the right, and fix the cable temporarily fixed by the wire tie.

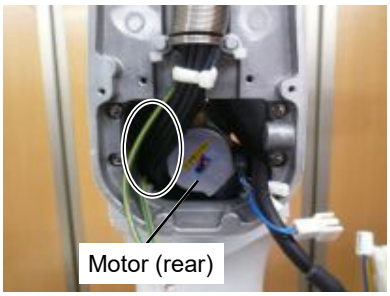
    Pushing depth: 10 mm



40. Temporarily fix the Joint #3 motor unit to the Arm #2 and place the Joint #3 timing belt to the pulleys.

    Hexagon socket head cap bolts: 2-M4×15 (with a plain washer)

    Pass the cables to the left side of the motor's rear side as shown in the photo.



41. Connect the Joint #3 motor connectors and put them in the Arm #2.

    Connectors: X031, X131, BR031, BT3

42. Fix two ground wires to the Arm #2.

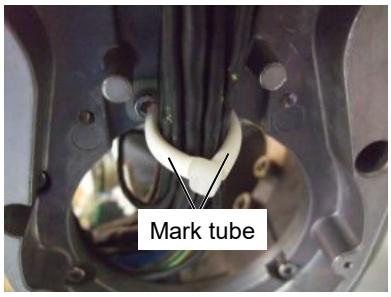
    Hexagon socket head cap bolts: 2-M4×8
    Circle (right): X031 ground terminal, X131 ground terminal
    Circle (left): Ground wire terminal

43. Fix the cable protection spring (ø 25 Length: 130 mm) to the Arm #1.

    Wire tie: AB100 (2 ties)

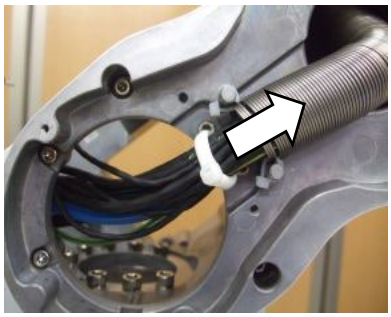
44. Temporarily fix the cables to the cable binder.

    Wire tie: AB150
    Mark tube: 23 mm (2 tubes)



45. Push the cable in the direction of an arrow in the photo on the right, and fix the cable temporarily fixed by the wire tie.

    Pushing depth: 6 mm



46. Fix the cable protection spring (ø25, 130 mm) to the Arm #1 cable fixing plate.

    Wire tie: AB100 (2 ties)
    Number of turns of spring to fix: 3 turns

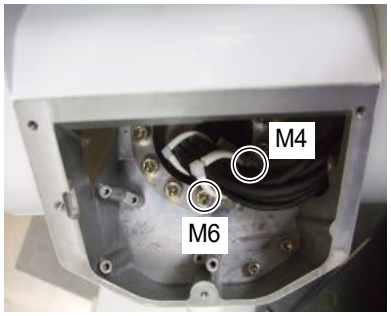
47. Temporarily fix the cables to the Arm #1 cable fixing plate.

    Wire tie: AB150 (2 ties)
    Mark tube: 68 mm (2 tubes)

    Set the heads of the wire ties to the side of the cables as shown in the photo on the right.

48. Fix the Arm #1 cable fixing plate to the Arm #1.

    Hexagon socket head cap bolt: M4×8, M6×20
    M6 tightening torque: 17.6 N·m (180 kgf·cm)



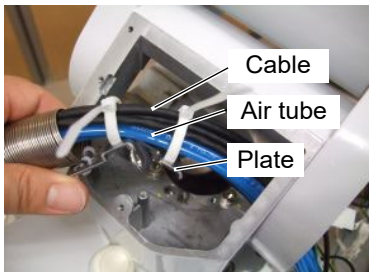
49. Fix the cables temporarily fixed by the wire tie.

Precautions for cable unit fixation to the plate:

NOTE

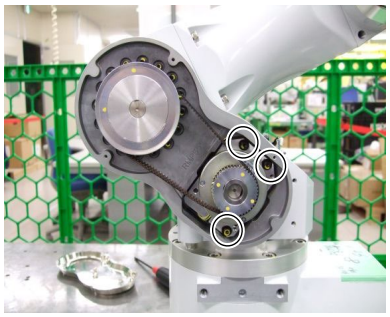
For the upper side, pass the mark tube and the wire tie through the hole of the plate and wrap around the cutout. For the lower side, pass the other mark tube and the wire tie through the hole of the plate, as shown in the photo on the right.

When installing the cable unit, place the plate, the air tube, and the cables as shown in the photo on the right (example), and then fix the plate and the cable unit with a wire tie.



50. Temporarily fix the Joint #2 motor unit to the Arm #1 and place the Joint #2 timing belt to the pulleys.

    Hexagon socket head cap bolts: 3-M4×15 (with a plain washer)

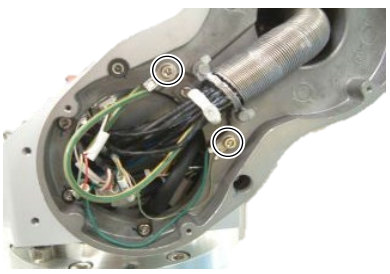


51. Connect the Joint #2 motor connectors and put them in the Arm #2.

    Connector: X021, X121, BR021, BT2

52. Fix the ground wires to the Arm #2.

    Hexagon socket head cap bolts: 2-M4×8
    Circle (right): X021 ground terminal, X121 ground terminal
    Circle (left): ground wire terminal



53. Install the battery board.

    Hexagon socket head cap bolts: 2-M3×8
    Tightening torque: 0.7 ± 0.05 N·m

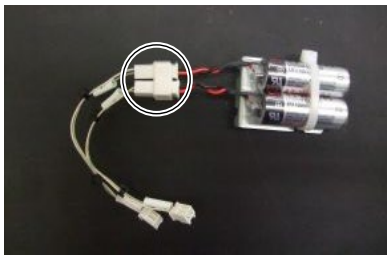
54. Install the connector to the battery board.

    Connector: CN3

55. * If you are not replacing the battery relay cable, go to the step (56).

    If replacing the battery relay cable:
    Install the connectors to the battery unit.

    Connector: BT (2 connectors)
    (The connectors can be installed on either side)



56. Install the connectors to the battery board.

    Connector: 2 connectors for the batteries, BT-CN1, BT-CN2, CN3

    Wire tie: AB100

57. Install the control board 1 to the Arm #1 and connect the connector.

    Cross recessed head screws: 3-M3×8

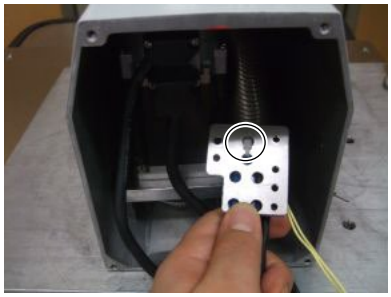
    Tightening torque: 0.45 ± 0.1 N·m

    Connector: GS01

58. Bind the cable protection spring (ø29, 130 mm) to the base cable fixing plate.

    Wire tie: AB100

    Number of turns of spring to fix: 3 turns

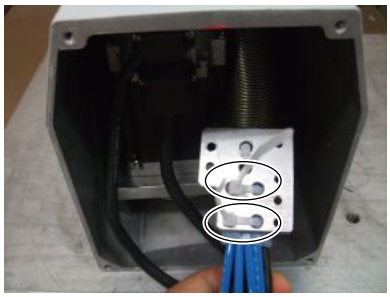


59. Wrap the silicone sheet around the cables as shown in the photo on the right.

    Silicone sheet: 30 mm × 150 mm

60. Temporarily bind the cables wrapped with the silicone sheet to the base cable fixing plate.

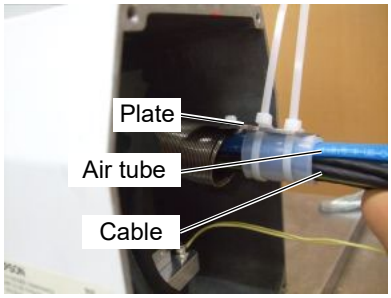
    Wire tie: AB150 (2 ties)



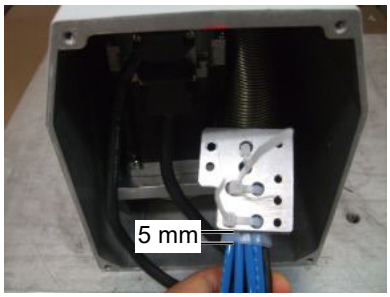
NOTE

Precautions for cable unit fixation to the plate

When installing the cable unit, place the plate, the air tube, and the cables as shown in the photo on the right (example), and then fix the plate and the cable unit with a wire tie.

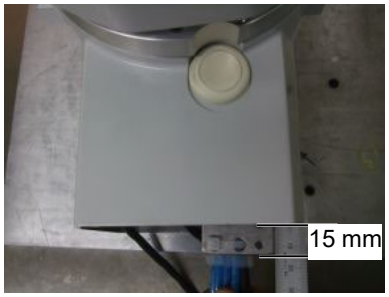


Fix the cables with the wire ties so that the silicone sheet projects 5 mm from the base cable plate.



61. Pull the cable out and adjust the plate position.

    Plate position: 15 mm



Fix the cable temporarily fixed by the wire tie.

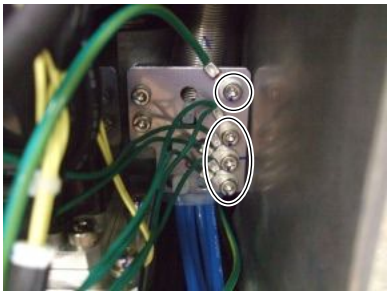
62. Fix the base cable fixing plate to the base.

    Hexagon socket head cap bolt: 2-M4×8

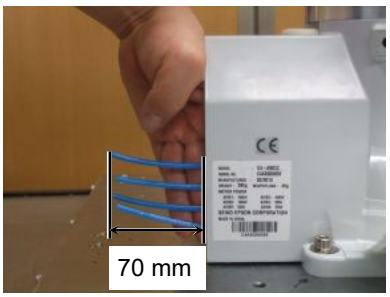
63. Fix the ground wires to the base cable fixing plate.
    Fix the ground wire terminal to the upper circled part.
    Fix the other ground terminals coming from the connectors to the lower circled part.
    Bind two ground wires together and fix to the three screw points.

    Hexagon socket head cap bolts: 4-M4×8

    Adjust orientation of the terminals and fix them as shown in the photo on the right.

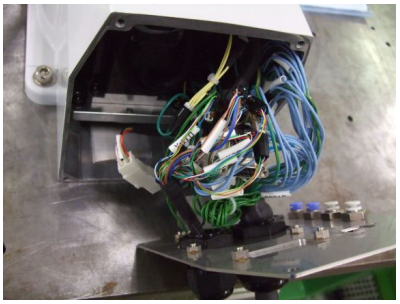


64. Cut the air tubes to the same length
    (about 70 mm from the end surface of the base).



65. Insert the air tubes to the air tube fitting on the connector plate.
66. Connect the connectors to the M/C cable.

    Connector:
    X010, X020, X030, X040, X050, X060,
    LED, BR010, BR011, BR020, BR030,
    BR040, BR050, BR060,
    BT1, X11, X12, X13, X14, X15, X16, XGND,
    GS01, GS02



67. Connect the D-sub 9-pin connector and the D-sub 15-pin connector to the connector plate.
68. Apply tension to the Joint #5 motor unit and fix it.

    For details, refer to *C4 Maintenance: 9.1 Joint #5 – Replacing the Motor*, Installation step 6.

69. Apply tension to the Joint #6 motor unit and fix the joint #6 motor unit.

    For details, refer to *C4 Maintenance: 10.1 Joint #6 – Replacing the Motor*, Installation step 6.

70. Apply tension to the Joint #3 motor unit and fix it.

    For details, refer to *C4 Maintenance: 7.1 Joint #3 – Replacing the Motor*, Installation step 6.

71. Apply tension to the Joint #2 motor unit and fix it.

    For details, refer to *C4 Maintenance: 6.1 Joint #2 – Replacing the Motor*, Installation step 6.

72. Mount the following covers and plates.

Arm #3 head cover	Arm #3 bottom cover
Arm #2 side cover (Both sides)	Arm #1 side cover (Both sides)
Arm #1 top cover	Connector plate

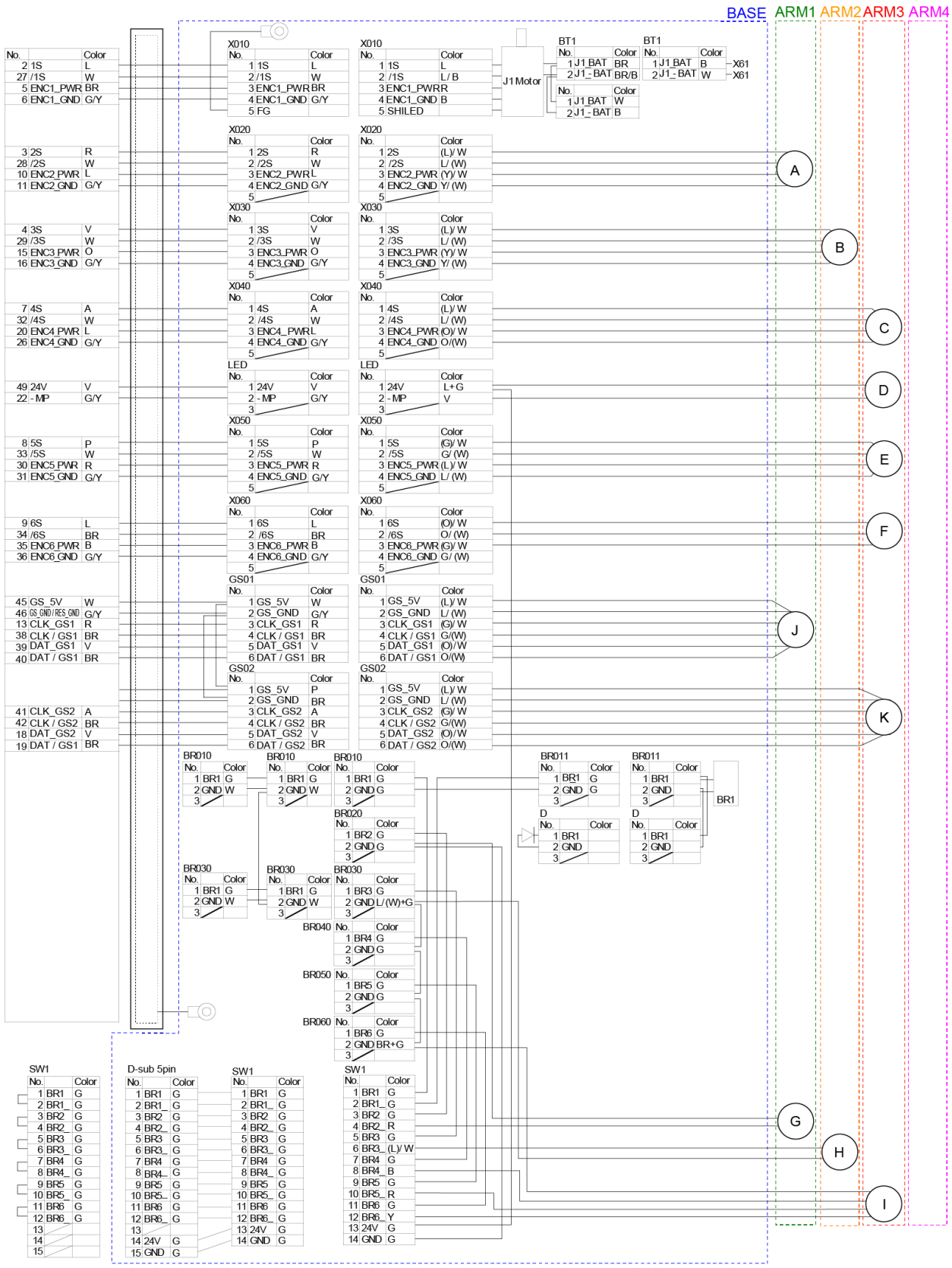
    For details, refer to *C4 Maintenance: 3. Covers*.

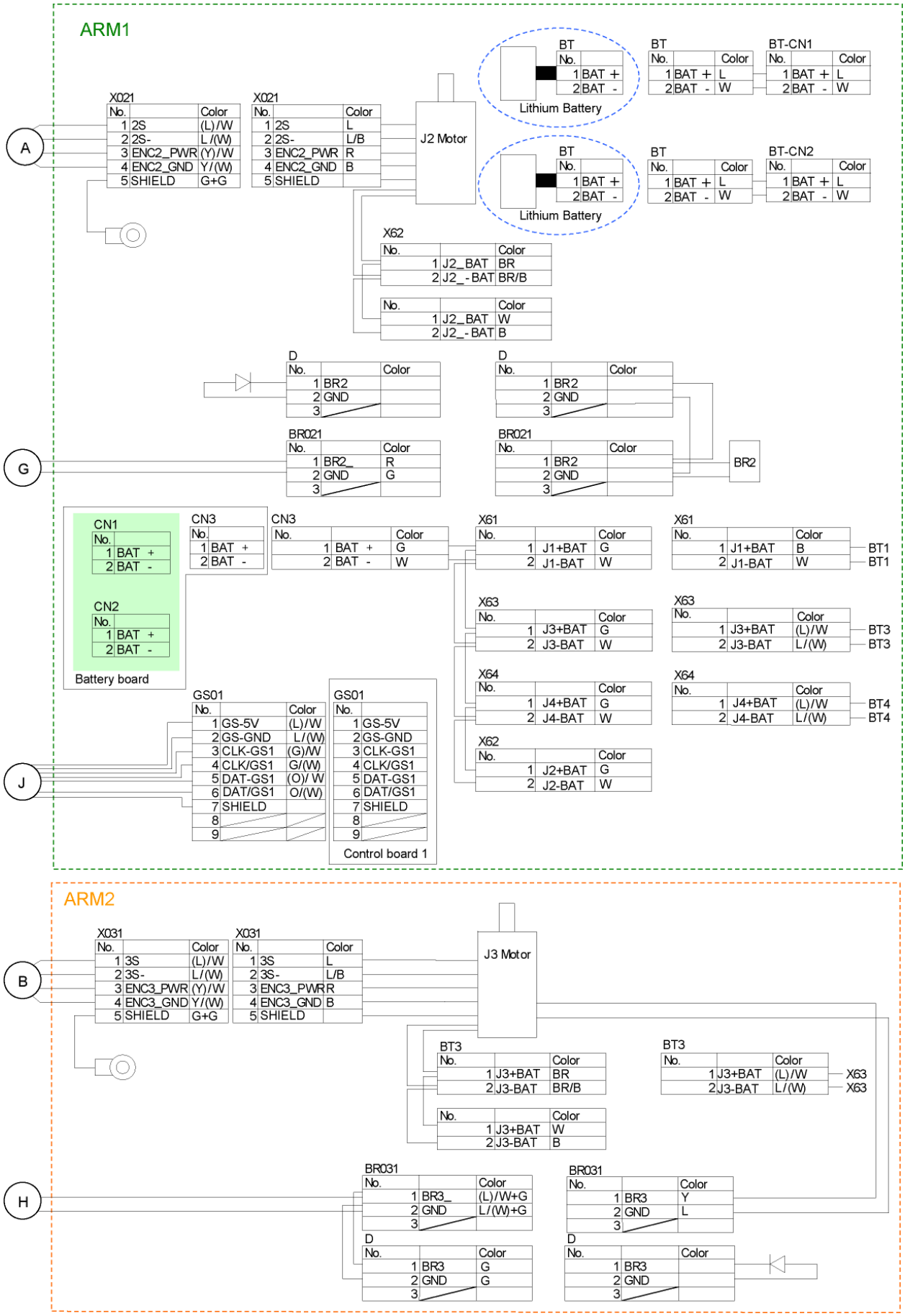
73. Perform the calibration.

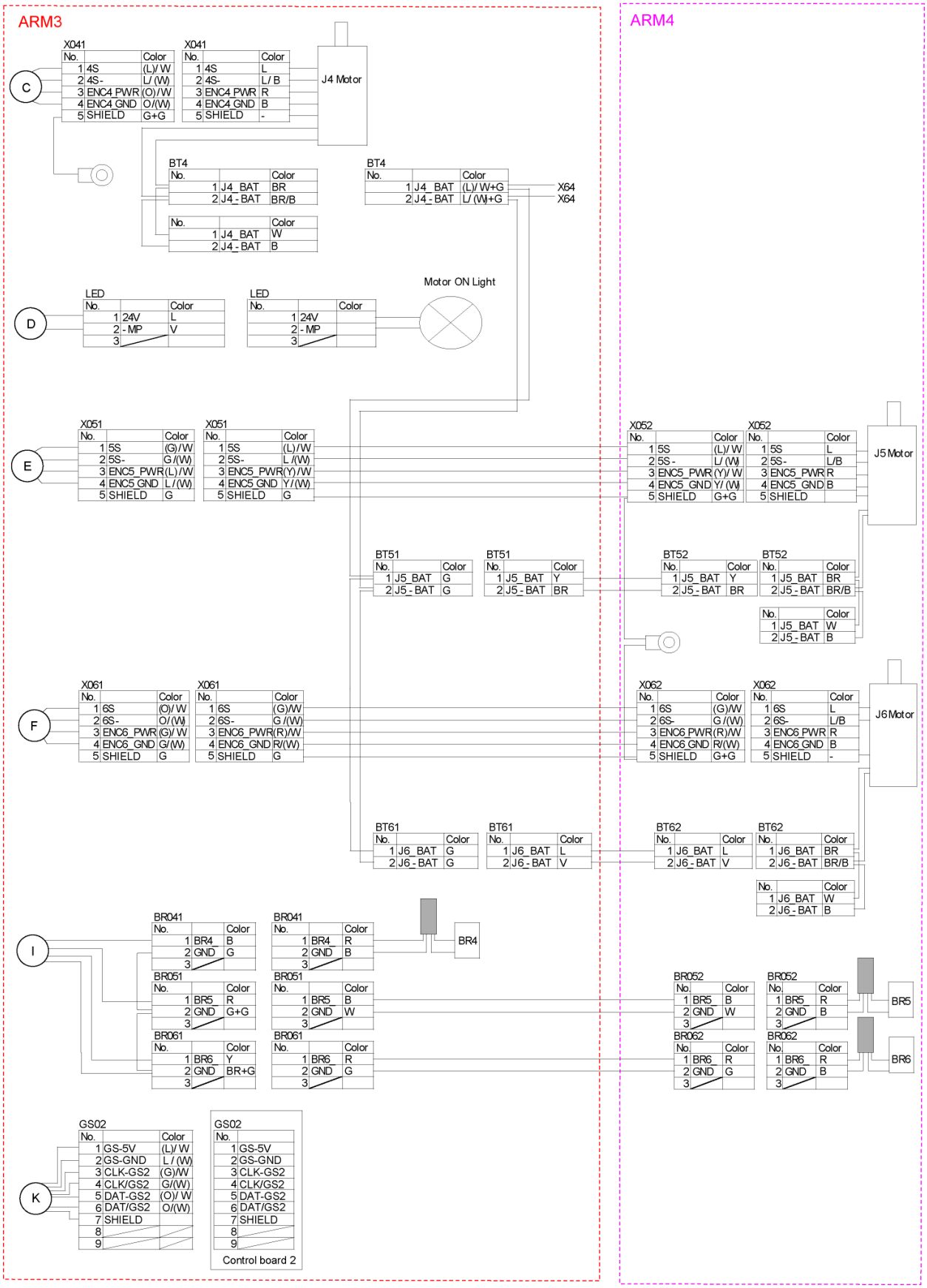
    For details, refer to *C4 Maintenance: 16. Calibration*.

4.2 Connector Pin Assignments

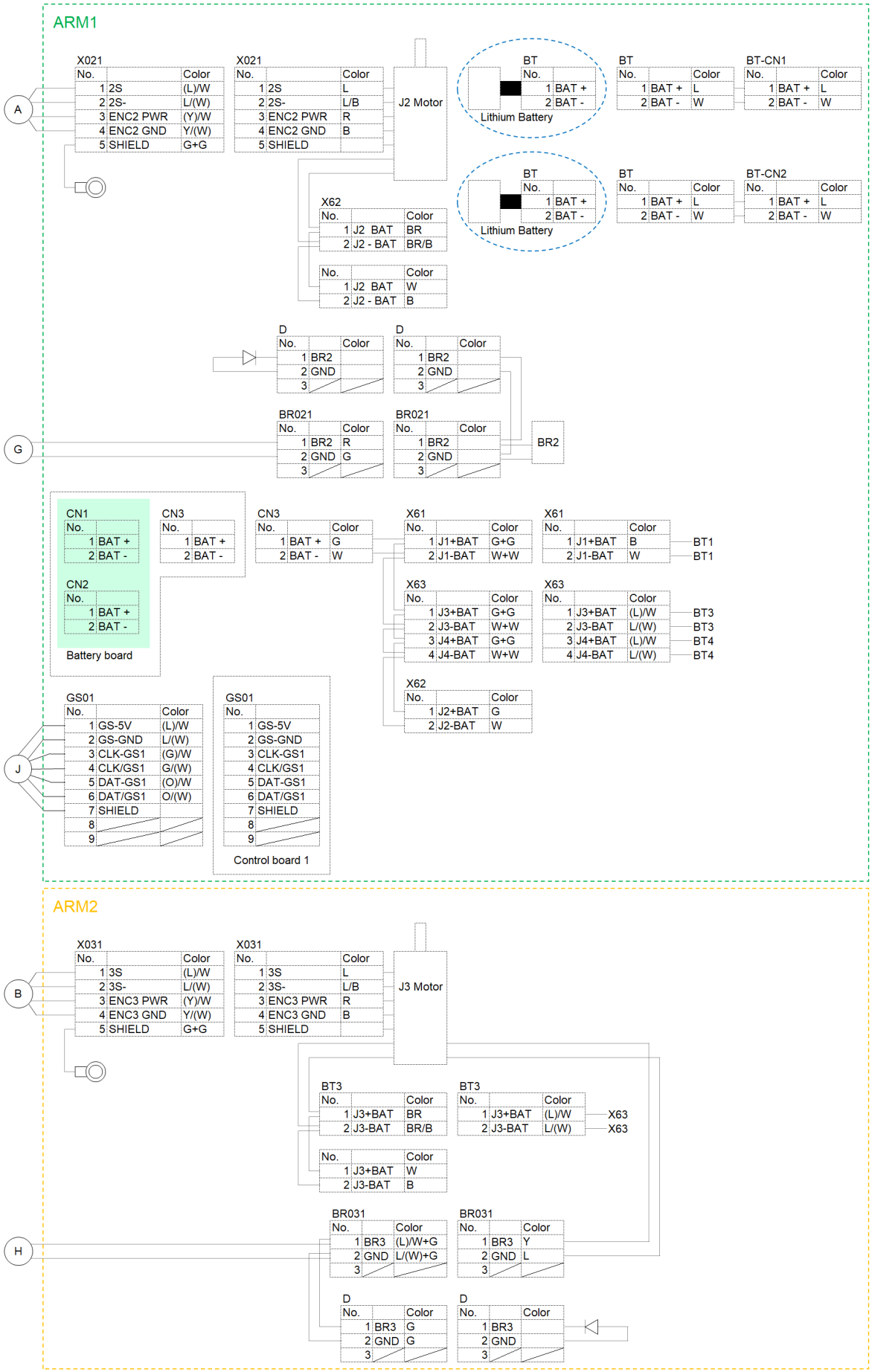
4.2.1 Signal Cable

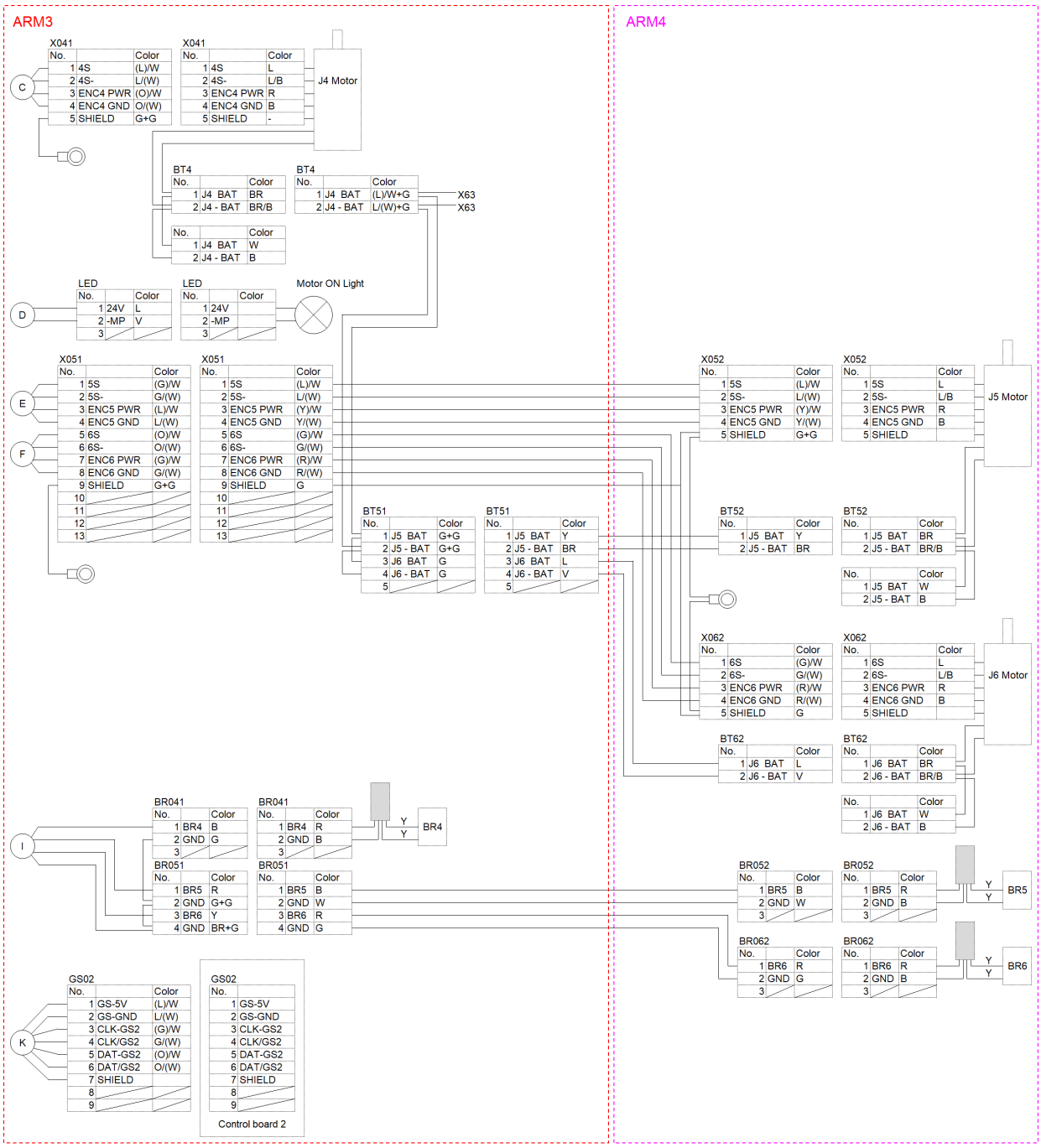



ARM1
A
G
J
X021
No. Color
1 2S (L)/W
2 2S- L/(W)
3 ENC2_PWR (Y)/W
4 ENC2_GND Y/(W)
5 SHIELD G+G
X021
No. Color
1 2S L
2 2S- L/B
3 ENC2_PWR R
4 ENC2_GND B
5 SHIELD
J2 Motor
BT
No.
1 BAT +
2 BAT -
Lithium Battery
BT
No. Color
1 BAT + L
2 BAT - W
BT-CN1
No. Color
1 BAT + L
2 BAT - W
BT-CN2
No. Color
1 BAT + L
2 BAT - W
X62
No. Color
1 J2_BAT BR
2 J2_ - BAT BR/B
No. Color
1 J2_BAT W
2 J2_ - BAT B
D
No. Color
1 BR2
2 GND
3
BR021
No. Color
1 BR2_ R
2 GND G
3
BR2
CN1
CN2
CN3
Battery board
CN3
No. Color
1 BAT + G
2 BAT - W
X61
No. Color
1 J1+BAT G
2 J1-BAT W
BT1
X63
No. Color
1 J3+BAT G
2 J3-BAT W
BT3
X64
No. Color
1 J4+BAT G
2 J4-BAT W
BT4
X62
No. Color
1 J2+BAT G
2 J2-BAT W
GS01
No. Color
1 GS-5V (L)/W
2 GS-GND L/(W)
3 CLK-GS1 (G)/W
4 CLK/GS1 G/(W)
5 DAT-GS1 (O)/ W
6 DAT/GS1 O/(W)
7 SHIELD
8
9
Control board 1
ARM2
B
H
X031
No. Color
1 3S (L)/W
2 3S- L/(W)
3 ENC3_PWR (Y)/W
4 ENC3_GND Y/(W)
5 SHIELD G+G
X031
No. Color
1 3S L
2 3S- L/B
3 ENC3_PWR R
4 ENC3_GND B
5 SHIELD
J3 Motor
BT3
No. Color
1 J3+BAT BR
2 J3-BAT BR/B
No. Color
1 J3+BAT W
2 J3-BAT B
BR031
No. Color
1 BR3_ (L)/W+G
2 GND L/(W)+G
3
D
No. Color
1 BR3 G
2 GND G
3
BR031
No. Color
1 BR3 Y
2 GND L
3
D
No. Color
1 BR3
2 GND
3

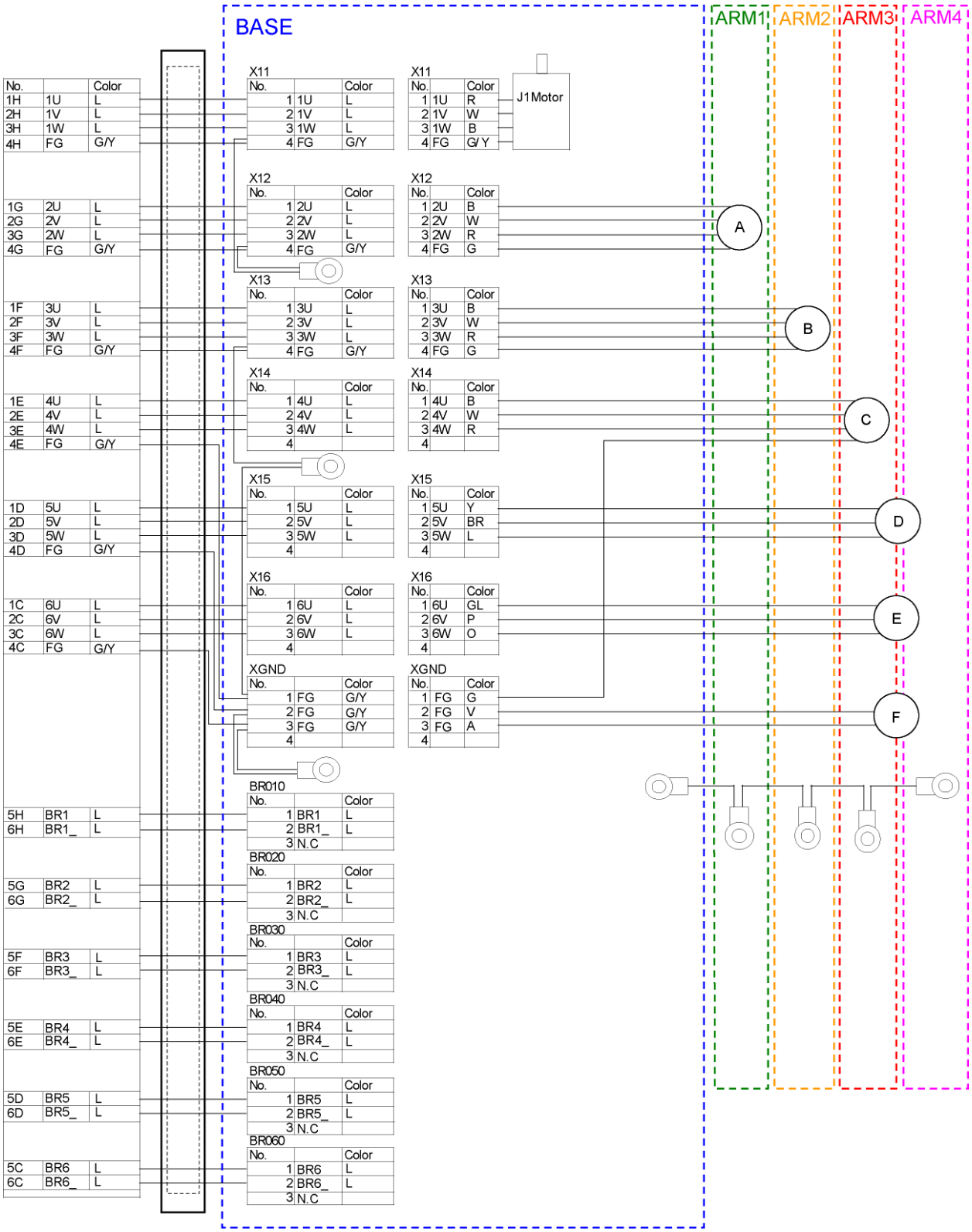

ARM3
ARM4
X041
X041
J4 Motor
BT4
BT4
X64
X64
LED
LED
Motor ON Light
X051
X051
X052
X052
J5 Motor
BT51
BT51
BT52
BT52
X061
X061
X062
X062
J6 Motor
BT61
BT61
BT62
BT62
BR041
BR041
BR4
BR051
BR051
BR052
BR052
BR5
BR061
BR061
BR062
BR062
BR6
GS02
GS02
Control board 2

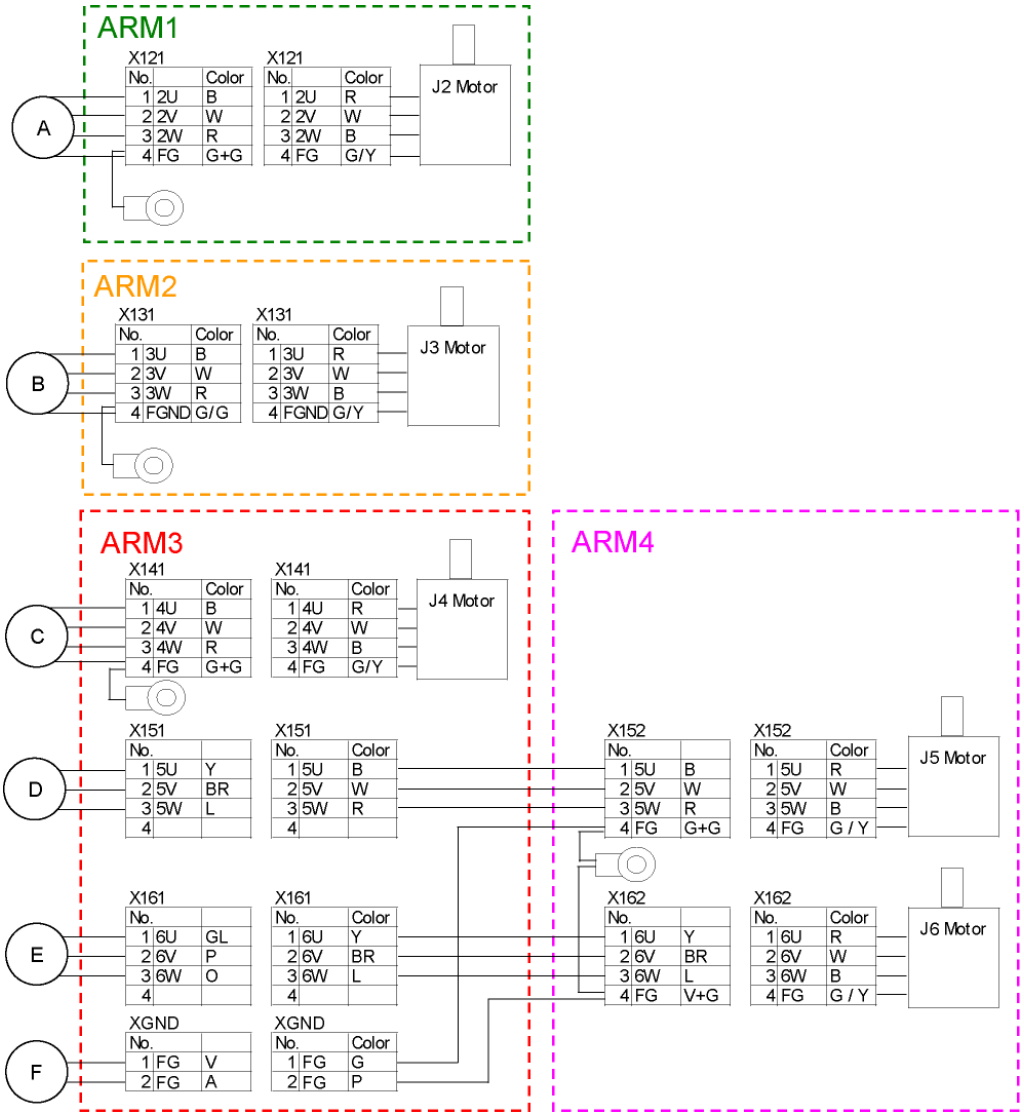
* For specifications without connector X061, BT61, BR061, X161, X72.


ARM1
X021
X021
J2 Motor
BT
Lithium Battery
BT
BT-CN1
BT
Lithium Battery
BT
BT-CN2
X62
D
D
BR021
BR021
BR2
A
G
CN1
CN2
Battery board
CN3
CN3
X61
X61
BT1
BT1
X63
X63
BT3
BT3
BT4
BT4
X62
GS01
GS01
Control board 1
J
ARM2
X031
X031
J3 Motor
BT3
BT3
X63
X63
BR031
BR031
D
D
B
H

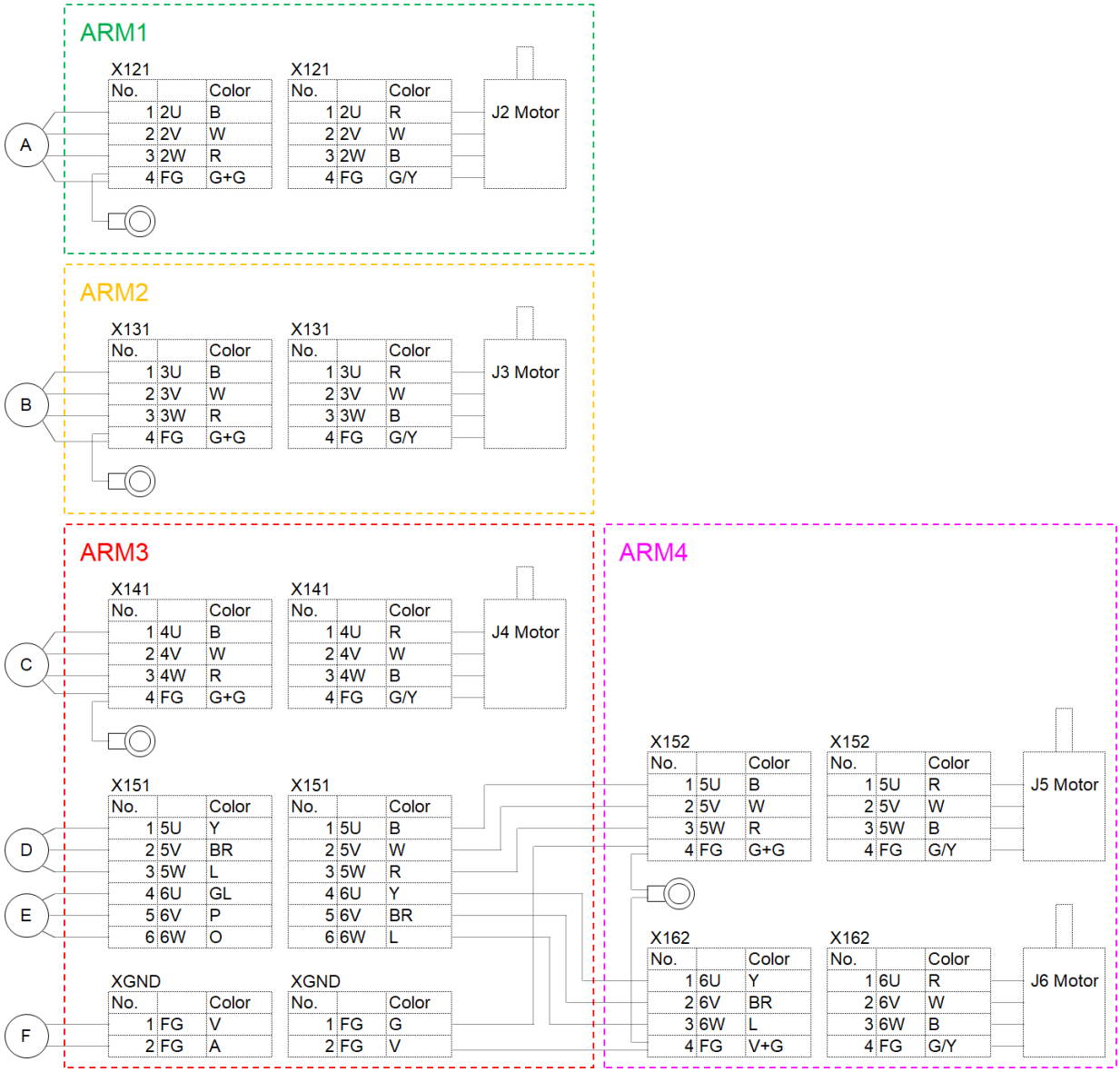

ARM3
ARM4
X041
J4 Motor
BT4
X63
LED
Motor ON Light
X051
BT51
X052
J5 Motor
BT52
X062
J6 Motor
BT62
BR041
BR4
BR051
BR052
BR5
BR062
BR6
GS02
Control board 2

4.2.2 Power Cable

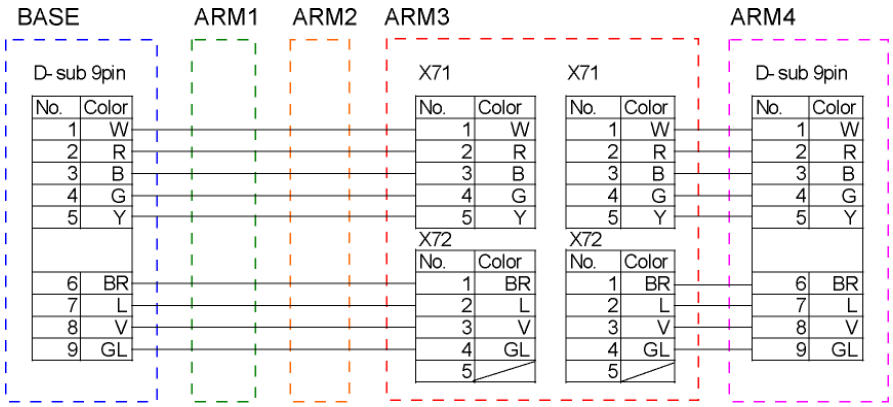



ARM1
X121
No. Color
1 2U B
2 2V W
3 2W R
4 FG G+G
X121
No. Color
1 2U R
2 2V W
3 2W B
4 FG G/Y
J2 Motor
A
ARM2
X131
No. Color
1 3U B
2 3V W
3 3W R
4 FGND G/G
X131
No. Color
1 3U R
2 3V W
3 3W B
4 FGND G/Y
J3 Motor
B
ARM3
ARM4
X141
No. Color
1 4U B
2 4V W
3 4W R
4 FG G+G
X141
No. Color
1 4U R
2 4V W
3 4W B
4 FG G/Y
J4 Motor
C
X151
No.
1 5U Y
2 5V BR
3 5W L
4
X151
No. Color
1 5U B
2 5V W
3 5W R
4
X152
No.
1 5U B
2 5V W
3 5W R
4 FG G+G
X152
No. Color
1 5U R
2 5V W
3 5W B
4 FG G / Y
J5 Motor
D
X161
No.
1 6U GL
2 6V P
3 6W O
4
X161
No. Color
1 6U Y
2 6V BR
3 6W L
4
X162
No.
1 6U Y
2 6V BR
3 6W L
4 FG V+G
X162
No. Color
1 6U R
2 6V W
3 6W B
4 FG G / Y
J6 Motor
E
XGND
No.
1 FG V
2 FG A
XGND
No. Color
1 FG G
2 FG P
F

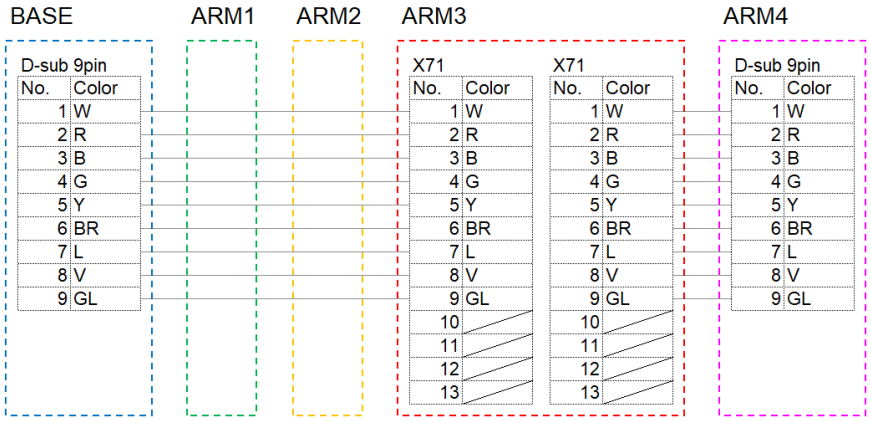
* For specifications without connector X061, BT61, BR061, X161, X72.



4.2.3 User Cable



* For specifications without connector X061, BT61, BR061, X161, X72.



4.2.4 Color of Cables

The following table shows the codes and cable colors indicated in the pin assignments.

4.2.1 Signal Cable
4.2.2 Power Cable
4.2.3 User Cable

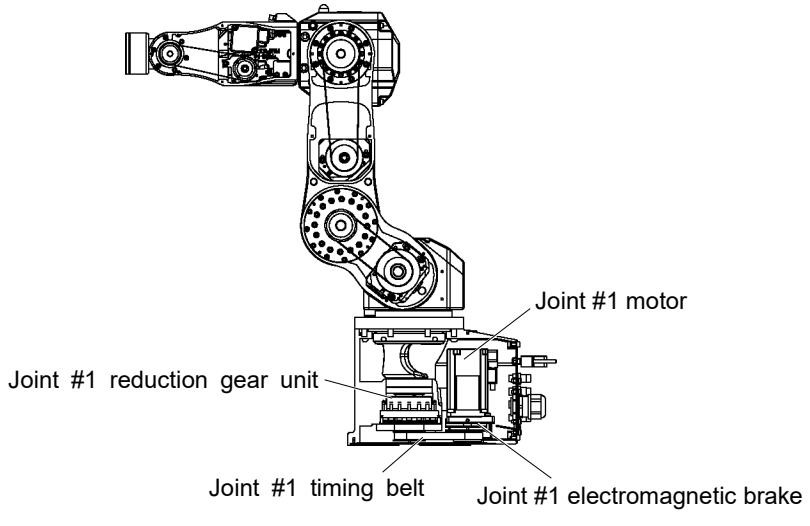
Code	Cable color
B	Black
W	White
R	Red
G	Green
Y	Yellow
BR	Brown
L	Blue
V	Violet
A	Azure
O	Orange
GL	Gray
P	Pink

5. Joint #1

WARNING	■ 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. ■ 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. ■ Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source. To shut off power to the robot system, disconnect the power plug from the power source. Performing any work while connecting the AC power cable to a factory power source 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 during replacement procedures. The shock may shorten the life of the motors and encoder and/or damage them. ■ Never disassemble the motor and encoder. Disassembled motor and encoder will cause a positional gap and cannot be used again. ■ After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

After parts have been replaced (motors, reduction gear units, timing belts, etc.), the Manipulator cannot perform positioning properly because a gap exists between the origin stored in each motor encoder 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 *C4 Maintenance 16. Calibration* and follow the steps to perform the calibration.



5.1 Joint #1 - Replacing the Motor

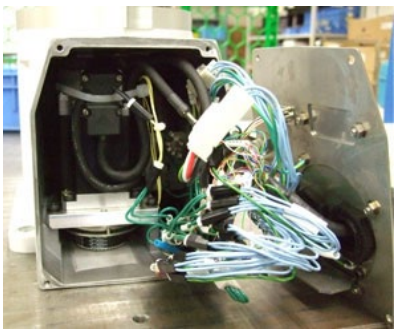
	Name		Quantity	Note
Maintenance Parts	AC servo motor 400 W		1	For the part code, refer to the *17. C4 Maintenance Part List.*
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M5 hexagon socket head set screws
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolts
	Cross-point screwdriver		1	For covers
	Torque wrench		1	
	Force gauge		1	For belt tension adjustment

Removal: Joint #1 Motor

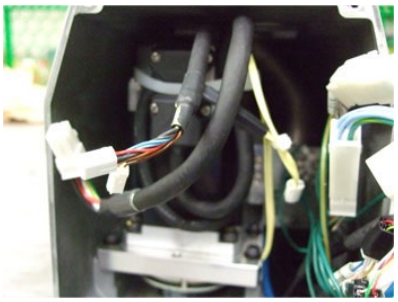
1. Turn ON the Controller.
2. Remove the connector plate.

   For details, refer to *C4 Maintenance: 3. Covers*.
3. Disconnect the connectors.

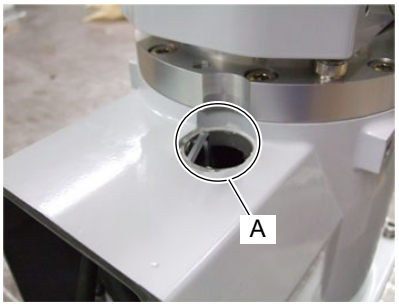
   Connector: X11, X010, BT1, BR011
   (Hold the clip to remove.)

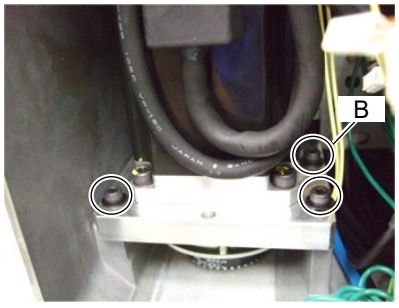


4. Remove the Joint #1 motor unit from the base.
   Hexagon socket head cap bolts: 3-M4×20 (with a plain washer)

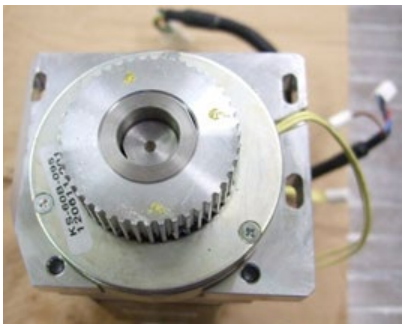


To remove the screw fixed to the rear of the motor unit (B), put a hexagonal wrench through the hole (A) after removing the cap.





5. Remove the pulley 1 and the drive boss from the Joint #1 motor unit.

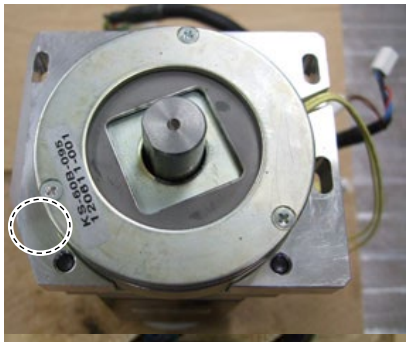


Drive boss and the pulley:
Hexagon socket head set screws: 2-M5×6 (with a brass bushing)

Pulley and the motor shaft:
Hexagon socket head set screws: 2-M5×10 (with a brass bushing)

There is a brass bushing on one of the set screws fixing the drive boss and the pulley 1.　Be careful not to lose it.

6. Remove the electromagnetic brake of the Joint #1.



Hexagon socket head set screw: 1-M5×8

7. Remove the motor plate from the Joint #1 motor.

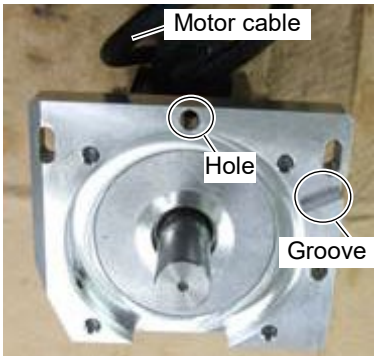
Hexagon socket head cap bolts: 4-M5×15

Installation: Joint #1 Motor

NOTE

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

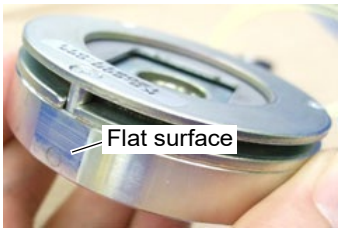
1. Mount the motor plate to the Joint #1 motor.



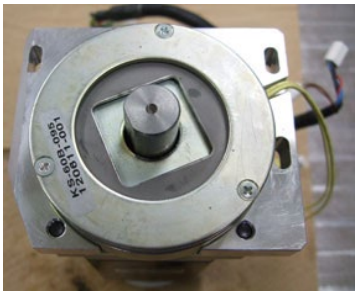
Hexagon socket head cap bolts: 4-M5×15
Tightening torque: 9.8 N·m (100 kgf·cm)

Be careful of the direction of the motor plate. (See the photo.)

2. Install the electromagnetic brake of the Joint #1 to the Joint #1 motor unit.



Be careful of the direction of the electromagnetic brake.
Align the wiring position of the brake and the clearance groove on the motor plate. Fix the flat surface of the electromagnetic brake to the set screw side.

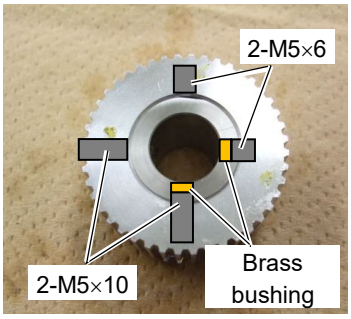


Be careful not to cut the cable by getting it caught between the brake and the plate.

Secure the set screw while pressing the electromagnetic brake to the motor plate.

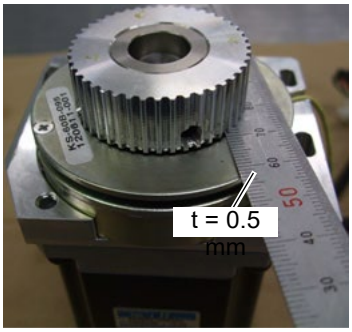
Hexagon socket head set screw: 1-M5×8
Tightening torque: 3.9 N·m (40 kgf·cm)

3. Install the drive boss and the pulley 1 to the Joint #1 motor unit.

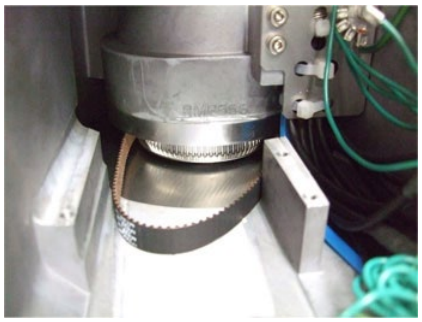


Fix the drive boss and the pulley 1 with the end surfaces of each part together.
Hexagon socket head set screws: 2-M5×6 (with a brass bushing)
Tightening torque: 3.9 N·m (40 kgf·cm)

Fix the pulley 1 and the motor shaft.
Leave 0.5 mm between the electromagnetic brake and the pulley.
Refer to the photo for layout of the set screws.
Hexagon socket head set screws: 2-M5×10 (with a brass bushing)
Tightening torque: 3.9 N·m (40 kgf·cm)



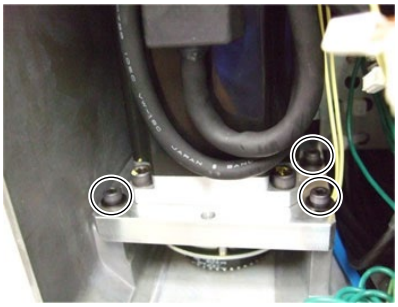
4. Put the Joint #1 timing belt to the Joint #1 pulley 2 on the Joint #1 side.



5. Pass the pulley 1 of the Joint #1 motor unit to the Joint #1 timing belt and loosely secure it to the base.
   Hexagon socket head cap bolts: 3-M4×20 (with a plain washer)

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

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



6. Apply proper tension to the Joint #1 motor unit and secure it.

   Pass a suitable cord or a string (insulation lock) to the drilled hole on the motor plate. Pull the cord using a force gauge or a similar tool to apply specified tension.

   Joint #1 timing belt tension: 78.4 N ± 9.8 N (8 kgf ± 1 kgf)

   Apply proper tension to the Joint #1 motor unit and secure it.

   Hexagon socket head cap bolt: 3-M4×20
   (with a plain washer)

   Tightening torque: 4.9 N·m (50 kgf·cm)

7. Connect the following connectors.
   Connectors: X11, X010, BT1, BR011

8. Mount the connector plate.
   For details, refer to *C4 Maintenance: 3. Covers*.

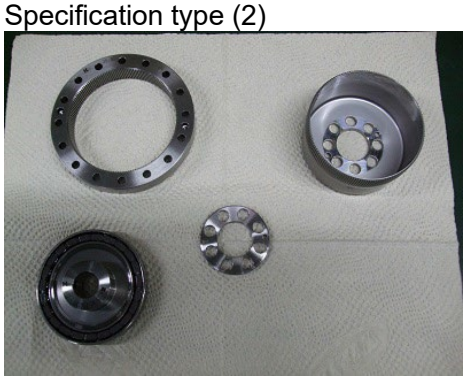
9. Calibrate the Joint #1.
   For details, refer to *C4 Maintenance: 16. Calibration*.

5.2 Joint #1 - Replacing the Reduction Gear Unit

The shapes and replacement procedures of the reduction gear units vary depending on the specification type. The reduction gear units have the following two specification types which differ depending on the time of shipment.
Before performing maintenance, confirm the specification type of the reduction gear unit.

Specification type (1)

Specification type (2)



A reduction gear unit consists of the following parts and accessories. When replacing the reduction gear unit, be sure to replace these parts and accessories all together as a set.

Reduction gear unit : Wave generator, Flexspline, Circular spline

Accessory : Spacer, Grip ring (only for Specification type 1)

For details, refer to *C4 Maintenance: 17. C4 Maintenance Parts List*.

It is recommended to replace the O-ring when replacing the reduction gear unit.

	Name		Quantity	Note
Maintenance Parts	Joint #1 reduction gear unit		1	1687022
	Joint #1 O-ring		1	1480857
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M5 hexagon socket head set screws
		width across flats: 3 mm	1	For M4 hexagon socket headcap bolts
		width across flats: 5 mm	1	For M6 hexagon socket headcap bolts
	Cross-point screwdriver		1	For covers
	Torque Wrench		1	
	Spatula		1	For greasing
	Force gauge		1	For belt tension adjustment
	Wiping cloth		2	For wiping grease

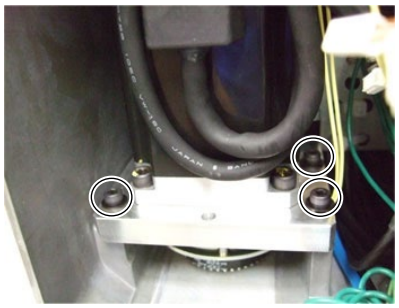
Removal: Joint #1 Reduction gear unit

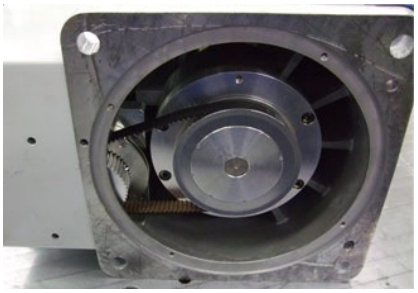
1. Turn OFF the Controller.
2. Turn the Manipulator laterally.

CAUTION	■ When turning the Manipulator laterally, there must be two or more people to work on it so that at least one of them can support the arm while the others are removing the bolts. Removing the bolts without supporting the arm may result in the arm falling, bodily injury, and/or malfunction of the robot system.

3. Remove the connector plate and the base bottom cover.
   For details, refer to *C4 Maintenance: 3. Covers*.
4. Loosen the set screws of the Joint #1 motor unit and remove the Joint #1 timing belt.

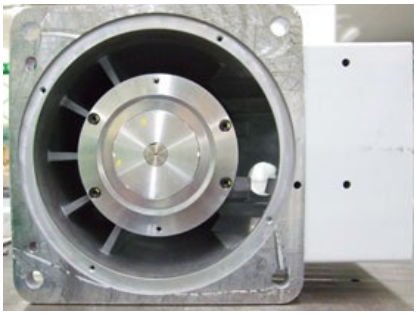
   Hexagon socket head cap bolt: 3-M4×20





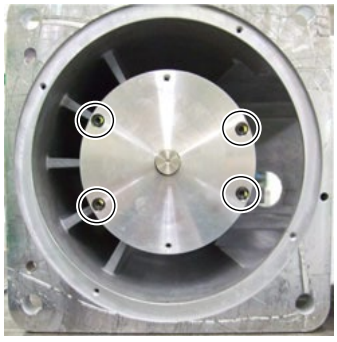
5. Remove the pulley 2.

   Hexagon socket head set screw: 2-M5×10 (with a brass bushing)



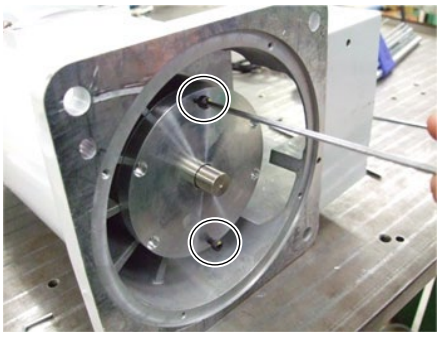
6. Remove the flange.

   Hexagon socket head cap bolt: 4-M4×15

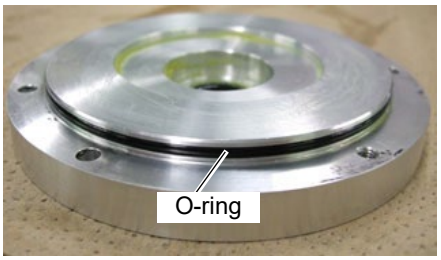


If it is difficult to remove the flange, insert the bolts to two parts as shown in the photo, and then tighten them evenly to remove the flange.
Use the dedicated screws for fixing the flange.

Wipe grease from the parts while removing them.



7. Remove the O-ring.



8. Remove the wave generator unit from the reduction gear unit.

Wipe grease from the parts while removing them.

If it is difficult to remove the wave generator unit, install the removed pulley 2 to the shaft and pull the parts together.

9. Remove the wave generator from the shaft.

Hexagon socket head set screws: 2-M5×6 (with a brass bushing)

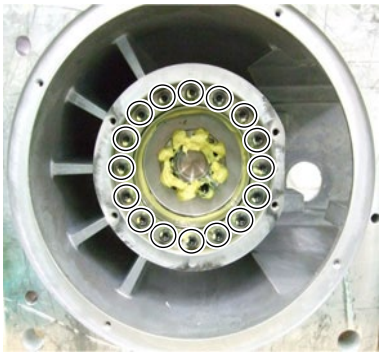
At this point, remove the bearing first. The bearing will be used again. Be careful not to lose it.

There is a brass bushing on one of the set screws. Be careful not to lose it.

Wipe grease from the parts while removing them.

10. Remove the circular spline from the base.

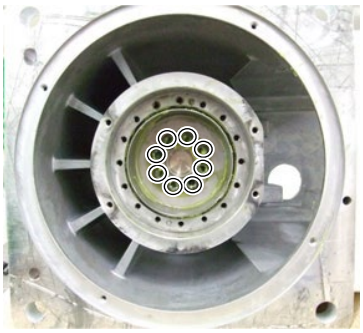
    Hexagon socket head cap bolt: 16-M4×20



    Insert the screws to two parts on the circular spline as shown in the photo.　Tighten them evenly and remove the circular spline.

11. Remove the flexspline from the base.

    Hexagon socket head cap bolt: 6-M6×15



12. Remove the friction plate (EKagrip) between the flexspline installation surface and the flexspline.

    This step is not necessary for the Manipulator with a serial number C40E004191 or later since a friction plate (EKagrip) is not included in the part.

13. Wipe grease using a cloth or similar material if it is attached to the base.

Installation: Joint #1 Reduction gear unit

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

1. Unpack the new reduction gear unit package and check if it contains the parts below.

Specification type (1)

Specification type (2)

2. Place the friction plate (EKagrip) on the end face of the shaft to match the screw holes.

   This step is not necessary for the specification type (2) since the friction plate (EKagrip) is not included in the part.

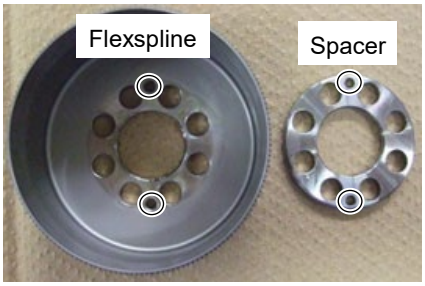
3. Apply grease all over the tooth flank of the flexspline.

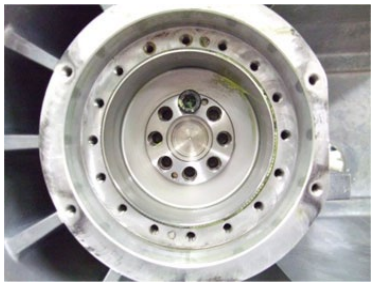
   Grease: SK-1
   Grease amount: enough to fill in the grooves

4. Install the flexspline to the shaft end face.
   Insert the spacer between the screws and the part.

   Hexagon socket head cap bolt: 6-M6×15
   Tightening torque: 17.6 N·m (180 kgf·cm)

   Install the flexspline to match the air escapement holes of the flex spline with these of the spacer.



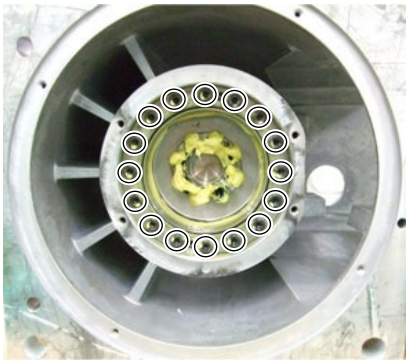


5. Apply grease all over the tooth flank of the circular spline.

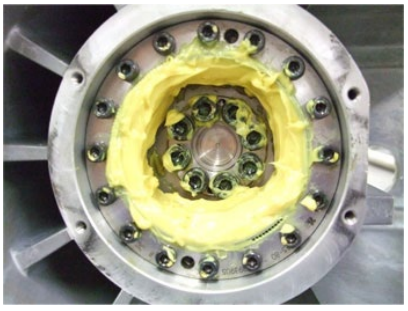
   Grease: SK-1A
   Grease amount: enough to fill the grooves

6. Install the circular spline.

   Hexagon socket head cap bolt: 16-M4×20
   Tightening torque: 4.9 N·m (50 kgf·cm)



7. Apply grease to the inside of the flexspline.
   Grease: SK-1A
   Grease volume: 40 g



8. Apply grease to the bearing of the wave generator.
   Grease: SK-1A

9. Install the wave generator to the shaft.

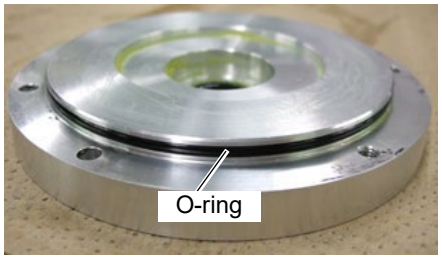
   Hexagon socket head set screws: 2-M5×6
   (with a brass bushing)
   Tightening torque: 3.9 N·m (40 kgf·cm)

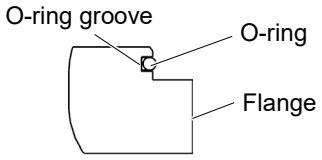
   When installing the part, press the wave generator all the way in and fix the set screw to the D-cut face of the shaft. Insert the brass bushing to the end of the other set screw.

10. Install the bearing.

11. Install the assembled wave generator unit to the reduction gear unit.

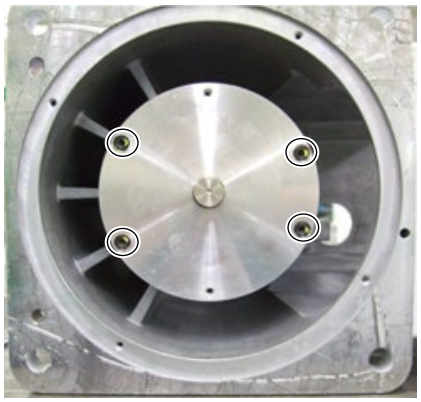
12. Put the O-ring into the groove on the flange.
    Carefully assemble the parts to avoid damaging the O-ring. (Otherwise the grease may leak.)





13. Install the flange to the base.
    Hexagon socket head cap bolt: 4-M4×15
    Tightening torque: 4.9 N·m (50 kgf·cm)

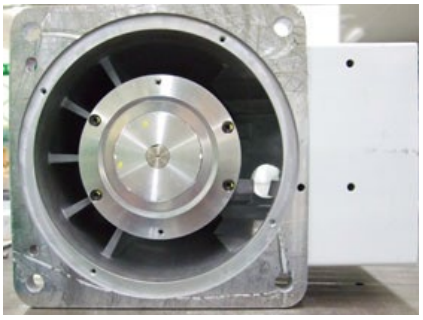
    Carefully insert the shaft to the flange to avoid damaging the seal.



14. Install the pulley 2.

    Hexagon socket head set screws: 2-M5×10
    (with a brass bushing)
    Tightening torque: 3.9 N·m (40 kgf·cm)

    Align the end of the shaft with the side of the pulley.



15. Loosely secure the Joint #1 motor unit.
    Make sure that the motor unit can be moved by hand, and it does not tilt when being pulled. If the unit is secured too loose or too tight, the belt will not have proper tension.

16. Mount the Joint #1 motor unit
    For details, refer to *C4 Maintenance: 5.1 Joint #1 motor*, Installation step (6).

17. Mount the connector plate and the base bottom cover.
    For details, refer to *C4 Maintenance: 3. Covers*.

18. Calibrate the Joint #1.
    For details, refer to *C4 Maintenance: 16. Calibration*.

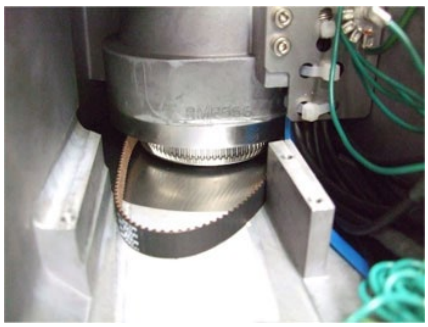
5.3 Joint #1 - Replacing the Timing Belt

	Name		Quantity	Note
Maintenance Part	Timing belt	Joint #1 C4-A601**	1	1520394
		Joint #1 C4-A901**	1	1593695
Tools	Hexagonal wrench (width across flats: 3 mm)		1	For M4 hexagon socket head cap bolt
	Torque wrench		1	
	Force gauge		1	For belt tension adjustment

Removal: Joint #1 Timing belt

1. Remove the Joint #1 motor unit.
   For details, refer to *C4 Maintenance: 5.1 Joint #1 motor*, Removal step (1) to (4).
2. Remove the Joint #1 timing belt.

   Work process is common between C4-A601** and C4-A901**



Installation: Joint #1 Timing belt

1. Place the Joint #1 timing belt around the Joint #1 pulley in the back in the photo.
2. Mount the Joint #1 motor unit.
   For details, refer to *C4 Maintenance: 5.1 Joint #1 motor*, Installation step (5) to (9).

5.4 Joint #1 - Replacing the Electromagnetic Brake

	Name		Quantity	Note
Maintenance Parts	Joint #1 electromagnetic brake		1	For the part code, refer to the *17. C4 Maintenance Part List.*
	Noise dissipative diode		1	
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M5 hexagon socket head set screw
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolt
	Torque wrench		1	
	Force gauge		1	For belt tension adjustment

Removal: Joint #1 Electromagnetic brake

1. Remove the Joint #1 electromagnetic brake from the Joint #1 motor unit.
   For details, refer to *C4 Maintenance: 5.1 Joint #1 motor*, Removal step (1) to (6).

2. Remove the following connector.

   Connector: D (for noise dissipative diode)

Installation: Joint #1 Electromagnetic brake

1. Install the following connector to the connector of the electromagnetic brake.

   Connector: D (for noise dissipative diode)

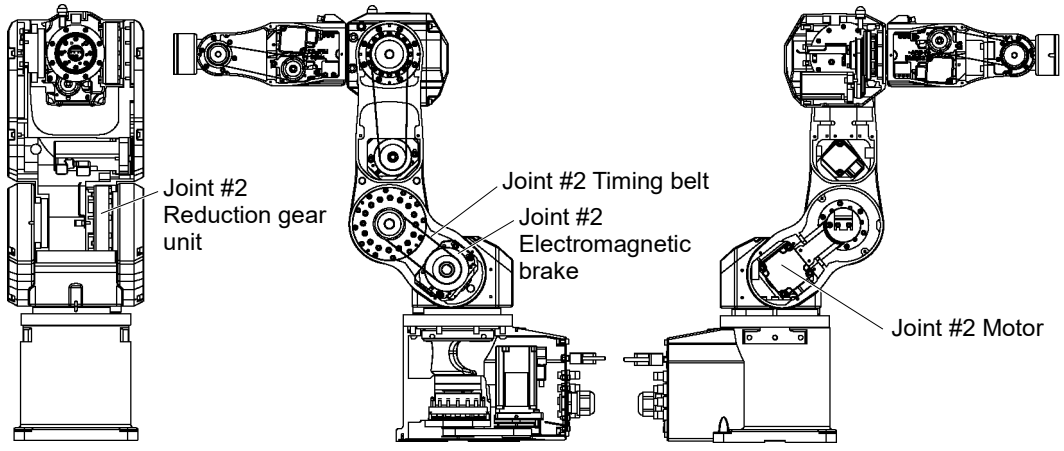
2. Mount the Joint #1 motor unit.
   For details, refer to *C4 Maintenance: 5.1 Joint #1 motor*, Installation step (2) to (9).

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 during replacement. It may shorten the life of the motors and encoder and/or damage them. ■ Never disassemble the motor and the encoder. Disassembled motor and encoder will cause a positional gap and cannot be used again. ■ After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

After parts have been replaced (motors, reduction gear units, timing belts, etc.), the Manipulator cannot perform positioning properly because a gap exists between the origin stored in each motor encoder and its corresponding origin stored in the Controller.
Therefore, it is necessary to match these origins after replacing the parts.
The process of aligning the two origins is called “Calibration”.
Refer to *C4 Maintenance 16. Calibration* and perform the calibration after the parts replacement.



6.1 Joint #2 - Replacing the Motor

	Name		Quantity	Note
Maintenance Parts	AC servo motor 400 W		1	For the part code, refer to the *17. C4 Maintenance Part List.*
	Radiation Sheet		1	1549699
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M5 hexagon socket set screw
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolt
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolt
	Cross-point screwdriver		1	For covers
	Torque wrench		1	
	Cloth		1	For pressing arms
	Force gauge		1	For belt tension

The brake is mounted on the Joint #2 to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. However, the brake does not work during replacement.

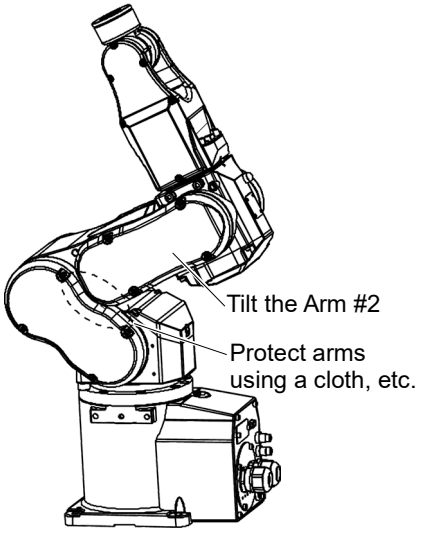
To replace the Joint #2 motor, tilt the Arm #2 and press it toward the Arm #1. (See the step (3)
When pressing the arm, put a cloth or a similar material between the arms to avoid each arm from contacting. This also protects the arm surfaces and coatings.

Removal: Joint #2 Motor

1. Remove the Arm #1 top cover and the Arm #1 side cover.
   For details, refer to *C4 Maintenance: 3. Covers*.

2. Turn ON the Controller power.

3. Tilt Arm #2.
   Put a cloth between Arm #1 and Arm #2 so that two arms do not touch each other.

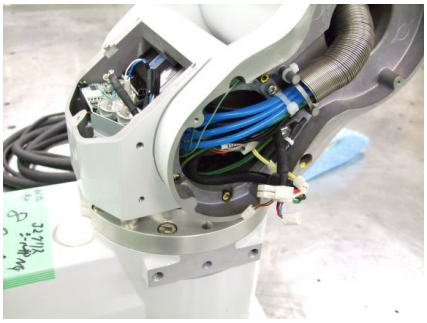


4. Turn OFF the Controller power.

5. Disconnect the following connectors.

   Connector: X121, X021, X62, BR021

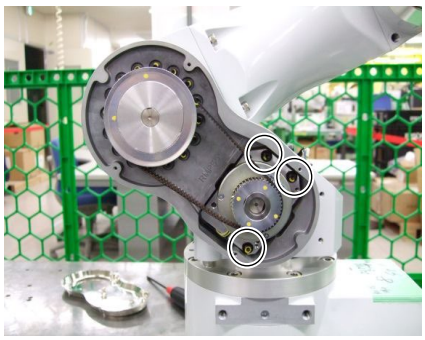
   (Hold the clip to remove.)



6. Tilt the Arm #2 and remove the Joint #2 motor unit and the belt from the Arm #1.

   If the bolts are removed with the Arm #2 is not tilted, the belt will come off and the Arm #2 will fall. Be sure to tilt the Arm.

   Hexagon socket head cap bolt: 3-M4×18 (with a plain washer)



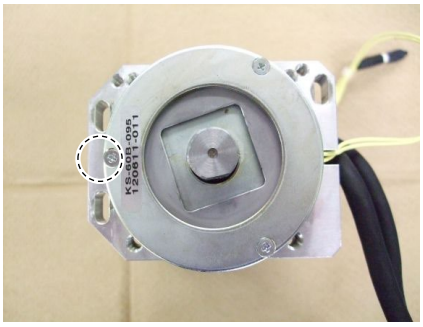
7. Remove the Joint #2 pulley 1 and the drive boss from the motor shaft of the Joint #2 motor unit.

Drive boss and the pulley
Hexagon socket set screws: 2-M5×6 (with a brass bushing)

Pulley and the motor shaft
Hexagon socket set screws: 2-M5×10 (with a brass bushing)

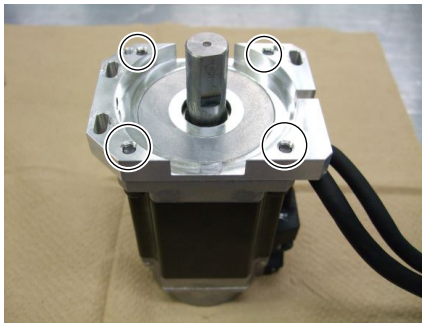
There is a brass bushing on one of the set screws fixing the driving boss and the pulley.
Be careful not to lose it.

8. Remove the Joint #2 electromagnetic brake.



Hexagon socket set screw: 1-M5×8

9. Remove the motor plate from the Joint #2 motor.



Hexagon socket head cap bolts: 4-M5×15

Installation: Joint #2 Motor

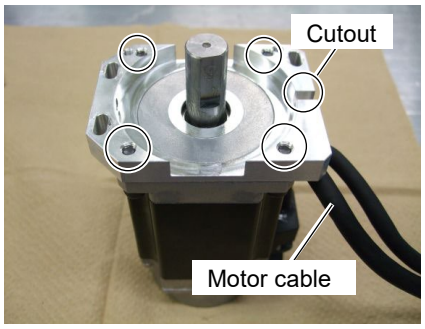
NOTE When tightening hexagon socket head cap bolts, refer to the *2.4 Tightening Hexagon Socket Head Cap Bolts.*

1. Install the motor plate to the Joint #2 motor.

   Hexagon socket head cap bolts: 4-M5×15

   Tightening torque: 9.8 N·m (100 kgf·cm)

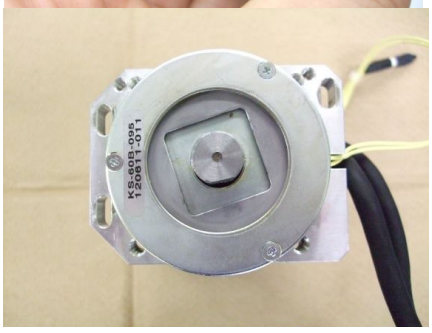
   Be careful of the direction of the motor plate. (See the photo.)



2. Mount the Joint #2 electromagnetic brake to the Joint #2 motor unit.
   Align the position of the brake wire with the groove on the motor plate. Then, set the flat surface of the brake to the set screw side and secure the brake. Be careful not to cut the brake wire by getting it caught between the brake and the motor plate.
   Press the brake toward the motor plate and tighten the set screw.

   Hexagon socket set screw: 1-M5×8

   Tightening torque: 3.9 N·m (40 kgf·cm)

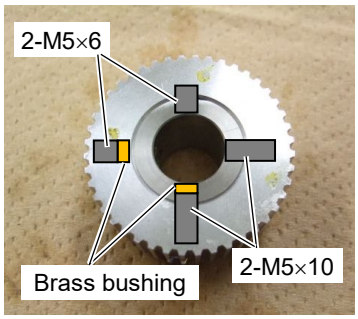


3. Mount the drive boss and the pulley 1 to the Joint #2 motor unit.

   Put the end faces of the brake boss and the pulley 1 together and fix them.

   Hexagon socket set screws: 2-M5×6 (with a brass bushing)

   Tightening torque: 3.9 N·m (40 kgf·cm)

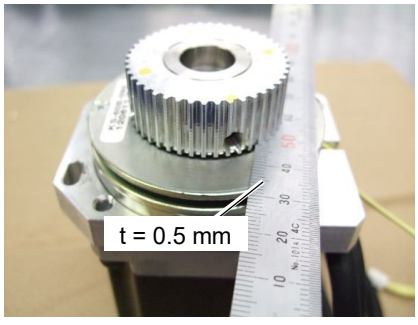


   Set the pulley 1 and the motor shaft.
   Leave 0.5 mm for the electromagnetic brake.

   Hexagon socket set screw: 2-M5×10 (with a brass bushing)

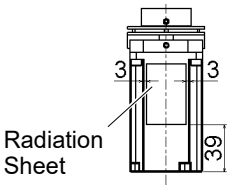
   Tightening torque: 3.9 N·m (40 kgf·cm)

   Fix the parts so that the end of the motor shaft and the surface of the pulley become flat.



   See the photo for positions of the set screws.

4. Attach the Radiation sheet to the Joint #2 motor.



5. Put the Joint #2 motor unit in the Arm #1.
   Place the timing belt around the pulley 1 and the pulley 2.
   Check that the teeth of the timing belt engage with these of the pulley.
   When securing the motor unit temporarily, make sure that the motor unit can be moved by hand, and it does not tilt when being pulled. If the unit is secured too loose or too tight, the belt will not have proper tension.

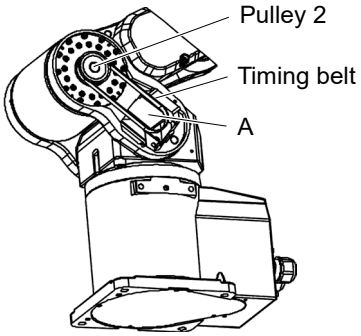
6. Apply tension to the Joint #2 motor unit and fix it.
   Install the screw for tension adjustment to the motor plate.

   Screw: M4×30 or longer (recommended length)

   Pass a suitable cord or a string (insulation lock) to the screw. Pull the cord using a force gauge or a similar tool to apply specified tension.

   Joint #2 timing belt tension = 78.4 N ± 9.8 N (8 kgf ± 1 kgf)

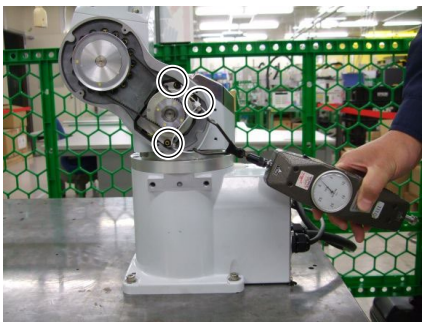
   Apply tension by pressing toward the “A” surface in the figure and secure the motor unit.



   Hexagon socket head cap bolt: 3-M4×18 (with a plain washer)

   Tightening torque: 4.9 N·m (50 kgf·cm)

   Make sure to remove the screw for tension adjustment.



7. Connect the following connectors.

   Connectors: X121, X021, X62, BR021

8. Mount the Arm #1 cover and the Arm #1 side cover.
   For details, refer to *C4 Maintenance: 3. Covers*.

9. Perform the calibration.
   For details, refer to *C4 Maintenance: 16. Calibration*.

6.2 Joint #2- Replacing the Reduction Gear Unit

A reduction gear unit consists of the following three parts. Also, two additional parts are included as accessories. When replacing the reduction gear unit, be sure to replace these parts all together as a set.

Reduction gear unit: Wave generator, Flexspline (CRB combined), Circular spline
Accessory: O-ring×2

For details, refer to *C4 Maintenance: 17. C4 Maintenance Parts List*.

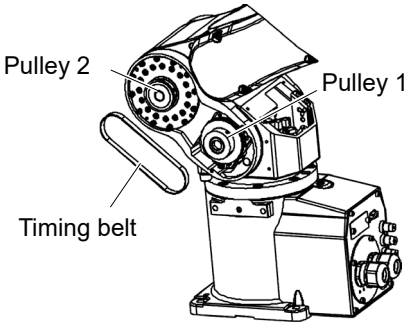
It is recommended replacing the O-ring (for Joint #2) when replacing the reduction gear unit.

	Name		Quantity	Note
Maintenance Parts	Joint #2 reduction gear unit		1	1687023
	Joint #2 O-ring		1	1510528
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolt For M5 hexagon socket set screw
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolt
	Cross-point screwdriver		1	For covers
	Torque wrench		1	
	Spatula		1	For applying grease
	Force gauge		1	For belt tension
	Wiping cloth		2	For wiping grease

Removal: Joint #2 Reduction gear unit

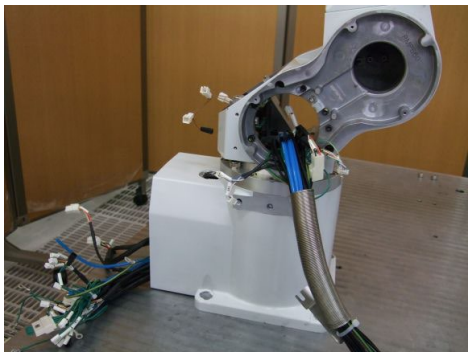
1. Remove the following covers.
   For details, refer to *C4 Maintenance: 3. Covers*.
   Arm #1 top cover
   Arm #1 side cover
   Arm #2 side cover
   Arm #3 head cover
   User plate
   When removing the user plate, remove the following parts as well.
   D-sub 9-pin connector
   4 air tubes

2. Remove the Joint #2 timing belt.
   For details, refer to *C4 Maintenance: 6.3 Joint #2 – Replacing the Motor*, Removal steps (1) through (4).



3. Remove the cable unit.
   For details, refer to *C4 Maintenance: 4.1 Replacing the Cable Unit*, removal steps (9) through (26).

4. Pull out the cables from the Arm #1.

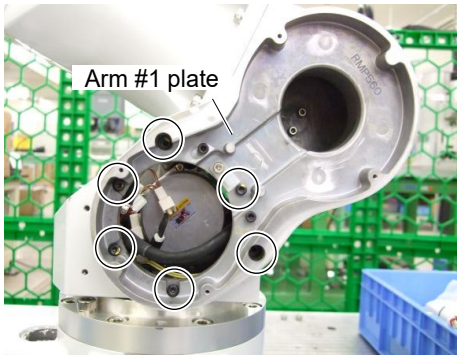


5. Turn the Manipulator laterally with the motor pulley facing down

CAUTION	■ When turning the Manipulator laterally, there must be two or more people to work on it so that at least one of them can support the arm while the other is removing the bolts. Removing the bolts without supporting the arm may result in the arm falling, bodily injury, and/or malfunction of the robot system.

6. Remove the Arm #1 plate.

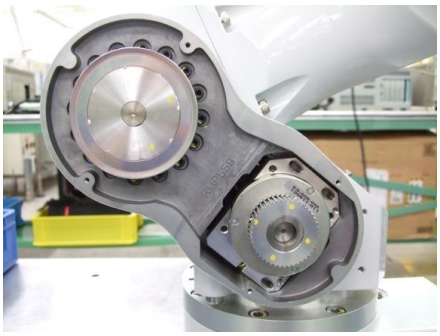
   Hexagon socket head cap bolt: 6-M4×12



7. Turn the Manipulator to the opposite side and remove the pulley 2.

   Hexagon socket set screws: 2-M5×10 (with a brass bushing)

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



8. Remove the screws securing the reduction gear unit.

   Hexagon socket head cap bolts: 16-M4×30

   By removing the screws, the Arm #2, #3, #4, #5, and #6 (end effector) can be separated.
   Have at least two workers so that one can support the Manipulator while the other worker is removing the bolts.

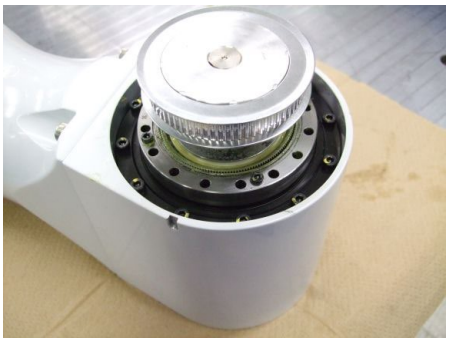
   Wipe grease on the parts while removing them.

9. Remove the wave generator from the reduction gear unit.

   If the wave generator unit does not come off easily, set the pulley 2 as shown in the photo to the shaft and pull out the parts.

   Remove the wave washer on the Arm #2 hole. The wave washer will be used again. Be careful not to lose it.

   Wipe grease on the parts while removing them.



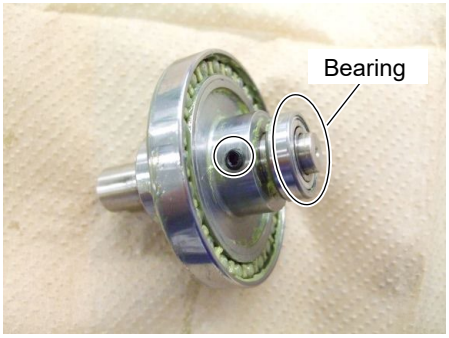
10. Remove the wave generator from the shaft.

    Hexagon socket set screws: 2-M5×6 (with a brass bushing)

    Remove the bearing.　The bearing will be used again.
    Be careful not to lose it

    There is a brass bushing on one of the set screws.
    Be careful not to lose it.

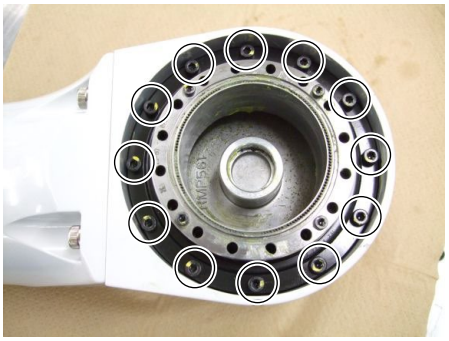
    Wipe grease on the parts while removing them.



11. Remove the reduction gear unit from the Arm #2.

    Hexagon socket head cap bolt: 12-M4×30

    Wipe grease on the parts while removing them.



12. Remove the O-ring.

    Wipe grease on the parts while removing them.

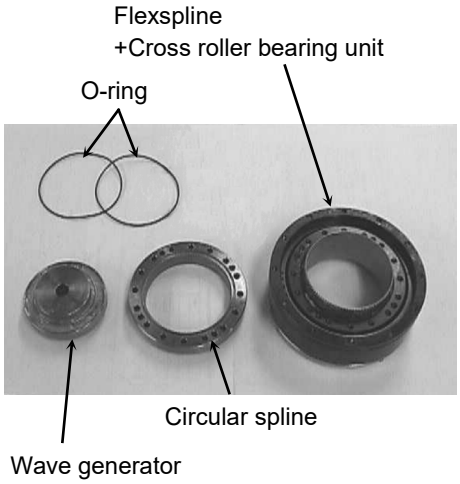
13. Wipe grease using a cloth or a similar material if it is attached to the Arm #1, and #2, etc.

Installation: Joint #2 Reduction gear unit

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

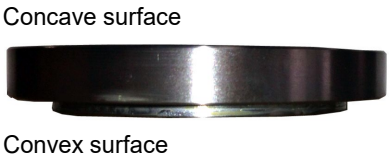
1. Unpack the new reduction gear unit package and check if it contains the parts on the right.

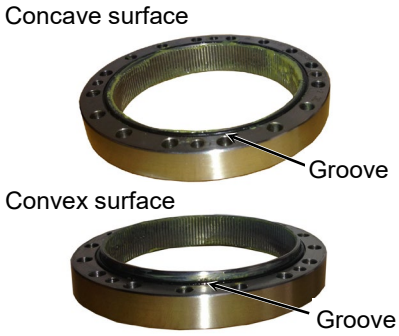
   Tooth grooves of the circular spline and the flexspline, and the bearing of the wave generator are pre-greased.
   Wipe grease if it is attached to the fitting parts.



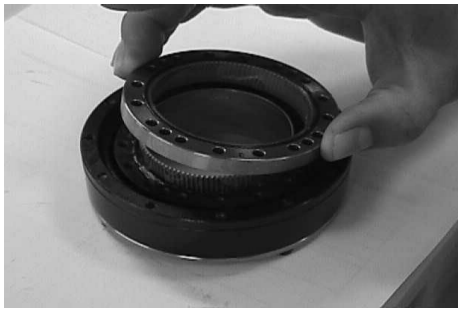
CAUTION	■ Do not adjust the bolts securing the flexspline and the cross roller bearing. If the bolts are adjusted, it requires centering of the parts by the reduction gear unit manufacturer.

2. Set the O-rings to the grooves on both faces of the circular spline.
   Make sure to fit the rings completely.

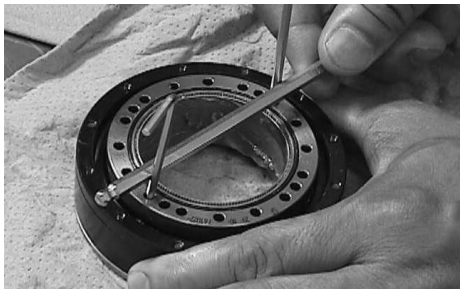




3. Set the flexspline with the convex surface facing down.
   After setting it, make sure to confirm that the surfaces of the circular spline and flexspline are matched.



4. Match the screw holes on the cross roller bearing's inner ring and the drilled holes on the circular spline.



5. Fix the cross roller bearing's inner ring and the circular spline.

   Hexagon socket head cap bolts: 4-M3×15

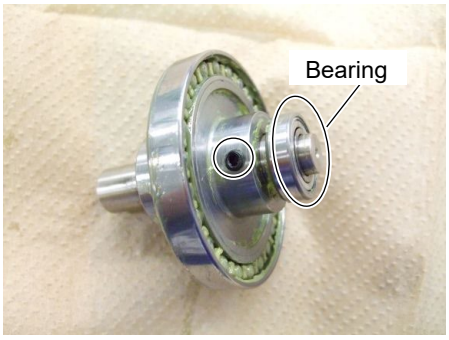
   Tightening torque: 2.5 N·m (25 kgf·cm)

6. Grease the bearing of the wave generator and install the wave generator to the shaft.

   Hexagon socket set screw: 2-M5×6 (with a brass bushing)

   Tightening torque: 3.9 N·m (40 kgf·cm)

   When installing the wave generator, push it to the end and set the set screws on the shaft's flat face.
   For the other set screw, set the brass bushing to the end.



7. Install the removed bearing to the shaft.

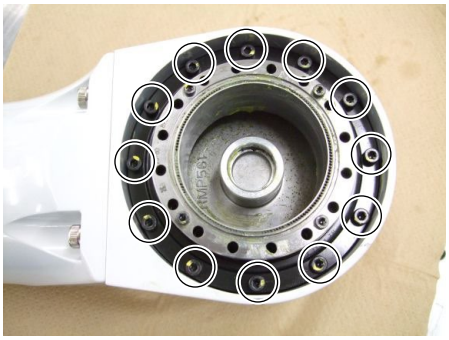
8. Set the O-ring to the groove on the installation face of the Arm #2 reduction gear unit.

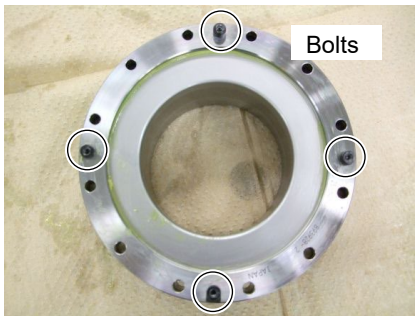
9. Install the reduction gear unit.

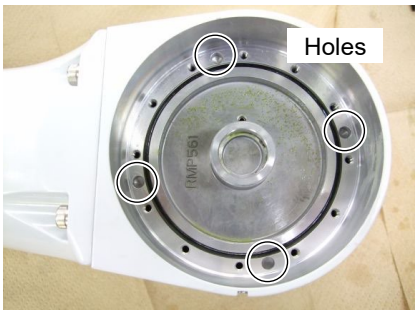
   Hexagon socket head cap bolt: 12-M4×30

   Tightening torque: 4.9 N·m (50 kgf·cm)

   Installation face of the Arm #2 reduction gear unit has clearance holes.
   Install the reduction gear unit to match the screws and the clearance holes.







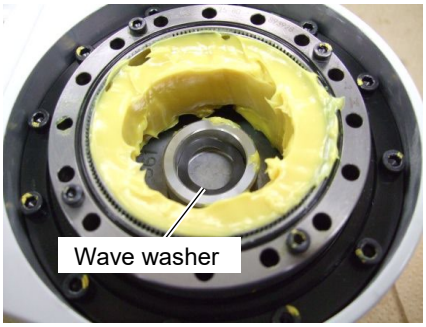
10. Grease the inner side of the flexspline.

    Grease: SK-1A

    Grease amount: 30 g

11. Set the wave washer to the position where the Arm #2 bearing will be set.

12. Insert the wave generator to the reduction gear unit and fix it.



13. Install the Arm #2 and the reduction gear unit to the Arm #1.

    Hexagon socket head cap bolt: 16-M4×30

    Tightening torque: 4.9 N·m (50 kgf·cm)

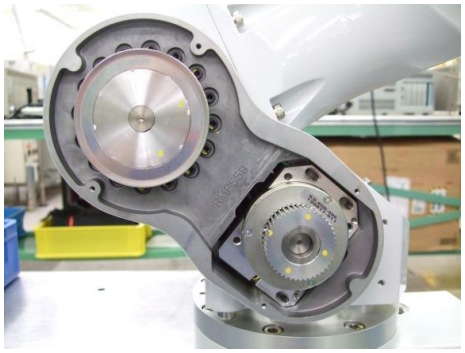
    Make sure to install after matching the screw hole positions.
    Match the positions of screws (reduction gear unit×4, arm×1) and clearance holes.
    When installing the shaft to the hole of the Arm #1, be careful not to damage the seal.
    Be careful not to let the O-ring on the groove of the circular spline comes off.

14. Install the pulley 2.

    Hexagon socket set screws: 2-M5×10 (with a brass bushing)

    Tightening torque: 3.9 N·m (40 kgf·cm)

    Join the end of the shaft and the side of the pulley, and then fix them.

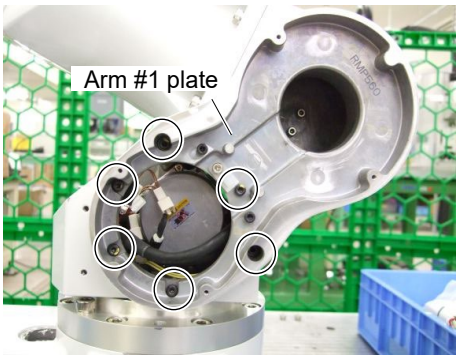


15. Turn the Arm to the opposite side and install the Arm #1 plate.

    Hexagon socket head cap bolts: 6-M4×12

    Tightening torque: 4.9 N·m (50 kgf·cm)

    After installing the plate, move the arm to make sure that there is no errors.



16. Install the cable unit.
    For details, refer to *C4 Maintenance: 4.1 Replacing the Cable Unit*, installation steps (7) through (43) and (62) through (64).

17. Place the Joint #2 timing belt to the pulley 1 and the pulley 2 of the Joint #2.

18. Apply tension to the Joint #2 motor unit and fix it.
    For details, refer to *C4 Maintenance: 6.1 Joint #2 – Replacing the Motor*, Installation steps (10) through (13).

19. Install the removed covers.
    For details, refer to *C4 Maintenance: 3. Covers*.

20. Perform the calibration.
    For details, refer to *C4 Maintenance: 16. Calibration.*

6.3 Joint #2 - Replacing the Timing Belt

	Name		Quantity	Note
Maintenance Parts	Timing belt	Joint #2 of C4-A601**	1	1520354
		Joint #2 of C4-A901**	1	1593696
Tools	Hexagonal wrench (width across flats: 3 mm)		1	For M4 hexagon socket head cap bolt
	Cross-point screwdriver		1	For covers
	Torque wrench		1	
	Cloth		1	For pressing arms
	Force gauge		1	For belt tension

Removal: Joint #2 Timing belt

1. Follow Removal steps (2) through (4) of *C4 Maintenance: 6.1 Joint #2 – Replacing the Motor.*

2. Remove the Arm #1 side cover.
   For details, refer to *C4 Maintenance: 3. Covers*.

3. Loosen the Joint #2 motor unit set screw.

   Hexagon socket head cap bolts: 3-M4×18
   (with a plain washer)

4. Remove the Joint #2 timing belt.
   Remove the timing belt from the pulley 1 first.
   Then, remove the timing belt from the pulley 2.

This procedure is common in C4-A601** and C4-A901**.

Installation: Joint #2 Timing belt

1. Place the Joint #2 timing belt to the pulley 1 and the pulley 2 of the Joint #2.
   Place the timing belt to the pulley 2 first. Then, place the timing belt to the pulley 1.

2. Secure the Joint #2 motor unit.
   For details, refer to *C4 Maintenance: 6.1 Joint #2 – Replacing the Motor*, Installation steps (6), (8), and (9).

6.4 Joint #2 - Replacing the Electromagnetic Brake

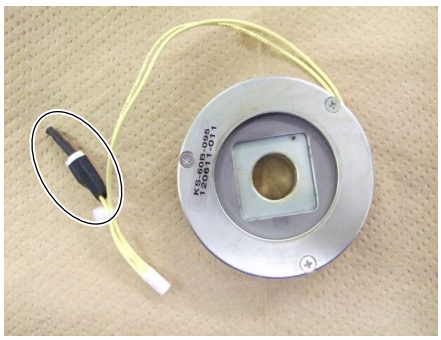
	Name		Quantity	Note
Maintenance Parts	Joint #2 electromagnetic brake		1	For the part code, refer to the *17. C4 Maintenance Part List.*
	Noise dissipative diode		1	
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M5 hexagon socket set screw
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolt
	Cross-point screwdriver		1	For covers
	Torque wrench		1	
	Cloth		1	For pressing arms
	Force gauge		1	For belt tension

Removal: Joint #2 Electromagnetic brake

1. Remove the Joint #2 electromagnetic brake.
   For details, refer to *C4 Maintenance: 6.1 Joint #2 – Replacing the Motor*, Installation steps (1) through (8).

2. Disconnect the following connectors.

   Connector: D (for noise dissipative diode)



Installation: Joint #2 Electromagnetic brake

1. Connect the following connector to the electromagnetic brake connector.

   Connector: D (for noise dissipative diode)

2. Assemble the Joint #2 electromagnetic brake and mount the motor unit.
   For details, refer to *C4 Maintenance: 6.1 Joint #2 – Replacing the Motor*, Installation steps (2) through (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.

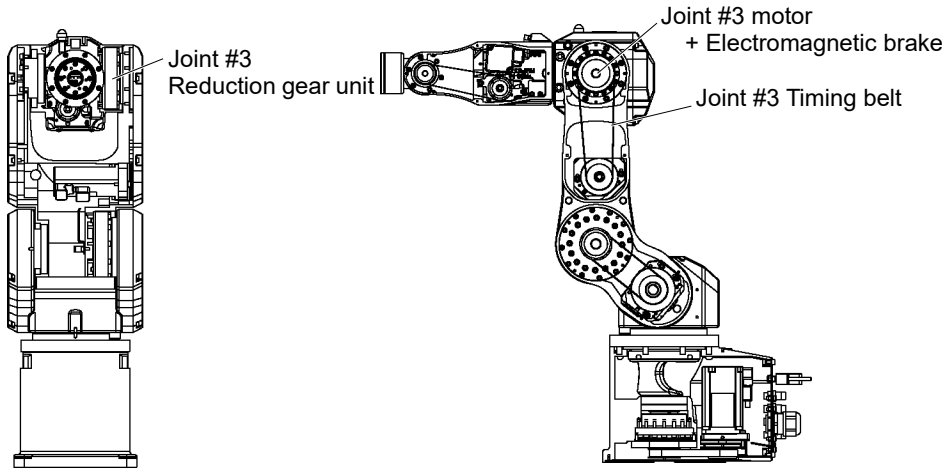
CAUTION	■ Be careful not to apply excessive shock to the motor shaft during replacement. The shock may shorten the life of the motors and encoder and/or damage them. ■ Never disassemble the motor and the encoder. Disassembled motor and encoder will cause a positional gap and cannot be used again. ■ After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

After parts have been replaced (motors, reduction gear units, electromagnetic brakes, timing belts, etc.), the Manipulator cannot perform positioning properly because a gap exists between the origin stored in each motor encoder and its corresponding origin stored in the Controller.

Therefore, it is necessary to match these origins after replacing the parts.

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

Refer to *C4 Maintenance 16. Calibration* and perform the calibration after the parts replacement.



7.1 Joint #3 - Replacing the Motor (with a Brake)

	Name		Quantity	Note
Maintenance Parts	AC servo motor 150 W (with a brake)		1	For the part code, refer to the *17. C4 Maintenance Part List.*
	Noise dissipative diode		1	
Tools	Hexagonal wrench	width across flats: 2 mm	1	For M4 hexagon socket set screws
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
	Cross-point screwdriver		1	For covers
	Torque wrench		1	
	Cloth		1	For pressing arms
	Force gauge		1	For belt tension adjustment
	Nipper		1	

The brake is mounted on the Joint #3 to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. However, the brake does not work during replacement.

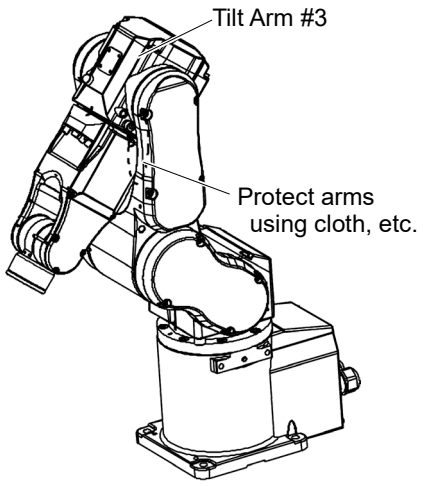
To replace the Joint #3 motor (with a brake), tilt the Arm #3 and press it toward the Arm #2. (See the step (2).)

When pressing the arm, put a cloth or a similar material between the arms to avoid them from contacting. This also protects the arm surfaces and coatings.

Removal: Joint #3 Motor (with a brake)

1. Turn ON the Controller power.

2. Tilt the Arm #3.
   Put a cloth between the Arm #2 and the Arm #3 so that two arms do not touch each other.



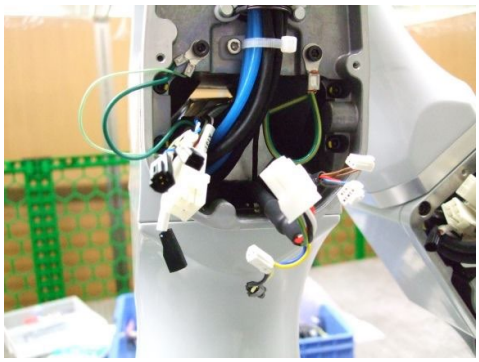
3. Turn OFF the Controller power.

4. Remove the Arm #2 side cover.
   For details, refer to *C4 Maintenance: 3. Covers*.

5. Disconnect the following connectors.

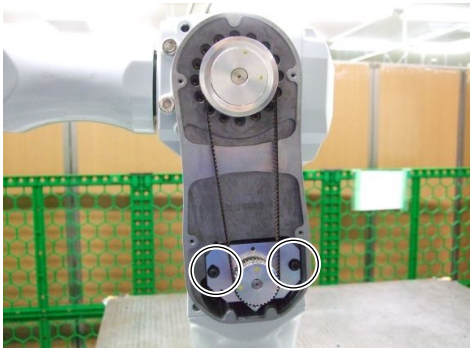
   Connector: X131, X031, BT3, BR031

   (Hold the clip to remove.)



6. Remove the Joint #3 motor unit and the belt from the Arm #2.

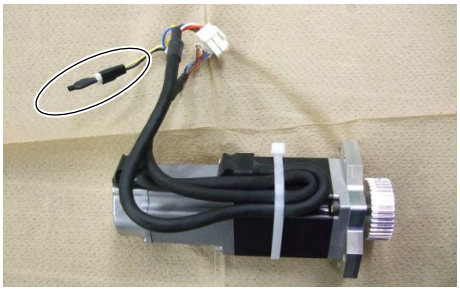
   Hexagon socket head cap bolts: 2-M4×15
   (with a plain washer)



7. Remove the connector for the noise dissipative diode.

   Connector: D

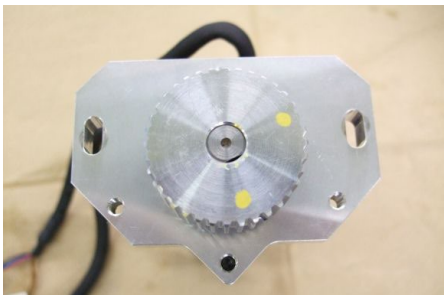
   The noise dissipative diode will be used again.
   Be careful not to lose it.



8. Remove the Joint #3 pulley 1 from the Joint #3 motor unit.

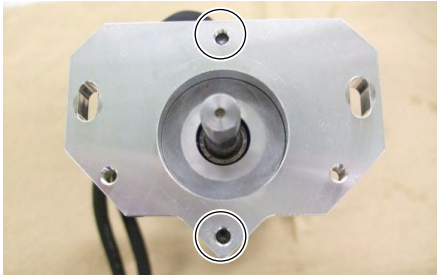
   Hexagon socket set screws: 2-M4×8 (with a brass bushing)

   There is a brass bushing in one of the set screw fixing the drive boss and the pulley. Be careful not to lose it.



9. Remove the motor plate from the Joint #3 motor.

   Hexagon socket head cap bolt: 2-M4×12



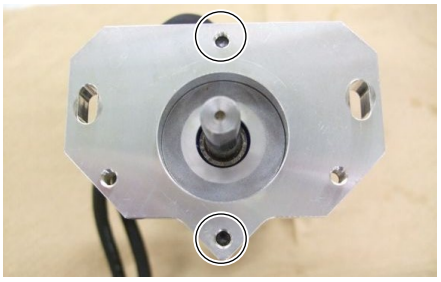
Installation: Joint #3 Motor (with a brake)

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

1. Install the motor plate to the Joint #3 motor.
   Be careful of the direction of the motor plate. Be sure to tilt the Arm. (See the figure.)

   Hexagon socket head cap bolt: 2-M4×12

   Tightening torque: 4.9 N·m (50 kgf·cm)

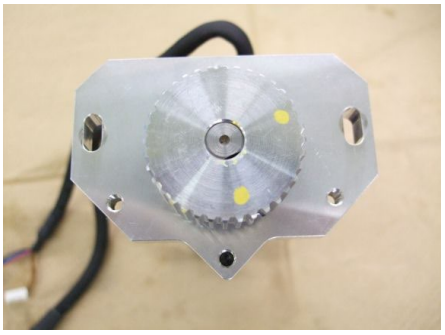


2. Mount the pulley 1 to the Joint #3 motor unit.

   Hexagon socket set screw: 2-M4×8 (with a brass bushing)

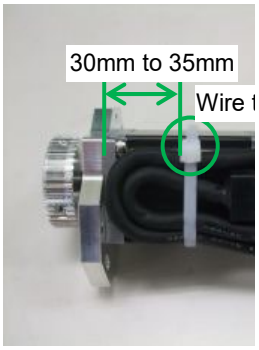
   Tightening torque: 2.5 N·m (25 kgf·cm)

   Set the set screw to the flat face of the motor shaft. For the other set screw, set the brass bushing to the end.
   Join the end of the motor shaft and the side of the pulley, and then fix them.



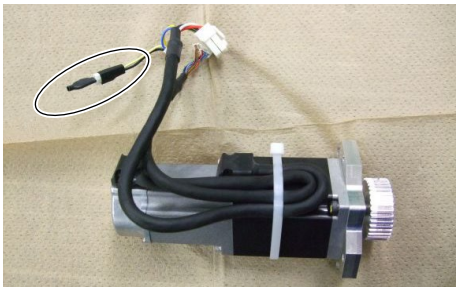
3. Fix the motor cable to the motor.

   Wire tie: AB200



4. Install the removed noise dissipative diode.

   Connector: D

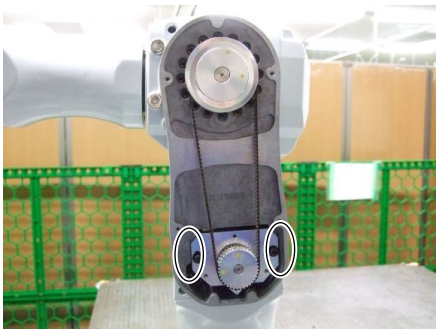


5. Install the motor unit to the Arm #2.

   Hexagon socket head cap bolts: 2-M4×15
   (with a plain washer)

   Temporarily tighten the screws.
   Tighten the screws loosely enough to hold the motor unit.

6. Place the Joint #3 timing belt around the pulley 1 and 2 and secure temporarily.
   Check that the teeth of the timing belt engage with these of the pulley.
   When securing the motor unit temporarily, make sure that the motor unit can be moved by hand, and it does not tilt when being pulled. If the unit is secured too loose or too tight, the belt will not have proper tension.
   Make sure that the clearance of the both motor units is the same.

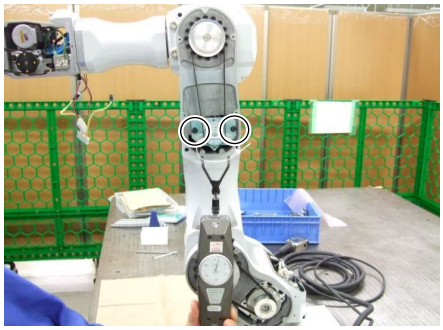


7. Apply tension to the Joint #3 motor unit and fix it.

   Install the screw for tension adjustment to the motor plate.

   Screw: M4×40 or longer (recommended length)

   Pass a suitable cord or a string (insulation lock) to the screw. Pull the cord using a force gauge or a similar tool to apply specified tension.



   Joint #3 timing belt tension = 68.6 N ± 9.8 N (7 kgf ± 1 kgf)

   Secure the Joint #3 motor unit by applying tention.

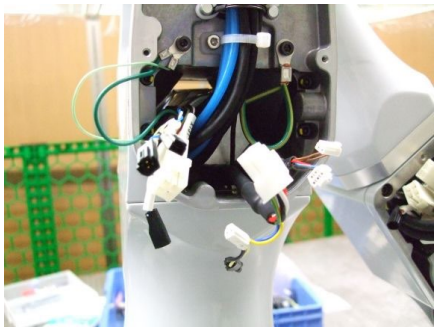
   Hexagon socket head cap bolt: 2-M4×15 (with a plain washer)

   Tightening torque: 4.9 N·m (50 kgf·cm)

   Make sure to remove the screw for tension adjustment.

8. Connect the following connectors.

   Connector: X131, X031, BT3, BR021



9. Install the Arm #2 side cover.
   For details, refer to *C4 Maintenance: 3. Covers.*

10. Perform the calibration.
    For details, refer to *C4 Maintenance: 16. Calibration.*

7.2 Joint #3 - Replacing the Reduction Gear Unit

A reduction gear unit consists of the following three parts. Also, two additional parts are included as accessories. When replacing the reduction gear unit, be sure to replace these parts all together as a set.

Reduction gear unit: Wave generator, Flexspline (CRB combined), Circular spline
Accessory: O-ring × 2

For details, refer to *C4 Maintenance: 17. C4 Maintenance Parts List*.

It is recommended replacing the O-rings (for Joint #3) when replacing the reduction gear unit.

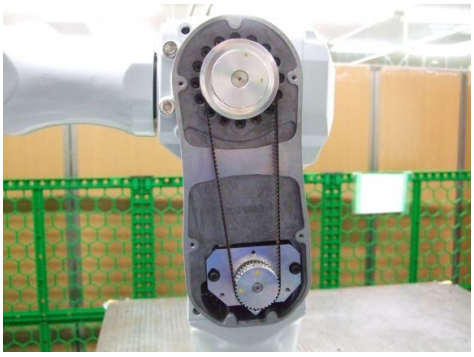
	Name		Quantity	Note
Maintenance Parts	Joint #3 reduction gear unit		1	1593859
	Joint #3 O-ring		1	1520370
Tools	Hexagonal wrench	width across flats: 2 mm	1	For M4 hexagon socket set screws
		width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
	Cross-point screwdriver		1	For covers
	Torque wrench		1	
	Spatula		1	For applying grease
	Force gauge		1	For belt tension adjustment
	Wiping cloth		2	For wiping grease

Removal: Joint #3 Reduction gear unit

1. Remove the following parts.
   Arm #2 side cover
   Arm #3 head cover
   Arm #4 side cover
   User plate
   When removing the user plate, remove the following parts from the plate.
   D-sub 9-pin connector
   4 air tubes

   For details, refer to *C4 Maintenance: 3. Covers.*

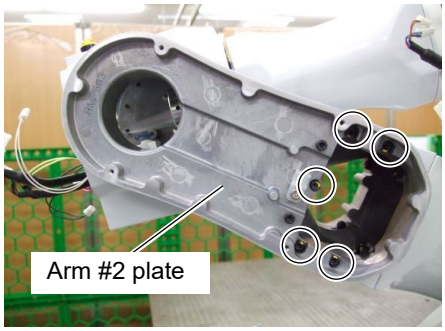
2. Remove the Joint #3 timing belt.
   For details, refer to *C4 Maintenance: 7.3 Joint #3 – Replacing the Motor*, Removal steps (1) through (3).



3. Remove the cable unit.
   For details, refer to *C4 Maintenance: 4.1 Replacing the Cable Unit*, steps (9) through (21).

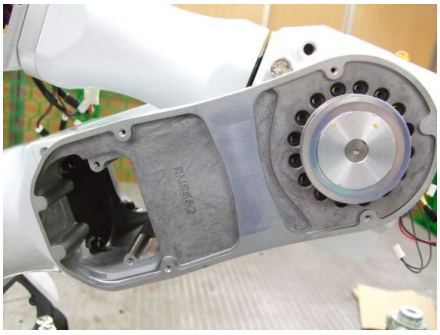
4. Remove the Arm #2 plate.

   Hexagon socket head cap bolts: 5-M4×12



5. Remove the pulley 2.

   Hexagon socket set screws: 2-M4×8
   (with a brass bushing)

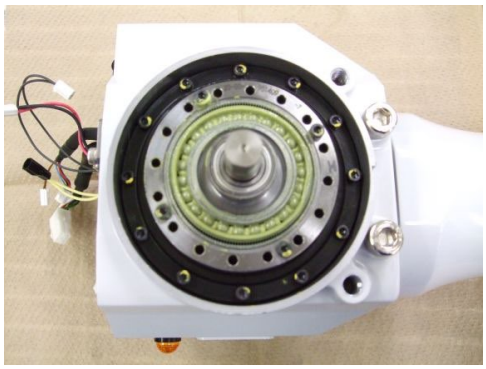


6. Remove the screws securing the reduction gear unit.

   Hexagon socket head cap bolts: 16-M3×20

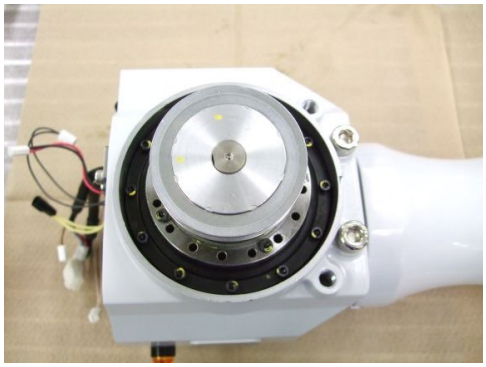
   By removing the screws, Arm #3, #4, #5, and #6 (end effector) can be separated.
   Have at least two workers so that one can support the Manipulator while the other worker is removing the screws.
   The parts are greased. Wipe grease while removing the parts.

7. Remove the wave generator from the reduction gear unit.



If the wave generator unit does not come off easily, set the pulley 2 to the shaft, as shown in the photo, and pull out the parts.

Remove the wave washer on the Arm #2 hole.
The wave washer will be used again.　Be careful not to lose it.



The parts are greased.　Wipe grease while removing the parts.

8. Remove the wave generator from the shaft.

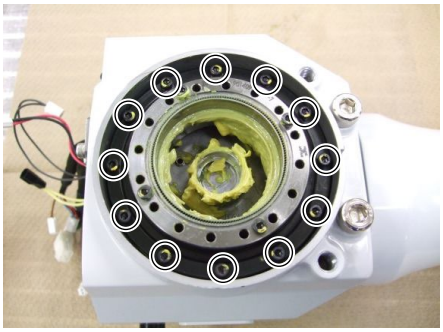
Hexagon socket set screws: 2-M4×5
(with a brass bushing)

Remove the bearing.　The bearing will be used again.　Be careful not to lose it.

There is a brass bushing on one of the set screws.
Be careful not to lose it.

The parts are greased.　Wipe grease while removing the parts.

9. Remove the reduction gear unit from the Arm #3.

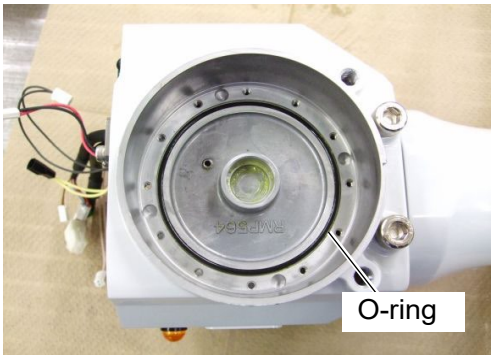


Hexagon socket set screws: 12-M3×26

The parts are greased.　Wipe grease while removing the parts.

10. Remove the O-ring.

    The parts are greased. Wipe grease while removing the parts.



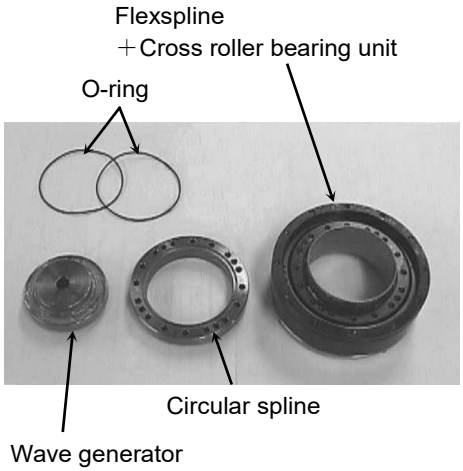
11. Wipe grease using a cloth or a similar material if it is attached to the Arm #2, and #3, etc.

Installation: Joint #3 Reduction gear unit

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

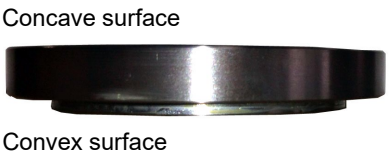
1. Unpack the new reduction gear unit package and check if it contains the parts on the right.

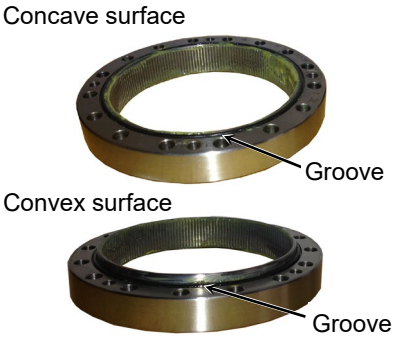
   Tooth grooves of the circular spline and the flexspline, and the bearing of the wave generator are pre-greased. Wipe grease if it is attached to the fitting parts.



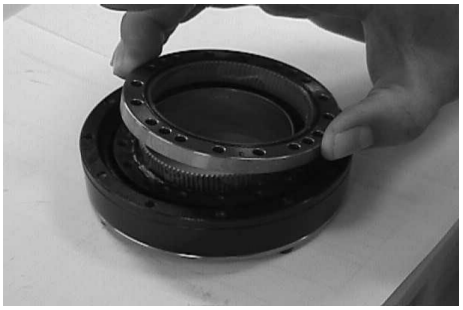
CAUTION	■ Do not adjust the bolts securing the flexspline and the cross roller bearing. If the bolts are adjusted, it requires centering of the parts by the reduction gear unit manufacturer.

2. Set the O-rings to the grooves on the both faces of the circular spline.
   Make sure to fit the rings completely.

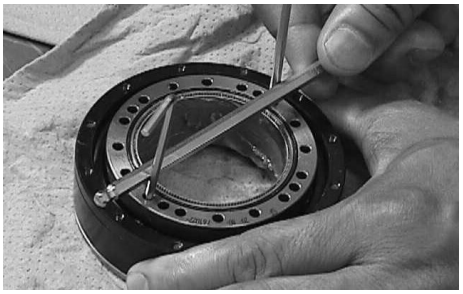




3. Set the flexspline with the convex surface facing down.



4. Match the screw holes on the cross roller bearing's inner ring and the drilled holes on the circular spline.



5. Fix the cross roller bearing's inner ring and the circular spline.

   Hexagon socket head cap bolts: 4-M3×12

   Tightening torque: 2.5 N·m (25 kgf·cm)

6. Grease the bearing of the wave generator and install it to the shaft.

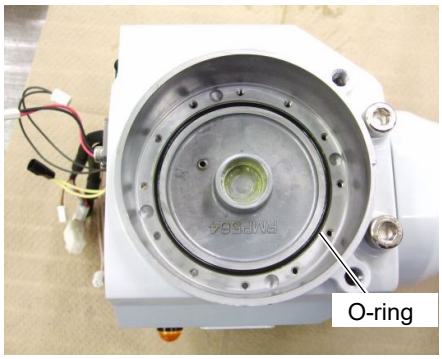
   Hexagon socket set screws: 2-M4×5 (with a brass bushing)

   Tightening torque: 2.5 N·m (25 kgf·cm)

   When installing the wave generator, push it to the end and set the set screws on the shaft's flat face.
   For the other set screw, set the brass bushing to the end.

7. Install the removed bearing to the shaft.

8. Set the O-ring to the O-ring groove on the installation face of the Arm #3 reduction gear unit.

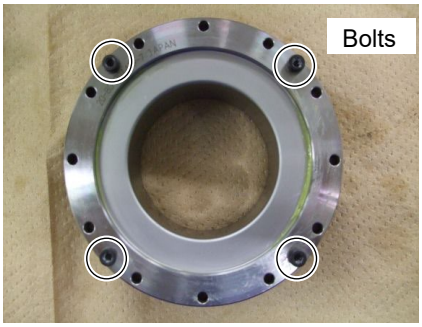


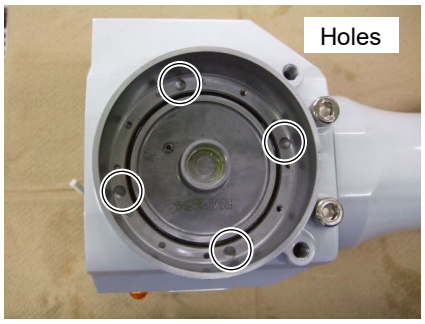
9. Install the reduction gear unit.

   Hexagon socket head cap bolts: 12-M3×26

   Tightening torque: 2.5 N·m (25 kgf·cm)

Installation face of the Arm #3 reduction gear unit has clearance holes.
Install the reduction gear unit to match the screws and the clearance holes.

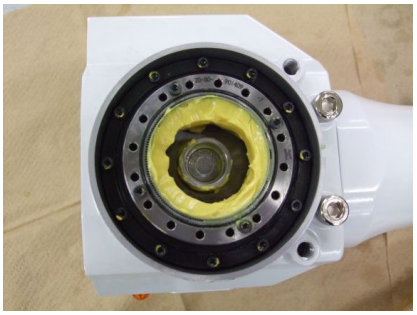




10. Grease the inner side of the flexspline.

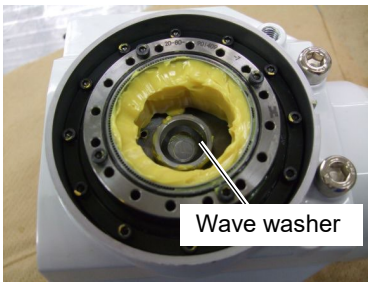
    Grease: SK-1A

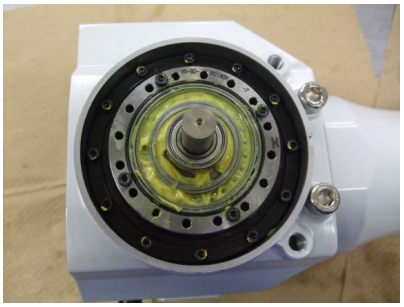
    Grease amount: 20 g



11. Set the wave washer to the position where the Arm #3 bearing will be set.

12. Insert the wave generator to the reduction gear unit and fix it.





13. Install the assembled Arm #3 to the Arm #2.

    Hexagon socket head cap bolts: 16-M3×20

    Tightening torque: 2.5 N·m (25 kgf·cm)

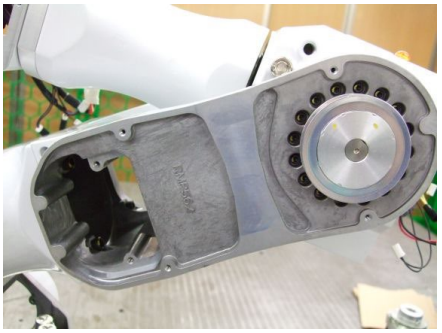
    When installing the shaft to the hole of the Arm #2, be careful not to damage the seal.
    Be careful not to let the O-ring on the groove of the circular spline comes off.

14. Install the pulley 2.

    Hexagon socket set screws: 2-M4×8 (with a brass bushing)

    Tightening torque: 2.5 N·m (25 kgf·cm)

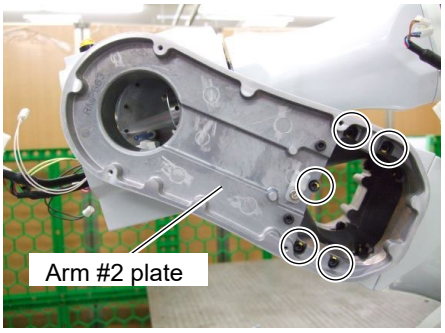
    Join the end of the shaft and the side of the pulley, and then fix them.



15. Install the Arm #2 plate.

    Hexagon socket head cap bolts: 5-M4×12

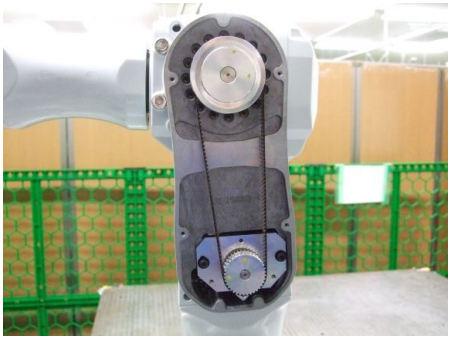
    Tightening torque: 4.9 N·m (50 kgf·cm)



16. Install the cable unit.
    For details, refer to *C4 Maintenance: 4.1 Replacing the Cable Unit*, Installation steps (5) through (39) and through (62) to (63).

17. Place the Joint #3 timing belt to the pulley 1 and the pulley 2 of the Joint #3.

18. Secure the Joint #3 motor unit by applying tension.
    For details, refer to *C4 Maintenance: 7.1 Joint #3 – Replacing the Motor (with a Brake)*, Installation steps (8) through (11).



19. Install the removed covers.
    For details, refer to*C4 Maintenance: 3. Covers.*

20. Perform the calibration.
    For details, refer to *C4 Maintenance: 16. Calibration.*

7.3 Joint #3 - Replacing the Timing Belt

	Name		Quantity	Note
Maintenance Parts	Timing belt	Joint #3 of C4-A601**	1	1593697
		Joint #3 of C4-A901**	1	1593698
Tools	Hexagonal wrench (width across flats: 3 mm)		1	For M4 hexagon socket head cap bolt
	Cross-point screwdriver		1	For covers
	Torque wrench		1	
	Cloth		1	For pressing arms
	Force gauge		1	For belt tension

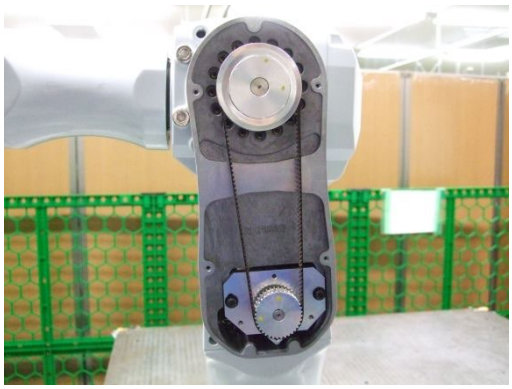
Removal: Joint #3 Timing belt

1. Follow Removal steps (1) through (4) of *C4 Maintenance: 7.1 Joint #3 – Replacing the Motor (with a Brake)*.

2. Loosen the Joint #3 motor unit set screw.

   Hexagon socket head cap bolts: 2-M4×15

3. Remove the Joint #3 timing belt.
   Remove the timing belt from the pulley 1 first.
   Then, remove the timing belt from the pulley 2.



Installation: Joint #3 Timing belt

1. Place the Joint #3 timing belt to the pulley 1 and the pulley 2 of the Joint #3.
   Place the timing belt to the pulley 2 first. Then, place the timing belt to the pulley 1.

2. Secure the Joint #3 motor unit.
   For details, refer to *C4 Maintenance: 7.1 Joint #3 – Replacing the Motor (with a Brake)*, Installation steps (6), (8), and (9).

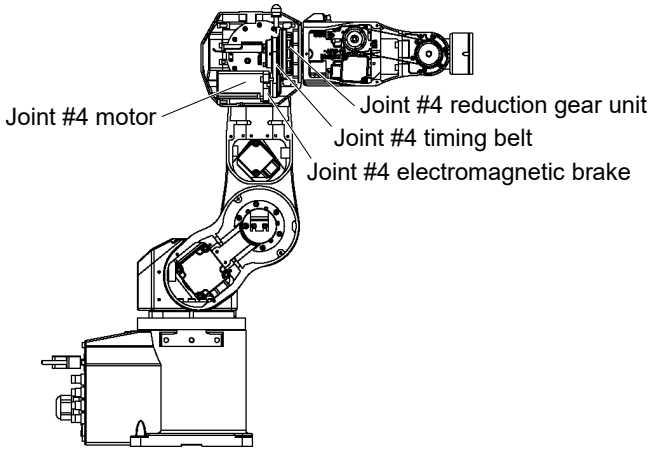
8. Joint #4

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 during replacement. The shock may shorten the life of the motors and encoder and/or damage them. ■ Never disassemble the motor and the encoder. Disassembled motor and encoder will cause a positional gap and cannot be used again. ■ After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

After parts have been replaced (motors, reduction gear units, timing belts, etc.), the Manipulator cannot perform positioning properly because a gap exists between the origin stored in each motor encoder and its corresponding origin stored in the Controller.

Therefore, it is necessary to match these origins after replacing the parts.
The process of aligning the two origins is called “Calibration”.
Refer to *C4 Maintenance 16. Calibration* and perform the calibration after the parts replacement.



8.1 Joint #4 - Replacing the Motor

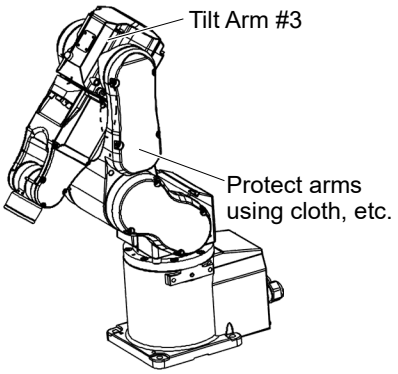
	Name		Quantity	Note
Maintenance Parts	AC servo motor 50 W		1	For the part code, refer to the *17. C4 Maintenance Part List.*
Tools	Hexagonal wrench	width across flats: 1.5 mm	1	For M3 hexagon socket set screws
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
	Cross-point screwdriver		1	For covers
	Force gauge		1	For belt tension adjustment

Removal: Joint #4 Motor

1. Turn OFF the Controller power.
2. Remove the Arm #3 head cover and the Arm #3 bottom cover.
   For details, refer to*C4 Maintenance: 3. Covers.*
3. Pull out the cables from the Arm #3 and disconnect the following connectors.

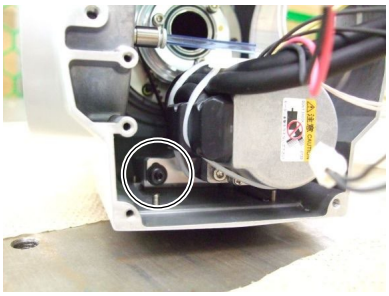
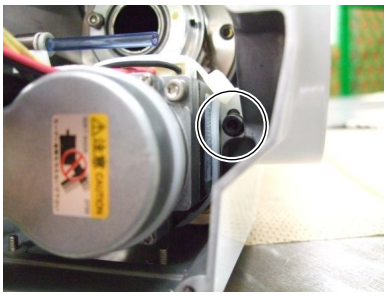
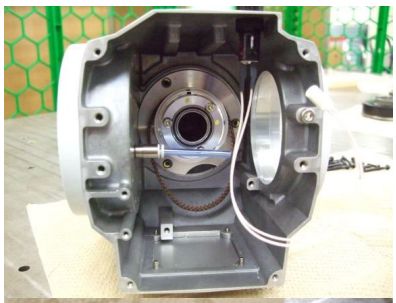
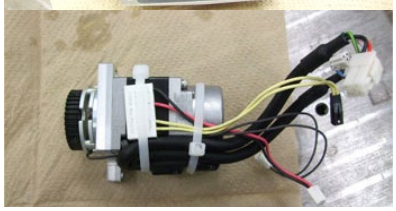
   Connector: X141, X041, BT4, BR041

   (Hold the clip to remove.)



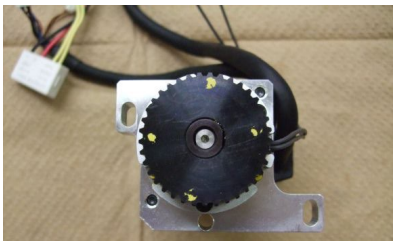
4. Remove the plate of the control board.
   For details, refer to *C4 Maintenance: 13.2 Joint #2 – Replacing the Motor*, Installation steps (3) through (5).
5. Remove the Joint #4 motor unit from the Arm #3.

   Hexagon socket head cap bolts: 2-M4×15 (with a small plain washer)

6. Cut off the wire tie binding the cables of the Joint #4 motor unit.

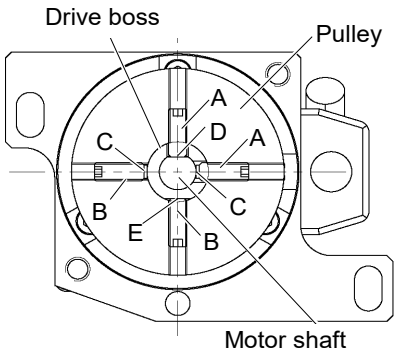
7. Remove the Joint #4 pulley 1 and the drive boss from the Joint #4 motor unit.



The drive boss and the pulley fixing:
Hexagon socket set screws: 2-M3×8 (with a brass bushing)

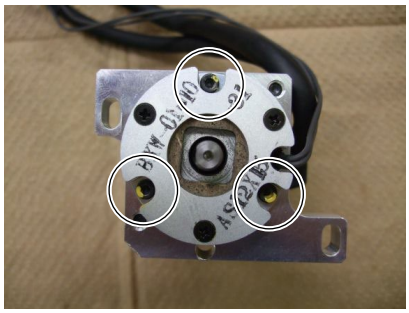
The pulley and the motor shaft fixing:
Hexagon socket set screws: 2-M3×8 (with a brass bushing)

There is a brass bushing in one of the set screw fixing the drive boss and the pulley.
Be careful not to lose it.



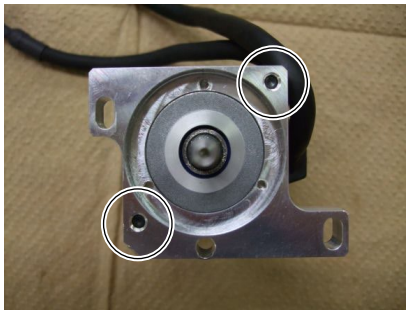
A : Pulley and motor shaft fixing screws
B : Pulley and drive boss fixing screws
C : Bushing
D : Flat face for motor shaft
E : Flat face for drive boss

8. Remove the Joint #4 electromagnetic brake.



Hexagon socket set screws: 3-M2.5×10

9. Remove the motor plate from the Joint #4 motor.



Hexagon socket head cap bolts: 2-M4×12

Installation: Joint #4 Motor

NOTE

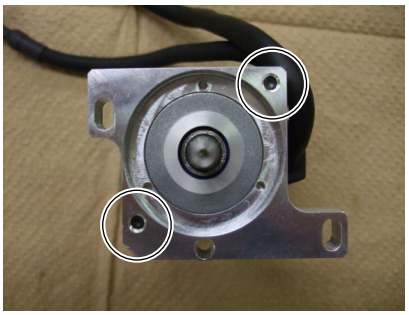
When tightening hexagon socket head cap bolts, refer to the *2.4 Tightening Hexagon Socket Head Cap Bolts.*

1. Install the motor plate to the Joint #4 motor.

   Hexagon socket head cap bolts: 2-M4×12

   Tightening torque: 4.9 N·m (50 kgf·cm)

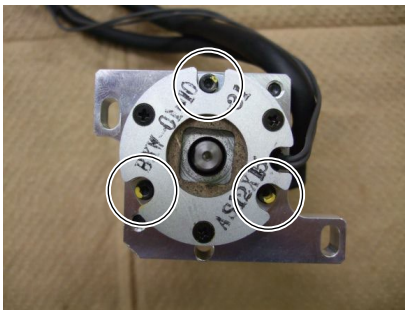
   Be careful of the direction of the motor plate. (See the photo.)



2. Mount the Joint #4 electromagnetic brake to the Joint #4 motor unit.

   Hexagon socket set screws: 3-M2.5×10

   Be careful of the direction of the Joint #4 electromagnetic brake wiring. (See the photo.)



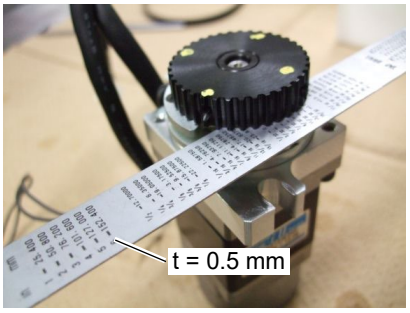
3. Mount the drive boss and the pulley 1 to the Joint #4 motor unit.

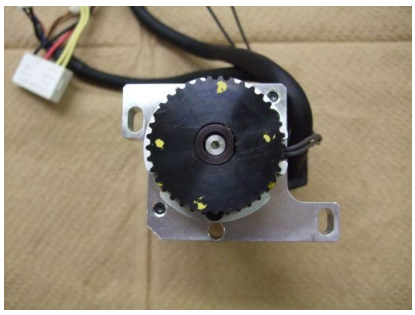
   Put the end faces of the drive boss and the pulley 1 together.

   Hexagon socket set screws: 2-M3×8 (with a brass bushing)

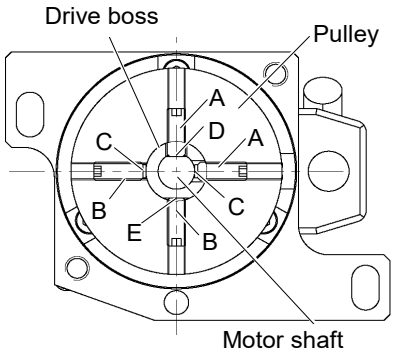
   Set the pulley 1 and the motor shaft.
   Leave 0.5 mm for the electromagnetic brake.

   Hexagon socket set screws: 2-M3×8 (with a brass bushing)



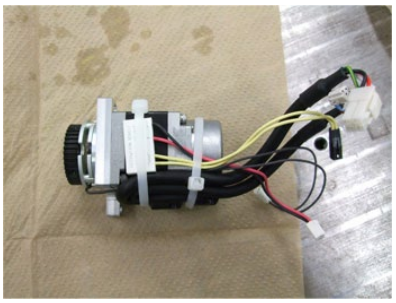


   Set the set screws to the positions as indicated below.

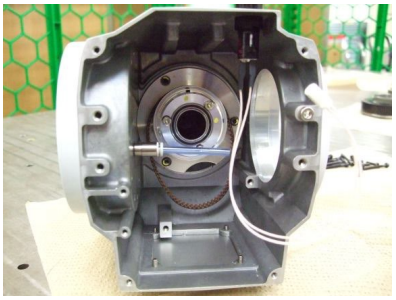


A : Pulley and motor shaft fixing screws
B : Pulley and drive boss fixing screws
C : Bushing
D : Flat face for motor shaft
E : Flat face for drive boss

4. Bind the cables of the Joint #4 motor unit with a cable tie.



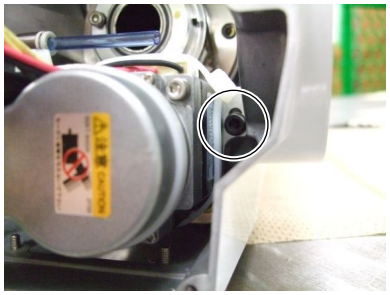
5. Place the Joint #4 timing belt to the Joint #4 pulley 2.

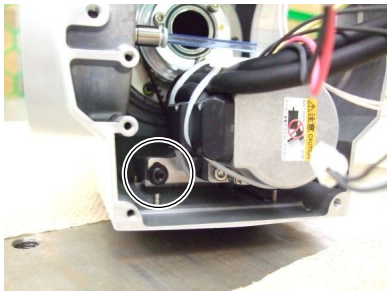


6. Put the Joint #4 motor unit inside the Arm #4.
   Place the timing belt around the pulley 1 and pulley 2.

   Hexagon socket head cap bolts: 2-M4×15

   Check that the teeth of the timing belt engage with these of the pulley.
   When securing the motor unit temporarily, make sure that the motor unit can be moved by hand, and it does not tilt when being pulled. If the unit is secured too loose or too tight, the belt will not have proper tension.



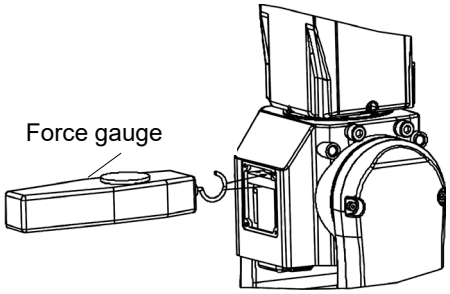


7. Apply tension to the Joint #4 timing belt and fix the Joint #4 motor unit.
   Turn ON the Controller and move the Arm #3 to the position where you can apply tension easily.
   Turn OFF the Controller power.
   Pass a suitable cord or a string (insulation lock) to the drilled hole of the motor plate. Then, pull the cord using a force gauge or a similar tool and apply specified tension to fix the motor unit.

   Joint #4 timing belt tension: 39.2 N ± 9.8 N (4 kgf ± 1 kgf)

   Hexagon socket head cap bolt: 2-M4×15 (with a plain washer)

   Tightening torque: 4.9 N·m (50 kgf·cm)



8. Install the control board 2.
   For details, refer to *C4 Maintenance: 13.2 Replacing the Control Board 2*, Installation steps (2) through (4).

9. Connect the following connectors.

   Connectors: X141, X041, BT4, BR041

10. Install the Arm #3 head cover and the Arm #3 bottom cover.
    For details, refer to*C4 Maintenance: 3. Covers*.

11. Calibrate the Joint #4.
    For details, refer to*C4 Maintenance: 16. Calibration*.

8.2 Joint #4 - Replacing the Reduction Gear Unit

A reduction gear unit consists of the waveform generator, flexspline, and circular spline. When replacing the reduction gear unit, be sure to replace these parts all together as a set.

For details, refer to *C4 Maintenance: 17. C4 Maintenance Parts List*.

It is recommended replacing the O-rings (for Joint #4) when replacing the reduction gear unit.

	Name		Quantity	Note
Maintenance Parts	Joint #4 reduction gear unit		1	1533648
	Joint #4 O-ring		1	1520372
Tools	Hexagonal wrench	width across flats: 1.5 mm	1	For M3 hexagon socket set screws
		width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
	Cross-point screwdriver		1	For covers
	Torque wrench		1	
	Spatula		1	For applying grease
	Force gauge		1	For belt tension adjustment
	Wiping cloth		1	For wiping grease

Removal: Joint #4 Reduction gear unit

1. Remove the Joint #4 motor unit from the Arm #3.
   For details, refer to *C4 Maintenance: 8.1 Joint #4 – Replacing the Motor*, Installation steps (1) through (5).

2. Remove the Joint #5 motor unit from the Arm #4.
   For details, refer to *C4 Maintenance: 9.1 Joint #5 – Replacing the Motor*, Installation steps (2) through (5).

3. Remove the Joint #6 motor unit from the Arm #4.
   For details, refer to*C4 Maintenance: 10.1 Joint #6 – Replacing the Motor*, Installation steps (3) through (5).

4. Remove the cable unit of the Arm #4.
   For details, refer to *C4 Maintenance: 4.1 Replacing the Cable Unit*, Installation steps (9) through (20).

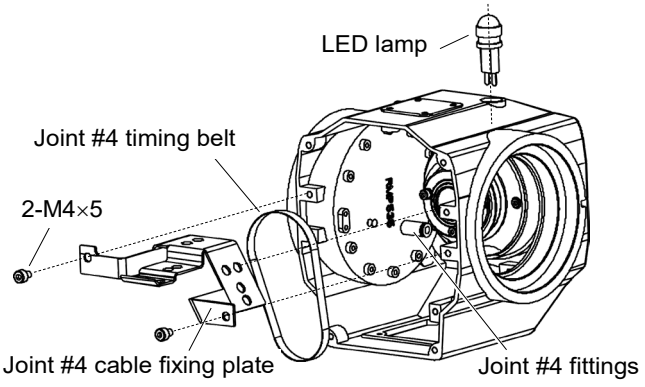
5. Remove the Arm #4 cable fixing plate.

   Hexagon socket head cap bolts: 2-M4×8

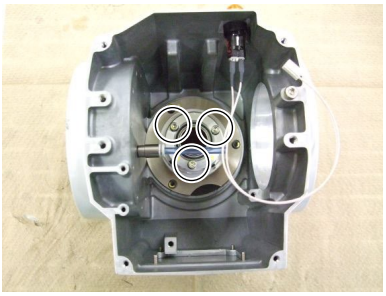
6. Remove the Joint #4 timing belt.

7. Remove the Joint #4 fitting.

8. Remove the LED lamp.



9. Remove the Joint #4 output pulley.



Hexagon socket set screws: 2-M3×8 (with a brass bushing)

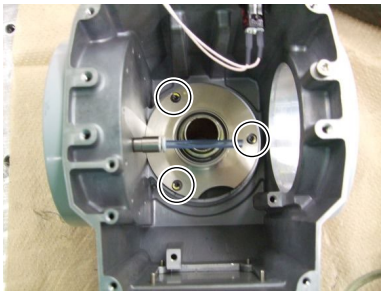
There is a brass bushing on the end of the set screw.
Be careful not to lose it.

When removing the Joint #4 output pulley, remove the bearing together.

Hexagon socket head cap bolts: 3-M3×6
(with a spring washer and a plain bushing)

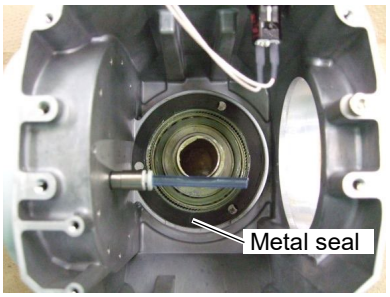
The bearing will be used again.　Be careful not to lose it.

10. Remove the Joint #4 reduction gear unit flange.



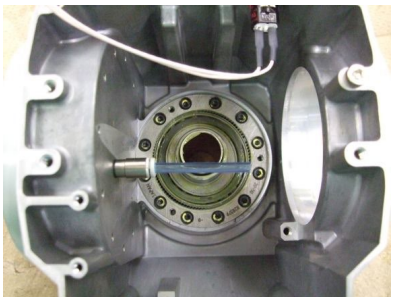
Hexagon socket head cap bolts: 3-M3×8

When removing the flange, remove the two bearings and the metal seal together.
The parts will be used again.　Be careful not to lose it.



The parts are greased.　Wipe grease on the parts while removing them.

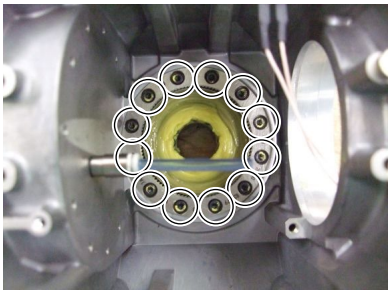
11. Remove the wave generator from the Joint #4 reduction gear unit.



The parts are greased.　Wipe grease on the parts while removing them.

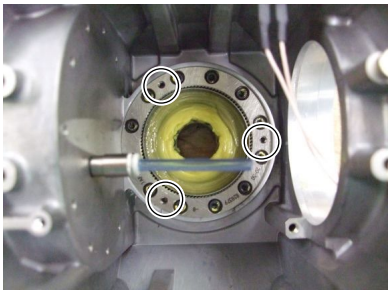
12. Remove the circular spline.

    Hexagon socket head cap bolts: 12-M3×10



    Set the screws to the removal taps of the circular spline and tighten them evenly to remove the circular spline.

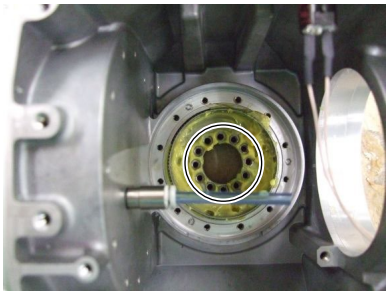
    Screws: 3-M3×10 or longer



    The parts are greased. Wipe grease on the parts while removing them.

13. Remove the flexspline.

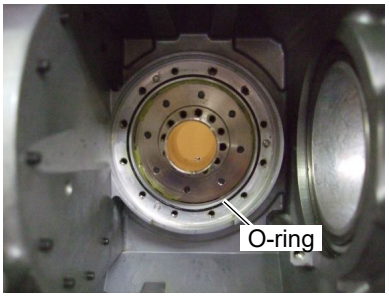
    Hexagon socket head cap bolts: 12-M3×10



    Since the flexspline turns when removing the screws and is difficult to remove, hold the Arm #4 by two workers as shown in the figure.

    The parts are greased. Wipe grease on the parts while removing them.

14. Remove the O-rings.



15. Wipe grease using a cloth or a similar material if it is attached to the Arm #3 or other parts.

Installation: Joint #4 Reduction gear unit

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

1. Unpack the new reduction gear unit package and check if it contains the parts on the right.

2. Grease the tooth surface of the circular spline to fill the groove.

   Grease: SK-1A

   Grease amount: About to fill the tooth grooves of the circular spline

3. Grease the tooth surface of the flexspline to fill the groove.

   Grease: SK-1A

   Grease amount: About to fill the tooth grooves of the flexspline

4. Grease the inner side of the flexspline.

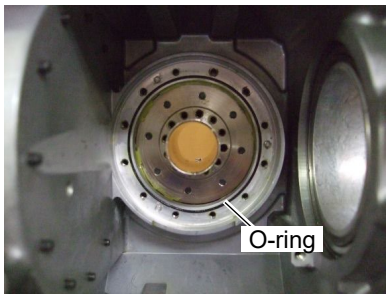
   Grease: SK-1A

   Grease amount: 10 g

5. Grease the bearing of the wave generator.

   Grease: SK-1A

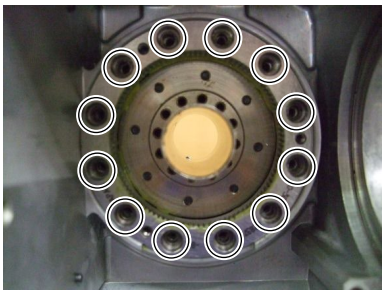
6. Install the O-ring to the Arm #4.



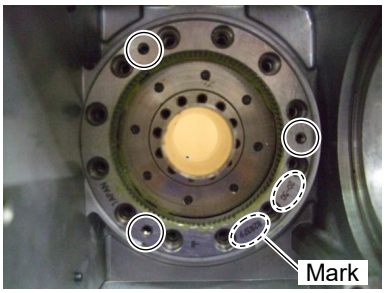
7. Install the circular spline to the Arm #4 with the inscribed side facing up.

   Hexagon socket head cap bolts: 12-M3×10

   Tightening torque: 2.5 N·m (25 kgf·cm)



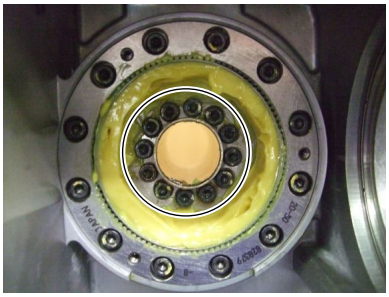
Be careful of the direction of the circular spline.
(See the figure: M3 screw position)



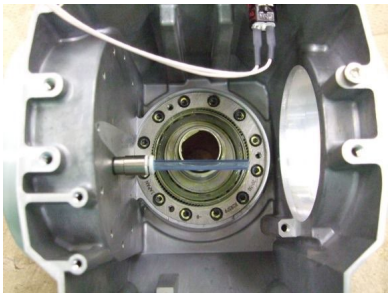
8. Install the flexspline.

   Hexagon socket head cap bolts: 12-M3×10

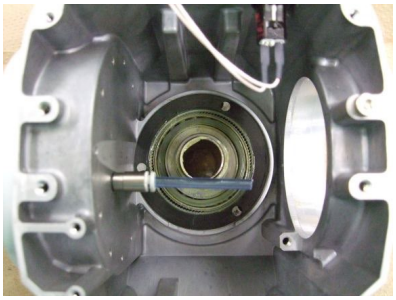
   Tightening torque: 2.5 N·m (25 kgf·cm)



9. Set the bearing to the wave generator and install it to the flexspline.



10. Install the metal seal.

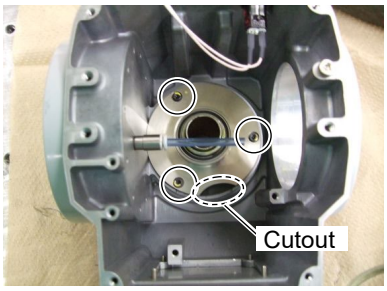


11. Install the bearing to the Joint #4 reduction gear unit flange and insert it to the cylinder of the circular spline.

    Hexagon socket head cap bolts: 3-M3×8

    Tightening torque: 2.5 N·m (25 kgf·cm)

    Be careful of the direction of the flange's cutout.

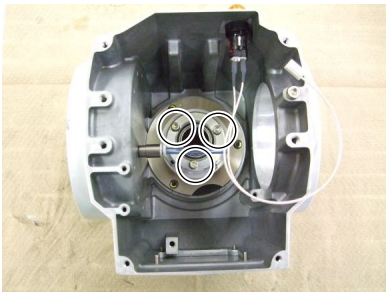


12. Install the Joint #4 output pulley.

    Hexagon socket set screws: 2-M3×8 (with a brass bushing)

13. Install the bearing.

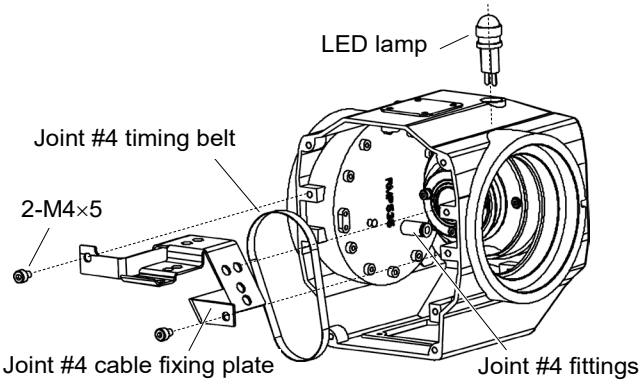
    Hexagon socket head cap bolts: 3-M3×6
    (with a spring washer and a plain bushing)



14. Install he LED lamp.

15. Install the Joint #4 fitting.

16. Install the Joint #4 timing belt.



17. Install the Joint #4 motor unit.
    For details, refer to *C4 Maintenance: 8.1 Joint #4 – Replacing the Motor*, Installation step (6).

18. Install the Joint #5 motor unit.
    For details, refer to *C4 Maintenance: 9.1 Joint #5 – Replacing the Motor*, Installation steps (4) through (5).

19. Install the Joint #6 motor unit.
    For details, refer to *C4 Maintenance: 10.1 Joint #6 – Replacing the Motor*, Installation steps (4) through (5).

20. Install the cable unit of the Arm #4.
    For details, refer to *C4 Maintenance: 4.1 Replacing the Cable Unit*, Installation steps (4) through (9) and (14) through (38).

21. Apply tension to the Joint #5 motor unit and fix it.
    For details, refer to *C4 Maintenance: 9.1 Joint #5 – Replacing the Motor*, Installation step (6).

22. Apply tension to the Joint #6 motor unit and fix it.
    For details, refer to *C4 Maintenance: 10.1 Joint #6 – Replacing the Motor*, Installation step (6).

23. Apply tension to the Joint #4 motor unit and fix it.
    For details, refer to *C4 Maintenance: 8.1 Joint #4 – Replacing the Motor*, Installation step (7).

24. Install the Arm #3 head cover, the Arm #3 bottom cover, and the Arm #4 side cover.
    For details, refer to *C4 Maintenance: 3. Covers*.

25. Perform the calibration.
    For details, refer to *C4 Maintenance: 16. Calibration*.

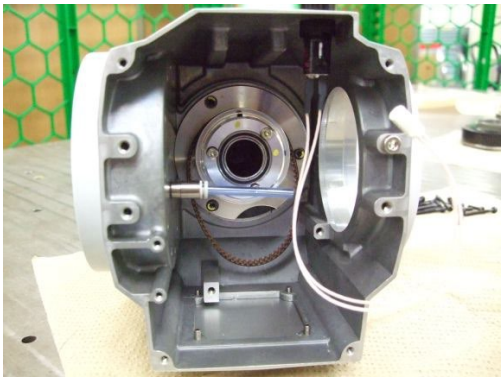
8.3 Joint #4 - Replacing the Timing Belt

	Name	Quantity	Note
Maintenance Parts	Joint #4 timing belt	1	1593699
Tools	Hexagonal wrench (width across flats: 3 mm)	1	For M4 hexagon socket head cap bolts
	Cross-point screwdriver		For covers
	Torque wrench		
	Force gauge	1	For belt tension adjustment

Removal: Joint #4 Timing belt

1. Remove the Joint #4 motor unit.
   For details, refer to *C4 Maintenance: 8.1 Joint #4 – Replacing the Motor*, Installation steps (1) through (5).

2. Remove the Joint #4 timing belt.



Installation: Joint #4 Timing belt

1. Place the Joint #4 timing belt around the Joint #4 pulley 2.

2. Install the Joint #4 motor unit.
   For details, refer to *C4 Maintenance: 8.1 Joint #4 – Replacing the Motor*, Installation steps (6) through (11).

8.4 Joint #4 - Replacing the Electromagnetic Brake

	Name		Quantity	Note
Maintenance Parts	Joint #4 electromagnetic brake		1	For the part code, refer to the *17. C4 Maintenance Part List.*
Tools	Hexagonal wrench	width across flats: 1.5 mm	1	For M3 hexagon socket set screws
		width across flats: 2 mm	1	For M2.5 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
	Cross-point screwdriver		1	For covers
	Nippers		1	
	Torque wrench		1	
	Force gauge		1	For belt tension adjustment

Removal: Joint #4 Electromagnetic brake

1. Remove the Joint #4 electromagnetic brake.
   For details, refer to *C4 Maintenance: 8.1 Joint #4 – Replacing the Motor*, Installation steps (1) through (8).

Installation: Joint #4 Electromagnetic brake

1. Mount the Joint #4 electromagnetic brake to the Joint #4 motor unit.
   For details, refer to *C4 M*aintenance: *8.1 Joint #4 – Replacing the Motor*, Installation steps (2) through (11).

9. Joint #5

 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.

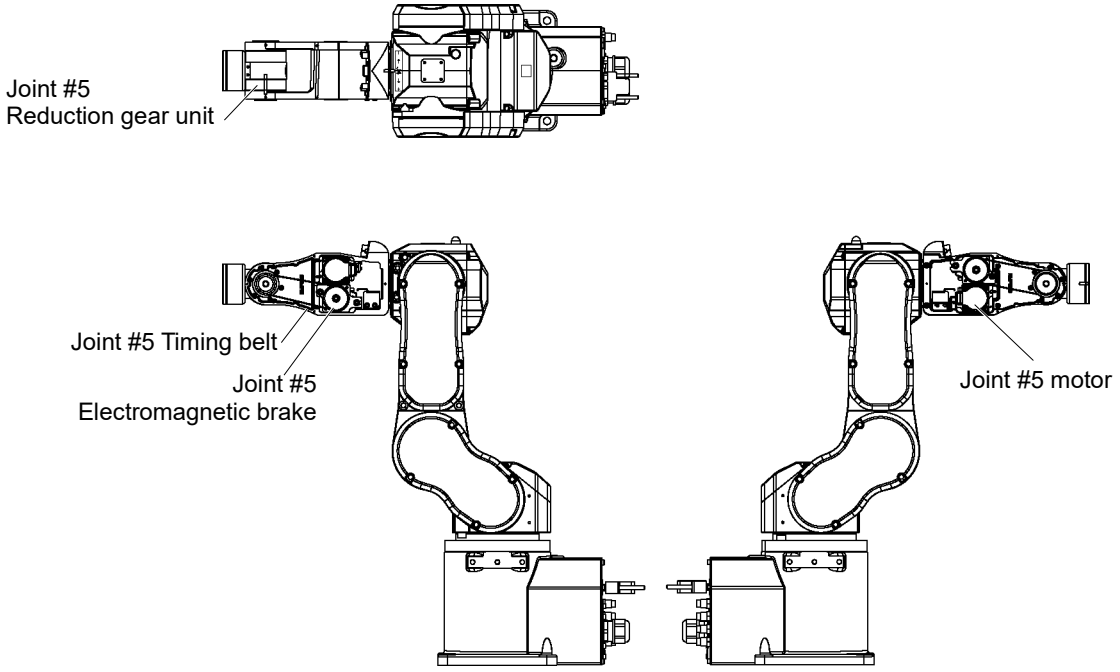
 CAUTION	■ Be careful not to apply excessive shock to the motor shaft during replacement. The shock may shorten the life of the motors and encoder and/or damage them. ■ Never disassemble the motor and the encoder. Disassembled motor and encoder will cause a positional gap and cannot be used again. ■ After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

After parts have been replaced (motors, reduction gear units, electromagnetic brakes, timing belts, etc.), the Manipulator cannot perform positioning properly because a gap exists between the origin stored in each motor encoder and its corresponding origin stored in the Controller.

Therefore, it is necessary to match these origins after replacing the parts.

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

Refer to *C4 Maintenance 16. Calibration* and perform the calibration after the parts replacement.



9.1 Joint #5 - Replacing the Motor

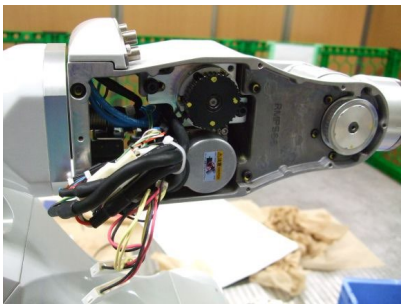
	Name		Quantity	Note
Maintenance Parts	AC servo motor 50 W		1	For the part code, refer to *17. C4 Maintenance Part Code.*
Tools	Hexagonal wrench	width across flats: 1.5 mm	1	For M3 hexagon socket set screws
		width across flats: 2 mm	1	For M2.5 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
	Cross-point screwdriver		1	For covers
	Nippers		1	
	Force gauge		1	For belt tension adjustment

The brake is mounted on the Joint #5 to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. However, the brake does not work during replacement.

Removal: Joint #5 Motor

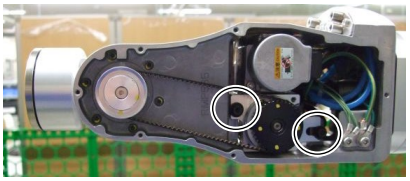
1. Turn OFF the Controller power.
2. Remove the Arm #4 side cover.
   For details, refer to *C4 Maintenance: 3. Covers*.
3. Pull out the cables from the Arm #4 and disconnect the following connectors.

   Connectors: X052, X152, BT52, BR052



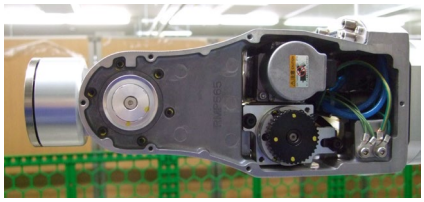
4. Loosen the bolts securing the Joint #5 motor unit and remove the belt.

   Hexagon socket head cap bolts: 2-M4×15 (with a plain washer)



5. Remove the Joint #5 motor unit.

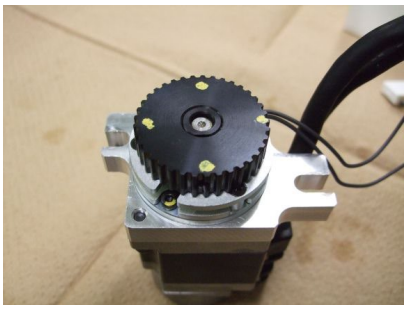
   Hexagon socket head cap bolts: 2-M4×15 (with a plain washer)



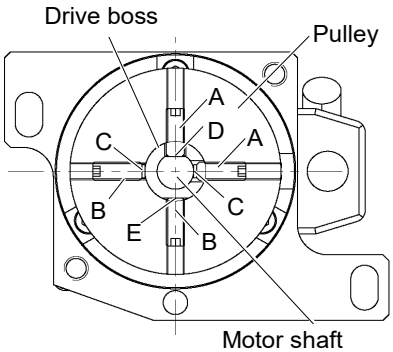
6. Remove the Joint #5 pulley 1 and the drive boss from the motor shaft of the Joint #5 motor unit.

   Drive boss and the pulley fixing screws:
   Hexagon socket set screws: 2-M3×8 (with a brass bushing)

   Pulley and the motor shaft fixing screws:
   Hexagon socket set screws: 2-M3×8 (with a brass bushing)



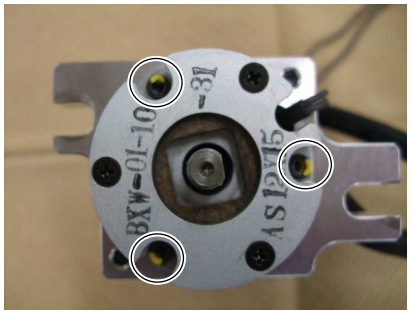
There is a brass bushing in one of the set screws fixing the drive boss and the pulley. Be careful not to lose it.



A : Pulley and motor shaft fixing screws
B : Pulley and drive boss fixing screws
C : Bushing
D : Flat face for motor shaft
E : Flat face for drive boss

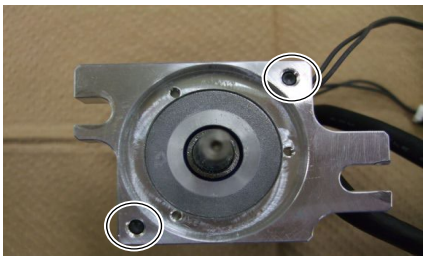
7. Remove the Joint #5 electromagnetic brake.

   Hexagon socket set screws: 3-M2.5×10



8. Remove the motor plate from the Joint #5 motor.

   Hexagon socket head cap bolts: 2-M4×12



Installation: Joint #5 Motor

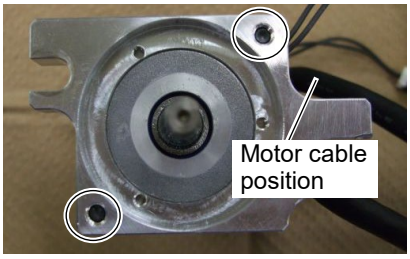
NOTE When tightening hexagon socket head cap bolts, refer to the *2.4 Tightening Hexagon Socket Head Cap Bolts.*

1. Install the motor plate to the Joint #5 motor.

   Hexagon socket head cap bolts: 2-M4×12

   Tightening torque: 4.9 N·m (50 kgf·cm)

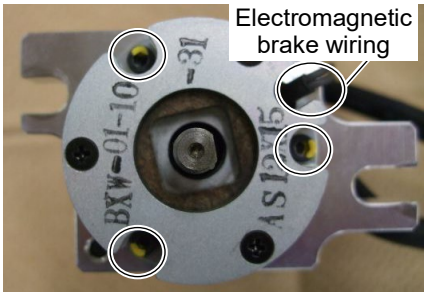
   Be careful of the direction of the motor plate. (See the photo.)



2. Mount the Joint #5 electromagnetic brake to the Joint #5 motor unit.

   Hexagon socket set screws: 3-M2.5×10

   Be careful of the direction of the Joint #5 electromagnetic brake wiring. (See the photo.)



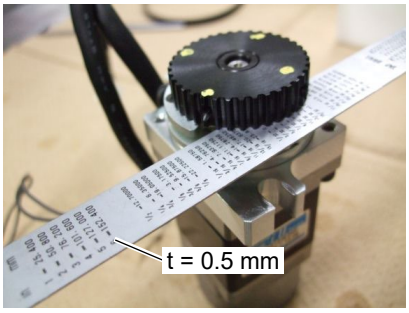
3. Mount the drive boss and the pulley 1 to the Joint #5 motor unit.

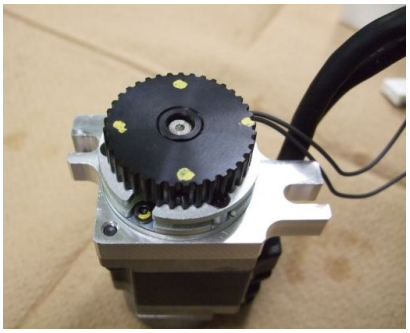
   Set the drive boss and the pulley 1 so that their surfaces become flat.

   Hexagon socket set screws: 2-M3×8 (with a brass bushing)

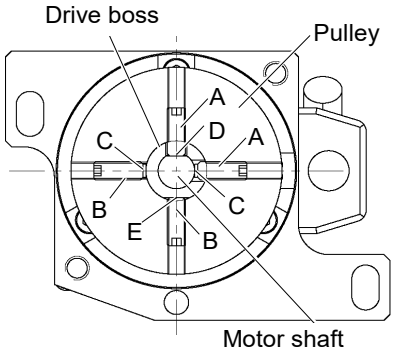
   Fix the pulley 1 and the motor shaft.
   Leave 0.5 mm for the electromagnetic brake.

   Hexagon socket set screws: 2-M3×8 (with a brass bushing)





   Set the set screws as indicated below.



A : Pulley and motor shaft fixing screws
B : Pulley and drive boss fixing screws
C : Bushing
D : Flat face for motor shaft
E : Flat face for drive boss

4. Put the Joint #5 motor unit to the Arm #4.

5. Place the timing belt around the pulley 1 and pulley 2.
   Make sure that the teeth of the timing belt engage with these of the pulley.

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

6. Apply tension to the Joint #5 motor unit and fix it.

   Joint #5 Timing belt tension = 39.2 N ± 9.8 N (4 kgf ± 1 kgf)

   Secure the Joint #5 motor unit by applying tension.

   Hexagon socket head cap bolts: 2-M4×15 (with a plain washer)

   Tightening torque: 4.9 N·m (50 kgf·cm)

7. Connect the following connectors.

   Connectors: X052, X152, BT52, BR052

8. Install the Arm #4 side cover.
   For details, refer to *C4 Maintenance: 3. Covers*.

9. Perform the calibration.
   For details, refer to *C4 Maintenance: 16. Calibration*.

9.2 Joint #5 - Replacing the Reduction Gear Unit

A reduction gear unit consists of the waveform generator, flexspline, and circular spline. When replacing the reduction gear unit, be sure to replace these parts all together as a set.

For details, refer to *C4 Maintenance: 17. Maintenance Parts List*.

	Name		Quantity	Note
Maintenance Parts	Joint #5 reduction gear unit		1	1539260
Tools	Hexagonal wrench	width across flats: 1.5 mm	1	For M3 hexagon socket set screws For M2 hexagon socket head cap bolts
		width across flats: 2 mm	1	For M2.5 hexagon socket head cap bolts
		width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
	Cross-point screwdriver		1	For covers
	Wrench	width 7	1	
		width 8	1	
	Force gauge		1	For belt tension adjustment

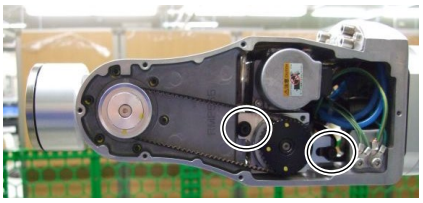
Removal: Joint #5 Reduction gear unit

1. Turn OFF the Controller power.

2. Remove the Arm #4 side cover.
   For details, refer to *C4 Maintenance: 3. Covers*.

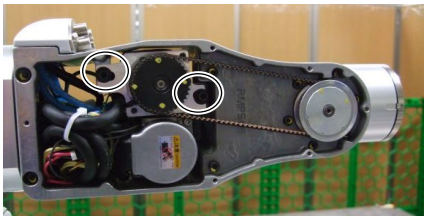
3. Loosen the set screws of the Joint #5 motor unit and remove the Joint #5 timing belt (6×315 mm).

   Hexagon socket head cap bolts: 2-M4×15 (with a plain washer)



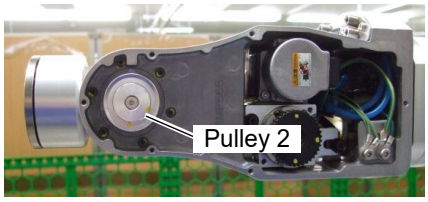
4. Loosen the set screws of the Joint #6 motor unit and remove the Joint #6 timing belt (6×324 mm).

   Hexagon socket head cap bolts: 2-M4×15 (with a plain washer)



5. Loosen the set screws of the pulley 2 and remove the Joint #5 pulley 2.

   Hexagon socket set screws: 2-M3×5 (with a brass bushing)

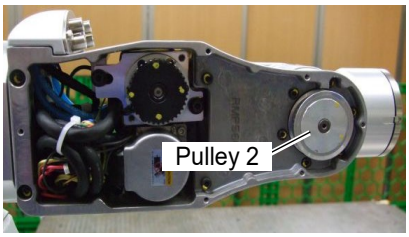


   There is a brass bushing in one of the set screws.
   Be careful not to lose it.

6. Loosen the set screws of the pulley 2 and remove the Joint #6 pulley 2.

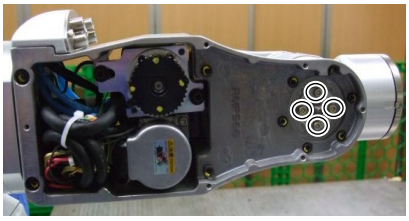
   Hexagon socket set screws: 2-M3×5 (with a brass bushing)

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



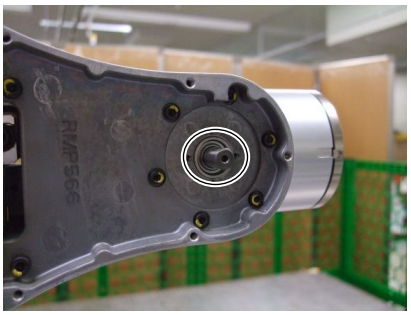
7. Remove the bearing retainer plate.

   Hexagon socket head cap bolts: 4-M3×6



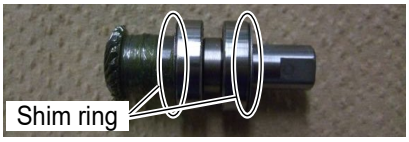
8. Pull out the gear unit.

   If it is difficult to remove the gear unit, install the removed pulley 2 to the shaft and remove the parts.



   The bearing of the gear unit has shim rings.
   Check the position and the number of the shim rings.

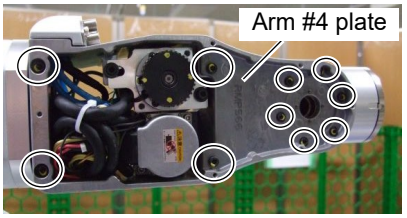
   When installing the gear unit, make sure to use the same number of the shim rings to the same position.



9. Remove the Arm #4 plate.

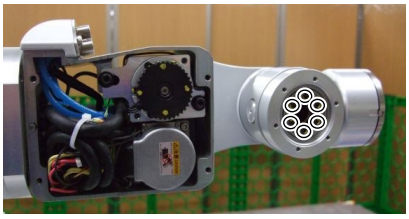
   Hexagon socket head cap bolts: 6-M3×12

   Hexagon socket head cap bolts: 4-M4×10



10. Remove the Joint #6 flange unit.

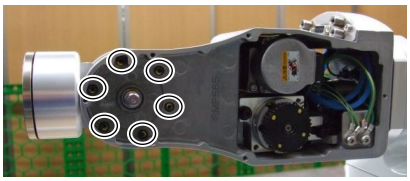
    Hexagon socket head cap bolts: 6-M3×15



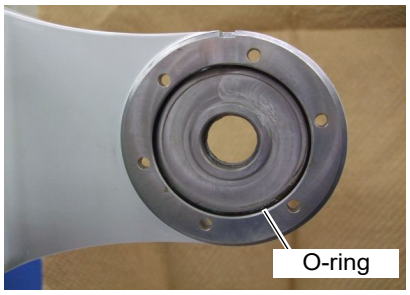
11. Loosen the set screws securing the Joint #5 reduction gear unit and remove the Arm #5 unit.

    Hexagon socket head cap bolts: 6-M3×15

    The parts are greased.　Wipe grease on the parts while removing them.



12. Remove the O-rings.
    The O-rings are on the installation surfaces of the Arm #4 and #5.
    The O-ring of the Arm #4 is on the Arm #4 plate which was removed in the step (9).
    For the O-ring of the Arm #5, see the photo on the right.

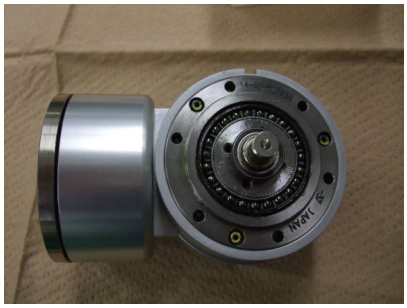


13. Remove the wave generator from the reduction gear unit.

    If it is difficult to remove the wave generator unit, install the removed pulley 2 to the shaft and remove the parts.

    When removing the wave generator, the bearing on the end of the shaft comes off together.　Do not lose the bearing.

    The parts are greased.　Wipe grease on the parts while removing them.



14. Remove the wave generator from the shaft.

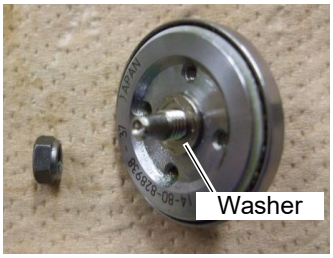
    Remove the bearing.　The bearing will be used again.　Be careful not to lose it.

    There is a washer between the nut and the wave generator.

    Be careful not to lose it.

    The parts are greased.　Wipe grease on the parts while removing them.

    Open-end wrench width for the shaft: 7 mm
    Open-end wrench width for the nut: 8 mm



15. Unscrew the set screws of the circular spline and the flexspline.

Circular spline fixing bolts:

Hexagon socket head cap bolts: 3-M2×10

Flexspline fixing bolts:

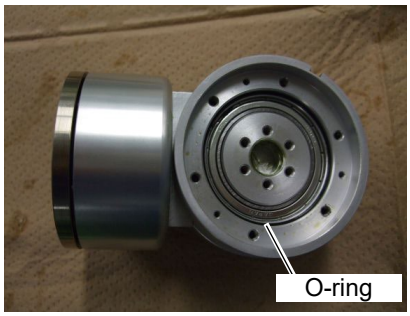
Hexagon socket head cap bolts: 6-M3×8

The parts are greased.　Wipe grease on the parts while removing them.

16. Remove the circular spline and the flexspline.

The parts are greased.　Wipe grease on the parts while removing them.

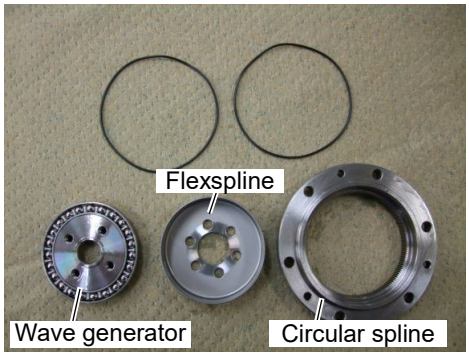
17. Remove the O-ring of the housing.



Installation: Joint #5 Reduction gear unit

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

1. Unpack the new reduction gear unit package and check if it contains the parts on the right.



2. Grease all over the tooth surface of the flexspline.

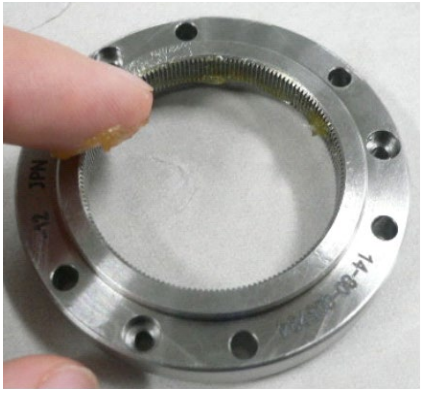
   Grease: SK-2

   Grease amount: About to fill the tooth groove of the flexspline.

3. Grease all over the tooth surface of the circular spline.

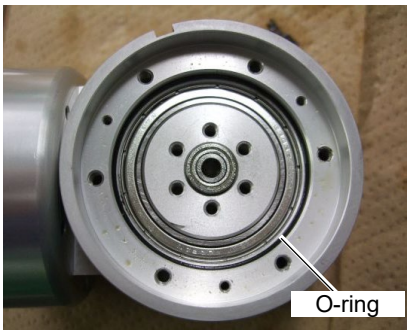
   Grease: SK-2

   Grease amount: About to fill the tooth groove of the circular spline.



4. Install the removed bearing to the Arm #5.

5. Install the O-ring (of the Joint #5 reduction gear unit) to the housing.



6. Install the flexspline so that the hole on the inner side can match the bearing's outer ring.

   Hexagon socket head cap bolts: 6-M3×8

   Tightening torque: 2.5 N·m (25 kgf·cm)

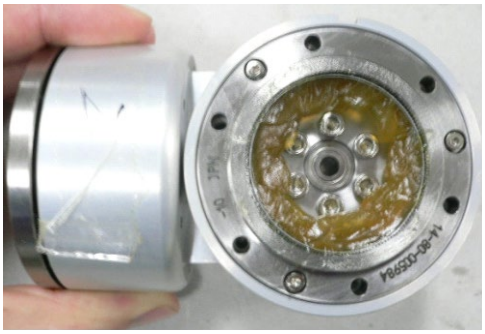
7. Install the circular spline.

   Hexagon socket head cap bolts: 3-M2×10

8. Grease the inner side of the flexspline.

   Grease: SK-2

   Grease amount: 3 g



9. Install the wave generator to the shaft.

   Insert the washer between the nut and the wave generator.

   Set an open-end wrench to the shaft and turn the nut.

   Open-end wrench width for the shaft: 7 mm

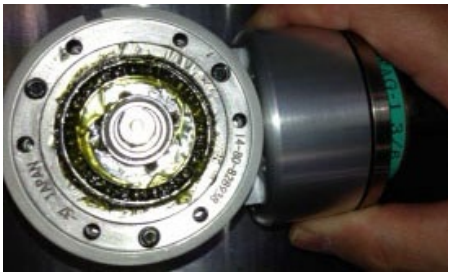
   Open-end wrench width for the nut: 8 mm

10. Grease the bearing of the wave generator.

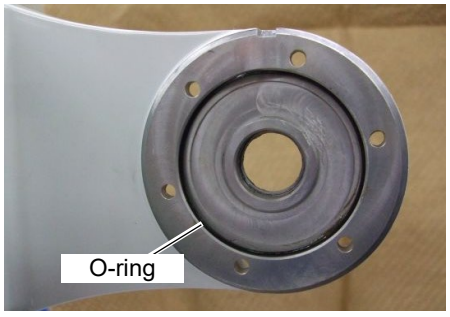
    Grease: SK-2

    Grease amount: About to fill space between the balls.

11. Insert the wave generator to the reduction gear unit.



12. Install the O-ring (of the Joint #5 reduction gear unit) to the Arm #4.

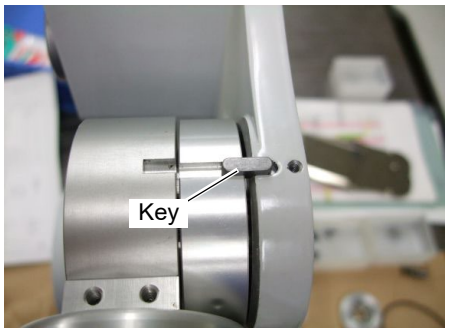


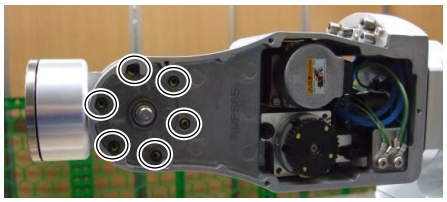
13. Install the Arm #5 unit to the Arm #4.

    Hexagon socket head cap bolts: 6-M3×15

    Tightening torque: 2.5 N·m (25 kgf·cm)

    When installing the unit, insert the key to the groove and match the grooves of the Arm #4 and the housing, then tighten the screws. Return the key to its original position after tightening the screws.



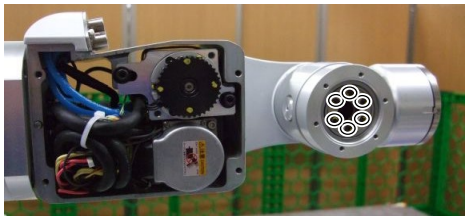


    The key is on the Arm #1, under the Arm #1 upper cover.
    Hexagon socket head cap bolts: M3×6

14. Install the Joint #6 flange unit.

    Hexagon socket head cap bolt: 6-M3×15

    Tightening torque: 2.5 N·m (25 kgf·cm)



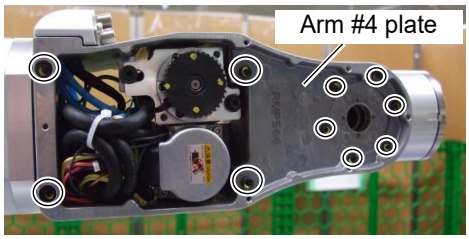
15. Install the Arm #4 plate.

    Hexagon socket head cap bolts: 6-M3×12

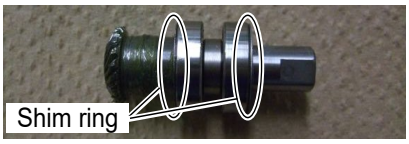
    Tightening torque: 2.5 N·m (25 kgf·cm)

    Hexagon socket head cap bolts: 4-M4×10

    Tightening torque: 4.9 N·m (50 kgf·cm)

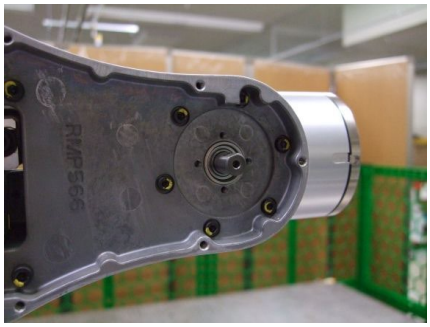


16. Insert the gear unit.



The bearing of the gear unit has shim rings.　Insert them together.

Use the same number of the shim rings to the same position as removed shim rings.



17. Install the bearing retainer plate.

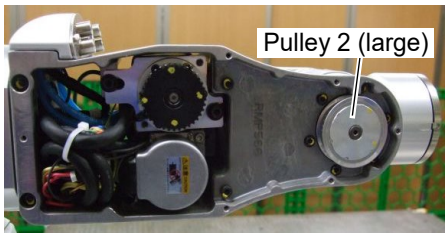
Hexagon socket head cap bolts: 4-M3×6

Tightening torque: 2.5 N·m (25 kgf·cm)

18. Install the Joint #6 pulley 2.

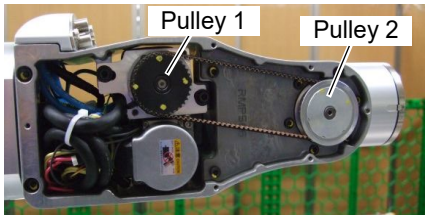
Hexagon socket set screws: 2-M3×5 (with a brass bushing)

Set the set screw on the flat face of the shaft.　For the other set screw, insert the brass bushing to the end.



19. Place the Joint #6 timing belt (6×324 mm) to the Pulley 1 and 2 and fix it temporarily.

Check that the teeth of the timing belt engage with these of the pulley.



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

20. Apply tension to the Joint #6 motor unit and fix it.

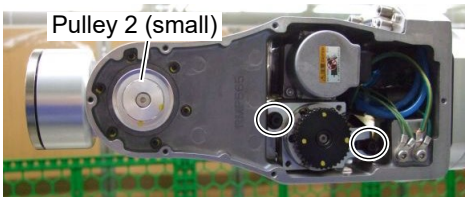
Joint #6 timing belt tension = 39.2 N ± 9.8 N (4 kgf ± 1 kgf)

Secure the Joint #6 motor unit by applying tension.

Hexagon socket head cap bolts: 2-M4×15 (with a plain washer)

Tightening torque: 4.9 N·m (50 kgf·cm)

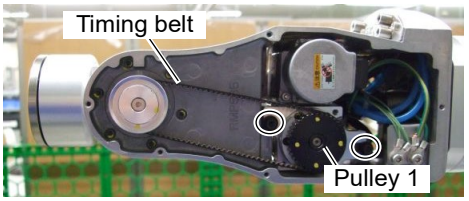
21. Install the Joint #5 pulley 2.



Hexagon socket set screw: 2-M3×5 (with a brass bushing)

Set the set screw on the flat face of the shaft. For the other set screw, insert the brass bushing to the end.

22. Place the Joint #5 timing belt (6×315 mm) around the Pulley 1 and 2 and fix it temporarily.



Check that the teeth of the timing belt engage with these of the pulleys.

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

23. Apply tension to the Joint #5 motor unit and fix it.

Joint #5 timing belt tension = 39.2 N ± 9.8 N (4 kgf ± 1 kgf)

Secure the Joint #5 motor unit by applying tension.

Hexagon socket head cap bolt: 2-M4×15 (with a plain washer)

Tightening torque: 4.9 N·m (50 kgf·cm)

24. Install the Arm #4 side cover.

For details, refer to *C4 Maintenance: 3. Covers*.

25. Perform the calibration.

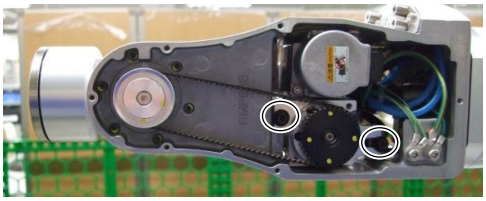
For details, refer to *C4 Maintenance: 16. Calibration*.

9.3 Joint #5 - Replacing the Timing Belt

	Name	Quantity	Note
Maintenance Parts	Joint #5 timing belt (315 mm)	1	1599367
Tools	Hexagonal wrench (width across flats: 2.5 mm)	1	For M4 hexagon socket head cap bolts
	Cross-point screwdriver	1	For covers
	Force gauge	1	For belt tension adjustment

Removal: Joint #5 Timing belt

1. Turn OFF the Controller power.
2. Remove the Arm #4 side cover.
   For details, refer to *C4 Maintenance: 3. Covers*.
3. Loosen the Joint #5 motor unit set screws.
   Hexagon socket head cap bolts: 2-M4×15
   (with a plain washer)



4. Remove the Joint #5 timing belt.

Installation: Joint #5 Timing belt.

1. Place the Joint #5 timing belt to the pulley 1 and the pulley 2 of the Joint #5.
2. Secure the Joint #5 motor unit.
   For details, refer to *C4 Maintenance: 9.1 Joint #5 – Replacing the Motor*, Installation steps (5), (6), (8), and (9).

9.4 Joint #5 - Replacing the Electromagnetic Brake

	Name	Quantity	Note
Maintenance Parts	Joint #5 electromagnetic brake	1	For the part code, refer to the *17. C4 Maintenance Part List.*
Tools	Hexagonal wrench (width across flats: 1.5 mm)	1	For M3 hexagon socket set screws
	Hexagonal wrench (width across flats: 2 mm)	1	For M2.5 hexagon socket head cap bolts
	Hexagonal wrench (width across flats: 3 mm)	1	For M4 hexagon socket head cap bolts
	Cross-point screwdriver	1	For covers
	Nippers	1	
	Force gauge	1	For belt tension adjustment

Removal: Joint #5 Electromagnetic brake

1. Remove the Joint #5 electromagnetic brake.
   For details, refer to *C4 Maintenance: 9.1 Joint #5 – Replacing the Motor*, Installation steps (1) through (7).

Installation: Joint #5 Electromagnetic brake

1. Mount the Joint #5 electromagnetic brake to the Joint #5 motor unit.
   For details, refer to *C4 Maintenance: 9.1 Joint #5 – Replacing the Motor*, Installation steps (2) through (9).

10. Joint #6

 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.

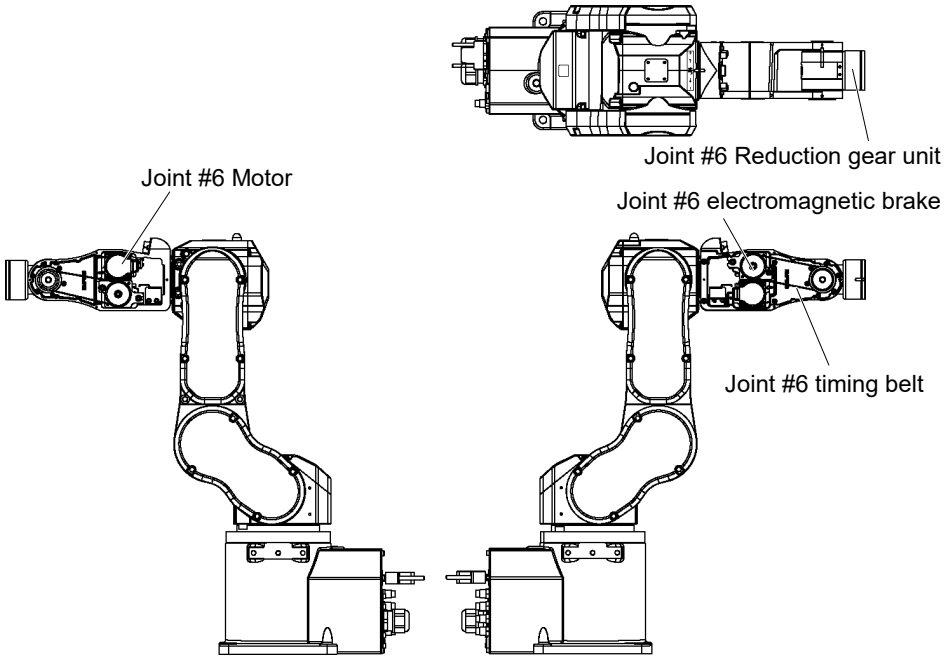
 CAUTION	■ Be careful not to apply excessive shock to the motor shaft during replacement. The shock may shorten the life of the motors and encoder and/or damage them. ■ Never disassemble the motor and the encoder. Disassembled motor and encoder will cause a positional gap and cannot be used again. ■ After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

After parts have been replaced (motors, reduction gear units, electromagnetic brakes, timing belts, etc.), the Manipulator cannot perform positioning properly because a gap exists between the origin stored in each motor encoder and its corresponding origin stored in the Controller.

Therefore, it is necessary to match these origins after replacing the parts.

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

Refer to *C4 Maintenance 16. Calibration* and perform the calibration after the parts replacement.



10.1 Joint #6 - Replacing the Motor

	Name		Quantity	Note
Maintenance Parts	AC servo motor 50 W		1	For the part code, refer to the *17. C4 Maintenance Part Code.*
Tools	Hexagonal wrench	width across flats: 1.5 mm	1	For M3 hexagon socket set screws
		width across flats: 2 mm	1	For M2.5 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
	Cross-point screwdriver		1	For covers
	Nippers		1	
	Force gauge		1	For belt tension adjustment

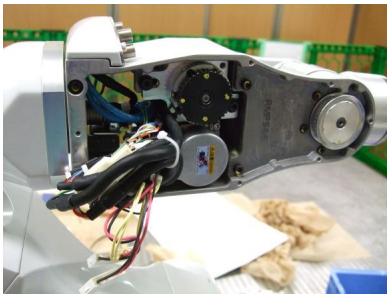
The brake is mounted on the Joint #6 to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. However, the brake does not work during replacement.

Removal: Joint #6 Motor

1. Turn OFF the Controller power.
2. Remove the Arm #4 side cover.
   For details, refer to *C4 Maintenance: 3. Covers*.

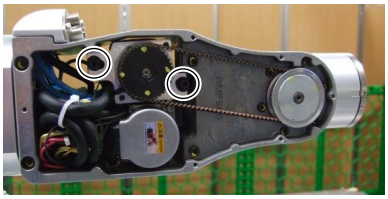
3. Pull out the cables from the Arm #4 and disconnect the following connectors.

   Connectors: X062, X162, BT62, BR062



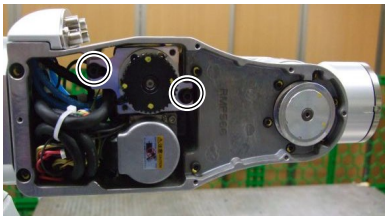
4. Loosen the bolts securing the Joint #6 motor unit and remove the belts.

   Hexagon socket head cap bolts: 2-M4×15 (with a plain washer)



5. Remove the Joint #6 motor unit.

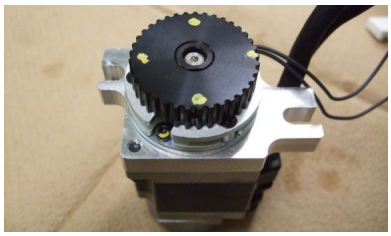
   Hexagon socket head cap bolts: 2-M4×15 (with a plain washer)



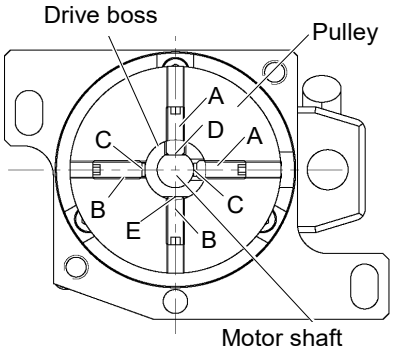
6. Remove the Joint #6 pulley 1 and the drive boss from the Joint #6 motor unit.

   The drive boss and the pulley fixing screws:
   Hexagon socket set screws: 2-M3×8 (with a brass bushing)

   Pulley and the motor shaft fixing screws:
   Hexagon socket set screws: 2-M3×8 (with a brass bushing)



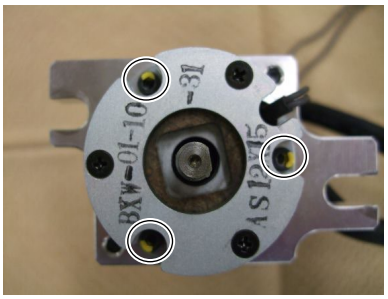
There is a brass bushing in one of the set screws fixing the drive boss and the pulley. Be careful not to lose it.



A : Pulley and motor shaft fixing screws
B : Pulley and drive boss fixing screws
C : Bushing
D : Flat face for motor shaft
E : Flat face for drive boss

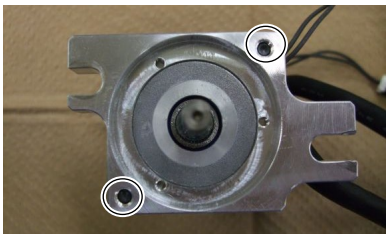
7. Remove the Joint #6 electromagnetic brake.

   Hexagon socket set screws: 3-M2.5×10



8. Remove the motor plate from the Joint #6 motor.

   Hexagon socket head cap bolts: 2-M4×12



Installation: Joint #6 motor

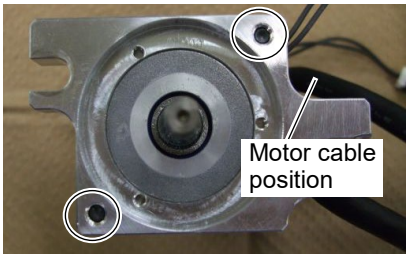
NOTE When tightening hexagon socket head cap bolts, refer to the *2.4 Tightening Hexagon Socket Head Cap Bolts.*

1. Install the motor plate to the Joint #6 motor.

   Hexagon socket head cap bolts: 2-M4×12

   Tightening torque: 4.9 N·m (50 kgf·cm)

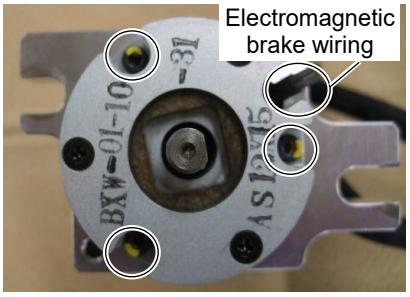
   Be careful of the direction of the motor plate. (See the photo.)



2. Mount the Joint #6 electromagnetic brake to the Joint #6 motor unit.

   Hexagon socket set screws: 3-M2.5×10

   Be careful of the direction of the Joint #6 electromagnetic brake wiring. (See the figure.)



3. Mount the drive boss and the pulley 1 to the Joint #6 motor unit.

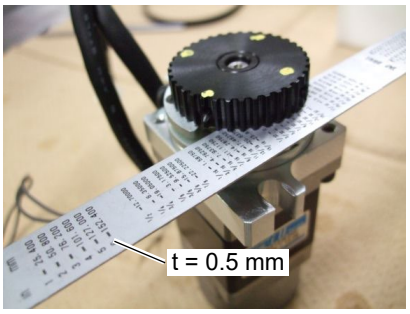
   Set the drive boss and the pulley 1 so that their surfaces become flat.

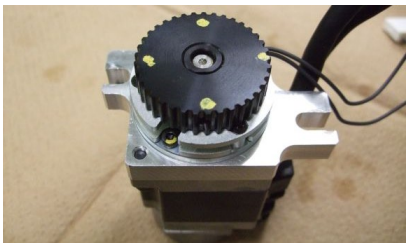
   Hexagon socket set screws: 2-M3×8 (with a brass bushing)

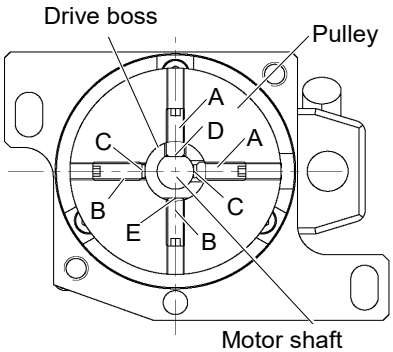
   Set the pulley 1 and the motor shaft.
   Leave 0.5 mm for the electromagnetic brake.

   Hexagon socket set screws: 2-M3×8 (with a brass bushing)

   Set the set screws as indicated below.

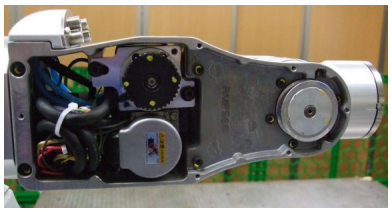






A : Pulley and motor shaft fixing screws
B : Pulley and drive boss fixing screws
C : Bushing
D : Flat face for motor shaft
E : Flat face for drive boss

4. Put the Joint #6 motor unit to the Arm #4.



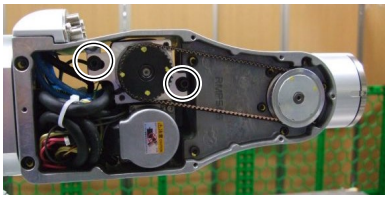
5. Place the timing belt around the pulley 1 and pulley 2.

   Make sure that the teeth of the timing belt engage with these of the pulley.

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

6. Apply tension to the Joint #6 motor unit and fix it.

   Joint #6 timing belt tension = 39.2 N ± 9.8 N (4 kgf ± 1 kgf)



   Secure the Joint #6 motor unit by applying tention.

   Hexagon socket head cap bolts: 2-M4×15 (with a plain washer)

   Tightening torque: 4.9 N·m (50 kgf·cm)

7. Connect the following connectors.

   Connectors: X062, X162, BT62, BR062

8. Install the Arm #4 side cover.
   For details, refer to *C4 Maintenance: 3. Covers*.

9. Perform the calibration.
   For details, refer to *C4 Maintenance: 16. Calibration*.

10.2 Joint #6 - Replacing the Reduction Gear Unit

	Name		Quantity	Note
Maintenance Parts	Joint #6 reduction gear unit		1	1539261
Tools	Hexagonal wrench	width across flats: 1.5 mm	1	For M3 hexagon socket set screws For M2 hexagon socket head cap bolts
		width across flats: 2 mm	1	For M2.5 hexagon socket head cap bolts
		width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
	Cross-point screwdriver		1	For covers
	Wrench	width 5.5	1	
		width 8	1	
	Force gauge		1	For belt tension adjustment

Removal: Joint #6 Reduction gear unit

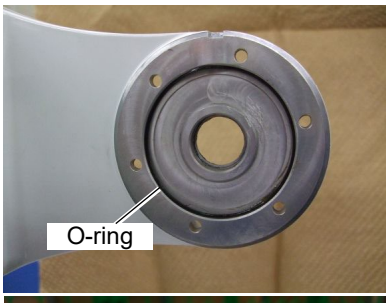
1. Turn OFF the Controller power.

2. Remove the Arm #4 side cover.
   For details, refer to *C4 Maintenance: 3. Covers*.

3. Remove the Joint #5 motor unit and the reduction gear unit.
   For details, refer to *C4 Maintenance: 9.2 Joint #5 – Replacing the Motor*, Installation steps (3) through (11).

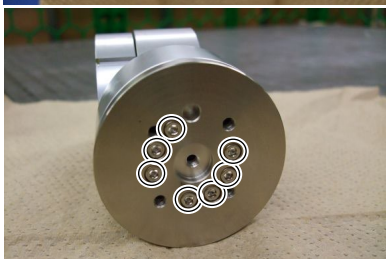
4. Remove the O-ring on the installation surface of the Arm #4 and #5.
   The O-ring of the Arm #4 is on the Arm #4 plate which was removed in the step (4).
   For the O-ring of the Arm #5, see the photo on the right.

   The O-ring will be used again. Be careful not to lose it.



5. Remove the Joint #6 flange.

   Hexagon socket head cap bolts: 7-M3×6

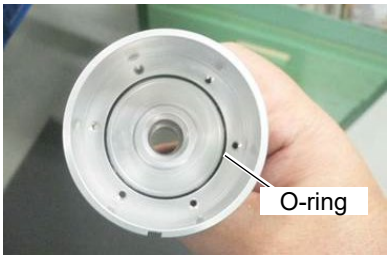


6. Remove the Joint #6 reduction gear unit from the Arm #5.
   Use a wrench to move the through holes of the screws. Insert a tool from the back side of the arm to push the reduction gear unit.

   Hexagon socket head cap bolt: 6-M3×28

   The parts are greased. Wipe grease on the parts while removing them.

7. Remove the O-ring of the Arm #5.



8. Unplug the Arm #5 plug.

   Set the screw to the plug and pull out.

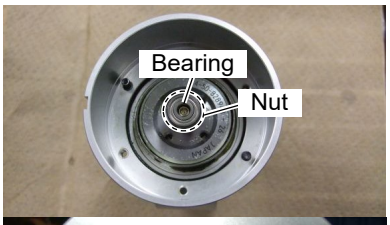
   Recommended screw length: M4×15 mm or longer

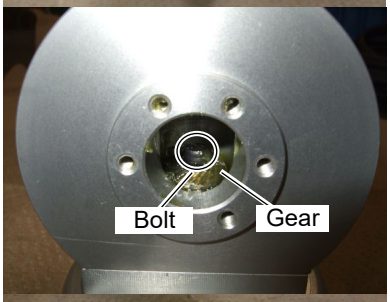
   The parts are greased. Wipe grease on the parts while removing them.

9. Remove the gear.
   Remove the bearing. Set the open-end wrench to the nut on the Joint #6 reduction gear unit. Insert the tool to the hole where the plug was, and then turn the screw to remove.

   Hexagon socket head cap bolt: 1-M3×8 (with a plain washer)

   The parts are greased. Wipe grease on the parts while removing them.





10. Remove the wave generator from the Arm #5.

    The parts are greased. Wipe grease on the parts while removing them.

11. Remove the wave generator from the shaft.

If the shaft has a bearing, remove it.　The bearing will be used again.　Be careful not to lose it.

There is a washer between the nut and the wave generator.
Be careful not to lose it.

The parts are greased.　Wipe grease on the parts while removing them.

Open-end wrench width for the shaft: 5.5 mm

Open-end wrench width for the nut: 8 mm

Installation: Joint #6 Reduction gear unit

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

1. Unpack the new reduction gear unit package and check if it contains the parts on the right.

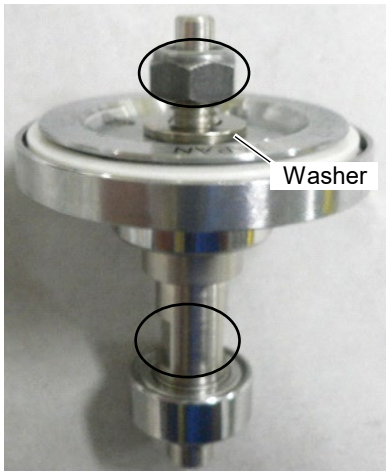
2. Install the wave generator to the shaft.

   Insert the washer between the nut and the wave generator.

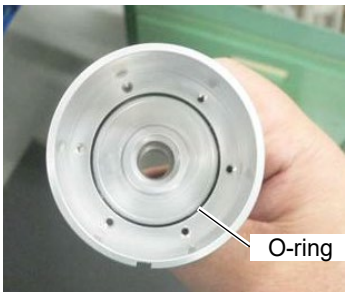
   Set the open-end wrench to the nut and D-cut part (black circle in the figure), and turn the nut.

   Open-end wrench width for the shaft: 5.5 mm

   Open-end wrench width for the nut: 8 mm



3. Install the O-ring (of the Joint #6 reduction gear unit) to the Arm #5.

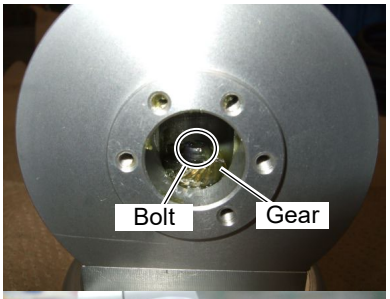


4. Insert the wave generator unit to the Arm #5.

5. Install the gear.
   Set the open-end wrench to the nut on the Joint #6 reduction gear unit. Insert the tool to the hole where the plug was, and then tighten the screw.

   Hexagon socket head cap bolt: 1-M3×8 (with a plain washer)

   Tightening torque: 2.5 N·m (25 kgf·cm)



6. Install the Joint #6 reduction gear unit to the Arm #5.

   Hexagon socket head cap bolts: 6-M3×28

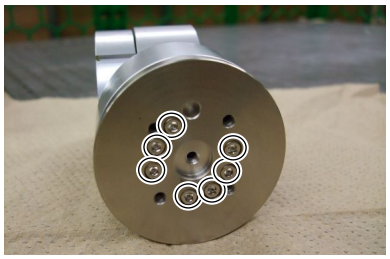
   Tightening torque: 2.5 N·m (25 kgf·cm)

   There is a bearing on the back side of the flexspline. If you removed the bearing during the removal steps, install the bearing first and install the Joint #6 reduction gear unit to the Arm #5.

7. Install the Joint #6 flange.

   Hexagon socket head cap bolts: 7-M3×6

   Tightening torque: 2.5 N·m (25 kgf·cm)

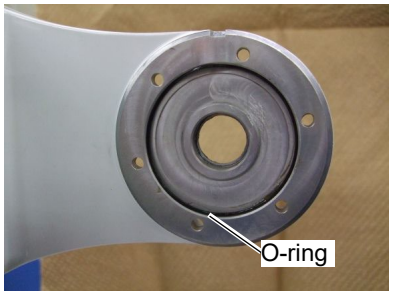


8. Inject grease to the gear and insert the plug to the end.

   Grease: SK-2

   Grease volume: 2 g

9. Install the removed O-ring.



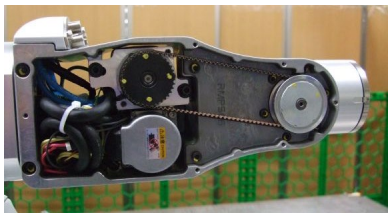
10. Install the Arm #5 unit to the Arm #4.
    For details, refer to *C4 Maintenance: 9.2 Joint #5 – Replacing the Motor*, Installation steps (13) through (25).

10.3 Joint #6 - Replacing the Timing Belt

	Name	Quantity	Note
Maintenance Parts	Joint #6 timing belt (324 mm)	1	1593701
Tools	Hexagonal wrench (width across flats: 3 mm)	1	For M3 hexagon socket head cap bolts
	Cross-point screwdriver	1	For covers
	Force gauge	1	For belt tension adjustment

Removal: Joint #6 Timing belt

1. Turn OFF the Controller power.
2. Remove the Arm #4 side cover.
   For details, refer to *C4 Maintenance: 3. Covers*.
3. Loosen the Joint #6 motor unit set screw.
   Hexagon socket head cap bolt: 2-M4×15 (with a plain washer)
4. Remove the Joint #6 timing belt.



Installation: Joint #6 Timing belt

1. Place the Joint #6 timing belt around the pulley 1 and 2 of the Joint #6.
2. Secure the Joint #6 motor unit.
   For details, refer to *C4 Maintenance: 10.1 Joint #6 – Replacing the Motor*, Installation steps (5), (6), (8) and (9).

10.4 Joint #6 - Replacing the Electromagnetic Brake

	Name		Quantity	Note
Maintenance Parts	Joint #6 electromagnetic brake		1	For part code, refer to the *17. C4 Maintenance Part code.*
Tools	Hexagonal wrench	width across flats: 1.5 mm	1	For M3 hexagon socket set screws
		width across flats: 2 mm	1	For M2.5 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
	Cross-point screwdriver		1	For covers
	Nippers		1	
	Force gauge		1	For belt tension adjustment

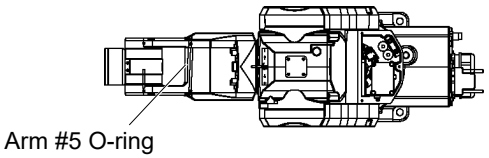
Removal: Joint #6 Electromagnetic brake

1. Remove the Joint #6 electromagnetic brake.
   For details, refer to *C4 Maintenance: 10.1 Joint #6 – Replacing the Motor*, Installation steps (1) through (7).

Installation: Joint #5 Electromagnetic brake

1. Mount the Joint #6 electromagnetic brake to the Joint #6 motor unit.
   For details, refer to *C4 Maintenance: 10.1 Joint #6 – Replacing the Motor*, Installation steps (2) through (9).

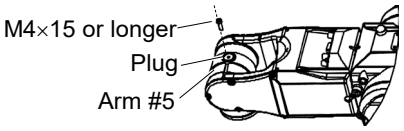
11. Replacing the Arm #5 O-ring



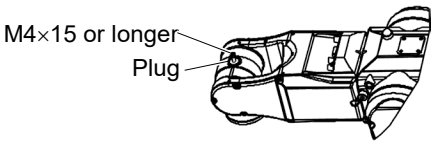
	Name	Quantity	Note
Maintenance Parts	O-ring (Arm #5)	1	1520374

Removal: Arm #5 O-ring

1. Turn ON the Controller power.
2. Move the Arm #5 to the angle where you can unplug the plug easily.



3. Turn OFF the Controller power.
4. Insert a screw to the plug.

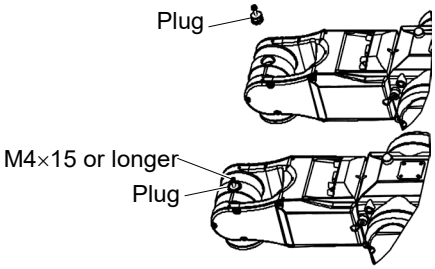


5. While holding the screw, disconnect the plug.
6. Remove the O-ring from the plug.

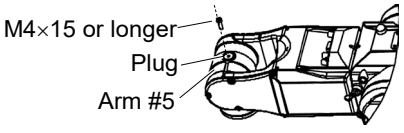
Installation: Arm #5 O-ring

1. Install the O-ring to the plug.

2. Insert the plug to the Arm #5.
   Push the plug to the stopper at the end.



3. Remove the screw.
   If you move the arm with the screw mounted, it may contact with the Manipulator body. Make sure to remove the screw.



12. Replacing the Battery 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.

WARNING	■ Take meticulous care when handling the lithium battery. Improper handling of the lithium battery as mentioned below is extremely hazardous and may result in heat generation, leakage, explosion, or inflammation. It also may cause serious safety problems. <Improper Handling> Attempting to charge Disassembling Connecting batteries improperly Exposing to fire Forcing discharge Deforming by pressure Short-circuit (Polarity; Positive/Negative) Heating (85 °C or more) Soldering the terminal of the lithium battery directly ■ When disposing the battery, consult with the professional disposal services or comply with the local regulation. Make sure that the battery terminal is insulated, even for a used buttery. 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 1.5 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.

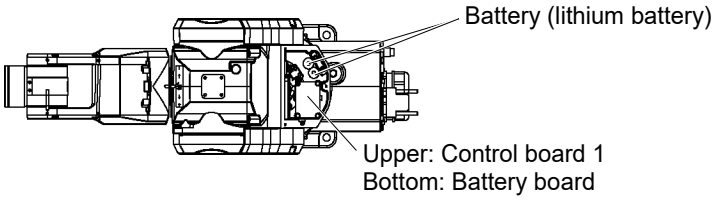
RC700 Series Maintenance Manual Maintenance 6. Alarm

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 *Maintenance: 14. Maintenance Parts List*.)

Be careful of the battery polarity to connect it correctly.



	Name		Quantity	Note
Maintenance Parts	Battery unit (Lithium battery)		1	1605912 (2 lithium batteries for replacement)
	Battery board		1	2177458
	Battery relay cable unit		1	1653173 (Reusable. See “Note” below)
Tools	Nippers		1	
	Cross-point screwdriver		1	For covers
	Hexagonal wrench	width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts

Note: The battery relay cable unit is reusable. If the cable or the connector clip is broken during replacement of the cable unit and battery, replace the cable unit. For details on the replacement, refer to Removal step (10) and Installation step (55) in *C4 Maintenance 4. Cable Unit.*

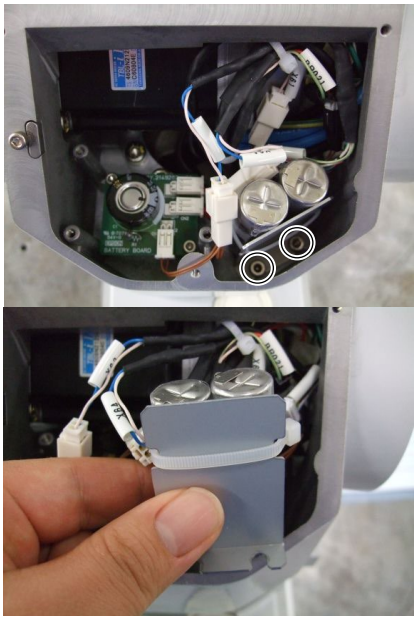
12.1 Replacing the Battery Unit (Lithium Battery)

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

1. Turn OFF the Controller power.
2. Remove the Arm #1 upper cover.
   For details, refer to *C4 Maintenance: 3. Covers*.
3. Loosen the screws fixing the L-shaped plate on the Arm #1 and remove the plate.

   Hexagon socket head cap bolts: 2-M4×8

   Be careful not to disconnect the battery connector.



NOTE If you removed all the batteries before connecting the new ones, the calibration data will be deleted and you will need to perform calibration. Follow the steps below to remove the lithium batteries.

4. Cut off the wire tie of the plate.

5. Disconnect the connector of one of two batteries. Then, connect the connector of the new battery.

6. Disconnect the connector of the other battery. Then, connect the connector of the new battery.

7. Bind two batteries to the plate using a wire tie.

Set the wire tie on the groove of the plate.

8. Fix the plate to the Arm #1.

   Hexagon socket head cap bolts: 2-M4×8

9. Install the Arm #1 upper cover.
   For details, refer to *C4 Maintenance: 3. Covers*.

10. Turn ON the Controller power.

11. Check operation to see if the Manipulator's position and posture are out of position. Move the Manipulator to two or three points (poses) of the registered points.

12. If the Manipulator is out of position, calibrate all the joints and axes.
    For details, refer to *C4 Maintenance: 16. Calibration*.

12.2 Replacing the Battery Board

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

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

Refer to *C4 Maintenance 16. Calibration* and perform the calibration after the parts replacement.

Removal: Battery board

1. Turn OFF the Controller power.
2. Remove the Arm #1 upper cover.
   For details, refer to *C4 Maintenance: 3. Covers*.
3. Disconnect the connector from the control board 1.

   Connector: GS01

4. Remove the control board 1.

   Cross recessed head screws: 3-M3×8

5. Disconnect the three connectors from the battery board.

   Connectors: 2 connectors for the batteries, CN3

6. Remove the battery board fixed to the Arm #1.

   Hexagon socket head cap bolts: 2-M3×8

Installation: Battery board

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

1. Install the battery board to the Arm #1.

   Hexagon socket head cap bolts: 2-M3×8

   Tightening torque: 0.7 ± 0.05 N·m

2. Connect the connectors to the battery board.

3. Install the control board 1.

   Cross recessed head screws: 3-M3×8

   Tightening torque: 0.45 ± 0.1 N·m

   Be careful of the direction of the control board 1.
   (See the photo.)

4. Install the connector to the control board 1.

   Connector: GS01

5. Install the Arm #1 upper cover.
   For details, refer to *C4 Maintenance: 3. Covers*.

6. Turn ON the Controller power.

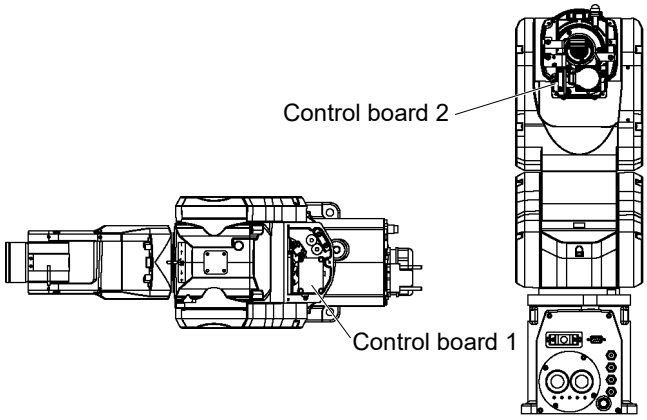
7. Check operation to see if the Manipulator's position and posture are out of position. Move the Manipulator to two or three points (poses) of the registered points.

8. Perform the calibration.
   For details, refer to *C4 Maintenance: 16. Calibration*.

13. Replacing the Control Board

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.

Always use the control board designated by us.



	Name	Quantity	Note
Maintenance Parts	Control board (1, 2)	1	2138032
Tools	Nippers	1	
	Cross-point screwdriver	1	For control boards
	Hexagonal wrench (width across flats: 2.5 mm)	1	For M3 hexagon socket head cap bolts
	Hexagonal wrench (width across flats: 3 mm)	1	For M4 hexagon socket head cap bolts

13.1 Replacing the Control Board 1

Removal: Control board 1

1. Follow *C4 Maintenance: 12.2 Replacing the Battery Board* Removal steps (1) through (4).

Installation: Control board 1

1. Follow *C4 Maintenance: 12.2 Replacing the Battery Board* Installation steps (11) through (14).

13.2 Replacing the Control Board 2

Removal: Control board 2

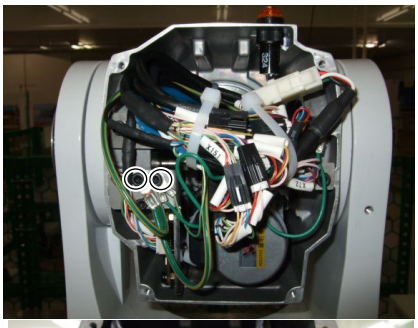
1. Turn OFF the Controller power.

2. Remove the Arm #3 head cover.

   For details, refer to *C4 Maintenance: 3. Covers*.

3. Remove the ground wire fixed to the plate.

   Hexagon socket head cap bolts: 2-M4×5



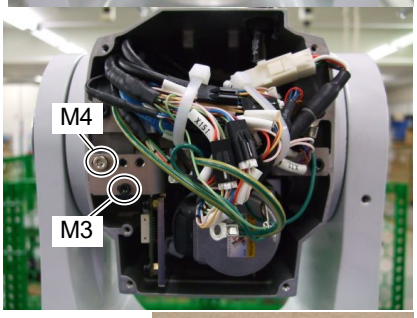
4. Remove the connector connected to the control board 2.

   Connector: GS02

5. Remove the plate fixed to the Arm #3.

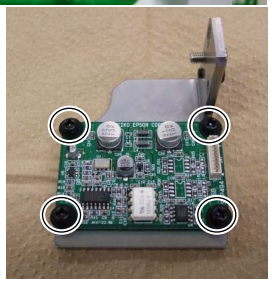
   Hexagon socket head cap bolt: M4×10

   Hexagon socket head cap bolt: M3×8



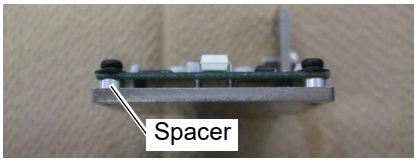
6. Remove the control board 2 fixed to the plate.

   Cross recessed head screw: 4-M3×8



There is a spacer between the plate and the control board 2.
The spacer will be used again. Be careful not to lose it.

Spacer: 4 spacers



Installation: Control board 2

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

1. Install the control board 2 to the plate.

   Cross recessed head screws: 4-M3×8

   Tightening torque: 0.45 ± 0.1 N·m

   Insert the spacer between the plate and the control board 2.

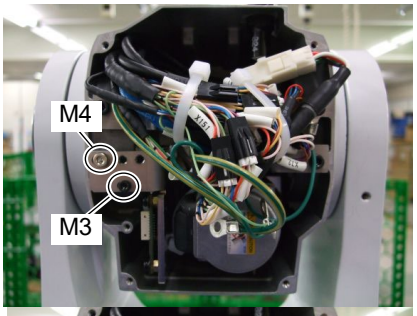
   Be careful of the direction of the control board 2.

   (See the photo.)

2. Install the plate with the control board 2 to the Arm #3.

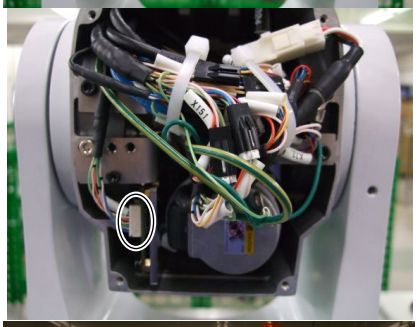
   Hexagon socket head cap bolt: M4×10

   Hexagon socket head cap bolt: M3×8



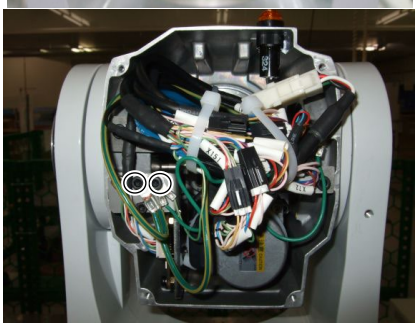
3. Connect the connector to the control board 2.

   Connector: GS02



4. Install the removed ground wire to the plate.

   Hexagon socket head cap bolt: 2-M4×5



5. Install the Arm #3 head cover.

   For details, refer to *C4 Maintenance: 3. Covers*.

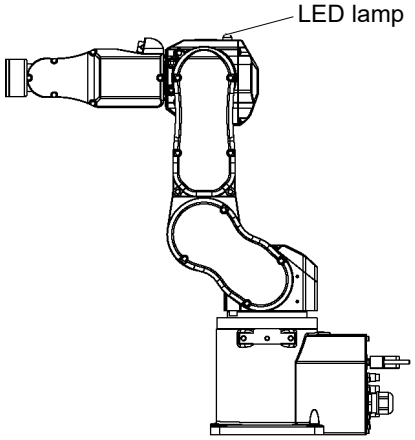
6. Turn ON the Controller power.

7. Check operation to see if the Manipulator's position and posture are out of position.
   Move the Manipulator to two or three points (poses) of the registered points.

8. If the Manipulator is out of position, calibrate all the joints and axes.
   For details, refer to *C4 Maintenance: 16. Calibration*.

14. Replacing the 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	For the part code, refer to the *17. C4 Maintenance Part List.*
Tools	Cross-point screwdriver	1	For covers

Removal: LED lamp

1. Turn OFF the Controller power.

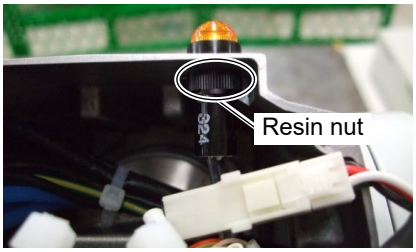
2. Remove the Arm #3 head cover.
   For details, refer to *C4 Maintenance: 3. Covers*.

3. Remove the connector connected to the LED lamp.
   The connector for the LED lamp (LED) is under the Arm #3 head cover.

   Connector: LED

4. Remove the LED lamp from the Arm #3.

   Turn the resin nut securing the LED lamp in the Arm #3 counter-clockwise.



Installation: LED lamp

1. Install the LED lamp to the Arm #3.
   Detach the resin nut from the LED lamp and pass the lamp through the Arm #3. Turn the nut clockwise from the inside of the Arm #3 and secure the lamp to the Arm #3.

2. Connect the following connectors.

   Connector: LED

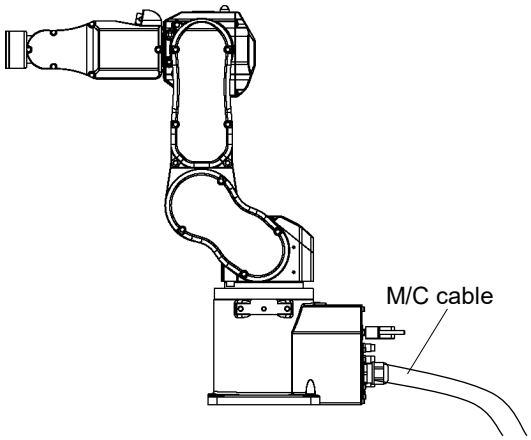
3. Install the Arm #3 head cover.
   For details, refer to *C4 Maintenance: 3. Covers*.

15. Replacing the M/C Cable

Each motor is fed power by the battery for backup. Therefore, position data is held even after turning OFF the Controller. The position data will be lost when the cable connector connected to the battery is disconnected. And the EPSON RC+ will display the error message of encoder alarm occurrence when the Controller is turned ON.

 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	■ When disconnecting the connectors during the replacement of the cable unit, be sure to reconnect the connectors to their proper positions by referring to the connector pin assignments. Improper connection of the connectors may result in improper function of the robot system. For details on the connections, refer to the *C4 Maintenance 4.2 Connector Pin Assignments*. ■ When installing 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. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check 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.) Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system.



NOTE

Make sure to calibrate after the cable replacement.
For details, refer to *C4 Maintenance: 16. Calibration*.

	Name			Quantity	Note
Maintenance Parts	M/C cable	3 m	Straight	1	2216979
			L-shaped	1	2217092
		5 m	Straight	1	2216980
			L-shaped	1	2216980
		10 m	Straight	1	2216981
			L-shaped	1	2217094
		15 m	Straight	1	2216982
			L-shaped	1	2217095
		20 m	Straight	1	2216983
			L-shaped	1	2217096
	M/C cable (UL specification)	3 m	Straight	1	2216984
		5 m	Straight	1	2216985
		10 m	Straight	1	2216986
	M/C cable (flexible, straight only)	3 m		1	R12NZ901E1
		5 m		1	R12NZ901E2
		10 m		1	R12NZ901E3
		15 m		1	R12NZ901E4
		20 m		1	R12NZ901E5
Tools	Hexagonal wrench (width across flats: 3 mm)			1	For M4 hexagon socket head cap bolts

Removal: M/C cable

1. Turn OFF the Controller power.

2. Disconnect the following connectors from the Controller.
   Power cable connector
   Signal cable connector

3. Remove the connector sub plate.
   For details, refer to *C4 Maintenance: 3. Covers*.

NOTE
Do not pull the sub plate forcibly.

Do not disconnect the M/C cable from the connector sub plate.

4. Remove the connectors.

   Connectors: X11, X12, X13, X14, X15, X16, XGND*, BR010, BR020, BR030, BR040, BR050, BR060
   X010, X020, X030, X040, X050, X060, LED, GS01, GS02
   * No XGND connecter for UL specification.

NOTE
Each connector is numbered. Each connector has a different shape.
Do not disconnect the battery connector (BT1*). Otherwise, you will need to calibrate.

Installation: M/C cable

1. Connect the connectors of the new M/C cable to these of the cable unit.
   Connect the connectors with the same number.

2. Install the connector sub plate to the connector plate.
   For details, refer to *C4 Maintenance: 3. Covers*.

3. Connect the following connectors to the Controller.
   Power cable connector
   Signal cable connector

4. Turn ON the Controller power.

5. Check operation to see if the Manipulator's position and posture are out of position.
   Move the Manipulator to two or three points (poses) of the registered points.

6. If the battery connector (BT1*) was disconnected, perform the calibration.
   For details, refer to *C4 Maintenance: 16. Calibration*.

7. If the Manipulator is out of position, calibrate all the joints and axes.
   For details, refer to *C4 Maintenance: 16. Calibration*.

16. Calibration

16.1. Overview

After parts have been replaced (motors, reduction gear units, timing belts, etc.), the Manipulator cannot perform positioning properly because a gap exists between the origin stored in each motor encoder and its corresponding origin stored in the Controller.
Therefore, it is necessary to match these origins after replacing the parts.
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 the *Installation and Design Precautions* in the *Safety* chapter of the *EPSON RC+ User’s Guide*. ■ 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.

In EPSON RC+, a coordinate point including the arm pose is defined as “point” and its data is called “point data”.

There are two methods to move the Manipulator during calibration.
- Releasing the electromagnetic brake and moving the arms manually.
  For details, refer to the *C Series Manual C4 Manipulator 1.6 How to Move Arms with the Electromagnetic Brake*.
- Moving the Manipulator using Jog & Teach.

Moving the Manipulator while releasing the electromagnetic brake involves risk as described below.
It is recommended to move the Manipulator using Jog & Teach.

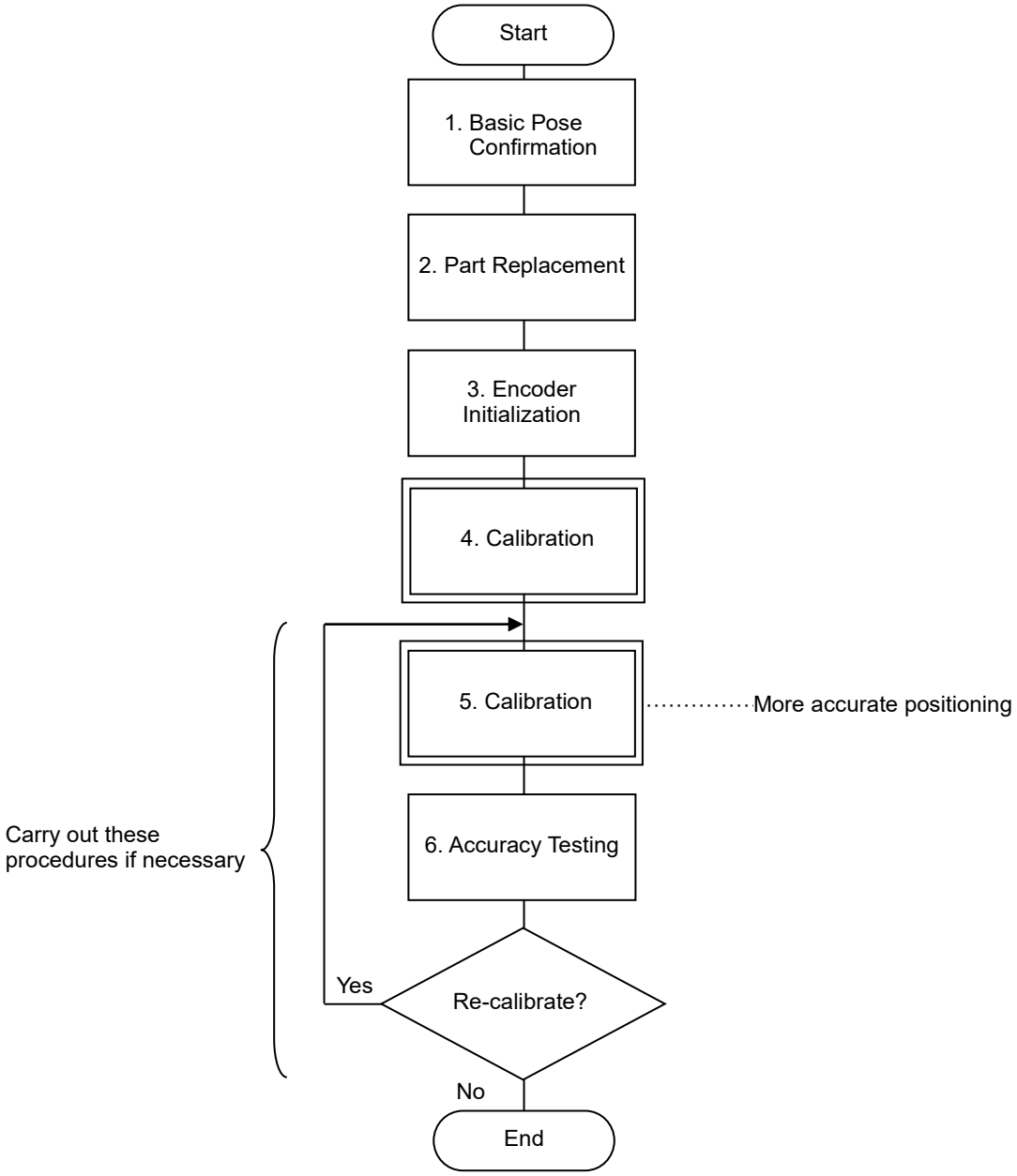
 CAUTION	■ Normally, release the brake of joints one by one. Take extra care if you need to release the brakes of two or more joints simultaneously. Releasing the brakes of two or more joints simultaneously may cause hands and fingers to be caught and/or equipment damage to or malfunction of the Manipulator as the arms of the Manipulator may move in unexpected directions. ■ Be careful of the arm falling when releasing the brake. While the brake is being released, the Manipulator’s arm falls by its own weight. The arm falling may cause hands and fingers to be caught and/or may cause equipment damage to or malfunction of the Manipulator.

For details on Jog & Teach, refer to *EPSON RC+ User's Guide 5.12.1 Robot Manager Command Tools: Robot Manager: Jog and Teach Page.*

NOTE

- For details about the basic pose, refer to *C Series Manual C4 Manipulator 3.7 Checking the Basic orientation.*
- Whenever possible, calibrate one joint at a time. (Also, replace parts of one joint at a time whenever possible.) If you calibrate the origins for multiple joints simultaneously, it will be more difficult to verify their origins and obtain the origin correct positions.
  However, joint #5 cannot be calibrated alone due to the structure of the Manipulator. Make sure you calibrate joint #5 and #6 at the same time.

Calibration Flowchart



16.2. Calibration Procedure

Command Input

Command execution is required in some calibration procedures.
Select the EPSON RC+ menu-[Tools]-[Command Window].

This step is omitted in the calibration procedures.

Jog Motion

Setting of the jog motion is required in some calibration procedures.
Select EPSON RC+ menu-[Tools]-[Robot Manager] and select the [Jog & Teach] page.

The panel, window, and page above are indicated as [Jog & Teach] in the calibration procedures.

Follow steps 1 to 6 to calibrate the Manipulator.

1. Basic Pose Confirmation

   Pose data (Point data) prior to the part replacement (motors, reduction gear unit, or belt) is necessary for the calibration.

   Verify the recorded pulse values of the basic pose obtained in the *Setup & C Series Manual C4 Manipulator 3.7 Checking the Basic orientation*.

2. Part Replacement

   Replace parts as instructed in this manual.
   Be careful not to injure yourself or damage parts during part replacement.

3. Encoder Initialization

   Turn ON the Controller while all joints are in the motion range.

   The error message “Encoder alarm has occurred. Check robot battery. EPSON RC+ must be restarted.” will be displayed.

   Initialize the encoder at the current position and reset the error.

   Initialize the encoder using one of the following procedures.

   Execute the following command at the [Monitor Window].

   EPSON RC+

   `>Encreset` [The joint number (1 to 6) of the encoder to be reset]

   Select EPSON RC+ menu-[Tools]-[Controller], then click <Reset Controller>.

After resetting the error, the motor encoder of the joint whose parts have been replaced will be initialized.
Set the jog mode to “Joint” in [Jog & Teach] and operate the Manipulator in jog motion to match the home position marks (0 pulse position) of the joint accurately.

When the joint cannot move to the home position, operate the Manipulator to match the tram mark placed in *Setup & Operation 3.7 Checking the Basic Orientation* as accurate as possible.

Initialize the encoder when the joint matches the home position or the tram mark.

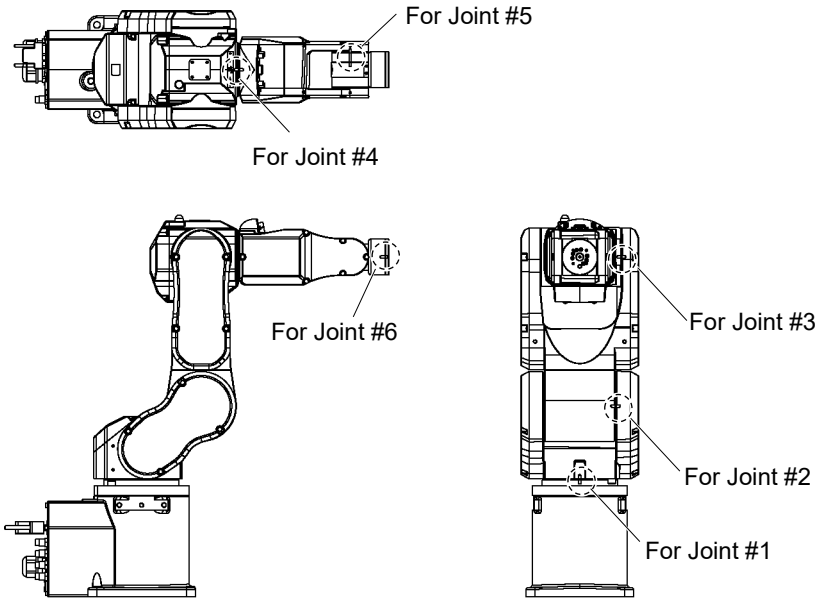
For the encoder initialization, refer to the procedure indicated above.

NOTE

When the origin of the Joint #5 is calibrated, the Joint #6 will be out of position. (Due to the structure of the Manipulator, any offset in the position of the Joint #5 affects the Joint #6.)
Calibrate the origin of the Joint #6 together when calibrating the Joint #5.

4. Calibration

Position of grooves for calibration



Position of the calibration key

The key is secured to the inside of the Arm #1 center cover using M4 screw.
Hexagon socket head cap bolts: M3×6
Be sure to put the key back to the original position after use.

4-1 Prepare the calibration key.

A calibration key is secured inside the Arm #1 center cover using the M4 screw. Be careful not to lose the screw.

4-2 Move the arm you want to calibrate to the position of the calibration groove.

EPSON RC+

Select menu-[Tool]-[Robot Manager]-[Jog & Teach] panel to move the Manipulator.

If an error occurs after replacing the motor and you cannot use the [Jog & Teach] panel or "Brake OFF, *" does not work (* is an axis number to calibrate.), go through the steps (4) and (5) now.

Then, [Jog & Teach] panel and "Brake OFF, *" will be available. Move the arm you want to calibrate to the position of the calibration groove and go on to the step 4-3.

4-3 Set the calibration key to the calibration groove (the grooves for Joints #1 to #6).

At this point, if the key cannot be set completely, the arm(s) is not in the origin. Move the arm until the key can be set completely.
The key will be broken if you move any arm with the key in the groove.
Do not move arm(s) once its position is fixed.

4-4 Reset the encoder.

EPSON RC+

Execute one of the following commands to reset the encoder of the joint you want to calibrate from the menu-[Tool]-[Command Window].

Joint #1 `>Encreset 1`
Joint #2 `>Encreset 2`
Joint #3 `>Encreset 3`
Joint #4 `>Encreset 4`
Joint #5 `>Encreset 5, 6`
Joint #6 `>Encreset 6`

4-5 Reboot the Controller.

EPSON RC+

Click EPSON RC+ menu-[Tool]-[Controller]-<Reset Controller>.

4-6 Input the command in the Command window and execute it.

EPSON RC+

Execute one of the following commands to reset the encoder of the joint you want to calibrate from the menu-[Tool]-[Command Window].

```
>calpls 0,0,0,0,0,0
```
* Manipulator does not move.

4-7 Perform the calibration.

EPSON RC+

Execute one of the following commands to reset the encoder of the joint you want to calibrate from the menu-[Tool]-[Command Window].

Joint #1 `>calib 1`
Joint #2 `>calib 2`
Joint #3 `>calib 3`
Joint #4 `>calib 4`
Joint #5 `>calib 5,6`
Joint #6 `>calib 6`

Move the arm to several points to check if the arm moves to the original positions properly.

Teach points if fine adjustment is necessary.

4-8 All joints are calibrated.

Put the calibration key back to the original position in the Arm #1 and secure it with the screw.

Hexagon socket head cap bolt: 1-M3×6

4-9 Mount the Arm #1 cover.

For details, refer to *C4 Maintenance: 3. Covers*.

5. Calibration (More accurate positioning)

EPSON RC+

Move the Manipulator to the selected point data by jogging in [Jog & Teach].

Move the joint* which is not calibrated to the specified point by motion command.

*When the Joint #5 is being calibrated, move the Joints #1 - #4 to the home positions.

For example, when the selected point data is “P1”, execute “Motor On” in [Control Panel] and execute “Go P1” in [Jog & Teach].

Position the calibrating joint* to the selected point data position accurately by jog command.

* When the Joint #5 is being calibrated, move the Joint #5 and #6 to the home positions.

Select the “Joint” jog mode from [Jog & Teach] to operate in the jog motion.

Enter the command below in the command window and execute it.

Execute the command below in the menu -[Tools]-[Command Window].

```
>calpls ppls(P1,1), ppls(P1,2), ppls(P1,3), ppls(P1,4),
ppls(P1,5), ppls(P1,6)
```

*The Manipulator will not move.

Perform the calibration. Input one of the following commands according to the joint being calibrated.

Joint #1 : `>calib 1`
Joint #2 : `>calib 2`
Joint #3 : `>calib 3`
Joint #4 : `>calib 4`
Joint #5 : `>calib 5,6`
Joint #6 : `>calib 6`

6. Accuracy Testing

Move the Manipulator to a different pose (point) to verify whether it moves back to the original position. If accuracy is inadequate, it is necessary to re-calibrate the origin using a different pose (point). You must set the pose (point) again if the Manipulator does not move back to the original position after re-calibration.

17. C4 Maintenance Parts List

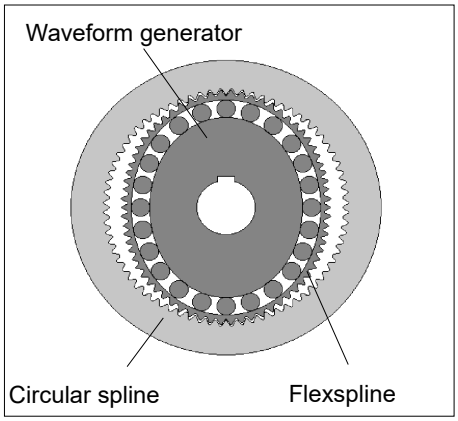
Name			Code	Old Code	Note		Reference	Overhaul**
Reduction gear unit *	Joint #1		1687022	R13N810041			5.2	✓
	Joint #2		1687023	R13N810051			6.2	✓
	Joint #3		1593859	R13N810061			7.2	✓
	Joint #4		1533648	R13B010023			8.2	✓
	Joint #5		1539260	R13B010024			9.2	✓
	Joint #6		1539261	R13B010025			10.2	✓
Bevel gear			1667824	R13B031603				✓
Timing belt	Joint #1	C4-A601**	1520394	R13B030220	Width 10 mm		5.3	✓
		C4-A901**	1593695	R13N832031				
	Joint #2	C4-A601**	1520354	R13B030221			6.3	✓
		C4-A901**	1593696	R13N832041				
	Joint #3	C4-A601**	1593697	R13N832081	Width 7 mm		7.3	✓
		C4-A901**	1593698	R13N832091				
	Joint #4		1593699	R13N832051	Width 6 mm		8.3	✓
	Joint #5		1599367	R13N832061	Width	315 mm	9.3	✓
	Joint #6		1593701	R13N832071	6 mm	324 mm	10.3	✓

* Reduction Gear Unit: A reduction gear unit consists of the following three parts. When replacing the reduction gear unit, be sure to replace these parts all together as a set.

Waveform generator

The waveform generator consists of an ellipsoidal cam and ball bearings on outer circumference.

The inner ring of the bearings is secured to the cam, while the outer ring is capable of flexible deformation through the ball bearings.



Flexspline

A thin, elastic, cup-shaped metal body with gear teeth around the outer circumference of the opening.

Circular spline

A rigid, ring-shaped body with gear teeth on the inner circumference.

The circular spline has two more teeth than the flexspline does.

The splines are greased. Be sure to keep the grease from being attaching to the clothes.

** Overhaul

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 box - [Motor On Hours].

For details, refer to *C4 Maintenance 2.2 Overhaul (Parts Replacement)*.

Name		Code	Old Code	Note	Reference
Battery board		2177458	R13N84C011		12.1
Battery unit (Lithium battery)		1605912	R13N860011	(2 lithium batteries for replacement)	12.1
Seal	Joint #4	1213320	R13A031200100		8.2
Grease ***	Joint #1, #2, #3, #4 : SK-1A	–	–	For purchasing grease, please contact the supplier of your region.	2.3, 5.2, 6.2, 7.2, 8.2
	Bevel gear Joint #5, #6 : SK-2	–	–		2.3, 9.2, 10.2
	Cable : GPL-224	–	–		4.1
Oil seal	Joint #1	1480855	R13B031224		
	Joint #6	1520625	R13B031248		
Grease seal	Joint #1, #2	1213292	R13B031249		
	Joint #3	1520361	R13B031250		
Control board 1, 2	Arm #1, #3	2138032	R13B040502		13
O ring	Joint #1	1480857	R13B031223		5.2
	Joint #2	1510528	R13B031242		6.2
	Joint #3	1520370	R13B031243		7.2
	Joint #4	1520372	R13B031244		8.2
	Arm #3, #4	1520371	R13B031245		
	Arm #5	1520374	R13B031247	For plug	11

*** Regarding purchase of grease

Due to the chemicals regulations of individual countries (the UN GHS), we are requesting our customers to purchase grease required for maintenance from the manufacturers listed in the table below as of April 2015.

Regarding purchase of grease, please contact the following manufacturers. If there is anything unclear, please contact the supplier of your region.

Product name	Manufacturer	URL
Harmonic Grease SK-1A Harmonic Grease SK-2	Harmonic Drive Systems Inc.	https://www.harmonicdrive.net/
Krytox®GPL-224	Chemours	https://www.chemours.com/en/brands-and-products

Name			Code	Old Code		Reference
M/C cable	3 m	Straight	2216979	1605915	R13N824011	15
		L-shaped	2217092	2169647	R13NZ910EW	
	5 m	Straight	2216980	1605916	R13N824021	
		L-shaped	2217093	2169648	R13NZ910EX	
	10 m	Straight	2216981	1605917	R13N824031	
		L-shaped	2217094	2169649	R13NZ910EY	
	15 m	Straight	2216982	2185605	–	
		L-shaped	2217095	2185614	–	
	20 m	Straight	2216983	2185495	–	
		L-shaped	2217096	2185615	–	
M/C cable (UL specification)	3 m	Straight	2216984	2182509	–	15
	5 m	Straight	2216985	2182510	–	
	10 m	Straight	2216986	2182511	–	
M/C power cable	3 m	Straight	2216987	2155584	R13N824041	
		L-shaped	2217097	2169357	R13NZ910EZ	
	5 m	Straight	2216988	2150707	R13N824051	
		L-shaped	2217098	2169358	R13NZ910F1	
	10 m	Straight	2216989	2155586	R13N824061	
		L-shaped	2217099	2169359	R13NZ910F2	
	15 m	Straight	2216990	2185612	–	
		L-shaped	2217100	2185620	–	
	20 m	Straight	2216991	2185496	–	
		L-shaped	2217101	2185621	–	
M/C power cable (UL specification)	3 m	Straight	2216992	2181813	–	
	5 m	Straight	2216993	2181914	–	
	10 m	Straight	2216994	2181915	–	
M/C signal cable	3 m		2216995	2150712	R13N827011	
	5 m		2216996	2150713	R13N827021	
	10 m		2216997	2150714	R13N827031	
	15 m		2216998	2185613	–	
	20 m		2216999	2185497	–	
M/C cable (flexible, straight only)	3 m		R12NZ901E1	–		15
	5 m		R12NZ901E2	–		
	10 m		R12NZ901E3	–		
	15 m		R12NZ901E4	–		
	20 m		R12NZ901E5	–		
M/C power cable (flexible)	3 m		2165292	–		
	5 m		2165291	–		
	10 m		2165290	–		
	15 m		2220939	–		
	20 m		2220940	–		
M/C signal cable (flexible)	3 m		2165295	–		
	5 m		2165294	–		
	10 m		2165293	–		
	15 m		2220937	–		
	20 m		2220938	–		
Battery relay cable unit			1653173	–	–	
Radiation Sheet	Joint #2		1549699	R13B031905	–	6.1

Name			Code	Old Code		Reference
Cover	Arm #1	Center cover	2165173	R13N834011	–	3
		Side cover	2165174	R13N834021	–	
	Arm #2	Side cover	2165175	R13N834031	–	
	Arm #3	Head cover	2165176	R13N834041	–	
	Arm #4	Side cover (right)	2165177	R13N834051	–	
		Side cover (left)	2165178	R13N834061	–	
	Arm #1	Center cover	1658607	R13N834131	–	3 (Plate)
		Side cover	2165179	R13N834141	–	
	Arm #2	Side cover	2165180	R13N834151	–	
	Arm #3	Head cover	2165181	R13N834161	–	
	Arm #4	Side cover (right)	2165182	R13N834171	–	
		Side cover (left)	2165183	R13N834181	–	

The parts in the table below have different parts code depending on the connector specifications. Before purchasing maintenance parts, check the serial number of the Manipulator body and be sure to purchase correct parts.

Serial number: C4**000001 ~ C4**039999
C4**N00001 ~ C4**N09999

Name		Code	Old Code	Note	Reference	Overhaul**
Motor	Joint #1, #2	2217331	R13N807011	400 W	5.1, 6.1	✓
	Joint #3	2217354	–	150 W + Electromagnetic brake	7.1	✓
	Joint #4, #5, #6	2217332	R13N807031	50 W	8.1, 9.1, 10.1	✓
Electromagnetic brake	Joint #1, #2	2217447	R13N835021		5.4, 6.4	✓
	Joint #4, #5, #6	2217448	R13N835011		8.4, 9.4 10.4	✓
Noise dissipative diode	Joint #1, #2, #3	2217333	R13N823011		5.4, 6.4, 7.1	
LED lamp		1605919	2217449		14	
Cable Unit	C4-A601**	2217356	R13N820011			
	C4-A901**	2217357	R13N820021			
	C4-A601**-UL	2217358	–			
	C4-A901**-UL	2217359	–			

Serial number: C4**040001 or later
C4**N10001 or later

Name		Code	Old Code	Note	Reference	Overhaul**
Motor	Joint #1, #2	2216079	R13N807011	400 W	5.1, 6.1	✓
	Joint #3	2216080	–	150 W + Electromagnetic brake	7.1	✓
	Joint #4, #5, #6	2216081	R13N807031	50 W	8.1, 9.1, 10.1	✓
Electromagnetic brake	Joint #1, #2	2216067	R13N835021		5.4, 6.4	✓
	Joint #4, #5, #6	2216068	R13N835011		8.4, 9.4 10.4	✓
Noise dissipative diode	Joint #1, #2, #3	2216071	R13N823011		5.4, 6.4, 7.1	
LED lamp		2216072	R13N830011		14	
Cable Unit	C4-A601**	2216075	R13N820011			
	C4-A901**	2216076	R13N820021			
	C4-A601**-UL	2216077	–			
	C4-A901**-UL	2216078	–			

18. C4 Option Parts List

Name	Code	Old Code	Note	Reference *
Brake release unit (with short connector)	R12NZ9006F	R12B120805	For Europe	6.1
	R12NZ900JE	R12B120806	For U.S. & Japan	
Brake release unit (Main unit only)	R12NZ900M2	R12B120803	For Europe	
	R12NZ900KV	R12B120804	For U.S. & Japan	
Camera plate unit	R12NZ9003F	R12B031922		6.2
PS compatible plate	R12NZ9003G	R12B031923		6.3
Base side angled fitting	R12NZ900HF	R12B031924		6.4
Base side fitting	R12NZ9003H	R12B031925		6.5
PS Compatible Plate (Base Adapter)	R12NZ900A5	R12N73L021		6.6
Adjustable Mechanical Stop	R12NZ900L1	R12N73L011		6.7

* Refer to each manipulator's page of C series manual.

C8 Maintenance

This volume contains maintenance procedures with safety precautions for C8 series Manipulators.

1. Safety Maintenance

Please read this chapter, this manual, and other relevant manuals carefully to understand safe maintenance procedures before performing any maintenance.

Only authorized personnel who have taken maintenance training held by the manufacturer or dealer should be allowed to perform the robot maintenance.

 WARNING	■ Do not remove any parts unless otherwise instructed by this manual. Follow the maintenance procedure strictly as described. Improper removal of parts or improper maintenance may cause not only malfunction of the robot system but serious safety problems. ■ If you have not received training, keep away from the Manipulator while the power is ON. 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. ■ When connecting / replacing the brake release unit or the external short connector, turn OFF the power to the Controller and the brake release unit. Connecting or disconnecting the connector while the power is ON may result in electrical shock.

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.) It may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. ■ If the Manipulator is operated without connecting the brake release unit or the external short connector, the brakes cannot be released and it may cause damage on them. After using the brake release unit, be sure to connect the external short connector to the Manipulator, or check connection of the connector for the brake release unit. ■ The Manipulator arms may become hot after the Manipulator operation due to heat generation of the motors. Be careful when performing maintenance. ■ When operating maintenance of manipulator, secure about 50 cm of empty space around the manipulator.

2. General Maintenance

This chapter describes maintenance inspection procedures. Performing maintenance inspection properly is essential to prevent trouble and ensure 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.

	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						√

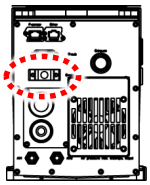
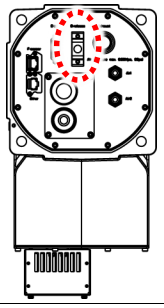
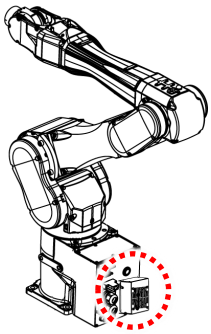
h = hour

2.1.2 Inspection Point

Inspection Point

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 either the external short connector or the brake release unit connector is connected.	The external short connector on the back side of the Manipulator, or the brake release unit connector.	√	√	√	√	√
Check the break operation	Joint #1 to 6 break	√	√	√	√	√
Check whether unusual sound or vibration occurs.	Whole	√	√	√	√	√
Check if the fan is running (C8-A1401***(C8XL) only)	Fan	√	√	√	√	√

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 either the external short connector or the brake release unit connector is connected.	Check whether external short connector or break release connector is connected. When neither is connected, connect either one. M/C Cable backward  M/C Cable downward 
Check the break operation	Check that the arm does not fall when in MOTOR OFF. If the arm falls when in MOTOR OFF and the brake is not released, 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.
Check if the fan is running (C8-A1401***(C8XL) only)	Check that the fan is running when in MOTOR ON. If the fan is not running when in MOTOR ON, 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].

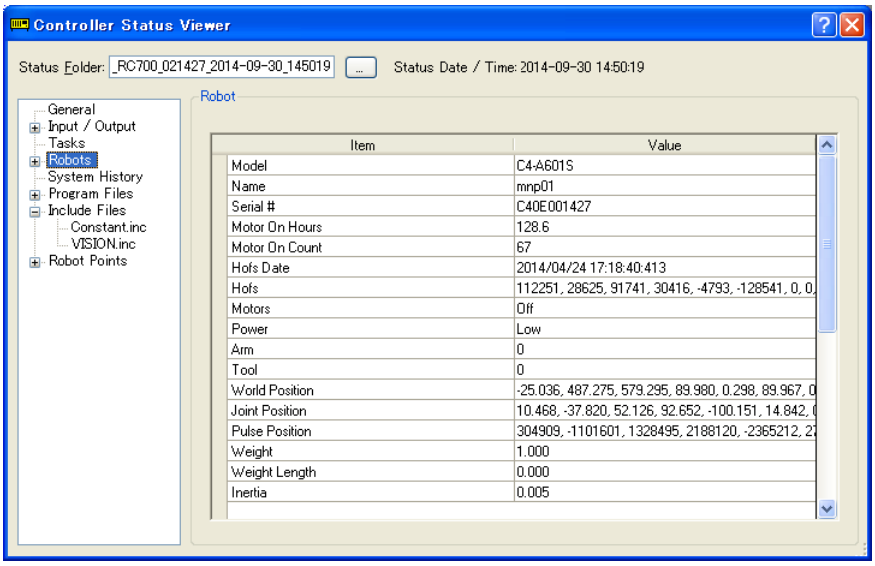
(1) Select EPSON RC+ menu-[Tools]-[Controller] to open the [Controller Tools] dialog.

(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.



For the parts subject to overhaul, refer to *C8 Maintenance 17. 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 reduction gear units and the bevel gear need greasing regularly. Only use the grease specified in the following table.

WARNING	■ Before greasing, 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	■ Keep enough grease in the Manipulator. Operating the Manipulator with insufficient grease will cause the noise or 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. ■ 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
Joints #1, 2, 3, 4, 5	Reduction gear units	Overhaul timing	SK-1A
Joint # 6			SK-2
Joint # 6	Bevel gear	Overhaul timing	SK-2

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.

	Name	Quantity	Note
Maintenance parts	Grease up kit	1	1674592 (A set of grease gun, nipple, and extension jig)
	Grease plug	1	1656158
	O-ring for grease inlet	1	1657289
Tools	Hexagonal wrench (width across flats: 2 mm)	1	For M3 hexagon socket countersunk head bolts
	Hexagonal wrench (width across flats: 2.5 mm)	1	For M3 hexagon socket head cap bolts
	Cross-point screwdriver (#2)	1	For cross-recessed head screws
	Flat head screwdriver	1	For grease plug

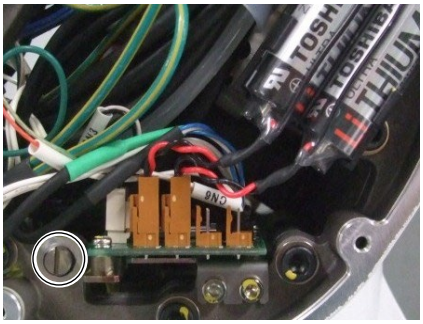
NOTE
☞ Before greasing, move the Manipulator so that the grease inlet is not directed down.
Do not remove the grease plug while the grease inlet is directed down. Otherwise the oil content separated from the grease may leak out.

NOTE
☞ Do not use any tool to install and remove the grease nipple and grease line extension jig.
Always handle them directly by your hand.
If the grease nipple or grease line extension jig is installed or removed with a tool such as wrench, they may be damaged.

2.3.1 Joint #1 Reduction Gear Unit (Table Top Mounting)

Greasing

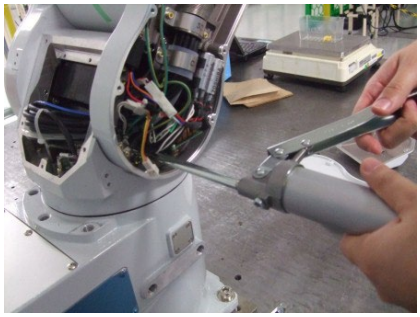
1. Remove the Arm #1 side cover.
   For details, refer to *C8 Maintenance: 3. Covers*.
2. Remove the grease plug from the Joint #1 grease inlet located inside the Arm #1.



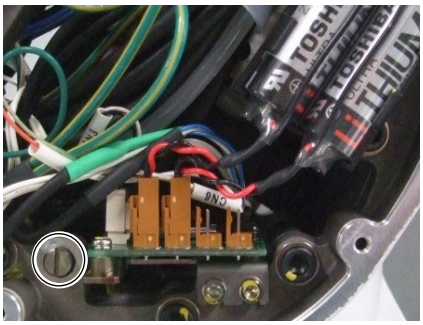
3. Attach the grease nipple to the Joint #1 grease inlet.
4. Inject grease from the grease nipple using a grease gun

   Grease: SK-1A

   Grease amount: 11g



5. Remove the grease nipple from the Joint #1 grease inlet.
6. Attach the grease plug to the Joint #1 grease inlet.
   If the grease plug is damaged or deteriorated, replace it with a new one.



7. Install the Arm #1 side cover.
   For details, refer to *C8 Maintenance: 3. Covers*.

2.3.2 Joint #1 Reduction Gear Unit (Ceiling Mounting, Wall mounting)

Greasing

1. Remove the base grease inlet cover.

   Hexagon socket flat head bolts: 4-M3×6

2. Remove the O-ring located in the base groove.
3. Remove the grease plug from the Joint #1 grease inlet located inside the base.
4. Attach the grease line extension jig and grease nipple to the Joint #1 grease inlet.

5. Inject grease from the grease nipple using a grease gun.

   Grease: SK-1A

   Grease amount: 11g

6. Remove the grease nipple and grease line extension jig from the Joint #1 grease inlet.
7. Attach the grease plug to the Joint #1 grease inlet.
   If the grease plug is damaged or deteriorated, replace it with a new one.

8. Apply a thin coat of grease (SK-1A) to the O-ring.
   Fit the O-ring into the base groove.
   Do not allow the O-ring to come out of the groove.
   If the O-ring is swollen, damaged, or deteriorated, replace it with a new one.

9. Install the base grease inlet cover.

   Hexagon socket flat head bolts: 4-M3×6

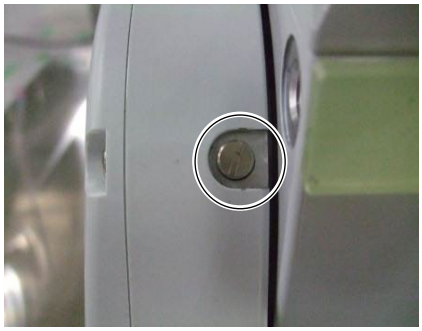
   Tightening torque: 2.0 ± 0.1 N·m

2.3.3 Joint #2 Reduction Gear Unit

Greasing

1. Remove the grease plug from the Joint #2 grease inlet of the Arm #1.

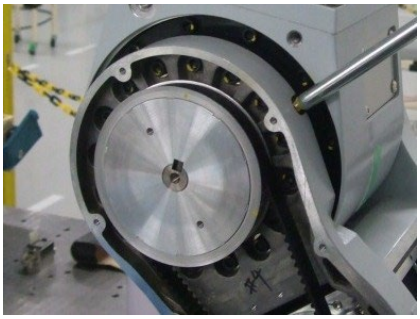
2. Attach the grease nipple to the Joint #2 grease inlet.



3. Inject grease from the grease nipple using a grease gun

   Grease: SK-1A

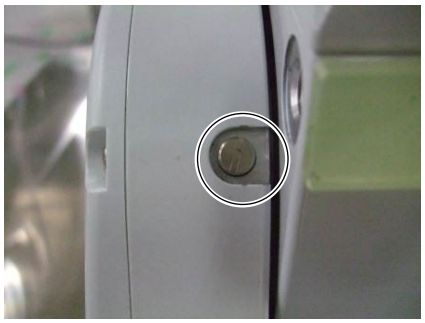
   Grease amount: 6g (C8, C8L)
   12g (C8XL)



4. Remove the grease nipple from the Joint #2 grease inlet.

5. Attach the grease plug to the Joint #2 grease inlet.

   If the grease plug is damaged or deteriorated, replace it with a new one.



2.3.4 Joint #3 Reduction Gear Unit

Greasing

1. Remove the grease plug from the Joint #3 grease inlet of the Arm #2.

2. Attach the grease nipple to the Joint #3 grease inlet.

3. Inject grease from the grease nipple using a grease gun

   Grease: SK-1A

   Grease amount: 3g

4. Remove the grease nipple from the Joint #3 grease inlet.

5. Attach the grease plug to the Joint #3 grease inlet.

   If the grease plug is damaged or deteriorated, replace it with a new one.

2.3.5 Joint #4 Reduction Gear Unit

Greasing

1. Remove the grease plug from the Joint #4 grease inlet of the Arm #4.

2. Attach the grease nipple to the Joint #4 grease inlet.

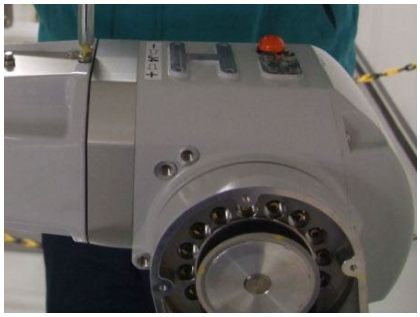
NOTE

The grease plug attaching hole located near the label with “4” printed is the Joint #4 grease inlet.
The grease inlet position differs depending on the model. Carefully identify the correct position.

3. Inject grease from the grease nipple using a grease gun

   Grease: SK-1A

   Grease amount: 2g



4. Remove the grease nipple from the Joint #4 grease inlet.

5. Attach the grease plug to the Joint #4 grease inlet.

   If the grease plug is damaged or deteriorated, replace it with a new one.

2.3.6 Joint #5 Reduction Gear Unit

Greasing

1. Remove the grease plug from the Joint #5 grease inlet of the Arm #5.

2. Attach the grease nipple to the Joint #5 grease inlet.

NOTE

The grease plug attaching hole located near the label with "5" printed is the Joint #5 grease inlet.
Be careful not to confuse it with the Joint #6 grease inlet.

3. Inject grease from the grease nipple using a grease gun.

   Grease: SK-1A

   Grease amount: 1g

NOTE

Be careful not to mix with the grease used in the Joint #6 (SK-2).

4. Remove the grease nipple from the Joint #5 grease inlet.

5. Attach the grease plug to the Joint #5 grease inlet.

If the grease plug is damaged or deteriorated, replace it with a new one.

2.3.7 Joint #6 Reduction Gear Unit

Greasing

1. Remove the grease plug from the Joint #6 grease inlet of the Arm #5.

2. Attach the grease nipple to the Joint #6 grease inlet.

NOTE

The grease plug attaching hole located near the label with “6” printed is the Joint #6 grease inlet.
Be careful not to confuse it with the Joint #5 grease inlet.

3. Inject grease from the grease nipple using a grease gun.

   Grease: SK-2

   Grease amount: 0.5g

NOTE

Be careful not to mix with the grease used in the Joint #5 (SK-1A).

4. Remove the grease nipple from the Joint #6 grease inlet.

5. Attach the grease plug to the Joint #6 grease inlet.

If the grease plug is damaged or deteriorated, replace it with a new one.

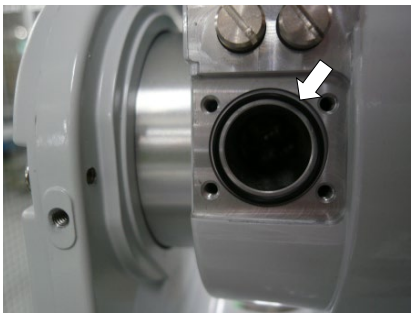
2.3.8 Joint #6 Bevel Gear

Greasing

1. Remove the Arm #5 grease inlet cover.

   Hexagon socket head cap bolts: 4-M3×6

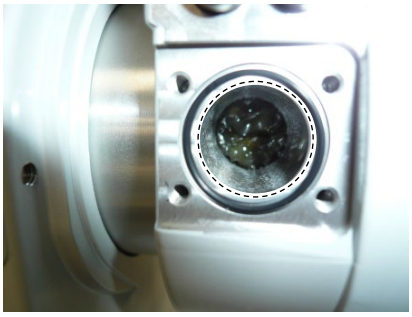
2. Remove the O-ring located in the base groove.



3. Apply grease to the mating surface of the bevel gear inside the Arm #5.

   Grease: SK-2

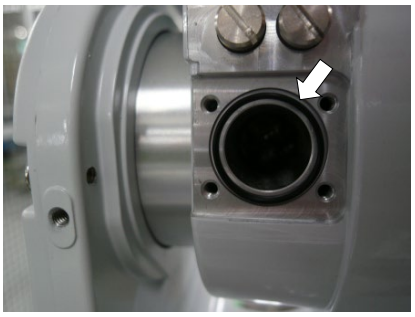
   Grease amount: 2g



4. Apply a thin coat of grease (SK-2) to the O-ring. Fit the O-ring into the base groove.

   Do not allow the O-ring to come out of the groove.

   If the O-ring is swollen, damaged, or deteriorated, replace it with a new one.



5. Install the Arm #5 grease inlet cover.

   Hexagon socket head cap bolts: 4-M3×6

   Tightening torque: 2.0 ± 0.1 N·m

2.4 Tightening Hexagon Socket Head Bolts

Hexagon socket head cap bolts (hereinafter, “bolts”) are used in places where mechanical strength is required. These bolts are fastened with the tightening torque shown in the following tables.

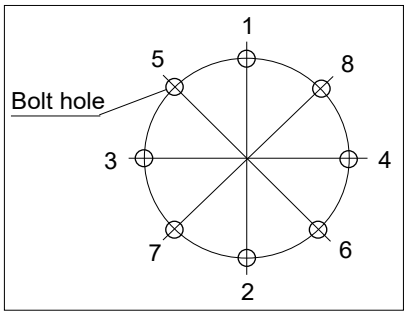
When it is required to refasten the bolts in some procedures in this manual (except special cases as noted), use a torque wrench so that the bolts are fastened with appropriate tightening torque as shown below.

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)

See below for the set screw.

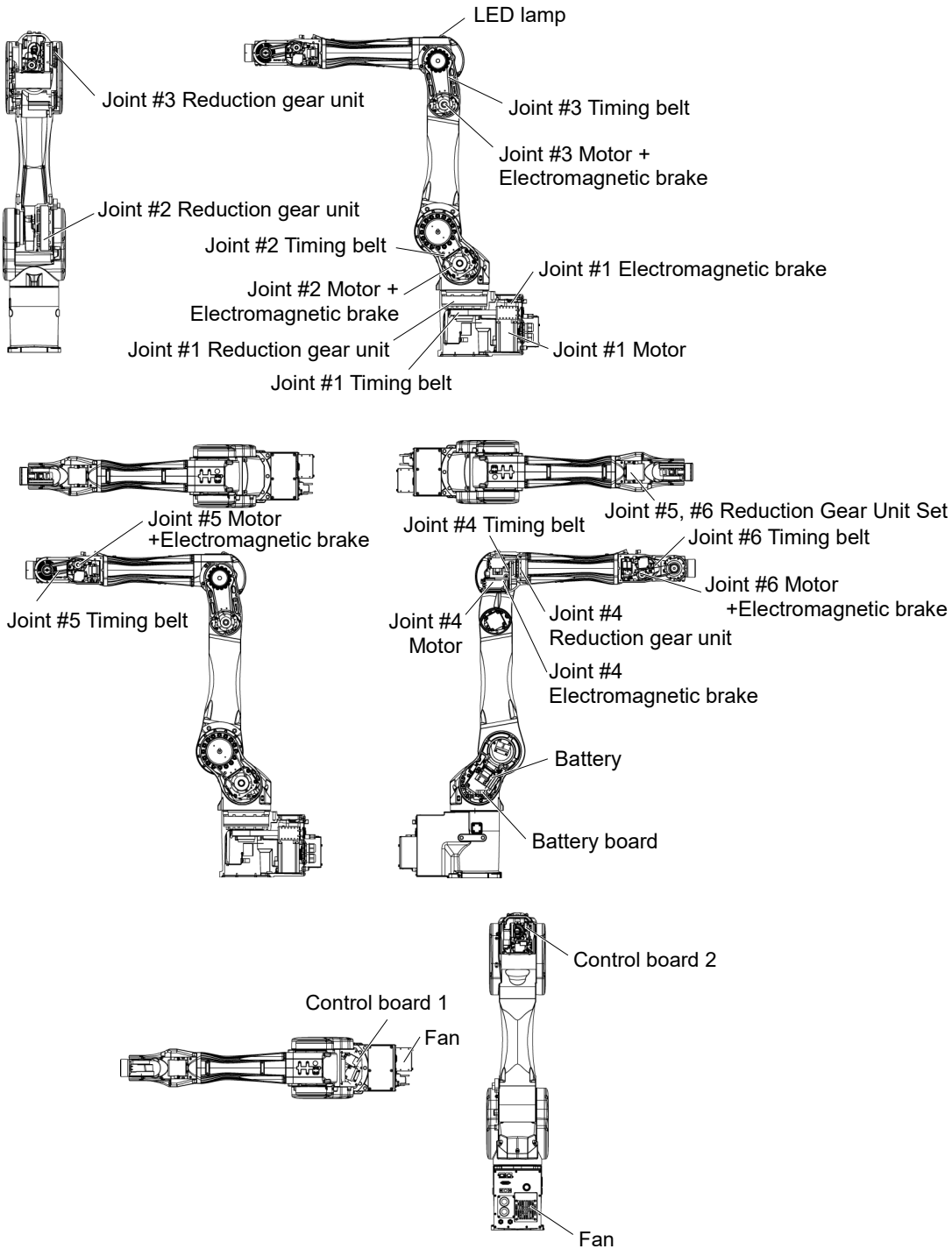
Set Screw	Tightening Torque
M4	2.4 ± 0.1 N·m (26 ± 1 kgf·cm)
M5	3.9 ± 0.2 N·m (40 ± 2 kgf·cm)
M6	8.0 ± 0.4 N·m (82 ± 4 kgf·cm)

It is recommended to fasten the bolts aligned on a circumference in a crisscross pattern as shown in the figure below.



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

2.5 Layout of Maintenance Parts



(Figure: C8-A1401* (C8XL))

3. Covers

This chapter describes methods of removing and installing the covers and gaskets which are common to all maintenance procedures by Manipulator model.

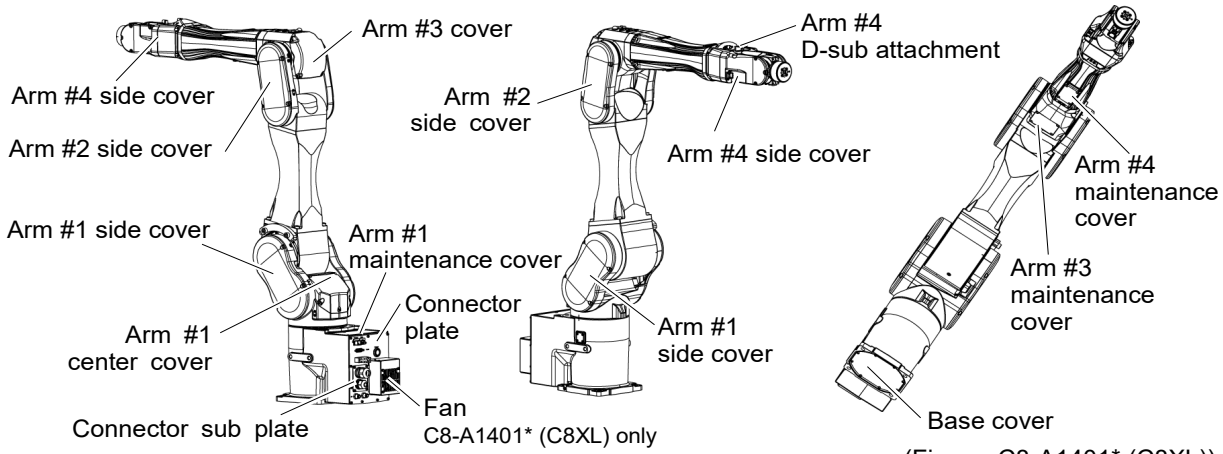
S: Standard model

C: Clean-room & ESD model

P: Protection model

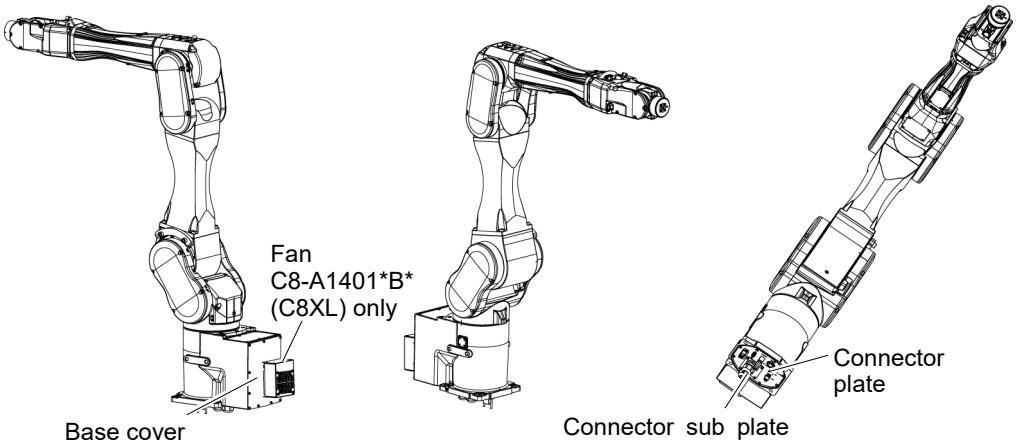
 WARNING	■ Do not connect or disconnect the motor connectors while the power to the robot system is turned ON. Connecting or disconnecting the motor connectors with the power ON is extremely hazardous and may result in serious bodily injury as the Manipulator may move abnormally, and also may result in 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.

Cable backward model



(Figure: C8-A1401* (C8XL))

Cable downward model



(Figure: C8-A1401*B* (C8XL))

	Name			Quantity	Note	
Maintenance parts	Cover	Arm #1	Center cover	1	1675435	Metal cover Common to Standard/ Clean-room models
			Side cover	2	1674537	Standard model Plastic cover
		Arm #2	Side cover (left)	1	1655114	
			Side cover (right)	1	1674542	
		Arm #3	Cover	1	1674543	
		Arm #4	Side cover	2	1674547	
		Arm #1	Side cover	2	1674548	Cleanroom model Plating cover
		Arm #2	Side cover (left)	1	1655127	
			Side cover (right)	1	1674550	
		Arm #3	Cover	1	1674551	
		Arm #4	Side cover	2	1674553	
	Gasket	Arm #1	Center gasket	1	1665238	Protection model
			Side gasket	2	1665240	
		Arm #2	Side gasket	2	1665241	
		Arm #3	Cover gasket	1	1665242	
			Maintenance gasket	1	1665254	
		Arm #4	Side gasket	2	1665243	
			Maintenance gasket	1	1665257	
			D-sub attachment gasket	1	1665255	
		Base	Rear gasket	1	1665244	
			Bottom gasket	1	1665247	
			Maintenance gasket	1	1665248	
			Sub plate gasket	1	1665246	
			Installation gasket	1	1668377	
			Gasket For heat sink	1	1694610	Cleanroom model Protection model
	Seal washer			4	1665882	For M4
	Air plug			2	1657011	For M6
Tools	Hexagonal wrench	width across flats: 2.5 mm		1	For M3 hexagon socket head cap bolts	
		width across flats: 3 mm		1	For M4 hexagon socket head cap bolts	
	Cross-point screwdriver (#2)			1	For cross recessed screws	

3.1 Arm #1 Center Cover

CAUTION	■ When mounting the cover, be careful not to get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the cover. Be sure to place the cables back to their original locations.

Removal

Remove the screws and then remove the Arm #1 center cover.

S, C models:

Cross recessed truss head small screws: 5-M4×10

P model:

Hexagon socket head cap bolts with captive washer: 5-M4×12

Remove the Arm #1 center gasket together.

Installation

S, C models:

Install the Arm #1 center cover to the Manipulator.

Cross recessed truss head small screws: 5-M4×10

Tightening torque: 0.9 ± 0.1 N·m

P model:

Install the gasket to the grove on the Arm #1 center cover.

Install the Arm #1 center cover to the Manipulator.

Hexagon socket head cap bolts with washer: 5-M4×12

Tightening torque: 4.0 ± 0.2 N·m

NOTE

Be careful not to get the gasket and cables caught between the cover and the Manipulator.

Replace the gasket if there are flaws or deteriorations.

3.2 Arm #1 Side Cover

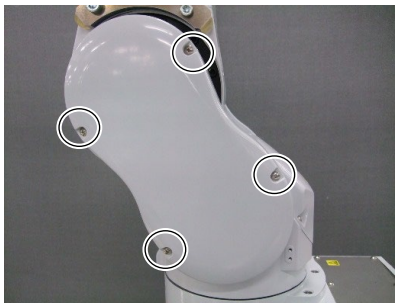
CAUTION	■ When mounting the cover, be careful not to get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the cover. Be sure to place the cables back to their original locations.

Removal

Remove the screws and then remove the Arm #1 side cover.

S, C models:

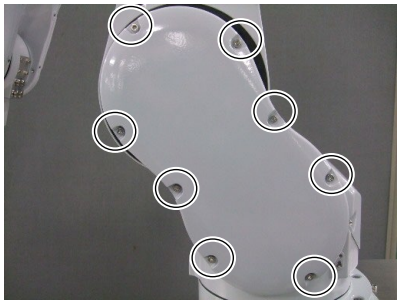
Cross recessed truss head small screws:
4-M4×10 (one side)



P model:

Hexagon socket head cap bolts with captive washer: 8-M4×12 (one side)

Remove the Arm #1 side gasket together.



NOTE

The Arm #1 side covers and Arm #1 side gaskets are the same between right and left.

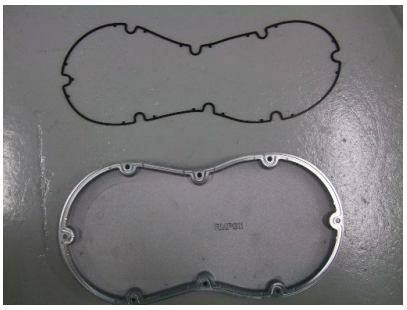
Installation

S, C models:

Install the Arm #1 side cover to the Manipulator.

Cross recessed truss head small screws:
4-M4×10 (one side)

Tightening torque: 0.9 ± 0.1 N·m



P model:

Install the gasket to the grove on the Arm #1 side cover.

Install the Arm #1 side cover to the Manipulator.

Hexagon socket head cap bolts with captive washer: 8-M4×12 (one side)

Tightening torque: 4.0 ± 0.2 N·m

NOTE

Be careful not to get the gasket and cables caught between the cover and the Manipulator.

Replace the gasket if there are flaws or deteriorations.

When replacing the side cover for the right side of the Arm #1, attach the electrical shock warning label to the place indicated in the photo.

3.3 Arm #2 Side Cover

CAUTION	■ When mounting the cover, be careful not to get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the cover. Be sure to place the cables back to their original locations.

Removal

Remove the screws and then remove the Arm #2 side cover.

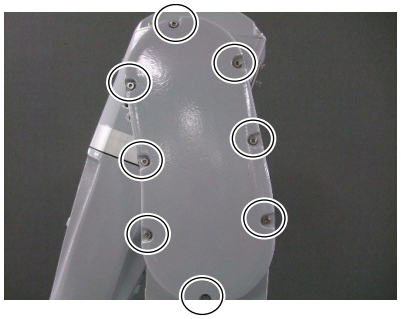
S, C models:

Cross recessed truss head small screws:
4-M4×10 (one side)

P model:

Hexagon socket head cap bolts with captive washer: 8-M4×12 (one side)

Remove the Arm #2 side gasket together.



NOTE

Note that the Arm #2 side covers and Arm #2 side gaskets are different between right and left.

Installation

S, C models:

Install the Arm #2 side cover to the Manipulator.

Cross recessed truss head small screws: 4-M4×10 (one side)
Tightening torque: 0.9 ± 0.1 N·m

P model:

Install the gasket to the grove on the Arm #2 side cover. Install the Arm #2 side cover to the Manipulator.

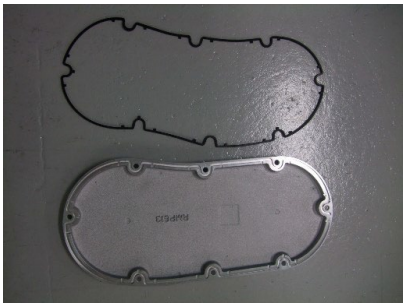
Hexagon socket head cap bolts with captive washer: 8-M4×12 (one side)

Tightening torque: 4.0±0.2N·m

NOTE

Be careful not to get the gasket and cables caught between the cover and the Manipulator.

Replace the gasket if there are flaws or deteriorations.



3.4 Arm #3 Cover

CAUTION	■ When mounting the cover, be careful not to get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the cover. Be sure to place the cables back to their original locations.

Removal

Remove the screws and then remove the Arm #3 head cover.

S, C models:

Cross recessed truss head small screws: 4-M4×10

P model:

Hexagon socket head cap bolts with captive washer: 4-M4×12

Remove the Arm #3 gasket together.

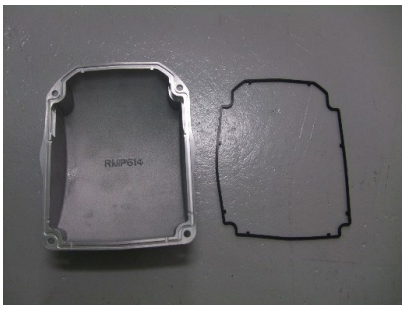
Installation

S, C models:

Install the Arm #3 cover to the Manipulator.

Cross recessed truss head small screws: 4-M4×10

Tightening torque: 0.9 ± 0.1 N·m



P model:

Install the gasket to the grove on the Arm #3 head cover, and then install the Arm #3 cover to the Manipulator.

Cross recessed truss head small screws with captive washer: 4-M4×12

Tightening torque: 4.0 ± 0.2 N·m

NOTE

Be careful not to get the gasket and cables caught between the cover and the Manipulator.

Replace the gasket if there are flaws or deteriorations.

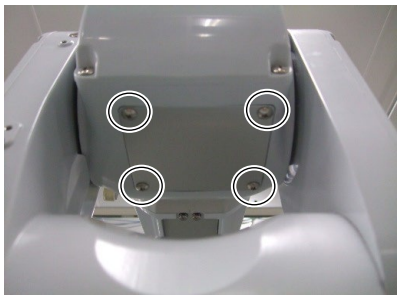
3.5 Arm #3 Maintenance Cover

CAUTION	■ When mounting the cover, be careful not to get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the cover. Be sure to place the cables back to their original locations.

Removal

1. Before removing the Arm #3 maintenance cover, move the arm to the position where you can remove the cover easily.

2. Remove the screws and then remove the Arm #3 maintenance cover.



S, C models:
Cross recessed truss head small screws: 4-M4×8

P model:
Hexagon socket head cap bolts: 4-M4×10

NOTE Remove the Arm #3 maintenance gasket together. The gasket has the spacers. Be careful not to lose them.

Installation
(S, C models)

Install the Arm #3 maintenance cover to the Manipulator.

Cross recessed truss head small screws: 4-M4×8

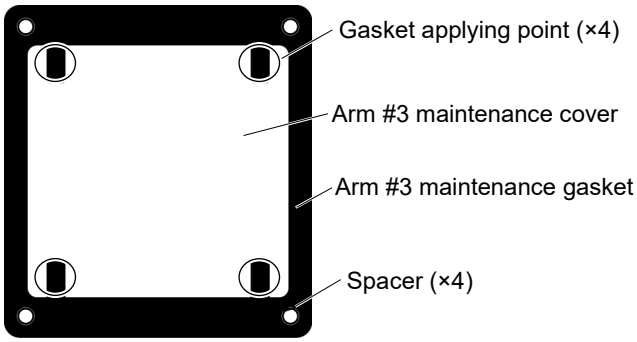
Tightening Torque: 0.9 ± 0.1 N·m

Be careful not to get the cables caught between the cover and the Manipulator.

Installation
(P model)

1. Install the spacers to the holes on the gasket.
(4 places)

2. Apply the liquid gasket to the Arm #3 maintenance gasket.
Install the Arm #3 maintenance gasket to the Arm #3 maintenance cover.
(See the figure for gasket applying points)



NOTE

After applying the liquid gasket, leave the gasket until the liquid gasket becomes solid and the gasket is fixed.

3. Install the Arm #3 maintenance cover to the Manipulator.

Hexagon socket head cap bolts: 4-M4×10

Tightening torque: 4.0 ± 0.2 N·m

NOTE

Be careful not to get the gasket and cables caught between the cover and the Manipulator.
Replace the gasket if there are flaws or deteriorations.

3.6 Arm #4 Side Cover

CAUTION	■ When mounting the cover, be careful not to get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the cover. Be sure to place the cables back to their original locations.

Removal

1. Remove the screws and then remove the Arm #4 side cover.

S, C models:
Cross recessed truss head small screws:
7-M4×10 (one side)

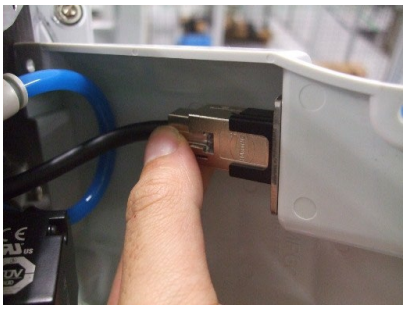
P model:
Hexagon socket head cap bolts with captive washer: 7-M4×12 (one side)

Remove the Arm #4 side gasket together.

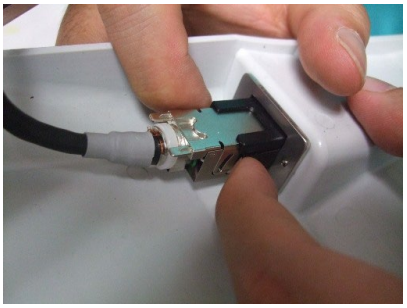
NOTE The Arm #4 side cover and Arm #4 side gasket are the same between right and left.

2. Remove the connectors.

RJ45 connector (left):
Remove the RJ45 connector from the connector on the cover.



F-sensor connector (right):
Open the two plastic clips of the connector on the cover and pull out the metallic connector.



Installation

Insert the connectors.

RJ45 connector:
Insert the RJ45 connector to the connector on the cover.

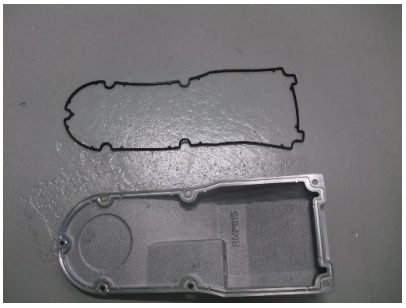
F-sensor connector:
Insert the metallic connector to the connector on the cover.

S, C models:
Install the Arm #4 side cover to the Manipulator.
Cross recessed truss head small screws: 7-M4×10 (one side)
Tightening torque: 0.9 ± 0.1 N·m

P model:
Install the Arm #4 side gasket to the grove on the Arm #4 side cover. Install the Arm #4 cover to the Manipulator.

Cross recessed truss head small screws:
7-M4×12 (one side)

Tightening torque: 4.0 ± 0.2 N·m



NOTE

Be careful not to get the gasket and cables caught between the cover and the Manipulator.

Replace the gasket if there are flaws or deteriorations.

When replacing the cover, attach the electrical shock warning label and other labels to the places indicated in the photos.

3.7 Arm #4 Maintenance Cover (C8XL only)

CAUTION	■ When mounting the cover, be careful not to get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the cover. Be sure to place the cables back to their original locations.

Removal

1. Before removing the Arm #4 maintenance cover, move the arm to the position where you can remove the cover easily.
2. Remove the screws and then remove the Arm #4 maintenance cover.

S, C models:
Cross recessed truss head small screws:
4-M4×10

P model:
Hexagon socket head cap bolts: 4-M4×10

NOTE Remove the Arm #3 maintenance gasket together. The gasket has the spacers. Be careful not to lose them.

Installation (S, C models)

Install the Arm #4 maintenance cover to the Manipulator.

Cross recessed truss head small screws: 4-M4×10

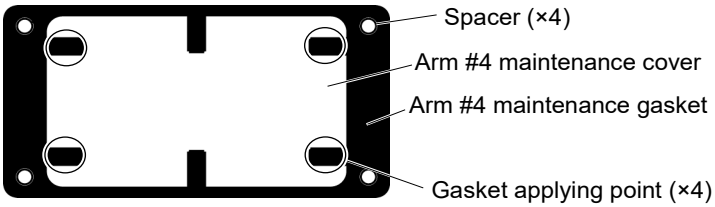
Tightening torque: 0.9 ± 0.1 N·m

Be careful not to get the cables caught between the cover and the Manipulator.

Installation (P model)

1. Install the spacers to the holes on the gasket. (4 places)

2. Apply the liquid gasket to the Arm #4 maintenance gasket.
   Install the Arm #4 maintenance gasket to the Arm #4 maintenance cover.
   (See the figure for gasket applying points)



NOTE ☞ After applying the liquid gasket, leave the gasket until the liquid gasket becomes solid and the gasket is fixed.

3. Install the Arm #4 maintenance cover to the Manipulator.

   Hexagon socket head cap bolts: 4-M4×10

   Tightening torque: 4.0 ± 0.2 N·m

NOTE ☞ Be careful not to get the gasket and cables caught between the cover and the Manipulator.

Replace the gasket if there are flaws or deteriorations.

3.8 Arm #4 D-sub Attachment

CAUTION	■ Do not remove the D-sub attachment forcibly. Removing it 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 D-sub attachment, be careful not to get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the D-sub attachment. Be sure to place the cables back to their original locations.

Removal

Remove the screws and then remove the D-sub attachment.

Hexagon socket head cap bolts: 2-M4×10

P model:

Remove the D-sub attachment gasket together.

Installation

S, C models:

Install the D-sub attachment.

Hexagon socket head cap bolts: 2-M4×10

Tightening torque: 4.0 ± 0.2 N·m

P model:

Install the D-sub attachment gasket to the Manipulator, and then install the D-sub attachment.

Hexagon socket head cap bolts: 2-M4×10

Tightening Torque: 4.0 ± 0.2 N·m

NOTE

Be careful not to get the gasket and cables caught between the cover and the Manipulator.

Replace the gasket if there are flaws or deteriorations.

3.9 Base Cover

3.9.1 M/C Cable Backward

CAUTION	■ When mounting the cover, be careful not to get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the cover. Be sure to place the cables back to their original locations.

The base cover of the M/C cable backward model is located on the bottom face of the base.

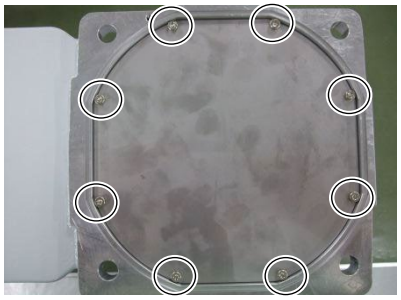
Removal

Remove the bolts and then remove the base cover.

Hexagon socket head cap bolts: 8-M4×10

P model:

Remove the base bottom gasket together.



Installation

S, C models:

Install the base cover to the Manipulator.

Hexagon socket head cap bolts: 8-M4×10

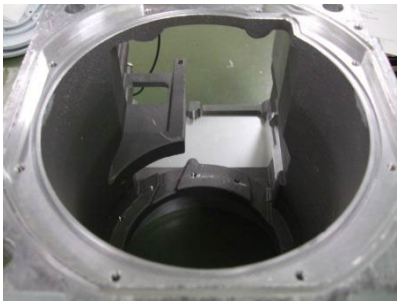
Tightening Torque: 4.0 ± 0.2 N·m

P model:

Install the gasket to the grove on the base bottom face, and then install the base cover to the Manipulator.

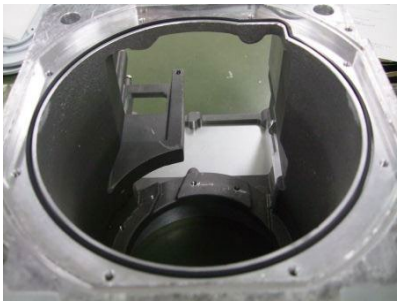
Hexagon socket head cap bolts: 8-M4×10

Tightening Torque: 4.0 ± 0.2 N·m



NOTE

If the bolts other than the hexagon socket head cap bolts are used, the bolt heads may protrude from the end face of the base and the cover may not be fixed stably.



NOTE

Be careful not to get the gasket and cables caught between the cover and the Manipulator.
Replace the gasket if there are flaws or deteriorations.

3.9.2 M/C Cable Downward

CAUTION	■ When mounting the cover, be careful not to get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the cover. Be sure to place the cables back to their original locations.

The base cover of the M/C cable downward model is located on the backside of the base.

C8-A701*B* (C8), C8-A901*B* (C8L)

Removal

Remove the bolts and then remove the base cover.

Hexagon socket head cap bolts: 11-M4×10

P model:

Remove the base rear gasket together.

NOTE

The gasket has the spacers. Be careful not to lose them.

C8-A701*B* (C8), C8-A901*B* (C8L)

Installation (S, C models)

Install the base cover to the Manipulator.

Hexagon socket head cap bolts: 11-M4×10

Tightening Torque: 4.0 ± 0.2 N·m

NOTE

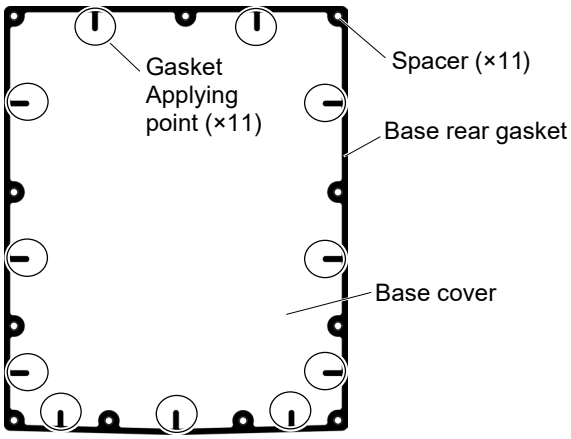
Be careful not to get the cables caught between the cover and the Manipulator.

C8-A701*B* (C8), C8-A901*B* (C8L)

Installation (P model)

1. Install the spacers to the holes on the gasket. (11 places)

2. Apply the liquid gasket to the base rear gasket. Install the base rear gasket to the base cover. (See the figure for gasket applying points)



NOTE

After applying the liquid gasket, leave the gasket until the liquid gasket becomes solid and the gasket is fixed.

3. Install the base cover to the Manipulator.

Hexagon socket head cap bolts: 11-M4×10

Tightening torque: 4.0 ± 0.2 N·m

NOTE

Be careful not to get the gasket and cables caught between the cover and the Manipulator.
Replace the gasket if there are flaws or deteriorations.

C8-A1401*B* (C8XL)

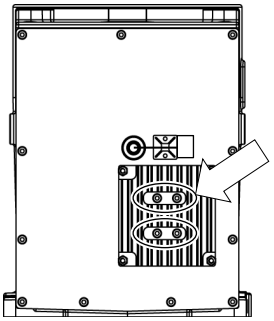
Removal

1. Remove the fan.
   For details, refer to *C8 Maintenance 15. Replacing the Fan.*

2. Remove the bolts on the heat sink.

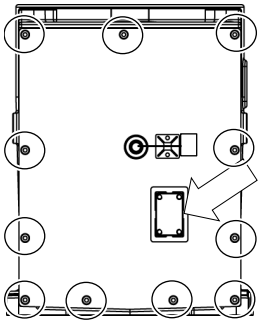
   Hexagon socket head cap bolts: 4-M4×15

3. Remove the heat sink.



NOTE

For cleanroom and protection models, remove the gasket between the heat sink and the base cover.



4. Remove the bolts, and then remove the base cover and the base rear gasket.

   Hexagon socket head cap bolts: 11-M4×10

NOTE

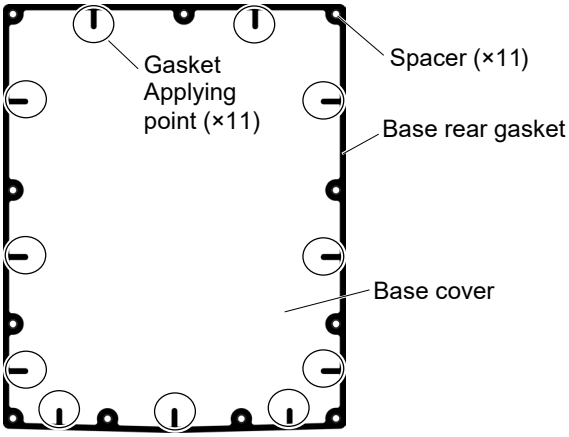
The gasket has the spacers. Be careful not to lose them.

C8-A1401*B* (C8XL)

Installation

1. Install the spacers to the holes on the gasket.
   (11 places)

2. Apply the liquid gasket to the base rear gasket.
   Install the base rear gasket to the base cover.
   (See the figure for gasket applying points)



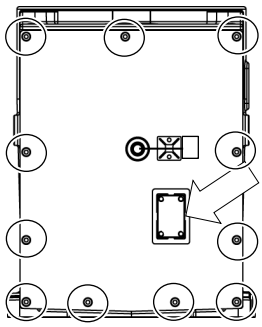
NOTE

After applying the liquid gasket, leave the gasket until the liquid gasket becomes solid and the gasket is fixed.

3. Install the base cover to the Manipulator.

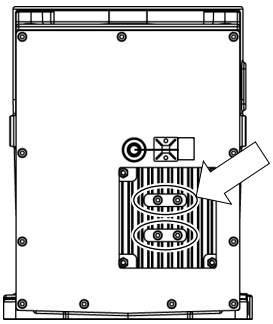
   Hexagon socket head cap bolts: 11-M4×10

   Tightening torque: 4.0 ± 0.2 N·m



NOTE Be careful not to get the gasket and cables caught between the cover and the Manipulator.
Replace the gasket if there are flaws or deteriorations.

NOTE For cleanroom and protection models, install the gasket between the heat sink and the base cover.



4. Install the heat sink.

   Hexagon socket head cap bolts: 4-M4×15

   Tightening torque: 4.0 ± 0.2 N·m

5. Install the fan.
   For details, refer to *C8 Maintenance 15. Replacing the Fan.*

3.10 Base Maintenance Cover

CAUTION	■ When mounting the cover, be careful not to get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the cover. Be sure to place the cables back to their original locations.

Removal

Remove the screws and then remove the base maintenance cover.

S, C models:
Cross recessed truss head small screws: 6-M4×10

P model:
Hexagon socket head cap bolts: 6-M4×10

Remove the base maintenance gasket together.
The gasket has the spacers. Be careful not to lose them.

Installation (S, C models)

Install the base maintenance cover to the Manipulator.

Hexagon socket head cap bolts: 6-M4×10

Tightening Torque: 0.9 ± 0.1 N·m

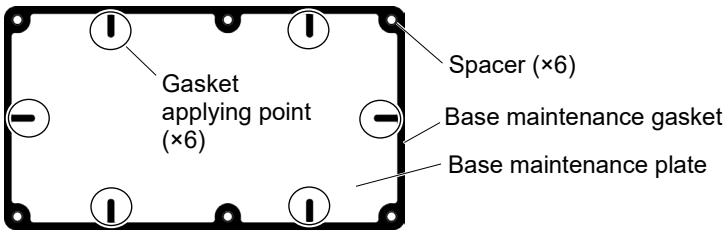
NOTE

Be careful not to get the cables caught between the cover and the Manipulator.

Installation (P model)

1. Install the spacers to the holes on the gasket. (6 places)


2. Apply the liquid gasket to the base maintenance gasket.
   Install the base maintenance gasket to the base cover.
   (See the figure for gasket applying points)



NOTE ☞ After applying the liquid gasket, leave the gasket until the liquid gasket becomes solid and the gasket is fixed.

3. Install the base maintenance cover to the Manipulator.

   Hexagon socket head cap bolts: 6-M4×10

   Tightening torque: 4.0 ± 0.2 N·m

NOTE ☞ Be careful not to get the gasket and cables caught between the cover and the Manipulator.
Replace the gasket if there are flaws or deteriorations.

3.11 Connector Plate

3.11.1 M/C Cable Backward

CAUTION	■ Do not remove the connector plate forcibly. It may result in damage to the cables, disconnection, and/or contact failure. These are 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 get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the connector plate. Be sure to place the cables back to their original locations.

C8-A701** (C8), C8-A901** (C8L)

Removal

Remove the bolts and then remove the connector plate.

Hexagon socket head cap bolts: 11-M4×10

P model:

Remove the base rear gasket together.

NOTE

The gasket has the spacers. Be careful not to lose them.

C8-A701** (C8), C8-A901** (C8L)

Installation (S, C models)

Install the connector plate to the Manipulator.

Hexagon socket head cap bolts: 11-M4×10

Tightening Torque: 4.0 ± 0.2 N·m

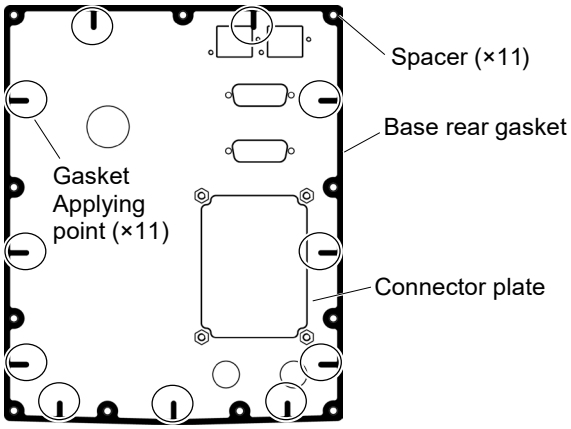
Be careful not to get the cables caught between the cover and the Manipulator.

C8-A701** (C8), C8-A901** (C8L)

Installation (P model)

1. Install the spacers to the holes on the gasket. (11 places)

2. Apply the liquid gasket to the base rear gasket. Install the base rear gasket to the connector plate. (See the figure for gasket applying points)



NOTE ☞ After applying the liquid gasket, leave the gasket until the liquid gasket becomes solid and the gasket is fixed.

3. Install the connector plate to the Manipulator.

Hexagon socket head cap bolts: 11-M4×10

Tightening torque: 4.0 ± 0.2 N·m

NOTE ☞ Be careful not to get the gasket and cables caught between the cover and the Manipulator.
Replace the gasket if there are flaws or deteriorations.

C8-A1401** (C8XL)

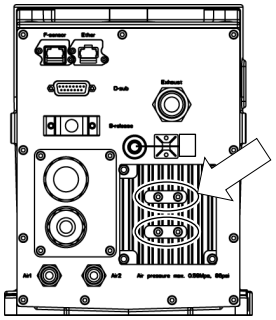
Removal

1. Remove the fan.
   For details, refer to *C8 Maintenance 15. Replacing the Fan.*

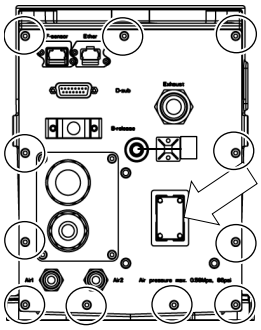
2. Remove the bolts on the heat sink

   Hexagon socket head cap bolts: 4-M4×15

3. Remove the heat sink.



NOTE For cleanroom and protection models, remove the gasket between the heat sink and the connecter plate.



4. Remove the bolts, and then remove the connecter plate. and the base rear gasket.

   Hexagon socket head cap bolts: 11-M4×10

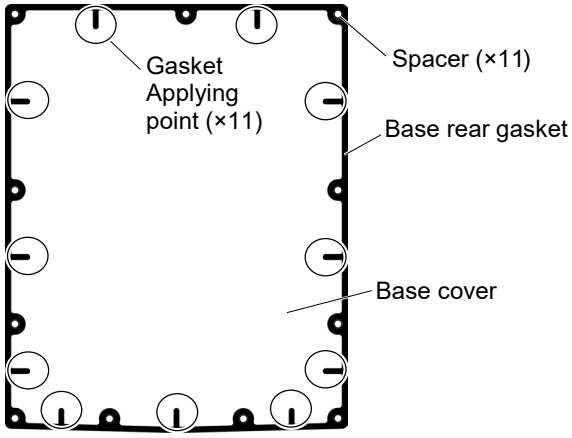
NOTE The gasket has the spacers. Be careful not to lose them.

C8-A1401** (C8XL)

Installation

1. Install the spacers to the holes on the gasket.
   (11 places)

2. Apply the liquid gasket to the base rear gasket.
   Install the base rear gasket to the base cover.
   (See the figure for gasket applying points)

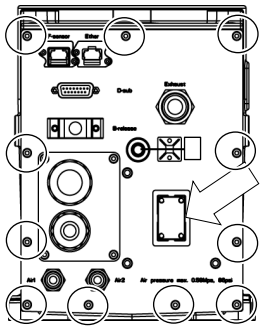


NOTE After applying the liquid gasket, leave the gasket until the liquid gasket becomes solid and the gasket is fixed.

3. Install the connecter plate to the Manipulator.

   Hexagon socket head cap bolts: 11-M4×10

   Tightening torque: 4.0 ± 0.2 N·m



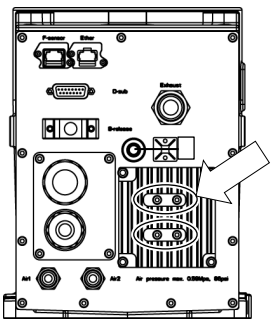
NOTE Be careful not to get the gasket and cables caught between the cover and the Manipulator.
Replace the gasket if there are flaws or deteriorations.

NOTE For cleanroom and protection models, install the gasket between the heat sink and the connector plate.

4. Install the heat sink.

   Hexagon socket head cap bolts: 4-M4×15

   Tightening torque: 4.0 ± 0.2 N·m



5. Install the fan.
   For details, refer to *C8 Maintenance 15. Replacing the Fan.*

3.11.2 M/C Cable Downward

CAUTION

- Do not remove the connector plate forcibly. It may result in damage to the cables, disconnection, and/or contact failure. These are 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 get the cables caught in it or bend them forcibly to push into the cover.
  Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system.
  When routing the cables, check the cable locations at removing the connector plate. Be sure to place the cables back to their original locations.

Removal

Remove the bolts and then remove the connector plate.

Hexagon socket head cap bolts: 8-M4×10

P model:
Remove the base bottom gasket together.

Installation

S, C models:
Install the connector plate to the Manipulator.

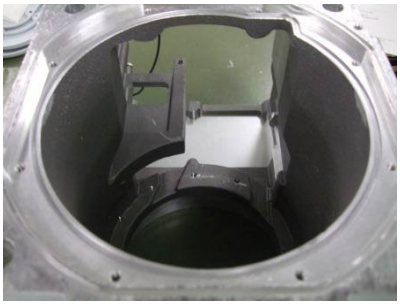
Hexagon socket head cap bolts: 8-M4×10

Tightening Torque: 4.0 ± 0.2 N·m

P model:
Install the base bottom gasket to grove on the base bottom face. Install the connector plate to the Manipulator.

Hexagon socket head cap bolts: 8-M4×10

Tightening Torque: 4.0 ± 0.2 N·m



NOTE

Be careful not to get the gasket and cables caught between the cover and the Manipulator.

Replace the gasket if there are flaws or deteriorations.

3.12 Connector Sub Plate

CAUTION

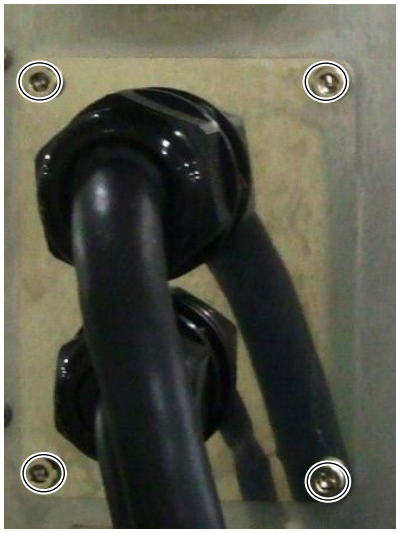
- Do not remove the connector sub plate forcibly. It may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system.
- When removing the connector sub plate, make sure to remove all connectors of the connector plate and the M/C cable. Removing only the connector sub plate may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system.
- When installing the connector sub plate, be careful not to get the cables caught in it or bend them forcibly to push into the cover.
  Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system.
  When routing the cables, check the cable locations at removing the connector sub plate. Be sure to place the cables back to their original locations.

Removal

Remove the bolts and then remove the connector sub plate.

S, C models:
Hexagon socket head cap bolts: 4-M4×10

P model:
Hexagon socket head cap bolts:
4-M4×10 (with a seal washer)



NOTE

Remove the base sub plate gasket together.
The gasket has the spacers.
Be careful not to lose the seal washers and spacers.

Installation (S, C models)

Install the connector sub plate to the Manipulator.

Hexagon socket head cap bolts: 4-M4×10

Tightening Torque: 4.0 ± 0.2 N·m

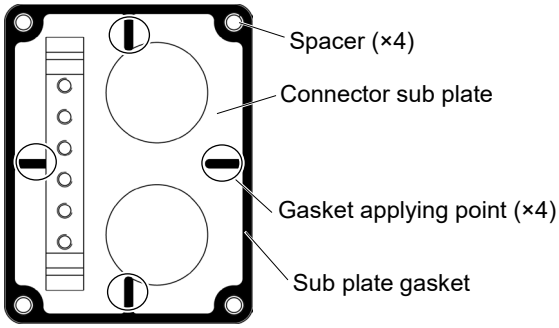
NOTE

Be careful not to get the cables caught between the cover and the Manipulator.

Installation (P model)

1. Install the spacers to the holes on the gasket. (4 places)

2. Apply the liquid gasket to the base sub plate gasket.
   Install the base sub plate gasket to the connector sub plate. (See the figure for gasket applying points)



NOTE

After applying the liquid gasket, leave the gasket until the liquid gasket becomes solid and the gasket is fixed.

3. Install the connector sub plate to the Manipulator.

   Hexagon socket head cap bolts: 4-M4×10 (with a seal washer)

   Tightening torque: 4.0 ± 0.2 N·m

NOTE

Be careful not to get the gasket and cables caught between the cover and the Manipulator.

Replace the seal washers and gasket if there are flaws or deteriorations.

4. Cable Unit

4.1 Replacing the Cable Unit

 WARNING	■ 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. ■ 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. ■ Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source. To shut off power to the robot system, disconnect the power plug from the power source. Performing any work while connecting the AC power cable to a factory power source 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 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.) Unnecessary strain on the cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. ■ 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.

CAUTION

■ When disconnecting the connectors during the replacement of the cable unit, be sure to reconnect the connectors to their proper positions.
Improper connection of the connectors may result in improper function of the robot system.
For details on the connections, refer to the *C8 Maintenance 4.2 Connector Pin Assignments.*

■ Carefully use alcohol and adhesive following respective instructions and also instructions below. Otherwise, it may cause a fire and/or safety problems.

- Never put alcohol or adhesive close to fire.
- Use alcohol or adhesive while ventilating the room.
- Wear protective gear including a mask, protective goggles, and oil-resistant gloves.
- If alcohol or adhesive gets on your skin, wash the area thoroughly with soap and water.
- If alcohol or adhesive gets into your eyes or mouth, flush your eyes or wash out your mouth with clean water thoroughly, and then see a doctor immediately.

■ Wear protective gear including a mask, protective goggles, and oil-resistant gloves during grease up. 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.

4.1.1 Replacing the Cable Unit (M/C Cable Backward)

	Name		Qty.	Note	
Maintenance Parts	Cable unit	C8-A701** (C8)	1	For standard, cleanroom models	2172929
			1	For protection model	2172932
		C8-A901** (C8L)	1	For standard, cleanroom models	2172930
			1	For protection model	2172933
		C8-A1401** (C8XL)	1	For standard, cleanroom models	2172931
			1	For protection model	2172934
	Belt tensile jig*		1	1674582	
	J1 brake positioning jig*		1	1675081	
	Wire tie	AB100	1	1675753	
		AB150	1	1675754	
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts	
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts	
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolts	
		width across flats: 5 mm	1	For M6 hexagon socket head cap bolts	
	Box wrench	width across flats: 5 mm	1	For D-Sub connector	
	Long nose pliers		1	For removing an air tube	
	Nippers		1	For cutting a wire tie	
	Cross-point screwdriver (#2)		1	For cross recessed head screws	
	Torque rench		1	For tightening torque control	
	Belt tension meter		1	Refer: Unitta U-505	

* The belt tensile jig is an assembly jig. Use this jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

When removing the Joint #2 motor, tilt the Arm #2 and press it against the Arm #1.
Reference: *C8 Maintenance: 6.1 Joint #2 - Replacing the Motor,* Removal step (2)

When removing the Joint #3 motor, tilt the Arm #2 and press it against the Arm #2.
Reference: *C8 Maintenance: 7.1 Joint #3 - Replacing the Motor,* Removal step (2)

When pressing the arm, put a piece of cloth or a similar material between the arms to avoid contacting each other. This protects the arm surfaces from scratching and paint peeling off.

Removal: Cable unit (M/C cable backward)

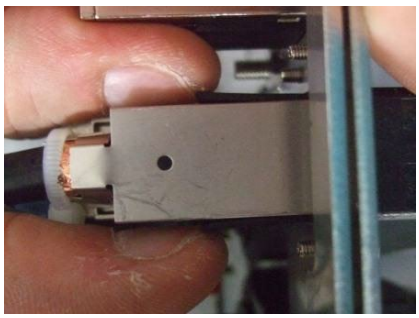
1. Move the Manipulator to the origin posture (0 pulse position).
2. Turn OFF the Controller.
3. Remove the following covers and plate.
   For details, refer to *C8 Maintenance: 3. Covers*.
   - Arm #4 side covers (both sides)
   - Arm #4 maintenance cover (C8XL only)
   - Arm #3 cover
   - Arm #3 maintenance cover
   - Arm #2 side covers (both sides)
   - Arm #1 side covers (both sides)
   - Arm #1 center cover
   - Base maintenance cover
   - Connector plate (M/C cable backward)
4. Remove the two air tubes inside the base.
5. Remove the two D-sub connectors.
6. Disconnect the cables from the base and disconnect the following connectors.

   Connectors: X11, X12, X14, BR010, BR011, X010, X020, X040, LED, GS01, BT1
   (Hold the clip to remove.)

7. Disconnect the following connectors.

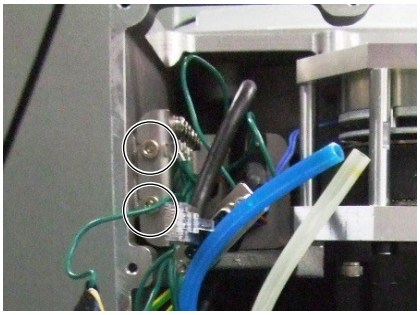
   RJ45 connector:
   Hold the clip to remove.

   F-sensor connector:
   Open the clips on the both ends of the connector and pull it out.



8. Remove the ground wire plate (M/C cable backward).

   Hexagon socket head cap bolts: 2-M4×10

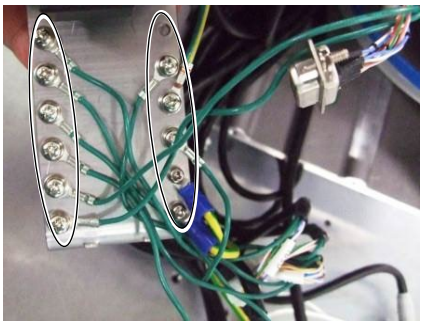


9. Remove the ground wire terminals.

   Cross recessed head screws with washer

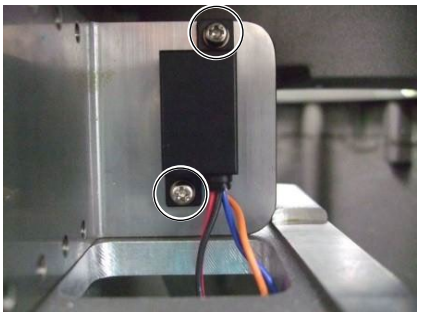
   S, C models : 9-M4×8, 2-M3×6

   P model : 10-M4×8, 2-M3×6



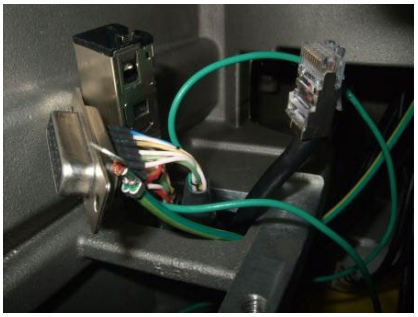
10. Remove the brake power supply.

    Cross recessed head screws with washer: 2-M3×6



11. Disconnect the following cables through the opening of the base.

    D-sub cable
    Ground wire
    RJ45 connector
    F-sensor connector

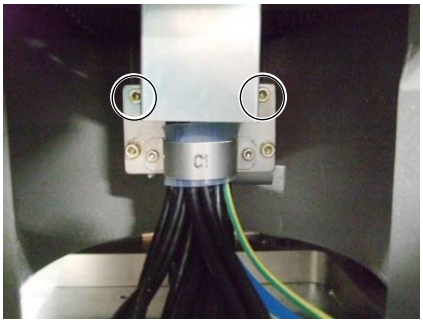


12. Remove the Joint #1 motor unit.

    For details, refer to *C8 Maintenance: 5.1.1 Joint #1 - Replacing the Motor (M/C Cable Backward,* Removal steps (6) and (7).

13. Remove the plate for preventing cable interference.

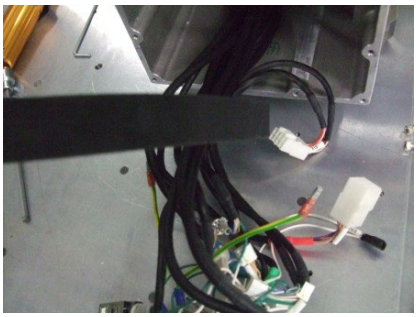
    Hexagon socket head cap bolts: 2-M3×6



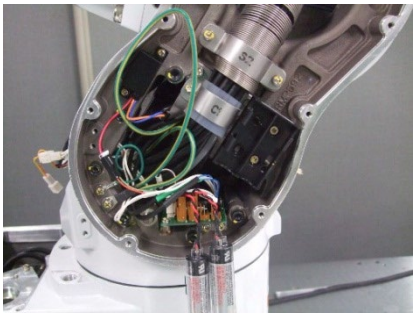
14. Remove the base cable bracket (C1) and the cable protection sheet.

    Hexagon socket head cap bolts: 2-M3×6

15. Remove the Joint #1 timing belt.

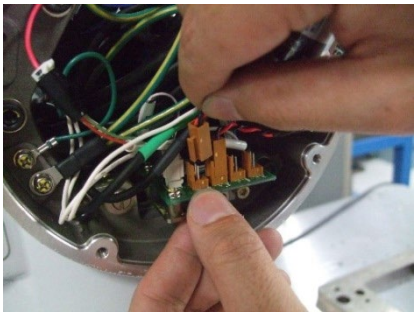


16. Remove the battery from the battery box.



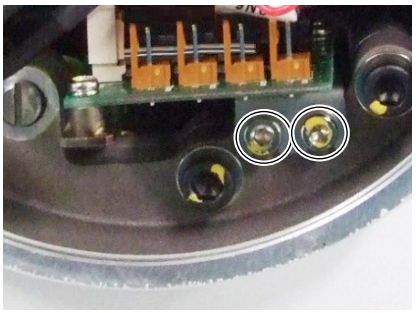
17. Disconnect the battery connector.

NOTE Hold the board by hand and pull up the battery cable to disconnect the connector.



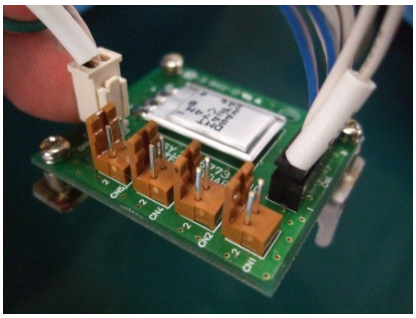
18. Remove the plate to which the battery board is fixed.

    Hexagon socket head cap bolts: 2-M4×10



19. Disconnect the battery connectors.

    Connectors: CN3, CN6



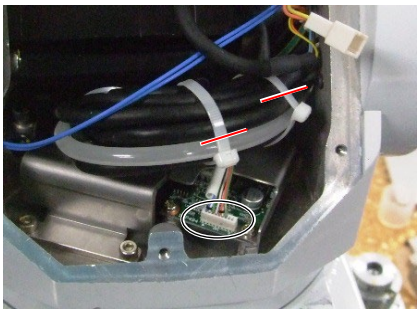
20. Remove the two ground wire terminals from the Arm #1.

    Cross recessed head screws with washer: 2-M4×8

21. Remove the Joint #2 motor unit.
    For details, refer to *C8 Maintenance: 6.1 Joint #2 - Replacing the Motor,* Removal steps (1) to (3) and (5) to (9).

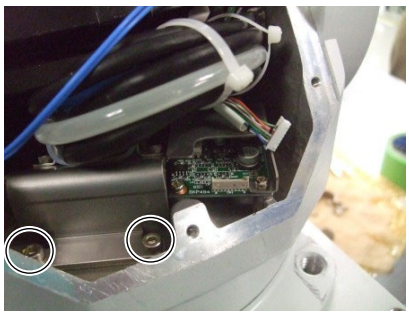
22. Cut off the wire tie that binds the cables inside the Arm #1 and remove the connector connected to the control board 1.

    Connector: GS01



23. Remove the Joint #1 cable fixing plate (Arm #1 side).

    Hexagon socket head cap bolts: 2-M4×10



24. Disconnect the internal cables from the base side to the Arm #1 side. Protect the connectors with masking tapes.

    - To protect the connector's clips

    - To avoid adherence of cable grease

NOTE

Disconnect the connectors one by one in order from the smallest connector to the largest one.

25. Remove the Arm #1 cable brackets (C1: 2 pieces) and cable protection tube.

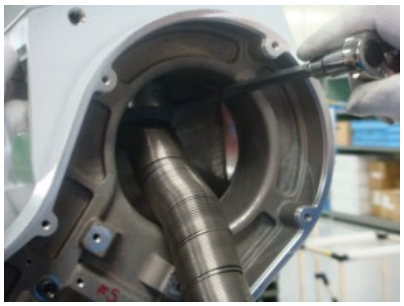
    Hexagon socket head cap bolts: 4-M3×6

26. Remove the Arm #1 cable brackets (C2 and S2: one each) and cable protection tube.

    Hexagon socket head cap bolts:　2-M3×6 (C2)
    2-M4×10 (S2)

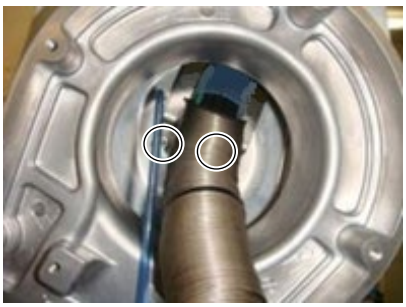
27. Remove the Arm #2 cable bracket (C2) and cable protection tube.

    Hexagon socket head cap bolts: 2-M3×6



28. Remove the Arm #2 cable fixing plate.

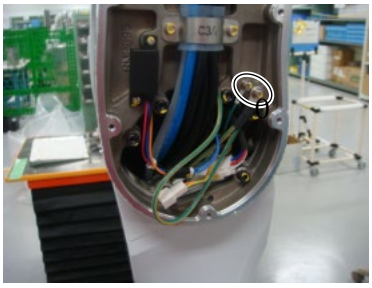
    Hexagon socket head cap bolts: 2-M4×10



29. Cut off the wire tie that binds the cable protection coils inside the Arm #2.

30. Remove the two ground wire terminals from the Arm #2.

    Cross recessed head screws with washer: 2-M4×8

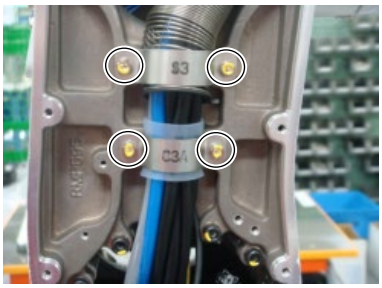


31. Remove the Joint #3 motor unit.

    For details, refer to *C8 Maintenance: 7.1 Joint #3 - Replacing the Motor,* Removal steps (1) to (3) and (5) to (8).

32. Remove the two Arm #2 cable brackets (C3A and S3).

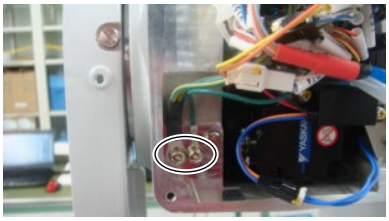
    Hexagon socket head cap bolts: 2-M4×8 (C3A)
    2-M4×8 (S3)



33. Remove the two air tubes inside the Arm #3.
    Remove the air tube fittings from the air tubes.
    The air tube fittings will be used again. Be careful not to lose them.

34. Remove the two ground wire terminals from the Arm #3.

    Cross recessed head screws with washer: 2-M4×8

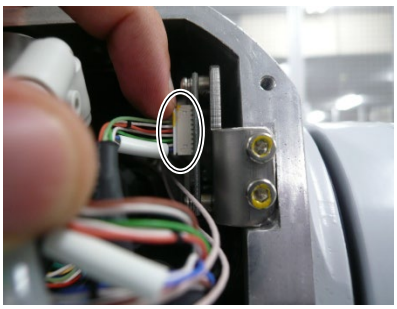


35. Disconnect the connectors inside the Arm #3.

    Connectors: X141, X151, X161, BR041, BR051, X041, X71, X72, PS, LED, BT51, BT4
    (Hold the clip to remove.)

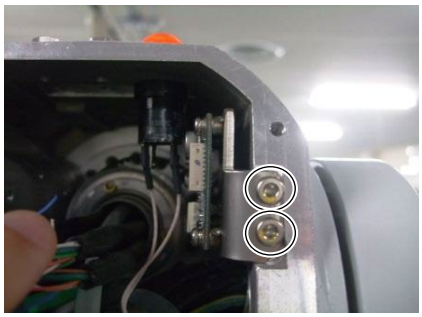
36. Remove the connector connected to the control board 2.

    Connector: GS02



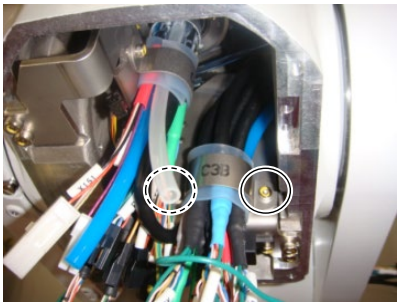
37. Remove the fixing plate of the Arm #3 control board 2.

    Hexagon socket head cap bolts: 2-M4×10



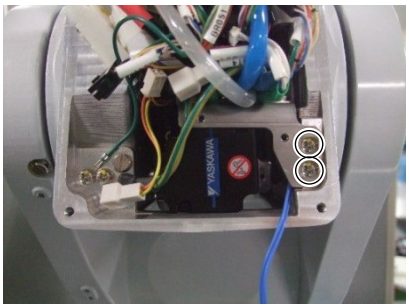
38. Remove the Arm #3 cable bracket (C3B).

    Hexagon socket head cap bolts: 2-M3×6

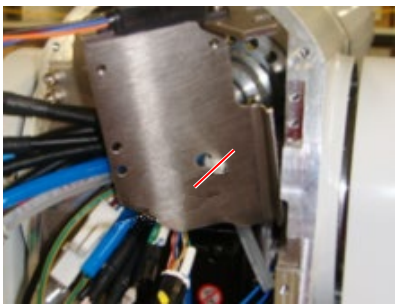


39. Remove the Arm #3 cable fixing plate 1.

    Hexagon socket head cap bolts: 2-M4×10



40. Cut off the wire tie that binds the cable protection coils inside the Arm #3.



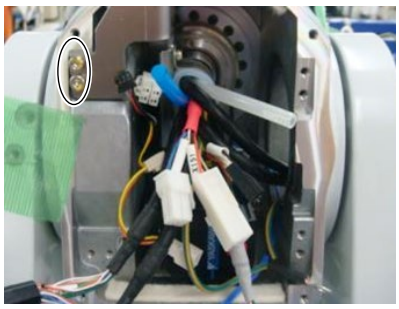
41. Disconnect the cables from the Arm #3 side to the Arm #2 side.

42. Pull out the separated cable unit (base side) from the Arm #1 side to the Arm #2 side.

    To protect the connectors and facilitate the work, first cover the connectors with a plastic bag.　Then, pass the cable unit through the arm.

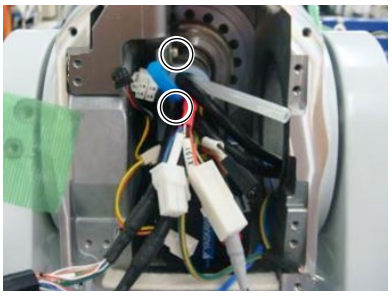
43. Remove the Arm #3 cable fixing plate 2.

    Hexagon socket head cap bolts: 2-M4×10



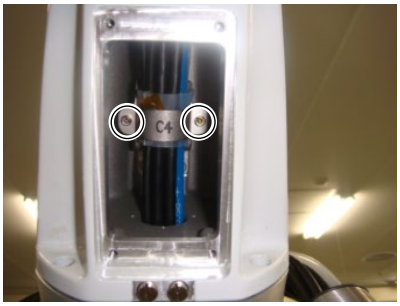
44. Remove the Arm #3 cable bracket (C4) and the cable protection sheet.

    Hexagon socket head cap bolts: 2-M3×6

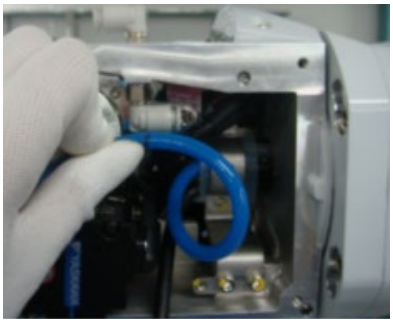


    C8XL:
    Remove the cable bracket (C4) and the cable protection sheet at the Arm #4 maintenance cover.

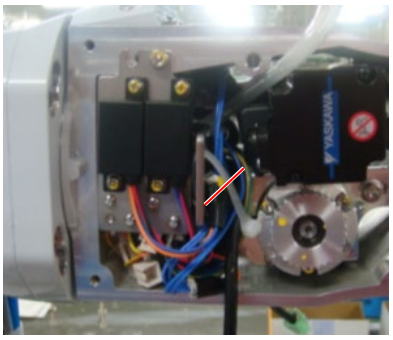
    Hexagon socket head cap bolts: 2-M3×6



45. Remove the two air tubes inside the Arm #4.

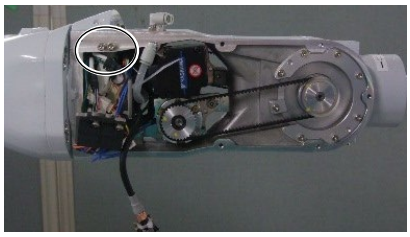


46. Cut off the wire tie that binds the cables of the Arm #4.



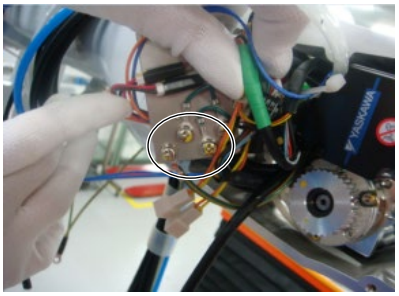
47. Loosen the bolts that fix the cable protection plate attached on the Arm #4, and disconnect the cables.

    Hexagon socket head cap bolts: 2-M4×10



48. Remove the ground wire terminals from the cable protection plate.

    Cross recessed head screws with washer: 4-M4×8



49. Remove the Joints #5 and #6 motor units.
    For details, refer to *C8 Maintenance: 9.1 Joint #5 - Replacing the Motor*, Removal steps (4) to (8), and *C8 Maintenance: 10.1 Joint #6 - Replacing the Motor,* Removal steps (4) to (7).

    The air tube fittings removed together with the Joint #5 motor unit will be used again.
    Be careful not to lose them.

50. Remove the Arm #4 D-sub attachment.

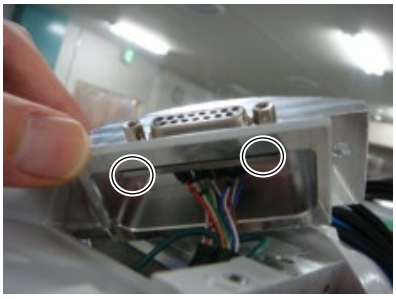
    Hexagon socket head cap bolts: 2-M4×10

    For details, refer to *C8 Maintenance: 3. Covers*.

51. Remove the following parts from the Arm #4 D-sub attachment.

    S, C models:
    D-sub connector
    D-sub connector fixing plate

    P model:
    D-sub connector



52. Remove the Arm #4 cable fixing plate.

    Hexagon socket head cap bolts: 2-M4×10

53. Remove the cable bracket (C4).

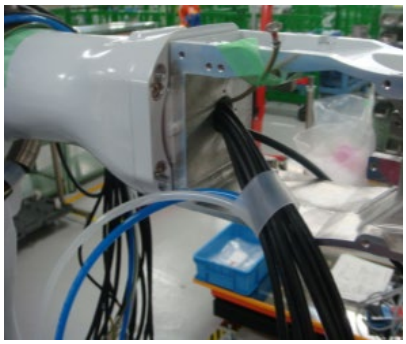
    Hexagon socket head cap bolts: 2-M3×6

54. Disconnect the following cables that have no relays from the Arm #4 side to the Arm #3 side.

    Ethernet cable

    X052/X062 cable

    Ground wire (green/yellow)



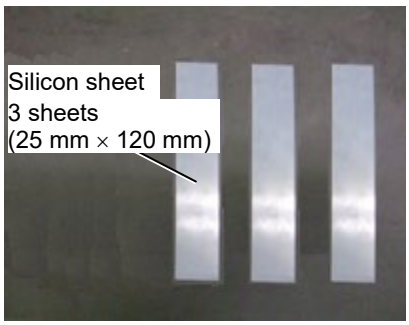
Installation: Cable unit (M/C cable backward)

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

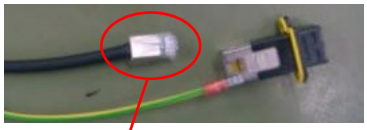
1. Check if the cable unit contains the following parts.

   Silicone sheet: 3 sheets (25 mm × 120 mm)

   F-sensor connector housing 2 pieces



2. Remove the Ethernet cable from the connector.
   Protect the cable ends with masking tapes to prevent the clip from damage.



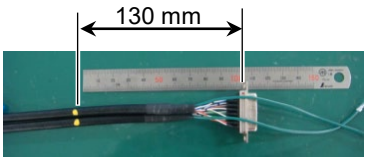
3. Remove the locking screws and nuts of the D-sub connector.

   The screws and nuts will be used again for fixing the connector.
   Be careful not to lose them.

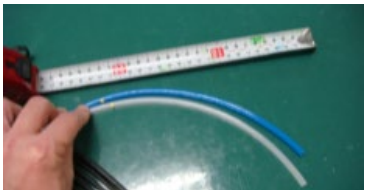
4. Disconnect the following connectors to separate the cables.

   Connectors:
   X051, X061, X151, X161, XGND, BR051, BR061, BT51, BT61, X71, X72, SW1

5. Place a mark at the fixing position of each cable you are going to pass through the Arm #4.



D-sub	: 130 mm from the connector end
Other cables	: 190 mm from the connector end
Air tube	: 210 mm from the end



6. Pass the separated cable unit (base side) from the Arm #2 to the Arm #1.

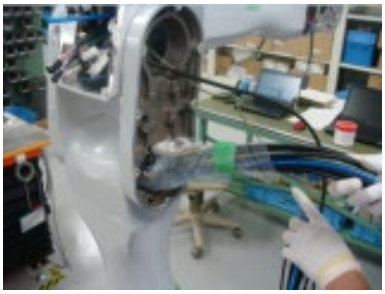
To protect the connectors and facilitate the work, first cover the connectors with a plastic bag. Then, pass the cable unit through the arm.

Pass the following cables that have no relays through the arm to the Arm #3 side.

Ethernet cable

X052/X062 cable

Ground wire (green/yellow)



Leave out the other connector cables for a certain length, as shown in the photo, in order to store them in the Arm #3.

7. Pass the Ethernet cable, X052/X062 cable, and ground wire (green/yellow) from the Arm #3 side to the Arm #4 side.

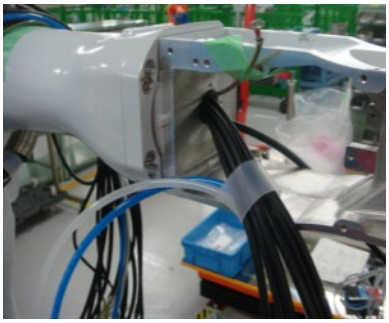
   C8/C8L:
   Pass the cables one by one through the arm from the Arm #3 side.

   C8XL:
   First pass the braid tube from the Arm #4 side to the Arm #3 side. Insert the connectors through the braid tube, as shown in the photo, and fix the tube with the wire tie so that connectors are not to be pulled out. Then, pull the braid tube from the Arm #4 side while pushing the cables from the Arm #3 side to pass the cables through.
   (See the photo.)

8. Pass the separated cable unit (Arm #4 side) from the Arm #4 to the Arm #3.

   C8/C8L:
   No silicone tube is provided.

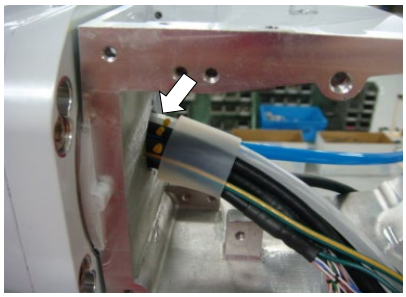
   C8XL:
   Silicone tube is provided. Leave out the silicone tube on the Arm #4 side.
   Pass the following cables through the silicone tube: Ethernet cable, X052/X062 cable, and ground wire (green/yellow) that have been passed from the Arm #3 side.



NOTE

As shown in the photo, disconnect the Ethernet cable and air tube (blue) at one side of the Arm #4.
Disconnect the remaining cables at the other side.

Align the marked positions and the position on the Arm #4 indicated with the arrow in the photo.



9. Install the cable fixing plate to the Arm #4.

   Hexagon socket head cap bolts: 2-M4×10

   Tightening torque: 4.0 ± 0.2 N·m

10. Use a cable bracket (C4) to fix the cables.

    Hexagon socket head cap bolts: 2-M3×6

    Tightening torque: 2.4 ± 0.1 N·m

C8/C8L:
Wrap the cables with the attached silicone sheet.
Use a cable bracket to fix the wrapped silicone sheet.

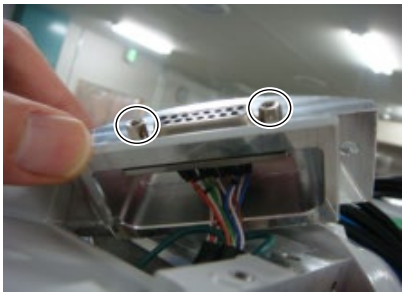
C8XL:
Place the silicone tube to the position where it is fixed with a cable bracket.
Use a cable bracket to fix the silicone tube.

11. Install the D-sub connector to the D-sub attachment of the Arm #4.

S, C models:

A D-sub connector fixing plate is provided.

Hold the D-sub connector between the D-sub attachment of the Arm #4 and the D sub connector fixing plate, and fix them with the locking screws removed in step 3 above. (The nuts and washers are not used.)



P model:

No D-sub connector fixing plate is provided.

The D-sub connector has screw holes.
Fix the D-sub connector using the locking screws removed in step 3 above.

12. Install the D-sub attachment to the Arm #4.

Hexagon socket head cap bolts: 2-M4×10

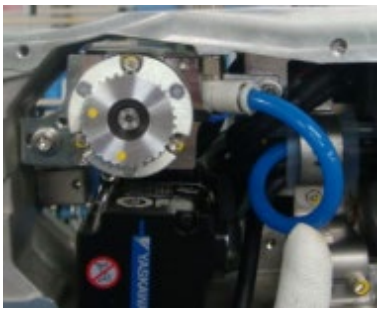
Tightening torque: 4.0 ± 0.2 N·m

NOTE

Do not to let the cables caught in the attachment.

For details, refer to *C8 Maintenance: 3. Covers*.

13. Install the motors for the Joints #5 and #6.
Connect the cables and air tube and store them inside.



Upper photo: Joint #5 motor side
Place the Ethernet cable and the air tube (blue) on the near side.

Lower photo: Joint #6 motor side
Place the other cables and the air tube (clear) on the front side.

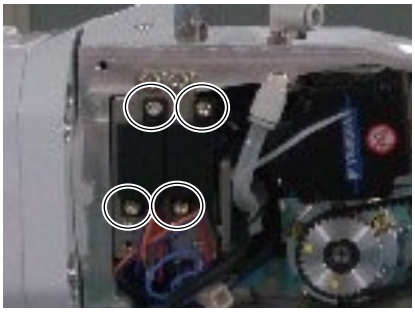
Fix the cables by binding them with a wire tie (INSULOC AB150 or equivalent) inserted through the hole of the cable fixing plate so that the cables do not interfere with the Joint #6 motor pulley.

Pay attention so that no connector is installed incorrectly and no cable is caught between components.

For details, refer to *C8 Maintenance: 9.1 Joint #5 - Replacing the Motor,* Installation steps (4) to (8), and *C8 Maintenance: 10.1 Joint #6 - Replacing the Motor,* Installation steps (4) and (7).

NOTE
Use the air tube fittings removed in the cable removal steps again.

14. Mount the brake power supply to the plate.
Mount the power so that the cables are directed down.

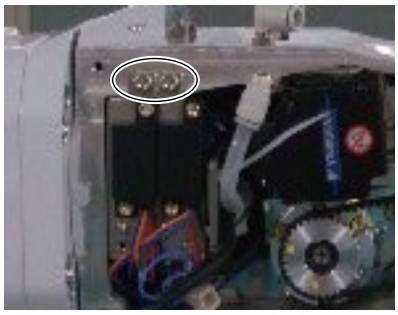


Cross recessed head screws with washer: 4-M3×6

Tightening torque: 0.45 ± 0.1 N·m

Installation locations:
Brake power supply for Joint #5: right side
Brake power supply for Joint #6: left side

15. Fix the cable protection plate to the Arm #4.



Hexagon socket head cap bolts: 2-M4×10

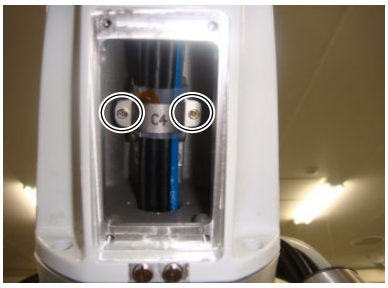
Tightening torque: 4.0 ± 0.2 N·m

NOTE
Be careful not to get the cables caught.
It may cause cable breakage.

16. C8XL:
    Fix the cables to the Arm #4 maintenance cover using a cable bracket (C4).

    Wrap the cables with the attached silicone sheet.
    Use a cable bracket to fix the wrapped silicone sheet.

    Hexagon socket head cap bolts: 2-M3×6
    Tightening torque: 2.4 ± 0.1 N·m

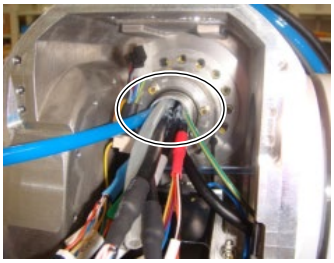


17. Apply grease to the cables in the sleeve.

    Grease: Krytox
    Amount: C8/C8XL approximately 3g
    C8L: approximately 6g

    Divide the above grease into halves and apply each half from the Arm #4 side and the Arm #3 side respectively.

    Pay attention so that the grease does not get into the cable fixing area in the Arm #3 and connectors.

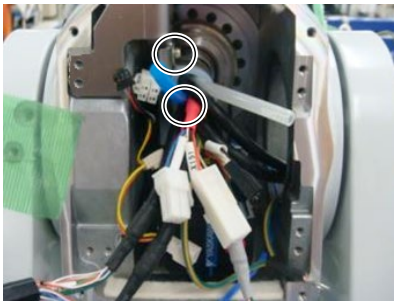


18. Use a cable bracket (C4) to fix the cables to the Arm #3 cable fixing plate 2.

    Wrap the cables with the attached silicone sheet.
    Use a cable bracket to fix the wrapped silicone sheet.

    Hexagon socket head cap bolts: 2-M3×6

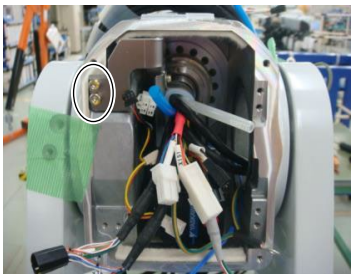
    Tightening torque: 2.4 ± 0.1 N·m



19. Install the Arm #3 cable fixing plate 2 to the Arm #3.

    Hexagon socket head cap bolts: 2-M4×10

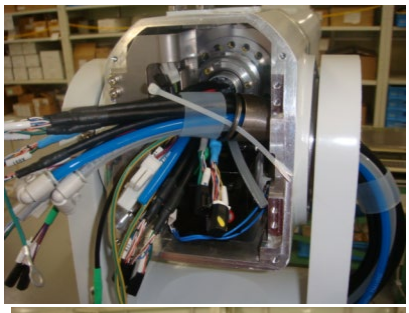
    Tightening torque: 4.0 ± 0.2 N·m

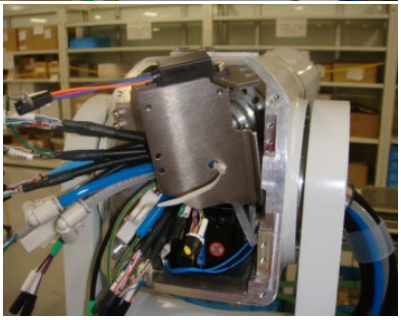


20. Use the cable protection spring to bind cables at the Arm #3 cable fixing plate 1.

    Type of wire tie: AB100

    Number of wire ties: 4

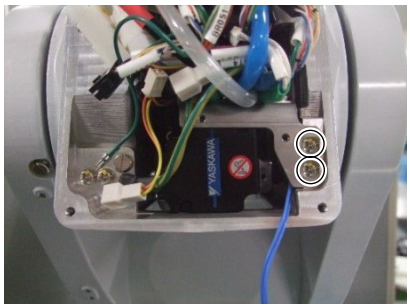




21. Install the Arm #3 cable fixing plate 1 to the Arm #3.

    Hexagon socket head cap bolts: 2-M4×10

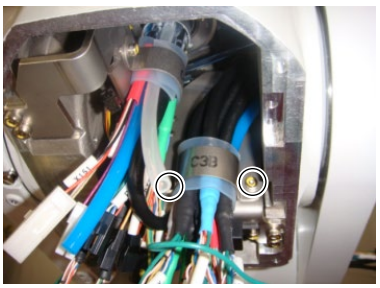
    Tightening torque: 4.0 ± 0.2 N·m



22. Use a cable bracket (C3B) to fix the cables.
    Place the two air tubes at the bottom part of the cables.
    Place the silicone tube to the position where it is fixed with a cable bracket.
    Use a cable bracket to fix the silicone tube.

    Hexagon socket head cap bolts: 2-M3×6

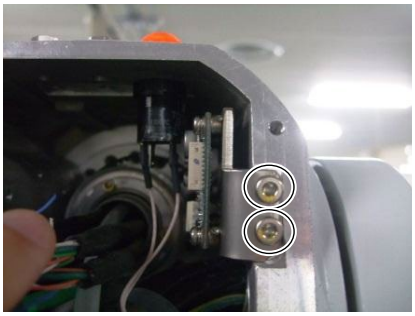
    Tightening torque: 2.4 ± 0.1 N·m



23. Install the control board 2 fixing plate to the Arm #3.

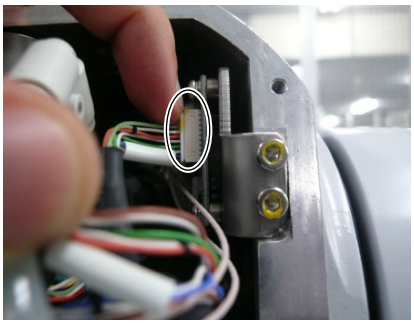
    Hexagon socket head cap bolts: 2-M4×10

    Tightening torque: 4.0 ± 0.2 N·m



24. Connect the connector to the control board 2.

    Connector: GS02



25. Connect the cable connectors inside the Arm #3.

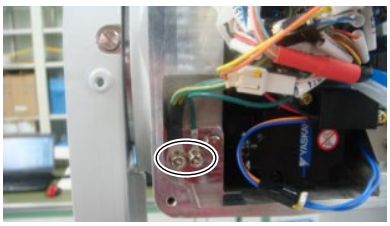
    Connectors: X141, X151, X161, BR041, BR051, X041, X71, X72, PS, LED, BT51, BT4
    (Hold the clip to remove.)

26. Install the two ground wire terminals to the Arm #3.

    Green/yellow: Left side Green: Right side

    Cross recessed head screws with washer: 2-M4×8

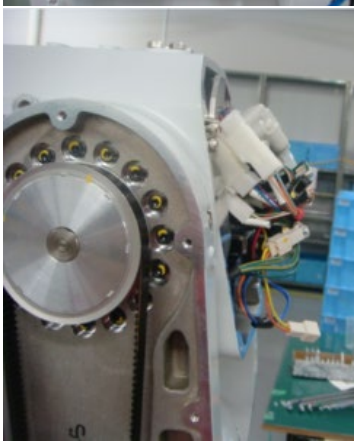
    Tightening torque: 0.9 ± 0.1 N·m



27. Use air tube fittings (elbows) to connect air tubes of the same color.

    Remove the air tube fittings from the old cables to use them again.

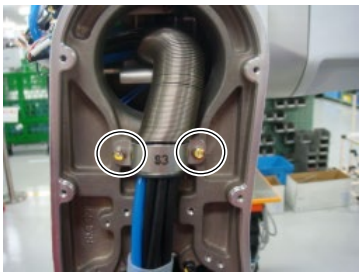
    Adjust the connector protrusion so that the cover can be installed.



28. Use brackets (S3) to fix the cable protection spring to the Arm #2.

    Hexagon socket head cap bolts: 2-M4×8

    Tightening torque: 4.0 ± 0.2 N·m

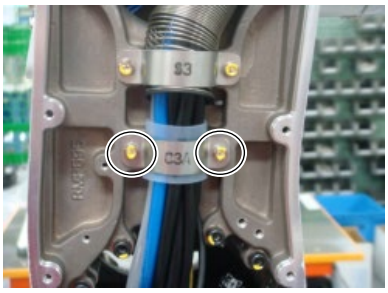


29. Use cable brackets (C3A) to fix the cables to the Arm #2 temporarily.

    Place the silicone tube to the position where it is fixed with a cable bracket.
    Use a cable bracket to fix the silicone tube temporarily.

    Hexagon socket head cap bolts: 2-M4×8

    Rough guide of temporary fixing:
    The cables can be pushed up even after fixing the cables.

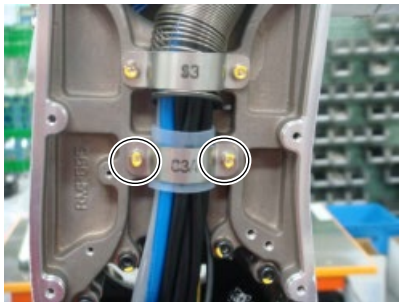


30. Push up the whole cables by 10 mm to the direction indicated with the arrow in the photo to allow for some space.

31. Fix the cables to the Arm #2 by fixing the cable brackets (C3A).
    Check that the silicone tube is not shifted away from the fixed position.

    Hexagon socket head cap bolts: 2-M4×8

    Tightening torque: 4.0 ± 0.2 N·m



32. Install the Joint #3 motor unit.
    For details, refer to *C8 Maintenance: 7.1 Joint #3 - Replacing the Motor,* Installation steps (4) and (8).

33. Fix the two ground wire terminals to the Arm #2.

    Green: Right side Green/yellow: Left side

    Cross recessed head screws with washer: 2-M4×8

    Tightening torque: 0.9 ± 0.1 N·m

34. Use the cable protection spring to bind cables at the Arm #2 cable fixing plate.

    Type of wire tie: AB100

    Number of wire ties: 4

    Be careful of the orientation of the Arm #2 cable fixing plate.
    The side with two U-shaped grooves should be placed down.

35. Use cable brackets (C2) to fix the cables to the Arm #2 cable fixing plate temporarily.

    Place the silicone tube to the position where it is fixed with a cable bracket.
    Use a cable bracket to fix the silicone tube temporarily.

    Hexagon socket head cap bolts: 2-M3×6

    Rough guide of temporary fixing:
    The cables can be pushed up even after fixing the cables.

36. Install the Arm #2 cable fixing plate to the Arm #2.
    After fitting the two U-shaped grooves to the fixing bolts, tighten the bolts.

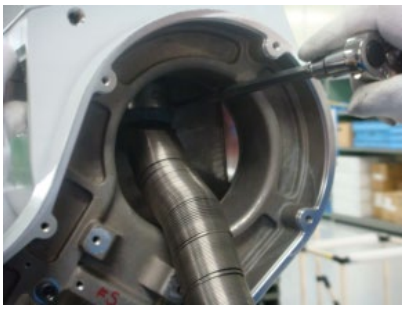
    Hexagon socket head cap bolts: 2-M4×10

    Tightening torque: 4.0 ± 0.2 N·m

37. Fix the cables to the Arm #2 cable fixing plate.
    Check that the silicone tube is not shifted away from the fixed position.

    Hexagon socket head cap bolts: 2-M3×6

    Tightening torque: 2.4 ± 0.1 N·m



38. Use brackets (S2) to fix the cable protection spring to the Arm #1.

    Hexagon socket head cap bolts: 2-M4×8

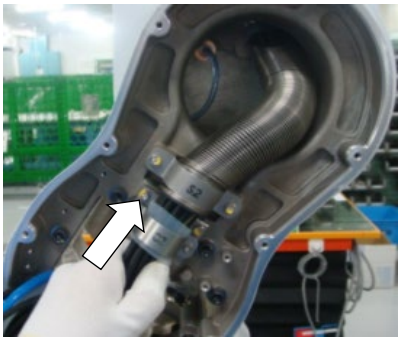
    Tightening torque: 4.0 ± 0.2 N·m

39. Use cable brackets (C2) to fix the cables to the Arm #2 temporarily.
    Place the silicone tube to the position where it is fixed with a cable bracket.
    Use a cable bracket to fix the silicone tube temporarily.

    Hexagon socket head cap bolts: 2-M3×6

    Rough guide of temporary fixing:
    The cables can be pushed up even after fixing the cables.

40. Push up the whole cables by 10 mm to the direction indicated with the arrow in the photo to allow for some space.



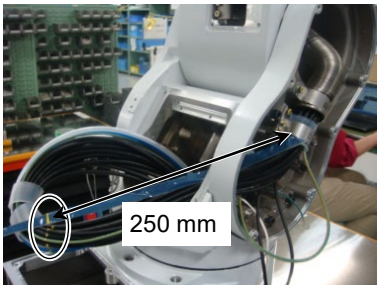
41. Fix the cables to the Arm #1.

    Check that the silicone tube is not shifted away from the fixed position.

    Hexagon socket head cap bolts: 2-M3×6

    Tightening torque: 2.4 ± 0.1 N·m

42. Place a mark at a position 250 mm from the cable bracket (C2).



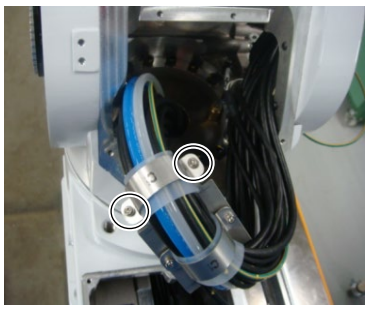
43. For the GS01 cable to be installed on the control board 1, place a mark at a position 130 mm from the connector.

44. For the X021, X121, BR021, and CN3 cables, place a mark at a position 160 mm from the connector respectively.

45. Use cable brackets (C1) to fix the cables to the Arm #1 cable fixing plate temporarily (2 positions).
Temporarily fix the silicone tube by aligning its end to the mark.

Hexagon socket head cap bolts: 4-M3×6

Rough guide of temporary fixing:
The cables can be pushed up even after fixing the cables.



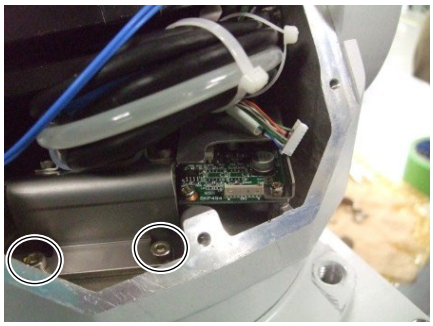
46. Fix the Arm #1 cable fixing plate temporarily to the Arm #1 and finely adjust the cable length.

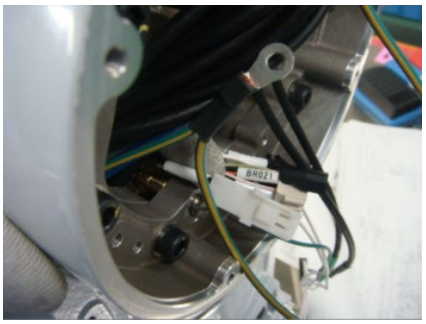
    Hexagon socket head cap bolts: 2-M4×10

    Rough guide of temporary fixing: The plate should not move.

    Notes for fine adjustment:

    - No excess looseness or tension on the cables.
      The cables should not be pressed strongly against the arm edge.
    - The X021, X121, BR021, and CN3 connectors should reach the end face of the Arm #1 when they are pulled out.
      The cables should not be too long.



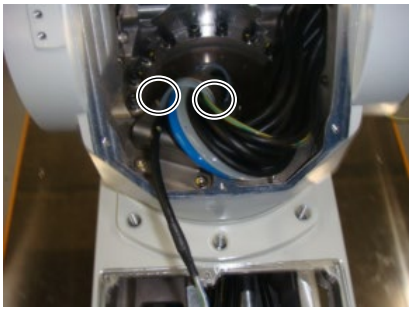


47. Place a mark on the cables at the sleeve outlet on the base side.

48. Fix the cable bracket (C1)-A on the near side so that the cable positions do not change.

    Hexagon socket head cap bolts: 2-M3×6

    Tightening torque: 2.4 ± 0.1 N·m



49. Remove the Arm #1 cable fixing plate fixed temporarily, and fix another cable bracket (C1)-B.

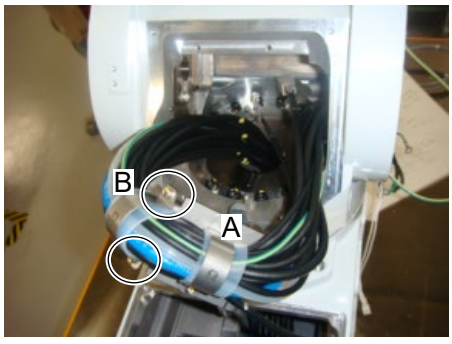
    Removing Arm #1 cable fixing plate:

    Hexagon socket head cap bolts: 2-M4×10

    Fixing cable bracket (C1)-B:

    Hexagon socket head cap bolts: 2-M3×6

    Tightening torque: 2.4 ± 0.1 N·m



50. Apply grease to the cables inside the J1 sleeve.

    Grease: Krytox

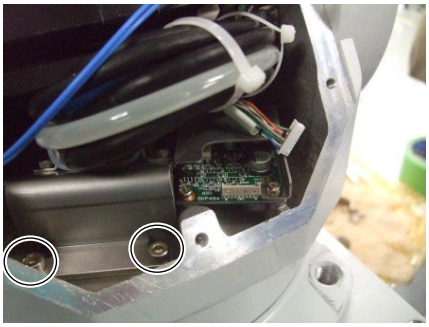
    Amount: Approximately 7.5g

    Application position:
    Between fixing section of the bracket (C1) and the mark on the base side

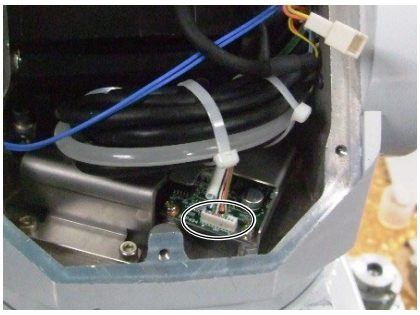
51. Fix the Arm #1 cable fixing plate to the Arm #1.

    Hexagon socket head cap bolts: 2-M4×10

    Tightening torque: 4.0 ± 0.2 N·m



52. Install the connector GS01 to the control board 1.



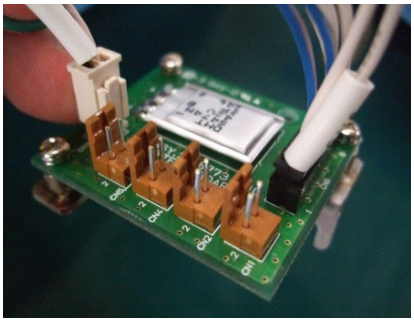
53. Install the Joint #2 motor and connect the connector.
    For details, refer to *C8 Maintenance: 6.1 Joint #2 - Replacing the Motor,* Installation steps (4) and (9).

54. Fix the two ground wire terminals to the Arm #2.

    Green: Right side Green/yellow: Left side

55. Connect the battery connectors.

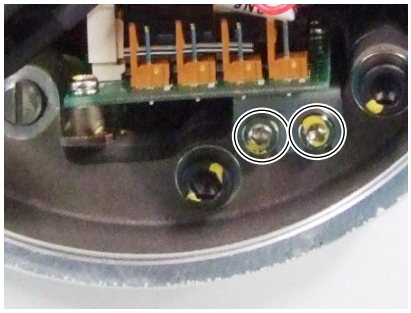
    Connectors: CN3, CN6



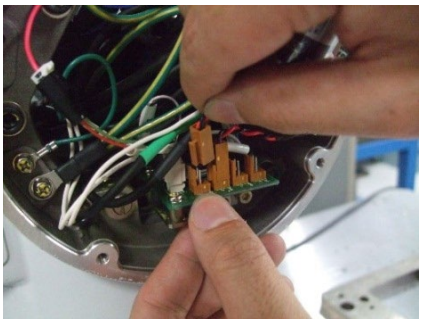
56. Install the battery board fixing plate.

    Hexagon socket head cap bolts: 2-M4×10

    Tightening torque: 4.0 ± 0.2 N·m



57. Connect the battery connectors.



58. Install the battery to the battery box.

59. Pass the Joint #1 timing belt through the cable.

60. Use cable brackets (C1) to fix the cables to the base cable fixing plate.

    Wrap the cables with the attached silicone sheet.
    Use a cable bracket to fix the wrapped silicone sheet.

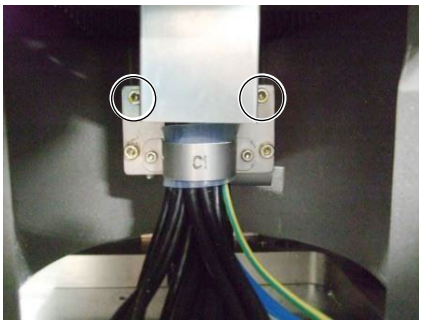
    Hexagon socket head cap bolts: 2-M3×6

    Tightening torque: 2.0 ± 0.1 N·m

61. Install the plate for preventing cable interference.

    Hexagon socket head cap bolts: 2-M3×6

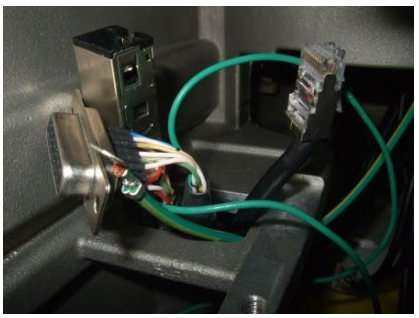
    Tightening torque: 2.0 ± 0.1 N·m



62. Install the Joint #1 motor unit.
For details, refer to *C8 Maintenance: 5.1.1 Joint #1 - Replacing the Motor (M/C Cable Backward),* Installation steps (1) to (4).

63. Push out the following cables upward through the opening of the base.

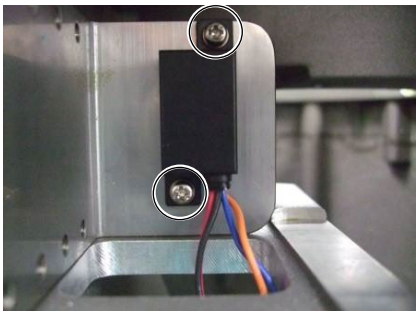
D-sub cable
Ground wire
RJ45 connector
F-sensor connector



64. Install the brake power supply to the plate.
The cables should be located in the direction as shown in the photo. (See the photo.)

Cross recessed head screws with washer: 2-M3×6

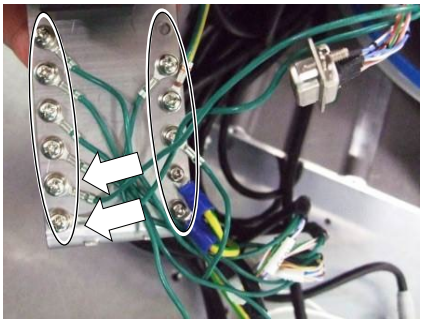
Tightening torque: 0.45 ± 0.1 N·m



65. Install the ground wire terminals to the plate.

Cross recessed head screws with washer

S, C models	:9-M4×8, 2-M3×6
P model	:10-M4×8, 2-M3×6
Tightening torque	:0.9 ± 0.1 N·m (M4×8) 0.45 ± 0.1 N·m (M3×6)

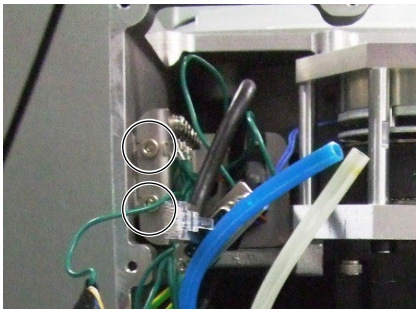


NOTE The installation positions of the D-sub cable ground terminals are predetermined. Make sure to install them to the two screw holes on the backside of the Manipulator (indicated with arrows in the photo).

66. Install the ground wire plate (M/C cable backward).

Hexagon socket head cap bolts: 2-M4×10

Tightening torque: 4.0 ± 0.2 N·m



67. Install the following connectors according to the marks on the connector plate.

RJ45 connector: Ether
F-sensor connector: F-sensor

68. Connect the M/C cable connectors.

    Connectors: X11, X12, X14, BR010, BR011, X010, X020, X040, LED, GS01, BT1

69. Install the D-sub connectors according to the marks on the connector plate.

    Left: D-sub connector for brake release (with a wire marker: SW1): B-release

    Right: D-sub connector for user wiring (without a wire marker: With round terminal): D-sub

70. Install the two air tubes according to the marks on the connector plate.

    Air1: Clear
    Air2: Blue

NOTE

Install the air tube with the correct color.

71. Install the covers and plate indicated below.

Arm #4 side covers (both sides)	Arm #4 maintenance cover (C8XL only)
Arm #3 cover	Arm #3 maintenance cover
Arm #2 side covers (both sides)	Arm #1 side covers (both sides)
Arm #1 center cover	Base maintenance cover
Connector plate (M/C cable backward)	

    For details, refer to *C8 Maintenance: 3. Covers*.

72. Perform calibration.

    For details, refer to *C8 Maintenance: 16. Calibration*.

4.1.2 Replacing the Cable Unit (M/C Cable Downward)

	Name		Qty.	Note	
Maintenance Parts	Cable unit	C8-A701*B* (C8)	1	For standard, cleanroom models	2172929
			1	For protection model	2172932
		C8-A901*B* (C8L)	1	For standard, cleanroom models	2172930
			1	For protection model	2172933
		C8-A1401*B* (C8XL)	1	For standard, cleanroom models	2172931
			1	For protection model	2172934
	Belt tensile jig*		1	1674582	
	J1 brake positioning jig*		1	1675081	
	Wire tie	AB100	1	1675753	
		AB150	1	1675754	
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts	
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts	
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolts	
		width across flats: 5 mm	1	For M6 hexagon socket head cap bolts	
	Box wrench	width across flats: 5 mm	1	For D-Sub connector	
	Long nose pliers		1	For removing an air tube	
	Nippers		1	For cutting a wire tie	
	Cross-point screwdriver (#2)		1	For cross recessed head screws	
	Torque rench		1	For tightening torque control	
	Belt tension meter		1	Refer: Unitta U-505	

* The belt tensile jig is an assembly jig. Use this jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

When removing the Joint #2 motor, tilt the Arm #2 and press it against the Arm #1.
Reference: *C8 Maintenance: 6.1 Joint #2 - Replacing the Motor,* Removal step (2)

When removing the Joint #3 motor, tilt the Arm #3 and press it against the Arm #2.
Reference: *C8 Maintenance: 7.1 Joint #3 - Replacing the Motor,* Removal step (2)

When pressing the arm, put a piece of cloth or a similar material between the arms to avoid contacting each other. This protects the arm surfaces from scratching and paint peeling off.

Removal: Cable unit (M/C cable downward)

1. Move the Manipulator to the origin posture (0 pulse position).
2. Turn OFF the Controller.
3. Turn the Manipulator laterally.

CAUTION	■ When turning the Manipulator laterally, there must be two or more people to work on it so that at least one of them can support the arm while the others are removing the bolts. Removing the bolts without supporting the arm may result in the arm falling, bodily injury, and/or malfunction of the robot system.

4. Remove the covers and plate indicated below.

Arm #4 side covers (both sides)	Arm #4 maintenance cover (C8XL only)
Arm #3 cover	Arm #3 maintenance cover
Arm #2 side covers (both sides)	Arm #1 side covers (both sides)
Arm #1 center cover	Base cover (M/C cable downward)
Base maintenance cover	Connector plate (M/C cable downward)

   For details, refer to *C8 Maintenance: 3. Covers*.

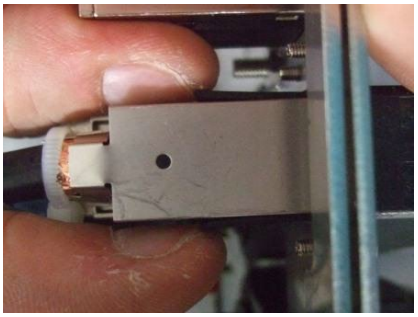
5. Remove the two air tubes in the base.
6. Remove the two D-sub connectors.
7. Disconnect the cable from the base and disconnect the following connectors.

   Connectors: X11, X12, X14, BR010, BR011, X010, X020, X040, LED, GS01, BT1
   (Hold the clip to remove.)

8. Disconnect the following connectors.

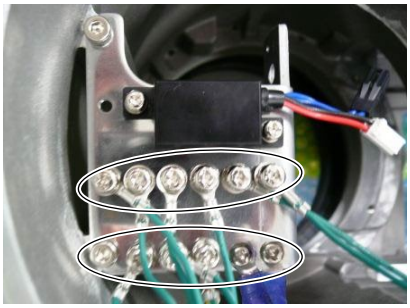
   RJ45 connector:
   Hold the clip to remove.

   F-sensor connector:
   Open the clips on the both ends of the connector and pull it out.



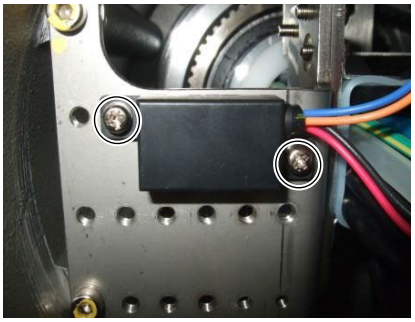
9. Remove the ground wire terminals.

   Cross recessed head screws with washer
   S, C models: : 9-M4×8, 2-M3×6
   P model : 10-M4×8, 2-M3×6



10. Remove the brake power supply.

    Cross recessed head screws with washer: 2-M3×6



11. The subsequent steps are the same as those for the M/C cable (backward).

    For details, refer to *C8 Maintenance: 4.1.1 Replacing the Cable Unit (M/C Cable Backward),* Removal steps (13) to (54).

Installation: Cable unit (M/C cable downward)

1. Perform the installation steps (1) to (62) of
   C8 Maintenance: 4.1.1 Replacing the Cable Unit (M/C Cable Backward).

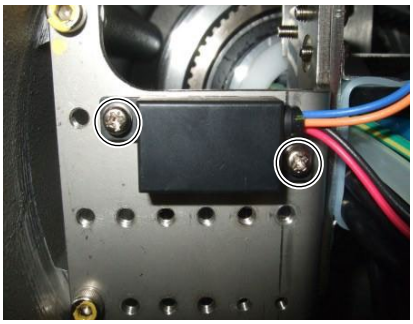
2. Turn the Manipulator laterally.

CAUTION	■ When turning the Manipulator laterally, there must be two or more people to work on it so that at least one of them can support the arm while the others are removing the bolts. Removing the bolts without supporting the arm may result in the arm falling, bodily injury, and/or malfunction of the robot system.

3. Install the brake power supply to the plate.
   The cables should be located in the direction as shown in the photo.
   (See the photo.)

   Cross recessed head screws with washer: 2-M3×6

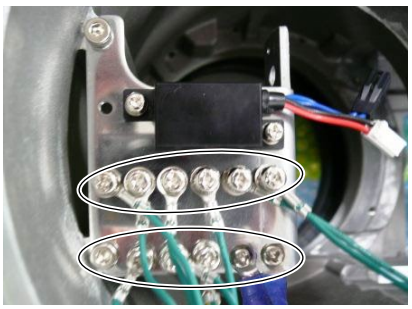
   Tightening torque: 0.45 ± 0.1 N·m



4. Install the ground wire terminals to the plate.

   Cross recessed head screws with washer

   S, C models: : 9-M4×8, 2-M3×6
   P model : 10-M4×8, 2-M3×6
   Tightening torque : 0.9 ± 0.1 N·m (M4×8)
   0.45 ± 0.1 N·m (M3×6)



5. Install the following connectors according to the marks on the connector plate.

   RJ45 connector: Ether
   F-sensor connector: F-sensor

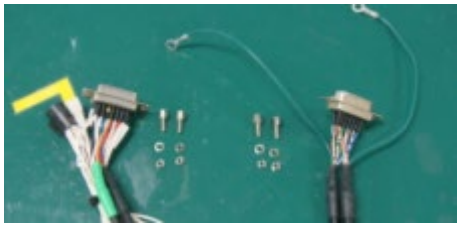
6. Connect the M/C cable connectors.

   Connectors: X11, X12, X14, BR010, BR011, X010, X020, X040, LED, GS01, BT1

7. Install the D-sub connectors according to the marks on the connector plate.

   Left: D-sub connector for brake release (with a wire marker: SW1): B-release

   Right: D-sub connector for user wiring (without a wire marker: With round terminal): D-sub



8. Install the two air tubes according to the marks on the connector plate.

   Air1: Clear
   Air2: Blue

NOTE

Install the air tube with the correct color.

9. Install the following covers and plate.

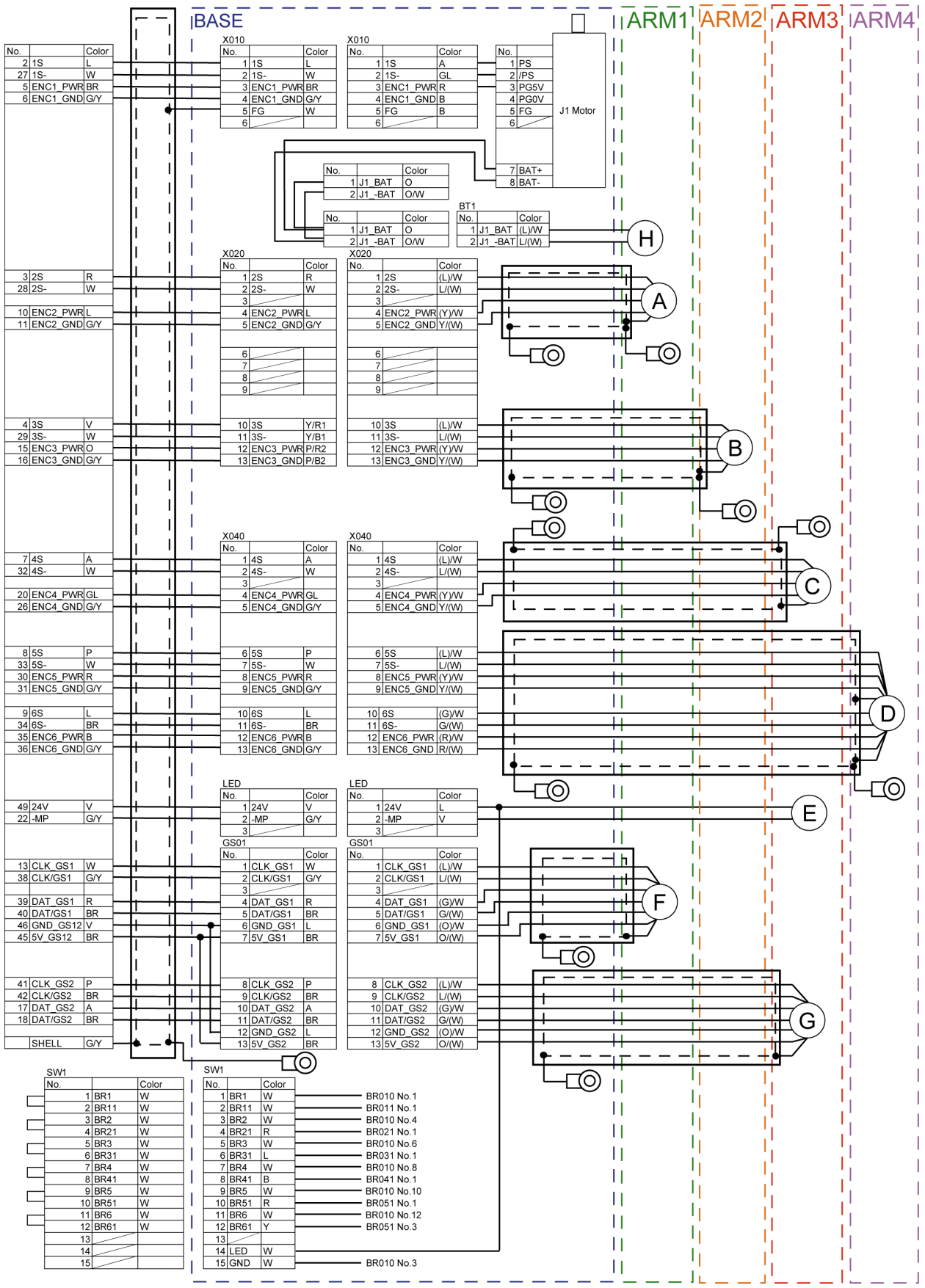
Arm #4 side covers (both sides)	Arm #4 maintenance cover (C8XL only)
Arm #3 cover	Arm #3 maintenance cover
Arm #2 side covers (both sides)	Arm #1 side covers (both sides)
Arm #1 center cover	Base cover (M/C cable downward)
Base maintenance cover	Connector plate (M/C cable downward)

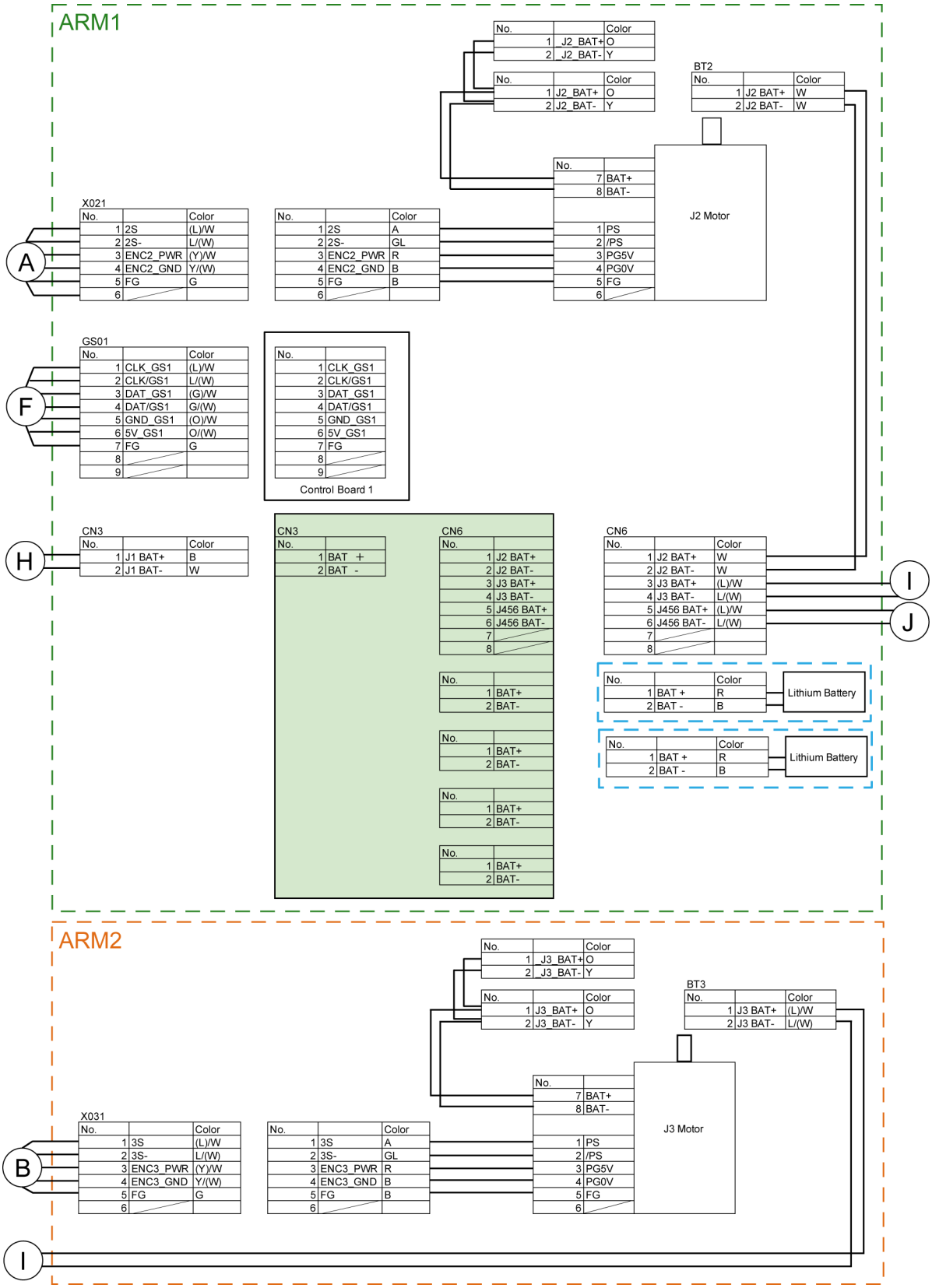
   For details, refer to *C8 Maintenance: 3. Covers*.

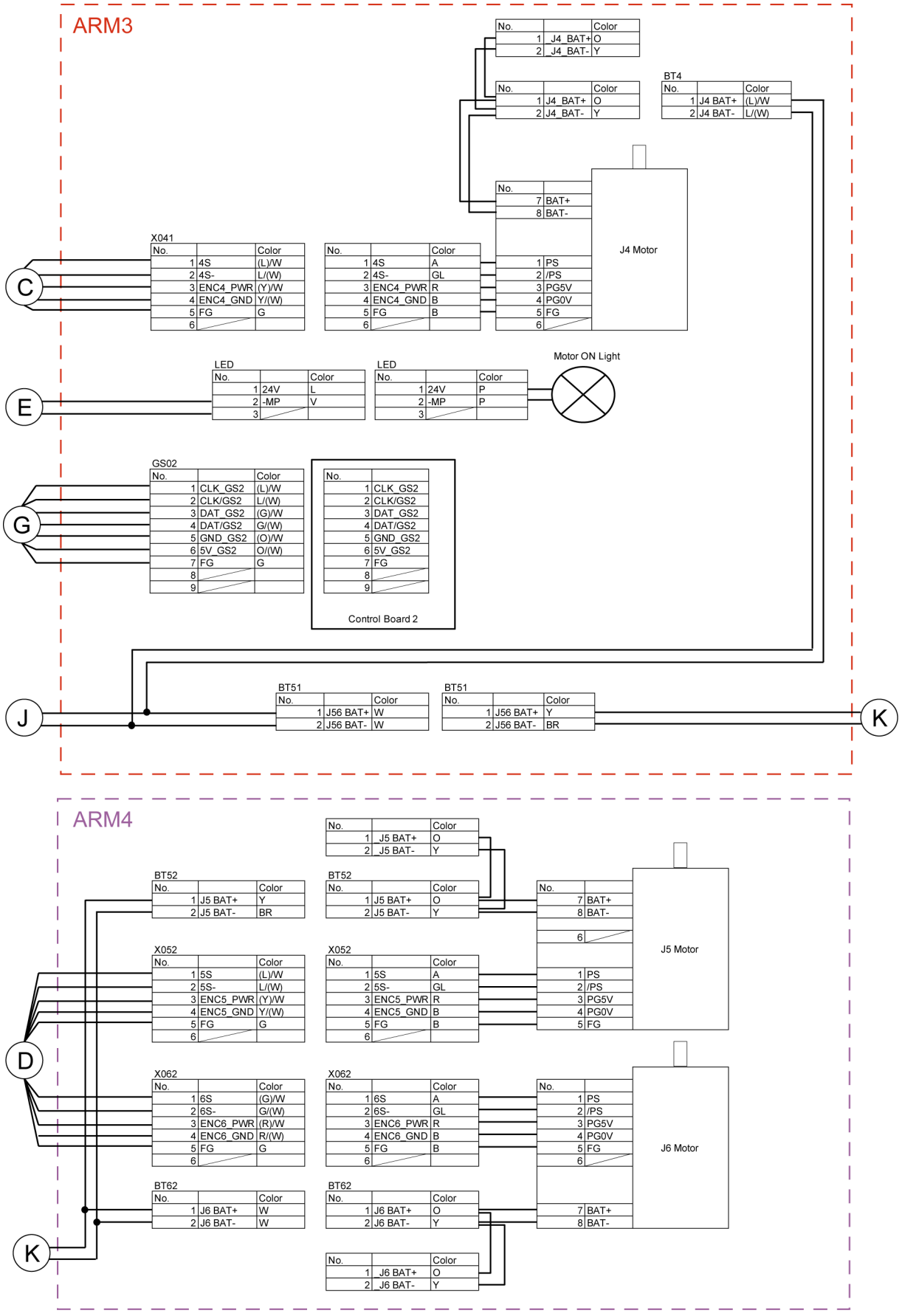
10. Perform calibration.
    For details, refer to *C8 Maintenance: 16. Calibration*.

4.2 Connector Pin Assignment

4.2.1 Signal Cable

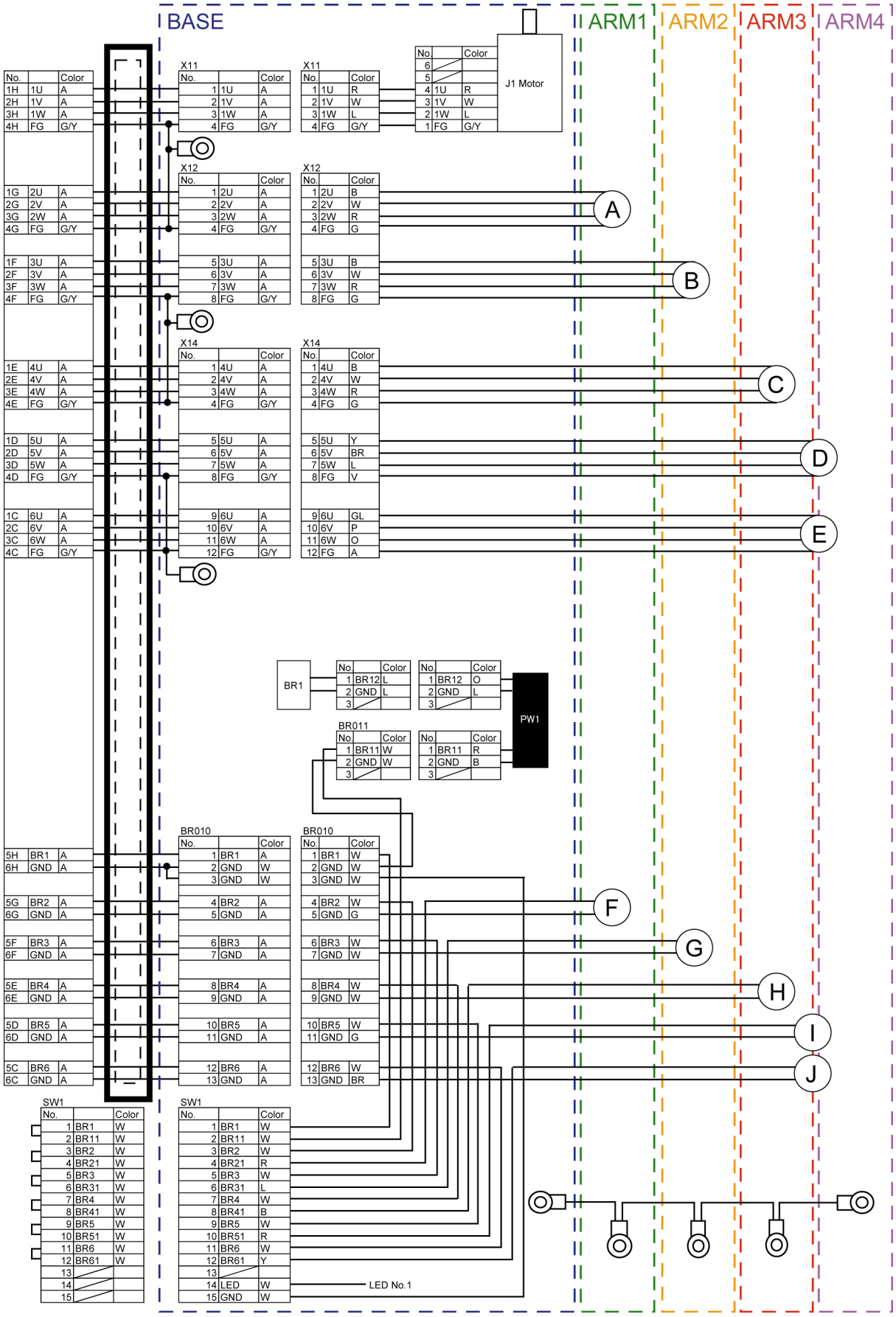



ARM1
No. Color
1 J2_BAT+ O
2 J2_BAT- Y
No. Color
1 J2_BAT+ O
2 J2_BAT- Y
BT2
No. Color
1 J2 BAT+ W
2 J2 BAT- W
No.
7 BAT+
8 BAT-
J2 Motor
1 PS
2 /PS
3 PG5V
4 PG0V
5 FG
6
X021
No. Color
1 2S (L)/W
2 2S- L/(W)
3 ENC2_PWR (Y)/W
4 ENC2_GND Y/(W)
5 FG G
6
No. Color
1 2S A
2 2S- GL
3 ENC2_PWR R
4 ENC2_GND B
5 FG B
6
A
GS01
No. Color
1 CLK_GS1 (L)/W
2 CLK/GS1 L/(W)
3 DAT_GS1 (G)/W
4 DAT/GS1 G/(W)
5 GND_GS1 (O)/W
6 5V_GS1 O/(W)
7 FG G
8
9
F
No.
1 CLK_GS1
2 CLK/GS1
3 DAT_GS1
4 DAT/GS1
5 GND_GS1
6 5V_GS1
7 FG
8
9
Control Board 1
CN3
No. Color
1 J1 BAT+ B
2 J1 BAT- W
H
CN3
No.
1 BAT +
2 BAT -
CN6
No.
1 J2 BAT+
2 J2 BAT-
3 J3 BAT+
4 J3 BAT-
5 J456 BAT+
6 J456 BAT-
7
8
No.
1 BAT+
2 BAT-
No.
1 BAT+
2 BAT-
No.
1 BAT+
2 BAT-
No.
1 BAT+
2 BAT-
CN6
No. Color
1 J2 BAT+ W
2 J2 BAT- W
3 J3 BAT+ (L)/W
4 J3 BAT- L/(W)
5 J456 BAT+ (L)/W
6 J456 BAT- L/(W)
7
8
I
J
No. Color
1 BAT + R
2 BAT - B
Lithium Battery
No. Color
1 BAT + R
2 BAT - B
Lithium Battery
ARM2
No. Color
1 J3_BAT+ O
2 J3_BAT- Y
No. Color
1 J3_BAT+ O
2 J3_BAT- Y
BT3
No. Color
1 J3 BAT+ (L)/W
2 J3 BAT- L/(W)
No.
7 BAT+
8 BAT-
J3 Motor
1 PS
2 /PS
3 PG5V
4 PG0V
5 FG
6
X031
No. Color
1 3S (L)/W
2 3S- L/(W)
3 ENC3_PWR (Y)/W
4 ENC3_GND Y/(W)
5 FG G
6
No. Color
1 3S A
2 3S- GL
3 ENC3_PWR R
4 ENC3_GND B
5 FG B
6
B
I

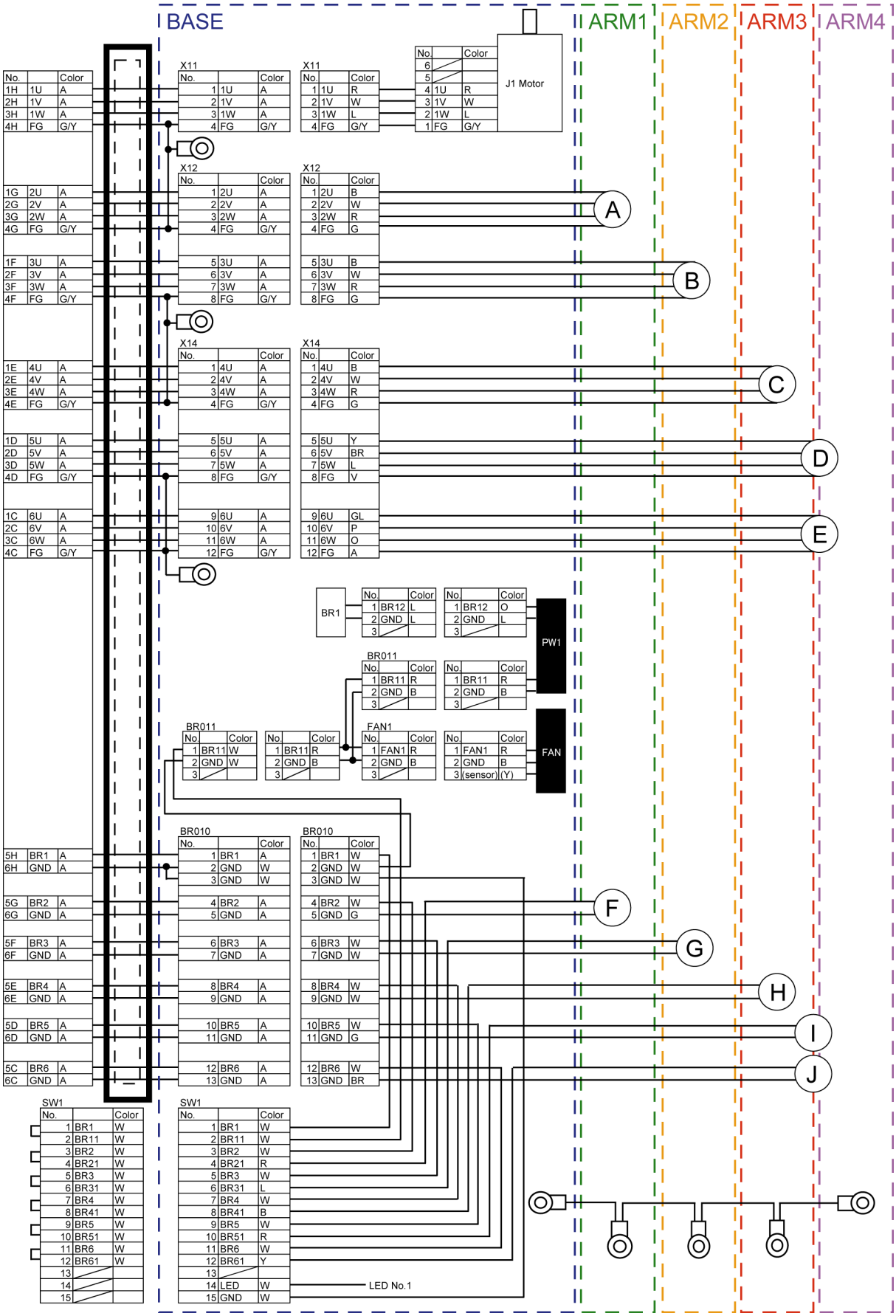

ARM3
No. Color
1 J4_BAT+ O
2 J4_BAT- Y
No. Color
1 J4_BAT+ O
2 J4_BAT- Y
BT4
No. Color
1 J4 BAT+ (L)/W
2 J4 BAT- L/(W)
No.
7 BAT+
8 BAT-
J4 Motor
X041
No. Color
1 4S (L)/W
2 4S- L/(W)
3 ENC4_PWR (Y)/W
4 ENC4_GND Y/(W)
5 FG G
6
No. Color
1 4S A
2 4S- GL
3 ENC4_PWR R
4 ENC4_GND B
5 FG B
6
1 PS
2 /PS
3 PG5V
4 PG0V
5 FG
6
C
LED
No. Color
1 24V L
2 -MP V
3
LED
No. Color
1 24V P
2 -MP P
3
Motor ON Light
E
GS02
No. Color
1 CLK_GS2 (L)/W
2 CLK/GS2 L/(W)
3 DAT_GS2 (G)/W
4 DAT/GS2 G/(W)
5 GND_GS2 (O)/W
6 5V_GS2 O/(W)
7 FG G
8
9
No.
1 CLK_GS2
2 CLK/GS2
3 DAT_GS2
4 DAT/GS2
5 GND_GS2
6 5V_GS2
7 FG
8
9
Control Board 2
G
BT51
No. Color
1 J56 BAT+ W
2 J56 BAT- W
BT51
No. Color
1 J56 BAT+ Y
2 J56 BAT- BR
J
K
ARM4
No. Color
1 J5 BAT+ O
2 J5 BAT- Y
BT52
No. Color
1 J5 BAT+ Y
2 J5 BAT- BR
BT52
No. Color
1 J5 BAT+ O
2 J5 BAT- Y
No.
7 BAT+
8 BAT-
6
J5 Motor
X052
No. Color
1 5S (L)/W
2 5S- L/(W)
3 ENC5_PWR (Y)/W
4 ENC5_GND Y/(W)
5 FG G
6
X052
No. Color
1 5S A
2 5S- GL
3 ENC5_PWR R
4 ENC5_GND B
5 FG B
6
1 PS
2 /PS
3 PG5V
4 PG0V
5 FG
D
X062
No. Color
1 6S (G)/W
2 6S- G/(W)
3 ENC6_PWR (R)/W
4 ENC6_GND R/(W)
5 FG G
6
X062
No. Color
1 6S A
2 6S- GL
3 ENC6_PWR R
4 ENC6_GND B
5 FG B
6
No.
1 PS
2 /PS
3 PG5V
4 PG0V
5 FG
6
J6 Motor
BT62
No. Color
1 J6 BAT+ W
2 J6 BAT- W
BT62
No. Color
1 J6 BAT+ O
2 J6 BAT- Y
7 BAT+
8 BAT-
No. Color
1 J6 BAT+ O
2 J6 BAT- Y
K

4.2.2 Power Cable

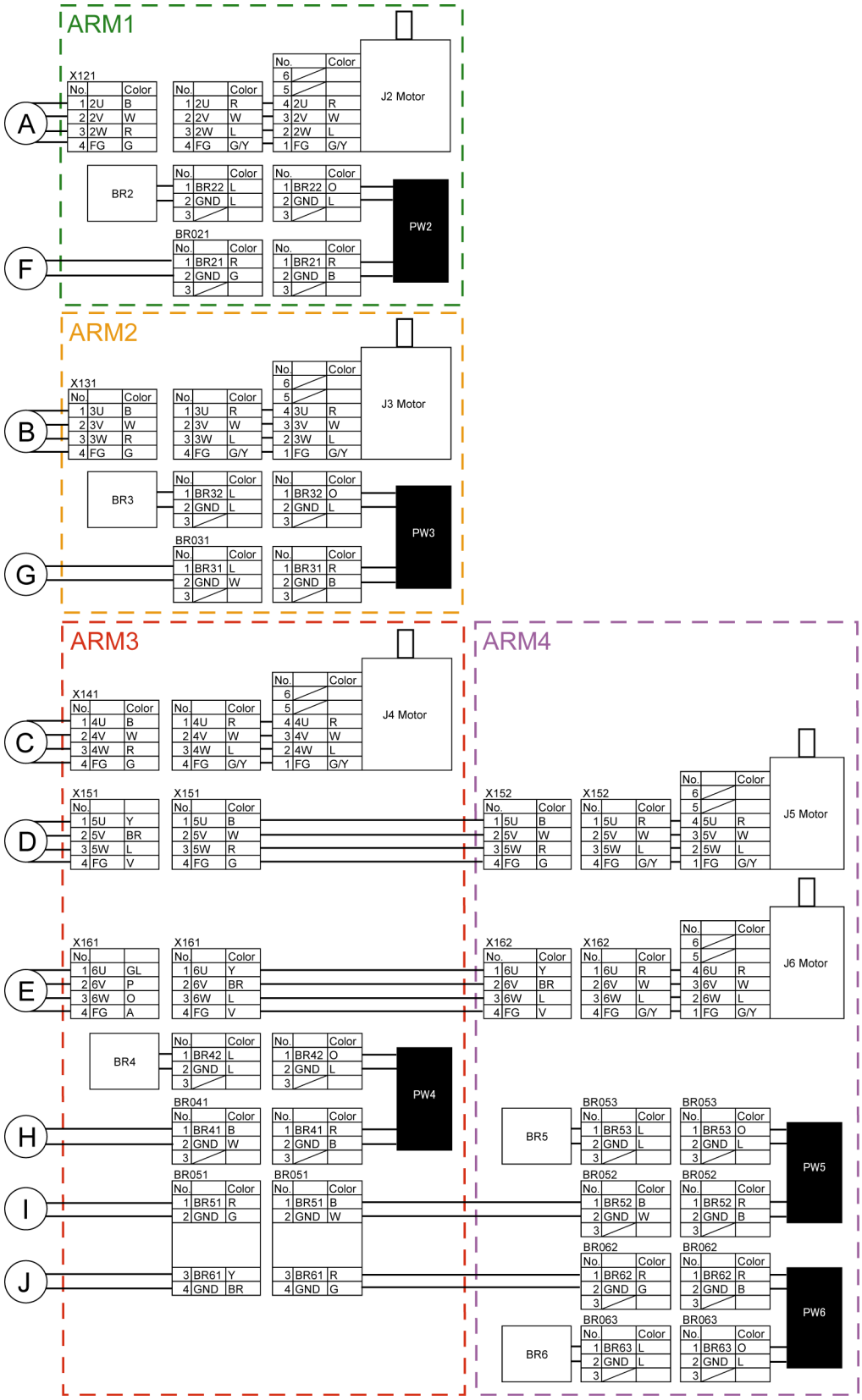
C8-A701*** (C8), C8-A901*** (C8L)



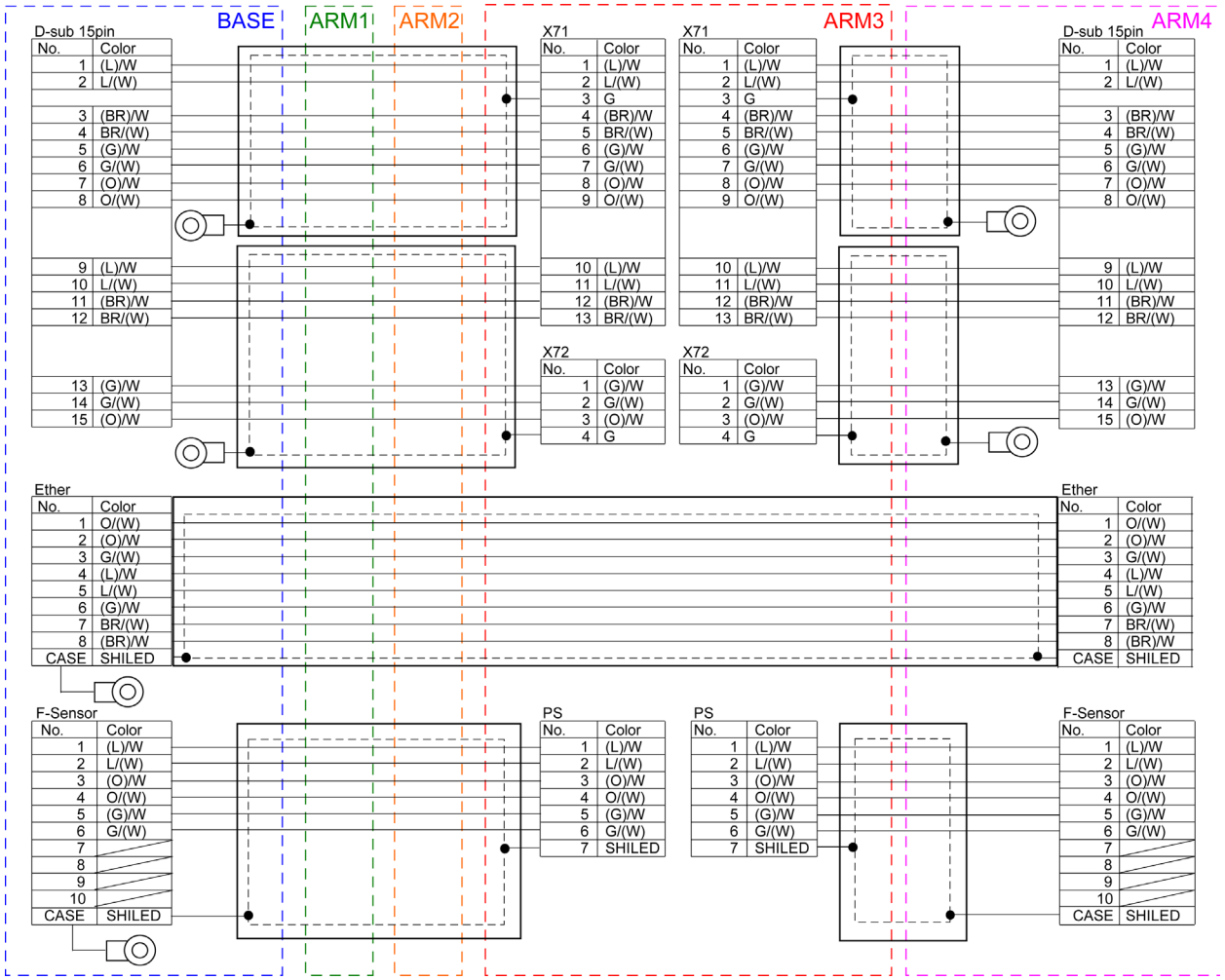
C8-A1401*** (C8XL)



C8-A701*** (C8), C8-A901*** (C8L), C8-A1401*** (C8XL)



4.2.3 User Cable



4.2.4 Color of Cables

The following table shows the codes and cable colors indicated in the pin assignments

4.2.1 Signal Cable

4.2.2 Power Cable

4.2.3 User Cable

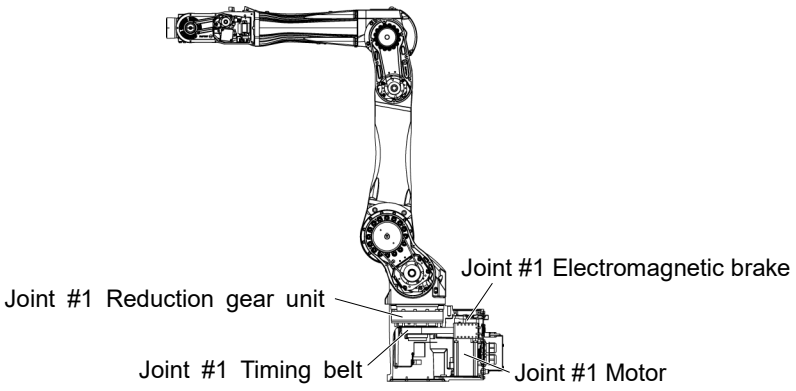
Code	Cable color
B	Black
W	White
R	Red
G	Green
Y	Yellow
BR	Brown
L	Blue
V	Violet
A	Azure
O	Orange
GL	Gray
P	Pink

5. Joint #1

WARNING	■ 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. ■ 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. ■ Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source. To shut off power to the robot system, disconnect the power plug from the power source. Performing any work while connecting the AC power cable to a factory power source 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 during replacement procedures. The shock may shorten the life of the motors and encoder and/or damage them. ■ Never disassemble the motor and encoder. Disassembled motor and encoder will cause a positional gap and cannot be used again.

After parts have been replaced (motors, reduction gear units, timing belts, etc.), the Manipulator cannot perform positioning properly because a gap exists between the origin stored in each motor encoder 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 *C8 Maintenance 16. Calibration* and follow the steps to perform calibration.



(Figure: C8-A1401* (C8XL))

Maintenance procedures differ depending on the installation type of the M/C cable.

5.1 M/C Cable Backward (Joint #1)

5.2 M/C Cable Downward (Joint #1)

5.1 M/C Cable Backward (Joint #1)

5.1.1 Joint #1 - Replacing the Motor (M/C Cable Backward)

	Name		Qty.	Note
Maintenance Parts	Motor unit (Joint #1)	C8-A701** (C8) C8-A901** (C8L)	1	2172921
		C8-A1401** (C8XL)	1	2172922
	Belt tensile jig*		1	1674582
	J1 brake positioning jig*		1	1675081
	Wire tie	AB100	-	1675753
		AB350	-	1697428
Tools	Hexagonal wrench	width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolts
		width across flats: 5 mm	1	For M6 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Nippers		1	For cutting the wire tie
	Pliers		1	For tightening the wire tie
	Belt tension meter		1	Refer: Unitta U-505

* The belt tensile jig and J1 brake positioning jig are assembly jigs. Use these jigs in relevant maintenance steps.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

Removal: Joint #1 Motor (M/C Cable Backward)

1. Turn OFF the Controller.
2. Remove the base maintenance cover.

   For details, refer to *C8 Maintenance: 3. Covers*.
3. Remove the connector plate (M/C cable backward).

   For details, refer to *C8 Maintenance: 3. Covers*.
4. Disconnect the cables from the base and disconnect the connectors.

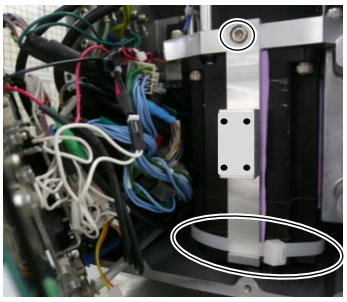
   Connector: X11, X010, BT1, BR011
   (Hold the clip to remove.)

C8-A701** (C8) C8-A901** (C8L)

NOTE When replacing only the brake, do not disconnect the connector BT1. If the connector is disconnected, perform calibration.

C8-A1401** (C8XL):
Remove the heat radiation block

1. Remove the wire tie and the bolts to remove the heat radiation block
   Hexagon socket head cap bolts: M5×15
   Wire tie: AB350



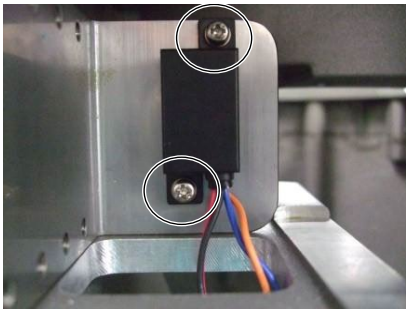
C8-A1401** (C8XL)

2. Remove the heat radiation sheet between the heat radiation block and the motor.

NOTE The heat radiation block, the heat radiation sheet, and the bolts will be used again. Be careful not to lose them.
Be careful not to tear the heat radiation sheet.

5. Remove the brake power supply.

   Cross recessed head screws with washer: 2-M3×6



6. Remove the Joint #1 brake plate from the Joint #1 motor unit.

   Hexagon socket head cap bolts: 3-M4×20

7. Remove the Joint #1 motor unit from the base.

   Hexagon socket head cap bolts: 3-M6×30 (with a plain washer)

   Be careful not to tear and lose the heat radiation sheet attached to the motor.

Installation: Joint #1 Motor (M/C Cable Backward)

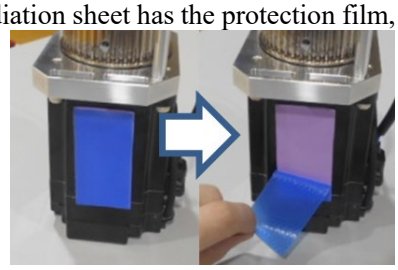
NOTE ☞ When tightening hexagon socket head cap bolts, refer to the *2.4 Tightening Hexagon Socket Head Cap Bolts.*

1. Put the Joint #1 timing belt on the Joint #1 pulley 2 of the Joint #1.

   Hold the belt so as not to drop it.

2. Check that the heat radiation sheet is attached on the right side of the motor (when seeing from the rear side of the Manipulator).

NOTE ☞ If the Manipulator is operated without the heat radiation sheet, the motor generates heat and the error may occur.
If the heat radiation sheet has the protection film, remove the film.



Pass the pulley 1 of the Joint #1 motor unit to the Joint #1 timing belt and loosely secure it to the base.

Hexagon socket head cap bolts: 3-M6×30 (with a plain washer)

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

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

3. Apply proper tension to the Joint #1 motor unit and secure it.
When securing the motor unit, attach the heat dissipation sheet to the right side of the base (when seeing from the rear side of the Manipulator).

Joint #1 timing belt tension: 89 to 149 N

Belt tension meter setting values

Weight: 4.0 g/mm width × m span, Width: 20 mm, Span: 160 mm

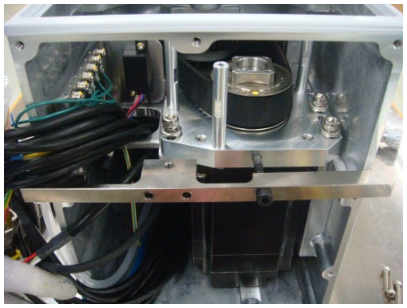
Hexagon socket head cap bolts: 3-M6×30 (with a plain washer)

Tightening torque: 13.0 ± 0.6 N·m

NOTE Regarding belt tension:

- Jumping (position gap) may occur if the value is below the lower limit.
- Vibration (abnormal noise) or reduction in life of the parts may occur if the value exceeds the upper limit.
- When you replace with a new belt, belt extends and the belt tension may decrease in the initial stage. Make sure to operate the robot two to three days and check the belt tension again.

When using the belt tension tensile jig (maintenance part):
Fix the belt tension tensile jig (for J1, J2, J3) to the Joint #1 motor plate.



Hexagon socket head cap bolts: M5×45

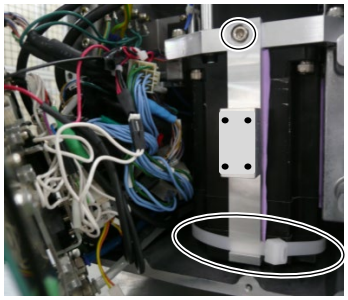
Use the belt tension tensile jig (for J1, J2, J3) as shown in the photo to apply a specified tension.

As the screw is tightened, the Joint #1 motor unit will be pulled and tension will be applied.

C8-A1401** (C8XL):

Install the heat radiation block

For details, refer to the *Heat radiation block Installation*



4. Install the Joint #1 electromagnetic brake / brake plate to the Joint 1 motor unit.

   Hexagon socket head cap bolts: 3-M4×20

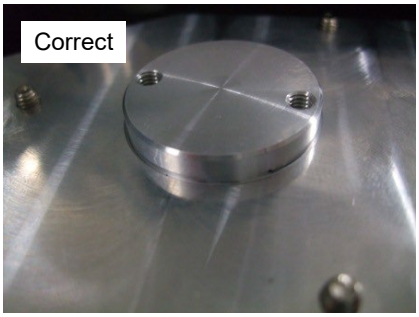
   Tightening torque: 4.0 ± 0.2 N·m

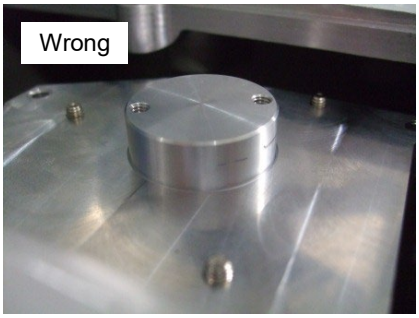
   Check that the motor and the brake core are aligned.

   Regarding brake misalignment:
   - Misalignment of the brake core may cause abnormal sound or apply abnormal torque on the brake. It may result in breakdown of the brake.

   When using the J1 brake positioning jig (maintenance part):

   Using the J1 brake positioning jig, check that the motor and the brake core are aligned when fixing the brake.
   If the J1 brake positioning jig cannot be inserted all the way, the motor and the brake core may be misaligned. In such a case, use the brake release unit (option part) to release the brake, and then align the brake.

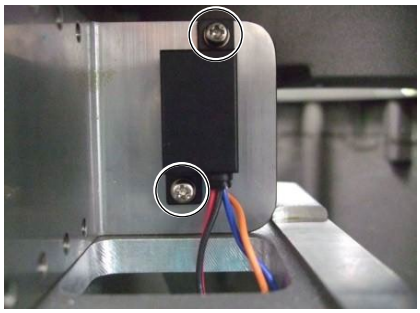




5. Install the brake power supply to the plate. Make sure to install the brake power supply so that the cables will be in the direction as shown in the photo.

   Cross recessed head screws with washer: 2-M3×6

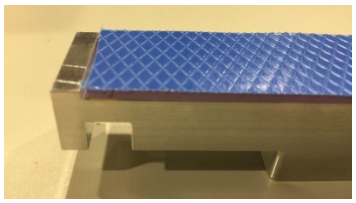
   Tightening torque: 0.45 ± 0.1 N·m



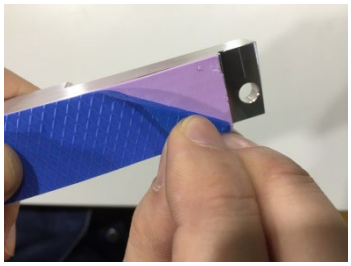
6. Connect the following connectors.
   Connectors: X11, X010, BT1, BR011
7. Mount the connector plate (M/C cable backward).
   For details, refer to *C8 Maintenance: 3. Covers*.
8. Mount the base maintenance cover.
   For details, refer to *C8 Maintenance: 3. Covers*.
9. Calibrate the Joint #1.
   For details, refer to*C8 Maintenance: 16. Calibration*.

Heat radiation block Installation

1. Check that the heat radiation sheet is attached on the heat radiation block.



NOTE ☞ If the Manipulator is operated without the heat radiation sheet, the motor generates heat and the error may occur.
If the heat radiation sheet has the protection film, remove the film.

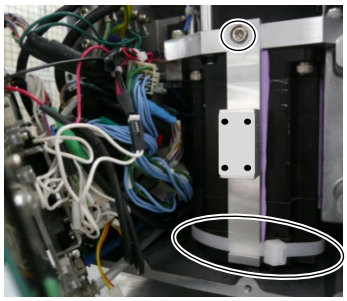


(Image of the protection film)

2. Fix the upper part of the heat radiation block to the Joint #1 motor plate with the bolts.

   Hexagon socket head cap bolts: M5×15

   Tightening torque: 4.0 ± 0.2 N·m

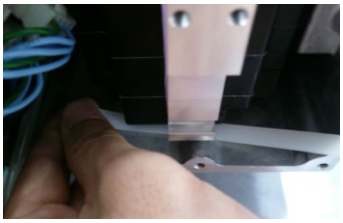


3. Fix the lower part of the heat radiation block to the motor with the wire tie.

   Wire tie: AB350

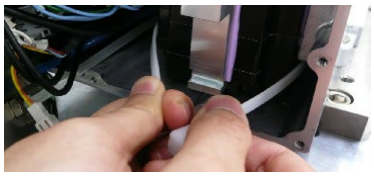
   3-1 Insert the wire tie under the motor.

   3-2 Hold the end of the wire tie.



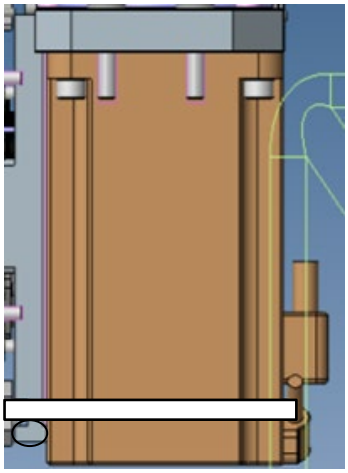
   3-3 While holding the end of the wire tie, push the wire tie to the direction as indicated with the arrow in the photo.

3-4 Wrap the wire tie around the motor.



3-5 Tighten the wire tie to hold the heat radiation sheet firmly.

Make sure that the heat radiation sheet sticks out of the heat radiation block.



NOTE

Do not tighten the wire tie too much. It may result in cable breakage.

5.1.2 Joint #1 - Replacing the Reduction Gear Unit (M/C Cable Backward)

	Name		Qty.	Note
Maintenance Parts	Reduction gear unit (Joint #1)	C8-A701** (C8)	1	1674602
		C8-A901** (C8L)	1	1674603
		C8-A1401** (C8XL)	1	1674604
	Belt tensile jig*		1	1674582
	J1 brake positioning jig*		1	1675081
	Wire tie (AB100)		1	1675753
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolts
		width across flats: 5 mm	1	For M6 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Belt tension meter		1	Refer: Unitta U-505
	Cloth (cushioning)		1	For pressing arms

* The belt tensile jig and J1 brake positioning jig are assembly jigs. Use the jigs when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

When removing the Joint #2 motor unit, tilt the Arm #2 and press it toward the Arm #1.
Reference: *C8 Maintenance 6.1 Joint #2 - Replacing the Motor,* Removal step (2)

When pressing the arm, put a piece of cloth or a similar material between the arms to avoid contacting each other. This protects the arm surfaces from scratching and paint peeling off.

Removal: Joint #1 Reduction gear unit (M/C Cable Backward)

⚠ CAUTION	■ This procedure has possibility of hands and fingers being caught and/or damage or malfunction to the Manipulator. Be very careful when performing maintenance. ■ Do not loosen the bolts while the Arm #2 is not tilted. It may cause the belt come off and the Arm #2 falls down, and it is extremely hazardous. Be sure to do the Removal steps (1) and (2) in *C8 Maintenance 6.1 Joint #2 - Replacing the Motor* before removing the motor. ■ When removing the Arm #1, there must be two or more people to work on it so that at least one of them can support the arm while the others are removing the bolts. Removing the bolts without supporting the arm may result in the arm falling, bodily injury, and/or malfunction of the robot system.

1. Remove the following parts.

   Connector plate
   Connector
   Cable grounding plate
   Brake power supply

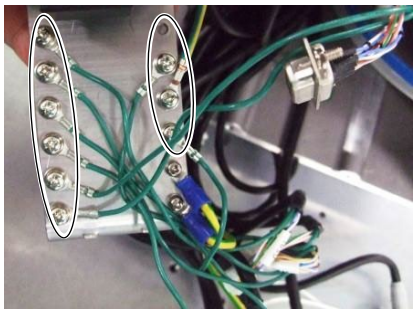
   For details, refer to *C8 Maintenance 5.1.3 Joint #1 - Replacing the Timing Belt (M/C Cable Backward)*, Removal steps (1) to (9).

2. Remove the ground terminals.

   Cross recessed head screws with washer

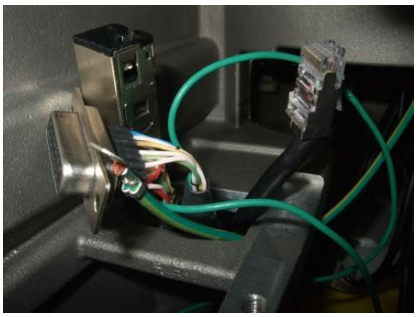
   S, C models : 9-M4×8, 2-M3×6

   P model : 10-M4×8, 2-M3×6



3. Disconnect the following parts from the hole inside the base.

   D-sub cable
   Ground wire
   RJ45 connector
   F-sensor connector

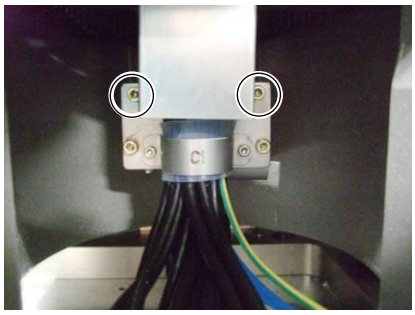


4. Remove the Joint #1 motor unit.

   For details, refer to *C8 Maintenance 5.1.1 Joint #1 – Replacing the Motor Unit (M/C Cable Backward)*, Removal steps (6) to (7).

5. Remove the cable interference prevention plate.

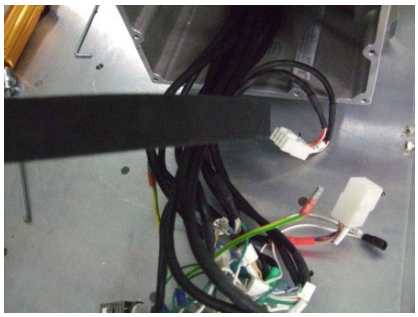
   Hexagon socket head cap bolts: 2-M3×6



6. Remove the base cable bracket (C1).

   Hexagon socket head cap bolts: 2-M3×6

7. Remove the Joint #1 timing belt.

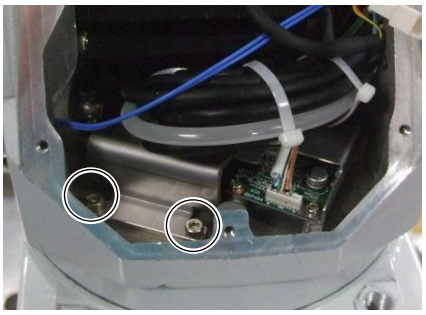


8. Remove the Joint #2 motor unit.

   For details, refer to *C8 Maintenance 6.1 Joint #2 - Replacing the Motor*, Removal steps (1) to (9).

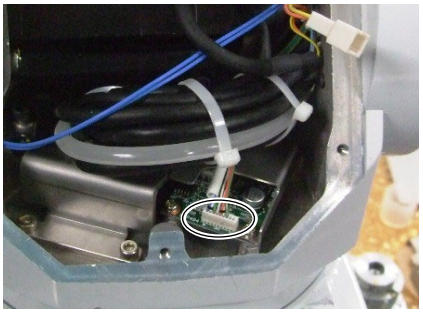
9. Remove the Joint #1 cable fixing plate (Arm #1 side).

   Hexagon socket head cap bolts: 2-M4×10



10. Remove the connector connected to the control board 1.

    Connector: GS01



11. Disconnect the internal cables from the base to the Arm #1 side. Protect the connectors with masking tapes.

    - To protect the connector's clips
    - To avoid adherence of cable grease

NOTE

Disconnect the cables one by one in order from the smallest connector to the largest one.
Do not attempt to pull all connectors at once.
Doing so may damage the cables.

12. Pull out the grease tube (between the base and the Arm #1) on the Arm #1 side from the fitting.

13. Remove the Arm #1 from the base.

    Hexagon socket head cap bolts:
    15-M6×30 (with a plain washer)

CAUTION	■ By removing the bolts, the Arm #1, #2, #3, #4, #5, and #6(end effector) can be separated. There is a possibility of hands and fingers being caught and/or damage or malfunction to the Manipulator. Be very careful when removing the arm. Have at least two workers so that one can support the Manipulator while the other worker is removing the bolts.

14. Remove the Joint #1 reduction gear unit.

    Hexagon socket head cap bolts: 12-M6×50

Installation: Joint #1 Reduction gear unit (M/C Cable Backward)

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

1. Install the Joint #1 reduction gear unit.

   Hexagon socket head cap bolts: 12-M6×50

   Tightening torque: 18.0 ± 0.9 N·m

   Installation face of the base reduction gear unit has clearance holes.
   Install the reduction gear unit to match the screws and the clearance holes.

2. Install the Arm #1 to the base.

   Hexagon socket head cap bolts: 15-M6×30 (with a plain washer)

   Tightening torque: 18.0 ± 0.9 N·m

CAUTION	■ There is a possibility of hands and fingers being caught and/or damage or malfunction to the Manipulator. Be very careful when installing the arm. Have at least two workers so that one can support the Manipulator while the other worker is removing the bolts.

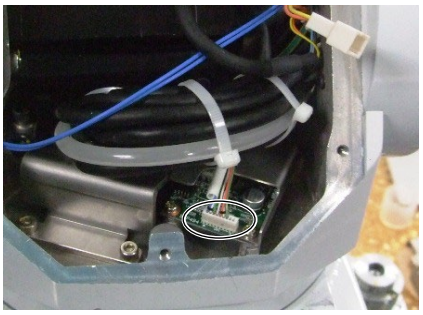
3. Connect the grease tube for the Arm #1 side to the fitting.

4. Pass the internal cables from the Arm #1 side to the base.
   Protect the connectors with masking tapes.
   - To protect the connector's clips
   - To avoid adherence of cable grease

NOTE
Disconnect the cables one by one in order from the largest connector to the smallest one.
Do not attempt to pull all connectors at once.
Doing so may damage the cables.

5. Connect the connector to the control board 1.

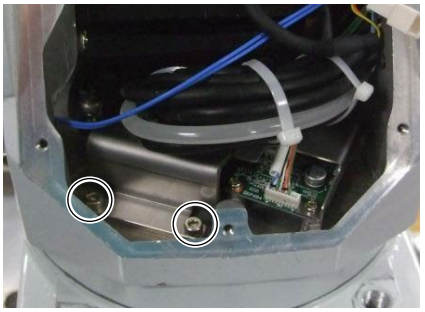
   Connector: GS01



6. Install the Joint #1 cable bracket (Arm #1 side).

   Hexagon socket head cap bolts: 2-M4×10

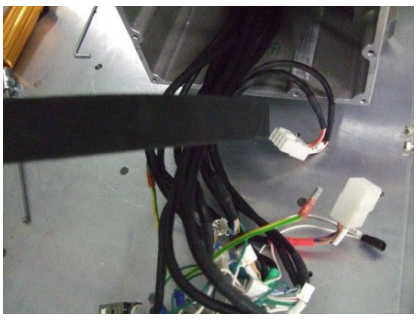
   Tightening torque: 4.0 ± 0.2 N·m



7. Install the Joint #2 motor unit.

   For details, refer to *C8 Maintenance 6.1 Joint #2 - Replacing the Motor*, Installation steps (4) to (9).

8. Pass the cables and the air tube inside the Joint #1 timing belt.



9. Mount the base cable bracket (C1).

   Wrap the cables with the attached silicone sheet.
   Use a cable bracket to fix the wrapped silicone sheet.

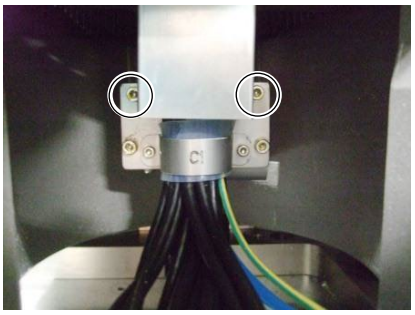
   Hexagon socket head cap bolts: 2-M3×6

   Tightening torque: 2.0 ± 0.1 N·m

10. Install the cable interference prevention plate.

    Hexagon socket head cap bolts: 2-M3×6

    Tightening torque: 2.0 ± 0.1 N·m

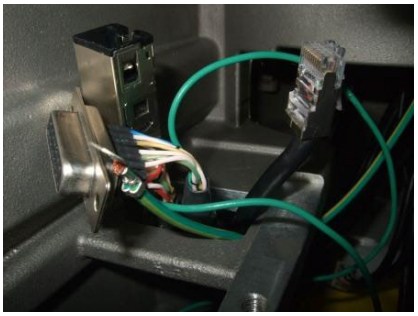


11. Install the Joint #1 motor unit.

    For details, refer to *C8 Maintenance 5.1.1 Joint #1 – Replacing the Motor (M/C Cable Backward)*, Removal steps (1) to (4).

12. Pass the following parts through the hole inside the base to the upper part of the base.

    D-sub cable
    Ground wire
    RJ45 connector
    F-sensor connector



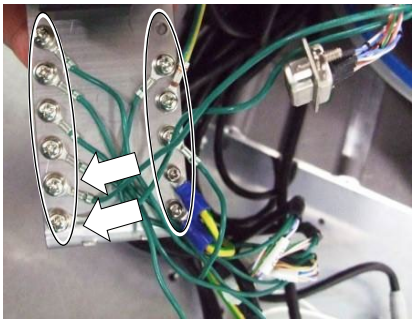
13. Connect the ground wires.

    Cross recessed head screws with washer

    S, C models : 9-M4×8, 2-M3×6

    P model : 10-M4×8, 2-M3×6

    Tightening torque : 0.9 ± 0.1N·m (M4×8)
    0.45 ± 0.1 N·m (M3×6)



NOTE The ground terminals of the D-sub cables have fixed installation positions. Install them to the two screw holes. (Photo: indicated by the arrows).

14. Install the following parts.

    Connector plate

    Connector

    Cable grounding plate

    Brake power supply

    For details, refer to *C8 Maintenance 5.1.3 Joint #1 – Replacing the Timing Belt (M/C Cable Backward)*, Installation steps (6) to (14).

5.1.3 Joint #1 - Replacing the Timing Belt (M/C Cable Backward)

	Name		Qty.	Note	
Maintenance Part	Timing belt (Joint #1)	C8-A701** (C8)	1	560 mm	1655928
		C8-A901** (C8L)	1	580 mm	1655929
		C8-A1401** (C8XL)	1	595 mm	1655930
	Belt tensile jig *		1	1674582	
	J1 brake positioning jig*		1	1675081	
	Wire tie AB100		1	1675753	
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolt	
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolt	
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolt	
		width across flats: 5 mm	1	For M6 hexagon socket head cap bolt	
	Box wrench	width across flats: 5 mm	1	For D-Sub connector	
	Long nose pliers		1	For removing the air tube	
	Cross-point screwdriver		1	For cross recessed head screws	
	Torque wrench		1	For tightening torque control	
	Belt tension meter		1	Refer: Unitta U-505	

* The belt tensile jig and J1 brake positioning jig are assembly jigs. Use these jigs in relevant maintenance steps.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

Removal: Joint #1 Timing belt (M/C Cable Backward)

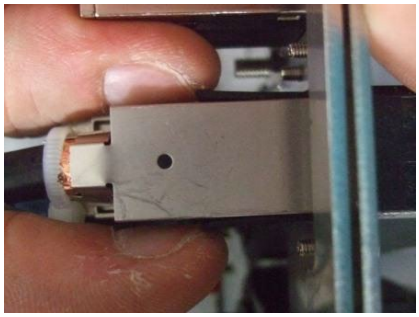
1. Turn OFF the Controller.
2. Remove the base maintenance cover.
   For details, refer to *C8 Maintenance 3. Covers*.
3. Remove the connector plate (M/C cable backward).
   For details, refer to *C8 Maintenance 3. Covers*.
4. Remove two air tubes inside the base.
5. Remove two D-sub connectors.
6. Disconnect the cables from the base and disconnect the connectors.

   Connector: X11, X12, X14, BR010, BR011, X010, X020, X040, LED, GS01, BT1
   (Hold the clip to remove.)

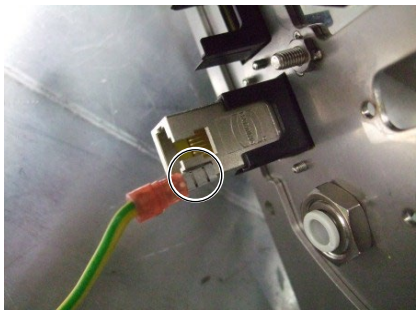
7. Disconnect the following connectors.

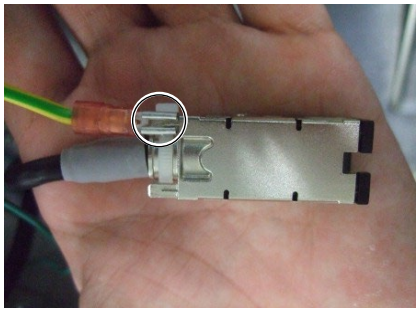
   RJ45 connector:
   Hold the clip to remove.

   F-sensor connector:
   Open the clips on the both ends of the connector and pull it out.



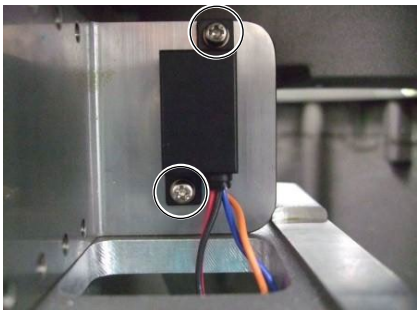
Remove the ground wire from each connector.
To remove the ground wire, hold the connector by hand and pull the ground wire.





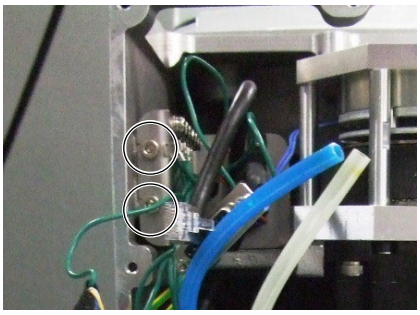
8. Remove the brake power supply.

   Cross recessed head screws with washer: 2-M3×6



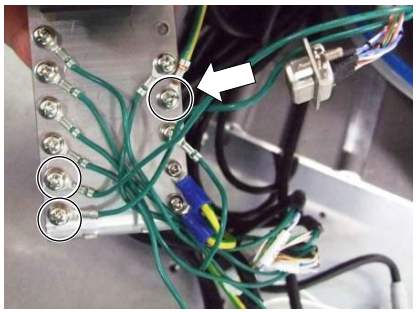
9. Remove the ground wire plate (M/C cable backward).

   Hexagon socket head cap bolts: 2-M4×10



10. Remove the following ground wire terminals.
    D-sub cable ground wire terminals (×2)
    Ground wire (green/yellow) terminal (×1) indicated by an arrow

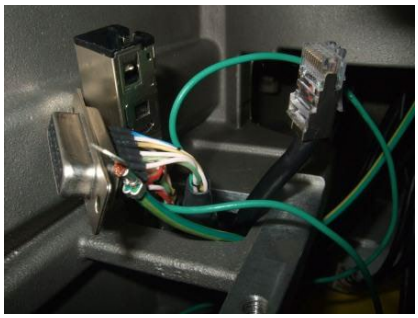
    Cross recessed head screws with washer: 3-M4×8



NOTE ☞ Positions of the ground wire (green/yellow) terminals may differ from the photo. Check the positions of the terminals before removing them.

11. Disconnect the following parts downward from the hole inside the base.

    D-sub cable
    Ground wire
    RJ45 connector
    F-sensor connector



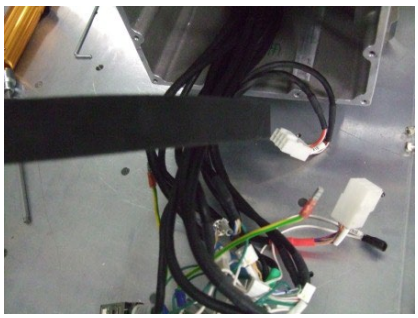
12. Remove the Joint #1 motor unit.
    For details, refer to *C8 Maintenance: 5.1.1 Joint #1-Replacing the Motor (M/C Cable Backward)*, Removal steps (6) to (7).

13. Remove the Joint #1 cable fixing plate.

    Hexagon socket head cap bolts: 2-M3×6

    Do not remove the base cable bracket (C1)

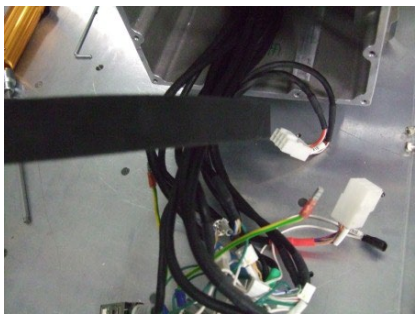
14. Remove the Joint #1 timing belt.



Installation: Joint #1 Timing belt (M/C Cable Downward)

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

1. Pass the cables and air tubes to the Joint #1 timing belt.



2. Mount the Joint #1 cable fixing plate.

   Hexagon socket head cap bolts: 2-M3×6

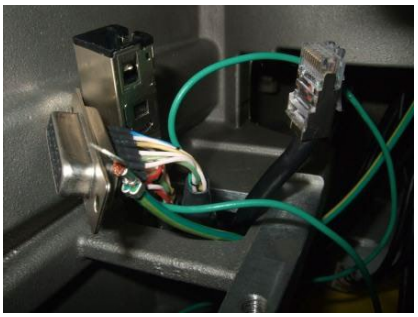
   Tightening torque: 2.0 ± 0.1 N·m

3. Mount the Joint #1 motor unit.

   For details, refer to *C8 Maintenance: 5.1.1 Joint #1-Replacing the Motor (M/C Cable Backward)*, Installation steps (1) to (4).

4. Disconnect the following parts from the hole inside the base to the upper side of the base.

   D-sub cable
   Ground wire
   RJ45 connector
   F-sensor connector

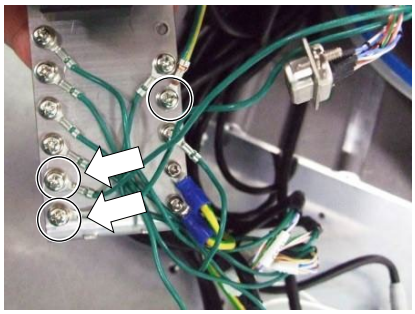


5. Install the terminals of the D-sub cable ground wire and ground wire (green/yellow).

   D-sub cable ground wire terminals (×2) indicated by arrows
   Ground wire (green/yellow) terminal (×1)

   Cross recessed head screws with washer: 3-M4×8

   Tightening torque: 0.9 ± 0.1 N·m

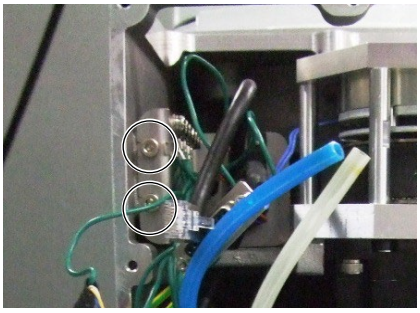


NOTE ☞ The installation positions of the D-sub cable ground terminals are fixed. Make sure to install them to the two screw holes on the backside of the Manipulator (as indicated by arrows in the photo).

6. Mount the ground wire plate (M/C cable backward).

   Hexagon socket head cap bolts: 2-M4×10

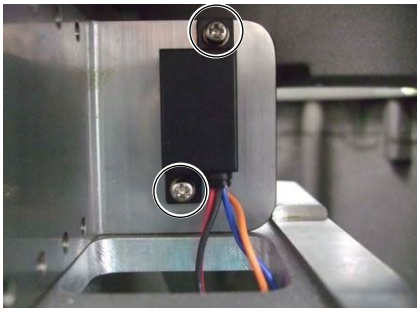
   Tightening torque: 4.0 ± 0.2 N·m



7. Install the brake power supply to the plate.　Make sure to install the brake power supply so that the cables will be in the direction as shown in the photo.

   Cross recessed head screws with washer: 2-M3×6

   Tightening torque: 0.45 ± 0.1 N·m



8. Install the following connectors in accordance with the indications on the connector plates.

   RJ45 connector: Ether

   F-sensor connector: F-sensor

   Install the ground wire to each connector.　To connect the ground wire, insert it while holding the connector by hand.

9. Connect the M/C cable connectors.

   Connector: X11, X12, X14, BR010, BR011, X010, X020, X040, LED, GS01, BT1

10. Install the D-sub connectors in accordance with the indications on the connector plates.

    Left: D-sub for brake release (with a wire marker: SW1) : B-release

    Right: D-sub for user wiring (no wire marker: with a round terminal): D-sub

11. Install two air tubes in accordance with the indications on the connector plates.
    Air1: Semitransparent
    Air2: Blue

NOTE

Be careful not to install the air tube of wrong color.

12. Install the connector plate (M/C cable backward).

    For details, refer to *C8 Maintenance: 3 Covers*.

13. Install the base maintenance cover.

    For details, refer to *C8 Maintenance: 3 Covers*.

14. Calibrate the Joint #1.

    For details, refer to *C8 Maintenance: 16. Calibration*.

5.1.4 Joint #1 - Replacing the Electromagnetic Brake (M/C Cable Backward)

	Name	Qty.	Note
Maintenance Parts	Electromagnetic brake (Joint #1, 2)	1	2172926
	J1 brake positioning jig *	1	1675081
	Wire tie (AB100)	1	1675753
Tools	Hexagonal wrench (width across flats: 3 mm)	1	For M4 hexagon socket head cap bolt
	Cross-point screwdriver (#2)	1	For cross recessed head screws
	Torque wrench	1	For tightening torque control

* The belt tensile jig and J1 brake positioning jig are assembly jigs. Use these jigs in relevant maintenance steps.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

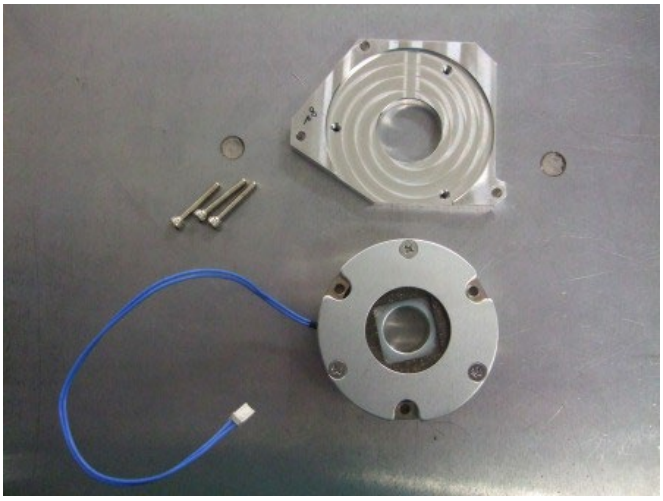
Removal: Joint #1 Electromagnetic brake (M/C Cable Backward)

1. Remove the Joint #1 electromagnetic brake from the Joint #1 motor unit.
   For details, refer to *C8 Maintenance: 5.1.1 Joint #1-Replacing the Motor (M/C Cable Backward)*, Removal steps (1) to (6).

NOTE
Do not disconnect the connector BT1. If the connector is disconnected, perform calibration.

2. Remove the Joint #1 brake from the brake plate.

   Hexagon socket head cap bolts: 3-M4×25



Installation: Joint #1 Electromagnetic brake (M/C Cable Backward)

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

1. Install the Joint #1 brake to the brake plate.

   Hexagon socket head cap bolts: 3-M4×25

   Tightening torque: 4.0 ± 0.2 N·m

   Be careful of the assembly direction of the Joint #1 electromagnetic brake. (See the photo)

2. Mount the Joint #1 brake plate to the Joint #1 motor unit.
   For details, refer to *C8 Maintenance: 5.1.1 Joint #1-Replacing the Motor (M/C Cable Backward)*, Installation steps (4) to (8).

NOTE
If you disconnected the connector BT1 in the removal steps, perform calibration.

5.2 M/C Cable Downward (Joint #1)

5.2.1 Joint #1 - Replacing the Motor (M/C Cable Downward)

	Name		Qty.	Note
Maintenance Parts	Motor unit (Joint #1)	C8-A701*B* (C8) C8-A901*B* (C8L)	1	2172921
		C8-A1401*B* (C8XL)	1	2172922
	Belt tensile jig*		1	1674582
	J1 brake positioning jig*		1	1675081
	Wire tie	AB100	1	1675753
		AB350	1	1697428
Tools	Hexagonal wrench	width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolts
		width across flats: 5 mm	1	For M6 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Nippers		1	For cutting the wire tie
	Pliers		1	For tightening the wire tie
	Belt tension meter		1	Refer: Unitta U-505

* The belt tensile jig and J1 brake positioning jig are assembly jigs. Use these jigs in relevant maintenance steps.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

Removal: Joint #1 Motor (M/C Cable Downward)

1. Turn OFF the Controller.
2. Turn the Manipulator laterally.

CAUTION	■ When turning the Manipulator laterally, there must be two or more people to work on it so that at least one of them can support the arm while the others are removing the bolts. Removing the bolts without supporting the arm may result in the arm falling, bodily injury, and/or malfunction of the robot system.

3. Remove the following covers.

   Base maintenance cover
   Base cover (M/C cable downward)
   Connector plate (M/C cable downward)

   For details, refer to *C8 Maintenance: 3 Covers*.

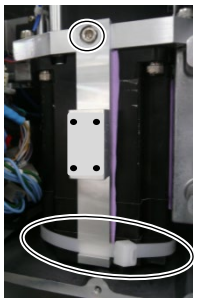
4. Disconnect the cables from the base and disconnect the following connectors.
   Connector: X11, X010, BT1, BR011
   (Hold the clip to remove.)

C8-A701** (C8) C8-A901** (C8L)

NOTE When only replacing the brake, do not disconnect the connector BT1. If the connector is disconnected, perform calibration.

C8-A1401** (C8XL):
Remove the heat radiation block.

1. Remove the wire tie and the bolts to remove the heat radiation block.
   Hexagon socket head cap bolts: M5×15
   Wire tie: AB350



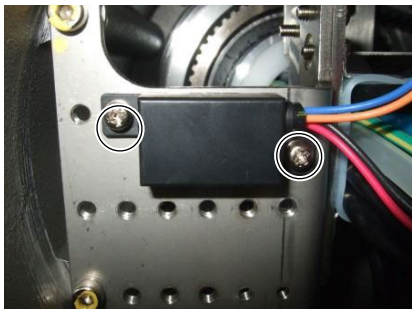
C8-A1401*B* (C8XL)

2. Remove the heat radiation sheet between the heat radiation block and the motor.

NOTE The heat radiation block, the heat radiation sheet, and the bolts will be used again. Be careful not to lose them.
Be careful not to tear the heat radiation sheet.

5. Remove the brake power supply.

   Cross recessed head screws with washer: 2-M3×6



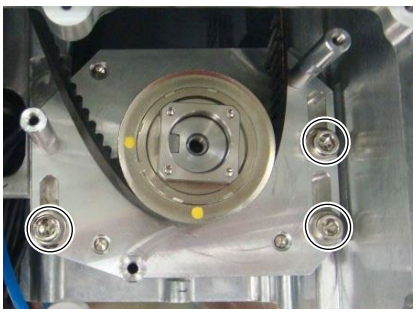
6. Remove the Joint #1 brake plate from the Joint #1 motor unit.

   Hexagon socket head cap bolts: 3-M4×20

7. Remove the Joint #1 motor unit from the base.

   Hexagon socket head cap bolts: 3-M6×30 (with a plain washer)

   Be careful not to tear and lose the heat radiation sheet attached to the motor.



Installation: Joint #1 Motor (M/C Cable Downward)

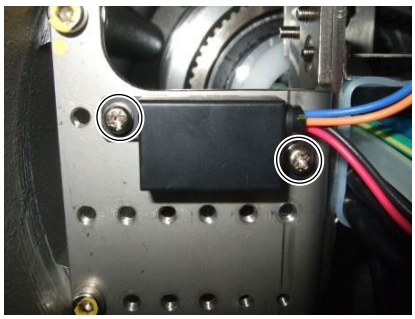
1. Mount the Joint #1 motor unit to the base.

   For details, refer to *Maintenance: 5.1.1 Joint #1-Replacing the Motor (M/C Cable Backward)*, Removal steps (1) to (4).

2. Install the brake power supply to the plate. Make sure to install the brake power supply so that the cables will be in the direction as shown in the photo.

   Cross recessed head screws with washer: 2-M3×6

   Tightening torque: 0.45 ± 0.1 N·m



3. Connect the following connectors.

   Connector: X11, X010, BT1, BR011

4. Install the following covers.

   Connector plate (M/C cable downward).
   Base cover (M/C cable downward)
   Base maintenance cover

   For details, refer to *C8 Maintenance: 3 Covers*.

5. Calibrate the Joint #1.

   For details, refer to *C8 MMaintenance: 16. Calibration*.

5.2.2 Joint #1 - Replacing the Reduction Gear Unit (M/C Cable Downward)

	Name		Qty.	Note
Maintenance Parts	Reduction gear unit (Joint #1)	C8-A701*B* (C8)	1	1674602
		C8-A901*B* (C8L)	1	1674603
		C8-A1401*B* (C8XL)	1	1674604
	Belt tensile jig*		1	1674582
	J1 brake positioning jig*		1	1675081
	Wire tie AB100		1	1675753
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolts
		width across flats: 5 mm	1	For M6 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Belt tension meter		1	Refer: Unitta U-505
	Cloth (cushioning)		1	For pressing arms

* The belt tensile jig and J1 brake positioning jig are assembly jigs. Use the jigs when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

When removing the Joint #2 motor unit, tilt the Arm #2 and press it toward the Arm #1.

Reference: *C8 Maintenance 6.1 Joint #2 - Replacing the Motor,* Removal step (2)

When pressing the arm, put a piece of cloth or a similar material between the arms to avoid contacting each other. This protects the arm surfaces from scratching and paint peeling off.

Removal: Joint #1 Reduction gear unit (M/C cable downward)

⚠ CAUTION	■ This procedure has possibility of hands and fingers being caught and/or damage or malfunction to the Manipulator. Be very careful when performing maintenance. ■ Do not loosen the bolts while the Arm #2 is not tilted. It may cause the belt come off and the Arm #2 falls down, and it is extremely hazardous. Be sure to do the Removal steps (1) and (2) in *C8 Maintenance 6.1 Joint #2 - Replacing the Motor* before removing the motor. ■ When removing the Arm #1, there must be two or more people to work on it so that at least one of them can support the arm while the others are removing the bolts. Removing the bolts without supporting the arm may result in the arm falling, bodily injury, and/or malfunction of the robot system.

1. Remove the following parts.

   Connector plate
   Connector
   Brake power supply

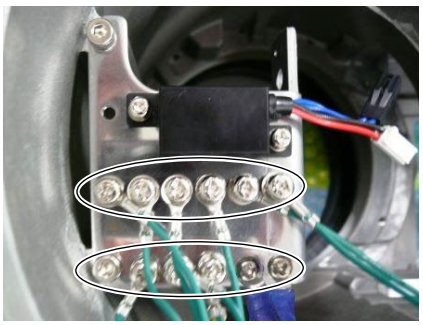
   For details, refer to *C8 Maintenance 5.2.3 Joint #1 - Replacing the Timing Belt (M/C Cable Downward)*, Removal steps (1) to (8).

2. Remove the ground terminals.

   Cross recessed head screws with washer

   S, C models : 9-M4×8, 2-M3×6

   P model : 10-M4×8, 2-M3×6



3. Remove the Joint #1 reduction gear unit.

   For details, refer to *C8 Maintenance 5.1.2 Joint #1 - Replacing the Reduction Gear Unit (M/C Cable Backward)*, Removal steps (4) to (14).

Installation: Joint #1 Reduction gear unit (M/C Cable Downward)

1. Install the Joint #1 reduction gear unit.

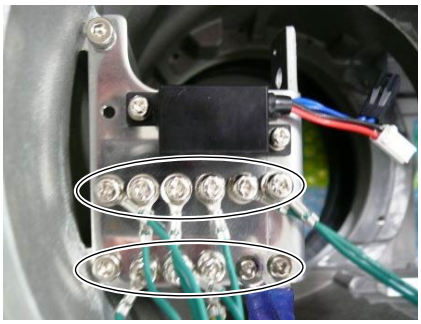
   For details, refer to *C8 Maintenance 5.1.2 Joint #1- Replacing the Reduction Gear Unit (M/C Cable Backward)*, Installation steps (1) to (11).

2. Install the ground terminals to the plate.

   Cross recessed head screws with washer

   S, C models : 9-M4×8, 2-M3×6

   P model : 10-M4×8, 2-M3×6



3. Install the following parts.

   Connector plate
   Connector
   Brake power supply

   For details, refer to *C8 Maintenance 5.2.3 Joint #1 - Replacing the Timing Belt (M/C Cable Downward), Installation steps (4) to (10)*.

5.2.3 Joint #1 - Replacing the Timing Belt (M/C Cable Downward)

	Name		Qty.	Note	
Maintenance Part	Timing belt (Joint #1)	C8-A701*B* (C8)	1	560 mm	1655928
		C8-A901*B* (C8L)	1	580 mm	1655929
		C8-A1401*B* (C8XL)	1	595 mm	1655930
	Belt tensile jig*		1	1674582	
	J1 brake positioning jig*		1	1675081	
	Wire tie AB100		1	1675753	
Tools	Hexagonal wrench	width across flats: 3 mm	1	For M4 hexagon socket head cap bolt	
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolt	
		width across flats: 5 mm	1	For M6 hexagon socket head cap bolt	
	Box wrench	width across flats: 5 mm	1	For D-Sub connector	
	Long nose pliers		1	For removing the air tube	
	Cross-point screwdriver		1	For cross recessed head screws	
	Torque wrench		1	For tightening torque control	
	Belt tension meter		1	Refer: Unitta U-505	

* The belt tensile jig and J1 brake positioning jig are assembly jigs. Use these jigs in relevant maintenance steps.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

Removal: Joint #1 Timing belt (M/C Cable Downward)

1. Turn OFF the Controller.

2. Turn the Manipulator laterally.

CAUTION	■ When turning the Manipulator laterally, there must be two or more people to work on it so that at least one of them can support the arm while the others are removing the bolts. Removing the bolts without supporting the arm may result in the arm falling, bodily injury, and/or malfunction of the robot system.

3. Remove the following covers.

   Base maintenance cover
   Base cover (M/C cable downward)
   Connector plate (M/C cable downward)

   For details, refer to *C8 Maintenance: 3 Covers*.

4. Disconnect the cables from the base and disconnect the following connectors.

   Connector: X11, X12, X14, BR010, BR011, X010, X020, X040,
   LED, GS01, BT1
   (Hold the clip to remove.)

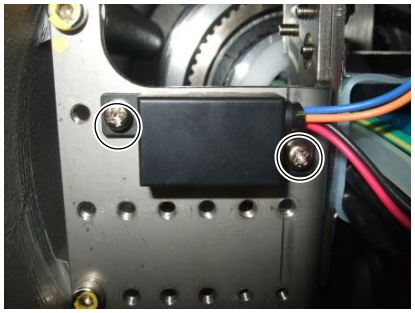
5. Disconnect the following parts.

   Air tubes
   RJ45 connector
   F-sensor connector
   D-sub connector

   For details, refer to *C8 Maintenance: 5.1.3 Joint #1-Replacing the Timing Belt (M/C Cable Backward)*, Removal steps (4) to (5), and (7).

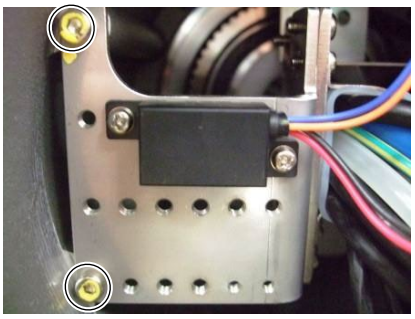
6. Remove the brake power supply.

   Cross recessed head screws with washer: 2-M3×6



7. Remove the ground wire plate (M/C cable downward).

   Hexagon socket head cap bolts: 2-M4×12



8. Remove the Joint #1 motor unit.

   For details, refer to *C8 Maintenance: 5.1.1 Joint #1-Replacing the Motor (M/C cable backward)*, Removal steps (6) to (7).

9. Remove the Joint #1 motor unit.

Installation: Joint #1 Timing belt (M/C Cable Downward)

1. Pass the cables and the air tubes to the Joint #1 timing belt.

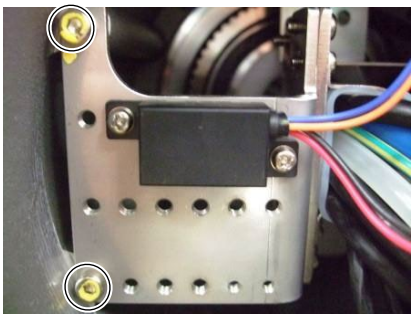
2. Mount the Joint #1 motor unit.

   For details, refer to *C8 Maintenance: 5.1.1 Joint #1-Replacing the Motor (M/C Cable Backward)*, Installation steps (1) to (4).

3. Mount the ground wire plate (M/C cable downward).

   Hexagon socket head cap bolts: 2-M4×12

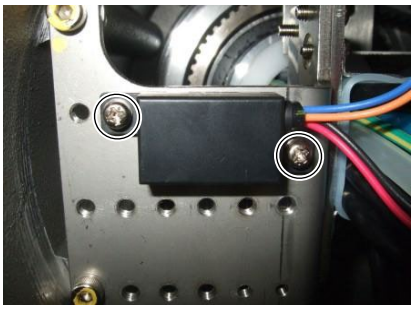
   Tightening torque: 4.0 ± 0.2 N·m



4. Install the brake power supply to the plate.　Make sure to install the brake power supply so that the cables will be in the direction as shown in the photo.

   Cross recessed head screws with washer: 2-M3×6

   Tightening torque: 0.45 ± 0.1 N·m



5. Connect the following connectors in accordance with the indications on the connector plates.

   RJ45 connector: Ether

   F-sensor connector: F-sensor

   Install the ground wire to each connector.　To connect the ground wire, insert in while holding the connector by hand.

6. Connect the M/C cable connectors.

   Connector: X11, X12, X14, BR010, BR011, X010, X020, X040, LED, GS01, BT1

7. Install the D-sub connector in accordance with the indications on the connector plates.

   Left: D-sub for brake release (with a wire marker: SW1): B-release

   Right: D-sub for user wiring (no wire marker: with a round terminal): D-sub

8. Install two air tubes in accordance with the indications on the connector plates.
   Air1: Semitransparent
   Air2: Blue

NOTE

Be careful not to install the air tube of wrong color.

9. Install the following covers.

   Connector plate (M/C cable downward)
   Base cover (M/C cable downward)
   Base maintenance cover

   For details, refer to *C8 Maintenance: 3 Covers*.

10. Calibrate the Joint #1.

    For details, refer to *C8 Maintenance: 16. Calibration*.

5.2.4 Joint #1 - Replacing the Electromagnetic Brake (M/C Cable Downward)

	Name	Qty.	Note
Maintenance Parts	Electromagnetic brake (Joint #1, #2)	1	2172926
	J1 brake positioning jig *	1	1675081
	Wire tie AB100	1	1675753
Tools	Hexagonal wrench (width across flats: 3 mm)	1	For M4 hexagon socket head cap bolt
	Cross-point screwdriver (#2)	1	For cross recessed head screws
	Torque wrench	1	For tightening torque control

* The J1 brake positioning jig is an assembly jig. Use the jig in relevant maintenance steps.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

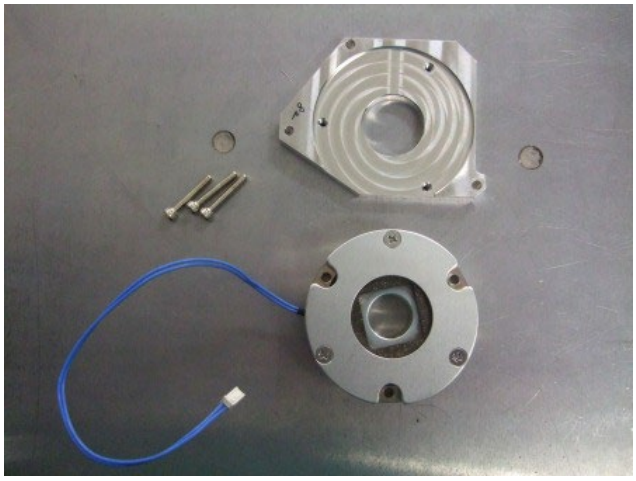
Removal: Joint #1 Electromagnetic brake (M/C Cable Downward)

1. Remove the Joint #1 brake plate from the Joint #1 motor unit.
   For details, refer to *C8 Maintenance: 5.2.1 Joint #1-Replacing the Motor (M/C Cable Downward)*, Removal steps (1) to (6).

NOTE
Do not disconnect the connector BT1. If the connector is disconnected, perform calibration.

2. Remove the Joint #1 brake from the brake plate.

   Hexagon socket head cap bolts: 3-M4×25



Installation: Joint #1 Electromagnetic brake (M/C Cable Downward)

NOTE

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

1. Install the Joint #1 brake to the brake plate.

   Hexagon socket head cap bolts: 3-M4×25

   Tightening torque: 4.0 ± 0.2 N·m

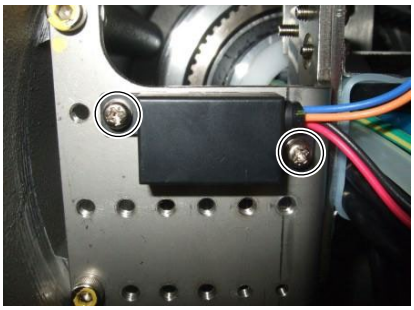
   Be careful of the assembly direction of the Joint #1 electromagnetic brake. (See the photo)

2. Mount the Joint #1 brake plate to the Joint #1 motor unit.
   For details, refer to *C8 Maintenance: 5.1.1 Joint #1 - Replacing the Motor (M/C Cable Backward)*, Installation step (4).

3. Install the brake power supply to the plate. Make sure to install the brake power supply so that the cables will be in the direction as shown in the photo.

   Cross recessed head screws with washer: 2-M3×6

   Tightening torque: 0.45 ± 0.1 N·m



4. Connect the M/C cable connectors.
   Connector: X11, X010, BT1, BR011

5. Install the following covers.

   Connector plate (M/C cable downward)
   Base cover (M/C cable downward)
   Base maintenance cover

   For details, refer to *C8 Maintenance: 3 Covers*.

NOTE

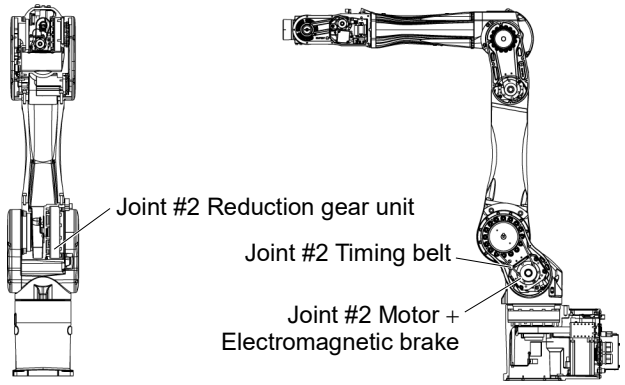
If you disconnected the connector BT1 in the removal steps, perform calibration.

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 during replacement. It may shorten the life of the motors and encoder and/or damage them. ■ Never disassemble the motor and the encoder. Disassembled motor and encoder will cause a positional gap and cannot be used again.

After parts have been replaced (motors, reduction gear units, timing belts, etc.), the Manipulator cannot perform positioning properly because a gap exists between the origin stored in each motor encoder and its corresponding origin stored in the Controller.
Therefore, it is necessary to match these origins after replacing the parts.
The process of aligning the two origins is called “Calibration”.
Refer to *C8 Maintenance 16. Calibration* and perform the calibration after the parts replacement.



(Figure: C8-A1401* (C8XL))

6.1 Joint #2 - Replacing the Motor

	Name		Qty.	Note
Maintenance Parts	AC servo motor 750 W		1	2168683
	Belt tensile jig*		1	1674582
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M5 hexagon socket set screw
		width across flats: 3 mm	1	For M6 hexagon socket head cap bolt
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolt
		width across flats: 5 mm	1	For M6 hexagon socket head cap bolt
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Thickness gauge (0.5 mm)		2	For pulley position adjustment
	Belt tension meter		1	Refer: Unitta U-505
	Cloth (cushioning)		1	For pressing arms

* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

When removing the Joint #2 motor, tilt the Arm #2 and press it against the Arm #1.

Reference: *C8 Maintenance: 6.1 Joint #2 - Replacing the Motor,* Removal step (2)

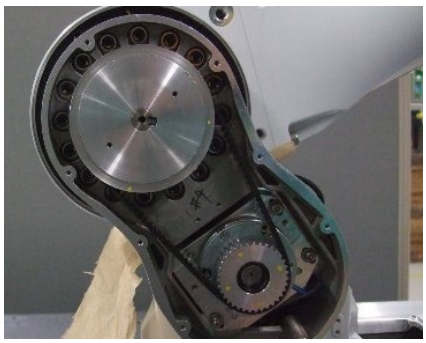
When pressing the arm, put a piece of cloth or a similar material between the arms to avoid contacting each other. This protects the arm surfaces from scratching and paint peeling off.

Removal: Joint #2 Motor

CAUTION	■ This procedure has possibility of hands and fingers being caught and/or damage or malfunction to the Manipulator. Be very careful when performing maintenance. ■ Do not loosen the bolts while the Arm #2 is not tilted. It may cause the belt come off and the Arm #2 falls down, and it is extremely hazardous. Be sure to do the Removal steps 1 and 2 before removing the motor.

1. Turn ON the Controller power.
2. Release the Joint #2 brake. Tilt the Arm #2 and push it against the Arm #1.

   The Arm #2 falls by its own weight when the Joint #2 motor unit is removed. Therefore, release the brake and tilt the Arm #2 in advance.
   Put a cloth between the Arm #1 and Arm #2 so that the arms do not touch each other.



   EPSON RC+ Command:

```
>brake off, 2
```

CAUTION	■ There is a possibility of hands and fingers being caught and/or damage or malfunction to the Manipulator. Be very careful when moving the Manipulator.

3. Turn OFF the Controller power.
4. Remove the Arm #1 center cover and the Arm #1 side cover.

   For details, refer to *C8 Maintenance: 3. Covers*.
5. C8-A701** (C8), C8-A901** (C8L)
   Remove the heat dissipation block and the heat dissipation sheet from the Arm #1.

   Hexagon socket head cap bolts: 2-M4×10

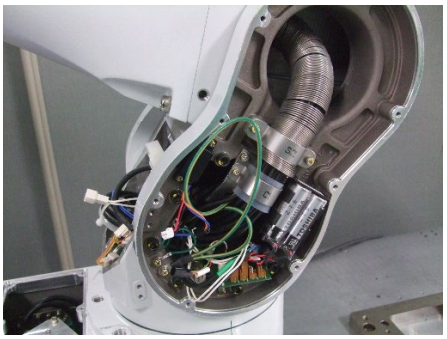
   The heat dissipation sheet attached to the motor unit will be used again. Be careful not to tear and lose it.

   C8-A1401** (C8XL)
   C8-A1401** does not have the heat dissipation block and the heat dissipation sheet, go on to the next step.

6. Disconnect the following connectors of the motor.

   Connector: X121, X021, BT2, BR021

   (Hold the clip to remove.)

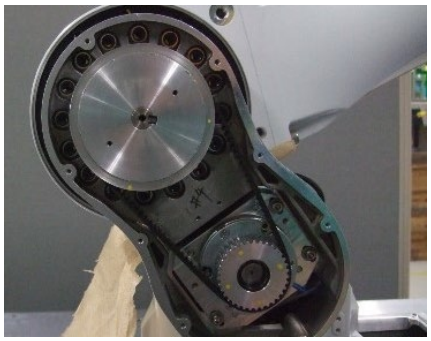


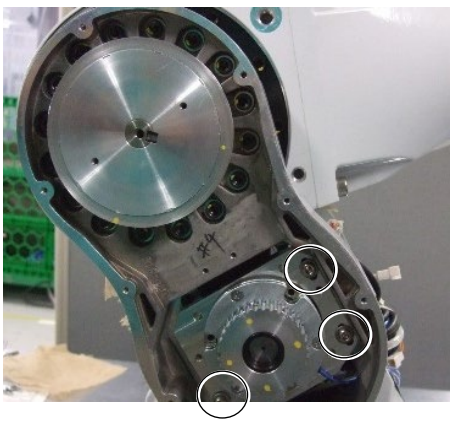
7. Remove the brake power supply.

   Cross recessed head screws with captive washer: 2-M3×6

8. Loosen the bolts securing the Joint #2 motor unit and remove the belt.

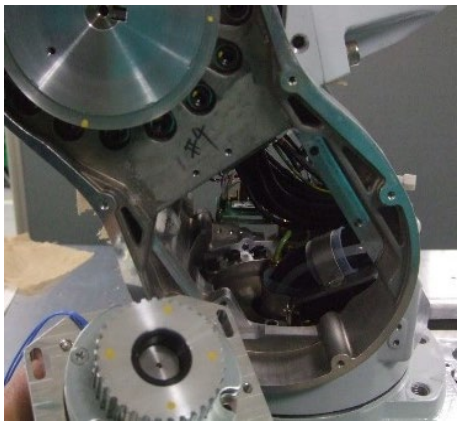
   Hexagon socket head cap bolts: 3-M5×25
   (with a plain washer)





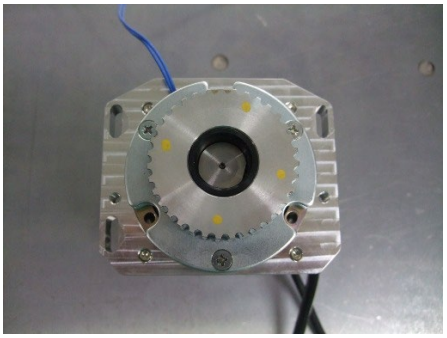
WARNING	■ Loosening the bolts while the Arm #2 is not bent may cause the belt come off and the Arm #2 falls down, and it is extremely hazardous. Be sure to do the Removal steps 1 and 2 before loosening the bolts.

9. Remove the Joint #2 motor unit.



10. Remove the Joint #2 pulley 1 and the drive boss from the motor shaft of the Joint #2 motor unit.
Remove two screws at the flat (D-cut) part of the motor shaft when viewing from above. (A in the figure)

Pulley and the motor shaft (A)
Hexagon socket set screws: 2-M5×12

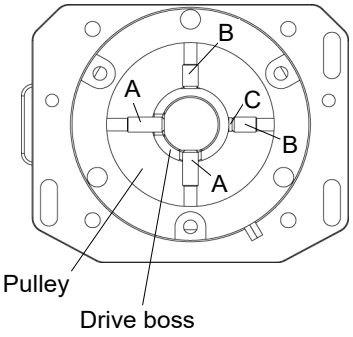


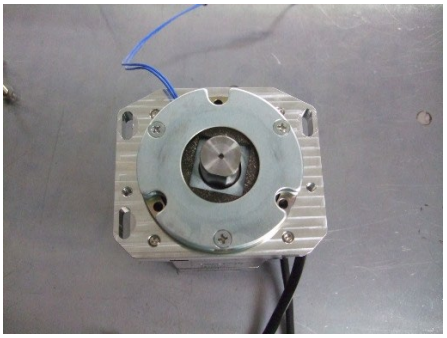
NOTE Do not remove the pulley and drive boss screws (B in the figure). There is a brass bushing on one of the set screws. If you removed the screws (B), be careful not to lose the brass bushing.

A: Pulley and motor shaft screws
(D-cut part of the motor shaft × 2)

B: Pulley and drive boss screws
Do not remove these screws.

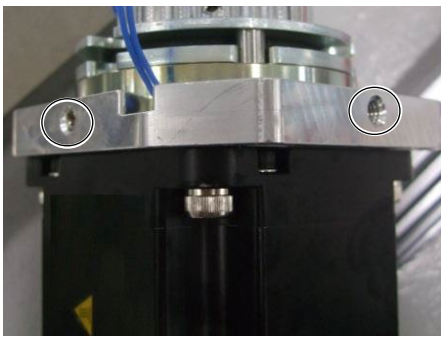
C: Bushing





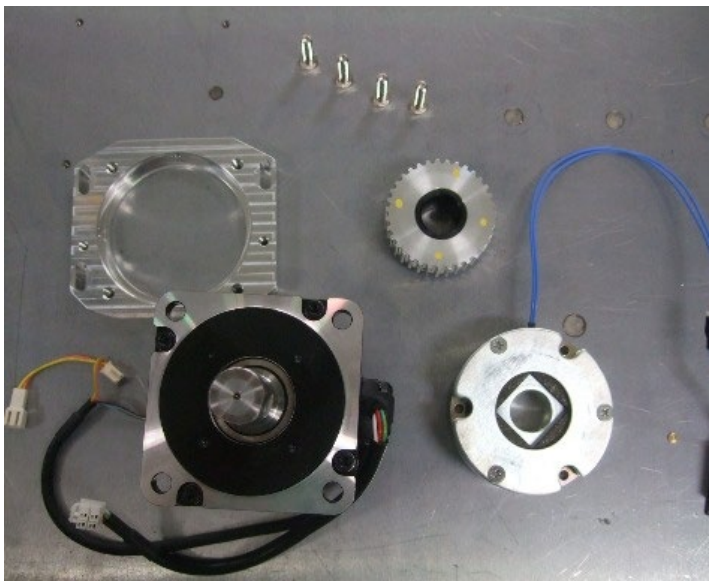
11. Remove the Joint #2 electromagnetic brake.

Hexagon socket set screws: 2-M6×6 (with a brass bushing)



12. Remove the motor plate from the Joint #2 motor.

    Hexagon socket head cap bolts: 4-M6×20



Installation: Joint #2 Motor

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

1. Install the motor plate to the Joint #2 motor.

   Hexagon socket head cap bolts: 4-M6×20

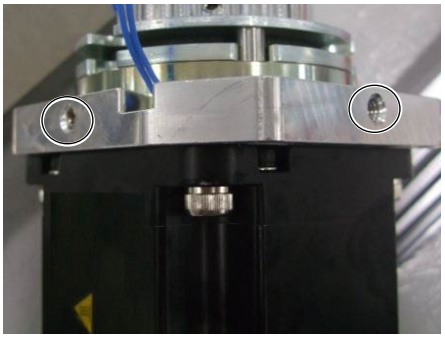
   Tightening torque: 13.0 ± 0.6 N·m

NOTE
Be careful of the assembly direction of the motor plate. (See the photo.)

2. Mount the Joint #2 electromagnetic brake to the Joint #2 motor unit.

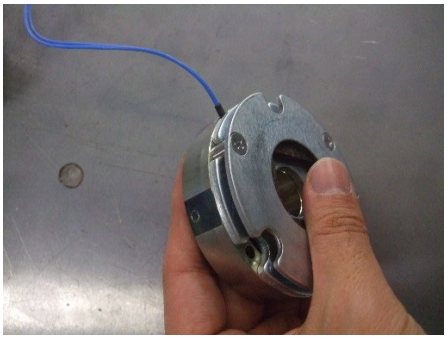
   Hexagon socket set screws: 2-M6×6 (with a brass bushing)

   Tightening torque: 6.0 ± 0.4 N·m

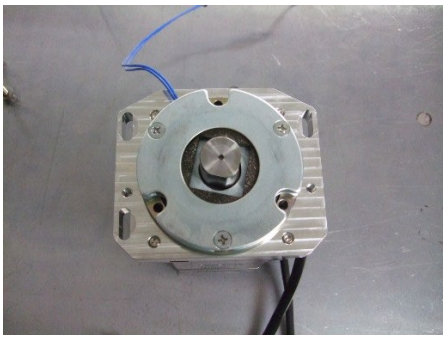


   Be careful of the assembly direction of the Joint #2 electromagnetic brake. (See the photo.)

   Fix the set screws while pressing the electromagnetic brake to the motor plate.
   The brass bushing is not necessary for the screw for the flat surface (D-cut). Set the bushing to the other screw and then fix the screw.



NOTE
If the screw positions are incorrect or the bushing is not set, it may cause damage on the side of the brake and may result in the part being unable to be removed.



3. Mount the drive boss and the pulley 1 to the Joint #2 motor unit.

Insert the pulley 1 so that the set screw is aligned to the flat surface of the motor shaft.

Fix the pulley 1 and the motor shaft.
Leave 0.5 mm between the pulley 1 and the electromagnetic brake.
The countersunk screw of the electromagnetic brake is projecting.
Using the feeler gauge (0.5 mm), leave a space for the projection.

NOTE If there is no space for the projection, the parts may chafe while the motor is driving and it may result in breakage.

Hexagon socket set screws: 2-M5×12

Tightening torque: 3.9 ± 0.2 N·m

If the drive boss and the pulley 1 are removed:
Align the end faces of the drive boss and the pulley 1, and then fix them.

Hexagon socket set screws: 2-M5×8 (with a brass bushing)

Tightening torque: 3.9 ± 0.2 N·m

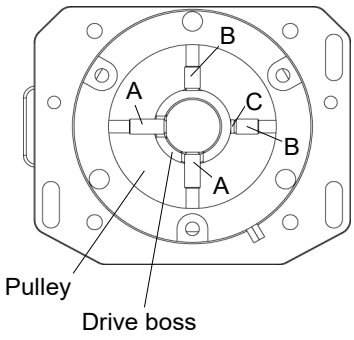
NOTE If the screw positions are incorrect or the bushing is not set, it may cause damage on the side of the part and may result in the part being unable to be removed.

Set the set screws to the positions indicated in the right figure.

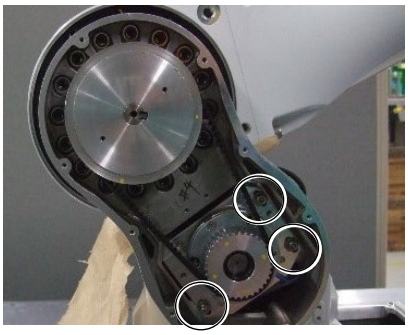
A: Pulley and motor shaft screws
(D-cut part of the motor shaft × 2)

B: Pulley and drive boss screws
Do not remove these screws.

C: Bushing



4. Put the Joint #2 motor unit in the Arm #1.



5. Set the timing belt around the pulley 1 and the pulley 2 and fix it temporarily.
Check that the teeth of the timing belt engage with these of the pulley.
As a rough guide of temporary fixing, check that the motor unit can be moved by hand, and it does not tilt when being pulled. If the belt is too loose or too tight, it will not have proper tension.

Hexagon socket set screws: 3-M5×25 (with a plain washer)

6. Apply tension to the Joint #2 timing belt and fix Joint #2 motor unit.

Joint #2 timing belt tension: 58 to 95 N

Belt tension meter setting values

Weight: 4.0 g/mm width × m span, Width: 14 mm,
Span: 146 mm

Hexagon socket set screws: 3-M5×25 (with a plain washer)

Tightening torque: 8.0 ± 0.4 N·m

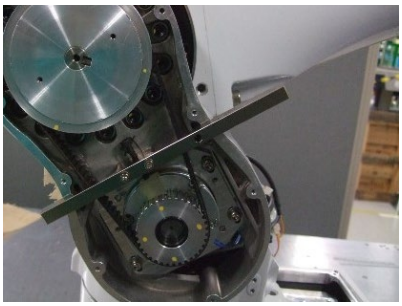
NOTE Regarding belt tension:

- Jumping (position gap) may occur if the value is below the lower limit.
- Vibration (abnormal noise) or reduction in life of the parts may occur if the value exceeds the upper limit.
- When you replace with a new belt, belt extends and the belt tension may decrease in the initial stage. Make sure to operate the robot two to three days and check the belt tension again.

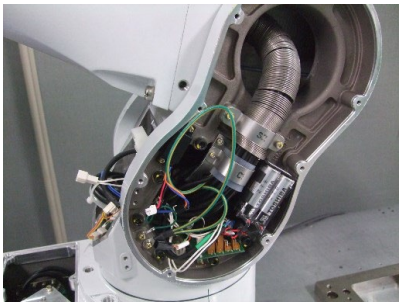
When using the belt tension tensile jig (maintenance part):

Fix the belt tension tensile jig (for J1, J2, and J3) with the screws (2-M4×35) and push the rubber against the pulley.

Tension is applied by pushing the set screw (M6×25) with the rubber.



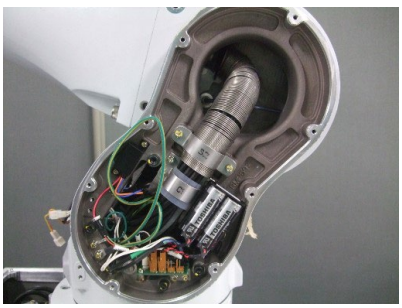
7. Install the brake power supply.



Cross recessed head screws with captive washer: 2-M3×6

Tightening torque: 0.45 ± 0.1 N·m

8. Connect the following connectors.



Connectors: X121, X021, BT2, BR021

9. C8-A701** (C8), C8-A901** (C8L)
   Mount the heat dissipation block and the heat dissipation sheet to the Arm #1.

   Hexagon socket head cap bolts: 2-M4×10

   Tightening torque: 4.0 ± 0.2 N·m

   C8-A1401** (C8XL)
   C8-A1401** does not have the heat dissipation block and the heat dissipation sheet, go on to the next step.

10. Mount the Arm #1 cover and the Arm #1 side cover.
    For details, refer to *C8 Maintenance: 3. Covers*.

11. Perform calibration.
    For details, refer to *C8 Maintenance: 16. Calibration*.

6.2 Joint #2- Replacing the Reduction Gear Unit

	Name			Qty.	Note
Maintenance Parts	Reduction gear unit (Joint #2)	C8-A701*** (C8) C8-A901** *(C8L)		1	1674605
		C8-A1401*** (C8XL)		1	1674606
	O-ring (Joint #2)	C8-A701*** (C8) C8-A901** *(C8L)	Arm #1	1	1263978
			Arm #2	1	1656161
		C8-A1401*** (C8XL)	Arm #1	1	1670635
			Arm #2	1	1656140
	Belt tensile jig*			1	1674582
Tools	Hexagonal wrench	width across flats: 2.5 mm		1	For M3 hexagon socket head cap bolts For M5 hexagon socket set screws
		width across flats: 3 mm		1	For M4 hexagon socket head cap bolts
		width across flats: 4 mm		1	For M5 hexagon socket head cap bolts
		width across flats: 5 mm		1	For M6 hexagon socket head cap bolts
	Cross-point screwdriver (#2)			1	For cross recessed head screws
	Torque wrench			1	For tightening torque control
	Belt tension meter (0.5 mm)			2	For adjusting the pulley position
	Belt tension meter			1	Refer: Unitta U-505
	Cloth (cushioning)			1	For pressing arms

* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.
The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

When removing the Joint #2 timing belt, tilt the Arm #2 and press it against the Arm #1.
Reference: *C8 Maintenance: 6.1 Joint #2 - Replacing the Motor,* Removal step (2)

When pressing the arm, put a piece of cloth or a similar material between the arms to avoid contacting each other. This protects the arm surfaces from scratching and paint peeling off.

Removal: Joint #2 Reduction gear unit

1. Remove the Joint #2 timing belt.

   For details, refer to *C8 Maintenance 6.3 Joint #2 - Replacing the Timing Belt*, Removal steps (1) to (3).

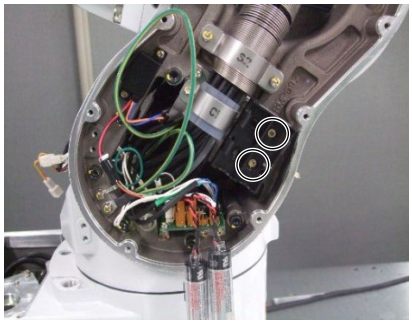
2. Remove the following parts.

   Battery
   Battery board
   Battery connector

   For details, refer to *C8 Maintenance 11.2 Replacing the Battery Board*, Removal steps (3) to (6).

3. Remove the battery box.

   Countersunk screws: 2-M3×8



4. Arm #1 side arm fixing bolts.

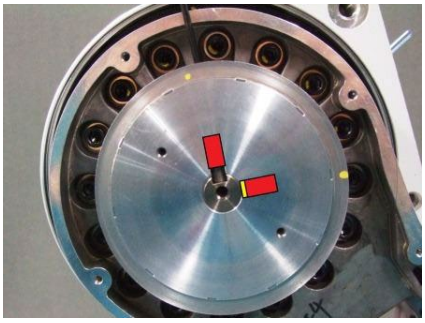
   Hexagon socket head cap bolts: 8-M6×25 (with a plain washer)

5. Remove the Joint #2 pulley 2 from the Joint #2 shaft.

   Hexagon socket set screws: 2-M5×10

   There is a brass bushing on one of the set screws.
   Be careful not to lose it.

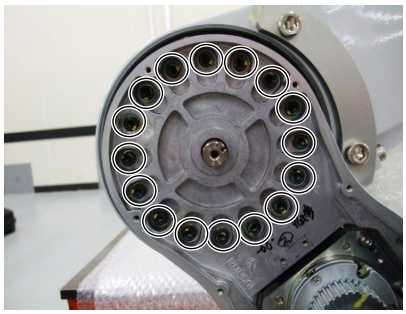
   C8XL:
   Remove the key from the shaft. The key will be used again. Be careful not to lose it.



6. Pull out the grease tube on the Arm #1 side from the fitting.

   The grease tube connects between the base and the Arm #1.

7. Remove the Arm #2.



Hexagon socket head cap bolts (with a plain washer)
C8, C8L: 16-M5×30
C8XL: 16-M6×35

Remove a wave washer on the Arm #1 side.
The wave washer will be used again. Be careful not to lose it.

Wipe grease on the part while removing it.

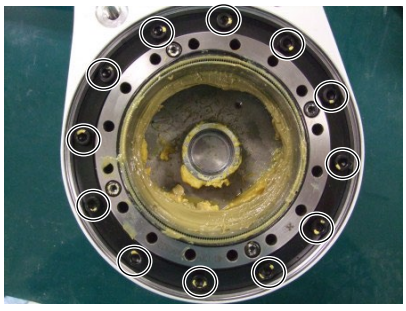
CAUTION	■ By removing the bolts, the Arm #1, #2, #3, #4, #5, and #6(end effector) can be separated. There is a possibility of hands and fingers being caught and/or damage or malfunction to the Manipulator. Be very careful when removing the arm. Have at least two workers so that one can support the Manipulator while the other worker is removing the bolts. ■ The Arms are connected by the internal cables. When replacing the parts, place the removed arm while not applying load on the cables. It may result in cable disconnection.

8. Remove the wave generator from the reduction gear unit.

If the wave generator unit does not come off easily, set the pulley 2 as shown in the photo to the shaft and pull out the parts.

Wipe grease on the part while removing it.

9. Remove the reduction gear unit from the Arm #2.



Hexagon socket head cap bolts (with plain washer)
C8, C8L: 12-M5×40
C8XL: 12-M6×45

Wipe grease on the part while removing it.

10. Remove the O-ring from the groove on the Arm #2.

    Wipe grease on the part while removing it.

Installation: Joint #2 Reduction gear unit

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

1. Apply a thin coat of grease (SK-1A) to the O-ring.
   Fit the O-ring to the groove on the Arm #2.

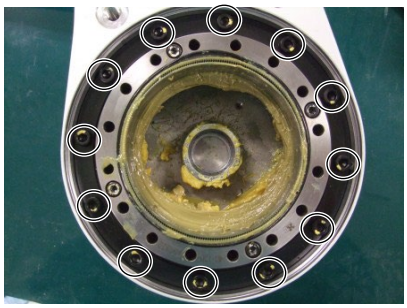
   Do not allow the O-ring to come out of the groove.

   If the O-ring is swollen, damaged, or deteriorated, replace it with a new one.

2. Install the reduction gear unit to the Arm #2.

   C8, C8L:
   Hexagon socket head cap bolts: 12-M5×40
   Tightening torque: 10.0 ± 0.5 N·m

   C8XL:
   Hexagon socket head cap bolts: 12-M6×45
   Tightening torque: 18.0 ± 0.9 N·m

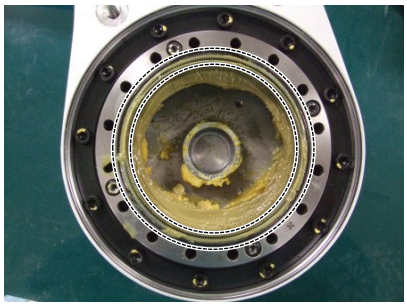


   Installation face of the Arm #2 reduction gear unit has clearance holes.
   Install the reduction gear unit to match the screws and the clearance holes.

3. Grease the inner side of the flexspline.

   Grease : SK-1A

   Grease amount : C8, C8L: 55 g
   C8XL: 102g



4. Insert the wave generator to the reduction gear unit and fix it.

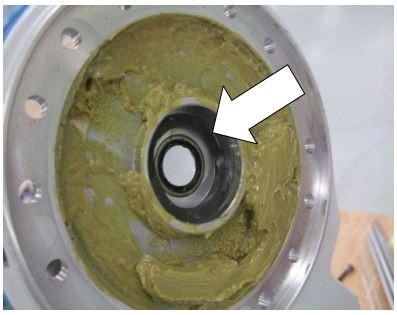
5. Apply a thin coat of grease (SK-1A) to the O-ring.
Fit the O-ring to the groove on the reduction gear unit.

Do not allow the O-ring to come out of the groove.

If the O-ring is swollen, damaged, or deteriorated, replace it with a new one.

6. Temporarily fix the Arm #1 side arm to the Arm #1.
At this time, set the wave washer to the Arm #1.

Hexagon socket head cap bolts: 8-M6×2 5(with a plain washer)



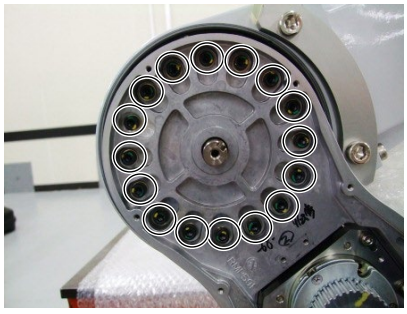
CAUTION	■ There is a possibility of hands and fingers being caught and/or damage or malfunction to the Manipulator. Be very careful when installing the arm. Have at least two workers so that one can support the Manipulator while the other worker is removing the bolts.

7. Fix the Arm #2.

C8, C8L:
Hexagon socket head cap bolts: 16-M5×30
(with a plain washer)
Tightening torque: 10.0 ± 0.5 N·m

C8XL:
Hexagon socket head cap bolts: 16-M6×35
(with a plain washer)
Tightening torque: 18.0 ± 0.9 N·m

After fixing the Arm, check that there is no backlash or misalignment on the reduction gear unit by moving the Arm by hand.



8. After fixing the Arm #2, fix the Arm #1 side arm.

   Hexagon socket head cap bolts: 8-M6×25 (with a plain washer)

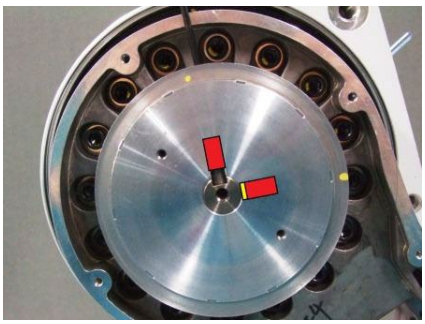
   Tightening torque: 18.0 ± 0.9 N·m

9. Install the Joint #2 pulley 2 to the Joint #2 shaft.

   Hexagon socket head cap bolts: 2-M5×10
   (with a brass washer)

   Tightening torque: 3.9 ± 0.2 N·m

   C8, C8L:
   Insert the pulley 2 so that one of the set screws is at the flat face of the shaft. The brass bushing is not necessary for the screw for the flat surface. Set the bushing to the other screw and then fix the screw.



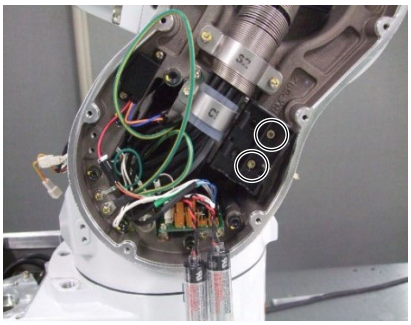
   C8XL:
   Set the key to the shaft and insert the pulley 2 while aligning to the key groove. The brass bushing is not necessary for the screw for the flat surface. Set the bushing to the other screw and then fix the screw.

NOTE If the screw positions are incorrect or the bushing is not set, it may cause damage on the side of the brake and may result in the part being unable to be removed.

10. Install the battery box.

    Countersunk screws: 2-M3×8

    Tightening torque: 0.45 ± 0.1 N·m



11. Install the following parts.
    Battery
    Battery board
    Battery connector

    For details, refer to *C8 Maintenance 11.2 Replacing the Battery Board*, Installation steps (2) to (5).

12. Install the Joint #2 timing belt.

    For details, refer to *C8 Maintenance 6.3 Joint #2 – Replacing the Timing Belt*, Installation steps (1) to (2).

6.3 Joint #2 - Replacing the Timing Belt

	Name		Qty.	Note	
Maintenance Parts	Timing belt (Joint #2)	C8-A701*** (C8)	1	475 mm	1655920
		C8-A901*** (C8L)	1	485 mm	1655924
		C8-A1401*** (C8XL)	1	540 mm	1655927
	Belt tensile jig *		1	1674582	
Tools	Hexagonal wrench (width across flats: 4 mm)		1	For M5 hexagon socket head cap bolt	
	Cross-point screwdriver		1	For cross recessed head screws	
	Torque wrench		1	For tightening torque control	
	Cloth (cushioning)		1	For pressing arms	
	Belt tension meter		1	Refer: Unitta U-505	

* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

When removing the Joint #2 motor, tilt the Arm #2 and press it against the Arm #1.
Reference: *C8 Maintenance: 6.1 Joint #2 - Replacing the Motor,* Removal step (2)

When pressing the arm, put a piece of cloth or a similar material between the arms to avoid contacting each other. This protects the arm surfaces from scratching and paint peeling off.

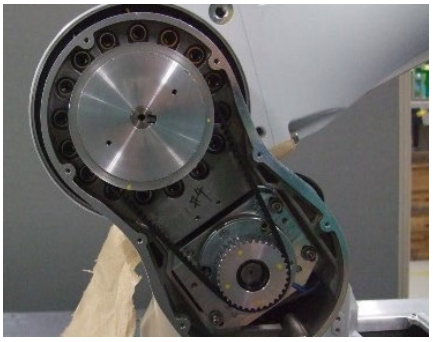
Removal: Joint #2 Timing belt

1. Follow Removal steps (1) through (4) of *C8 Maintenance: 6.1 Joint #2 – Replacing the Motor.*

2. Loosen the Joint #2 motor unit set screws.

   Hexagon socket head cap bolts: 3-M5×25
   (with a plain washer)

3. Remove the Joint #2 timing belt.



Installation: Joint #2 Timing belt

1. Pass the Joint #2 timing belt around the pulley 1 and the pulley 2 of the Joint #2.
   Pass the timing belt to the pulley 2 first, then, place it to the pulley 1.

2. Secure the Joint #2 motor unit.
   For details, refer to *C8 Maintenance: 6.1 Joint #2 – Replacing the Motor*, Installation steps (5) to (6) and (10) to (11).

6.4 Joint #2 - Replacing the Electromagnetic Brake

	Name		Qty.	Note
Maintenance Parts	Electromagnetic brake (Joint #1, #2)		1	2172926
	Belt tensile jig*		1	1674582
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M5 hexagon socket set screw
		width across flats: 3 mm	1	For M6 hexagon socket set screw
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolt
		width across flats: 5 mm	1	For M6 hexagon socket head cap bolt
	Cross-point screwdriver		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Feeler gauge (0.5 mm)		2	For adjusting the pulley position
	Belt tension meter		1	Refer: Unitta U-505
	Cloth (cushioning)		1	For pressing arms

* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

When removing the Joint #2 motor, tilt the Arm #2 and press it against the Arm #1.

Reference: *C8 Maintenance: 6.1 Joint #2 - Replacing the Motor,* Removal step (2)

When pressing the arm, put a piece of cloth or a similar material between the arms to avoid contacting each other. This protects the arm surfaces from scratching and paint peeling off.

Removal: Joint #2 Electromagnetic brake

1. Remove the Joint #2 electromagnetic brake.
   For details, refer to *C8 Maintenance: 6.1 Joint #2 – Replacing the Motor*, Removal steps (1) through (11).

Installation: Joint #2 Electromagnetic brake

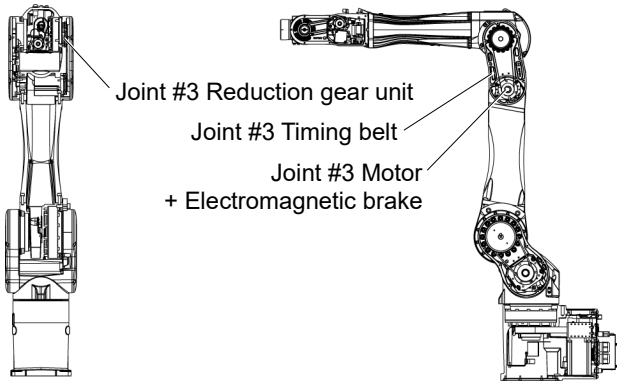
1. Mount the Joint #2 electromagnetic brake to the Joint #2 motor unit.
   For details, refer to *C8 Maintenance: 6.1 Joint #2 – Replacing the Motor*, Installation steps (2) through (11).

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 during replacement. The shock may shorten the life of the motors and encoder and/or damage them. ■ Never disassemble the motor and the encoder. Disassembled motor and encoder will cause a positional gap and cannot be used again.

After parts have been replaced (motors, reduction gear units, electromagnetic brakes, timing belts, etc.), the Manipulator cannot perform positioning properly because a gap exists between the origin stored in each motor encoder and its corresponding origin stored in the Controller.
Therefore, it is necessary to match these origins after replacing the parts.
The process of aligning the two origins is called “Calibration”.
Refer to *C8 Maintenance 16. Calibration* and perform the calibration after the parts replacement.



(Figure: C8-A1401* (C8XL))

7.1 Joint #3 - Replacing the Motor

	Name		Qty.	Note
Maintenance Parts	AC servo motor 400 W		1	2168684
	Belt tensile jig*		1	1674582
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M5 hexagon socket set screws
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Feeler gauge (0.5 mm)		2	For pulley position adjustment
	Belt tension meter		1	Refer: Unitta U-505
	Cloth (cushioning)		1	For pressing arms

* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

When removing the Joint #3 motor, tilt the Arm #2 and press it against the Arm #2.
Reference: *C8 Maintenance: 7.1 Joint #3 - Replacing the Motor,* Removal step (2)

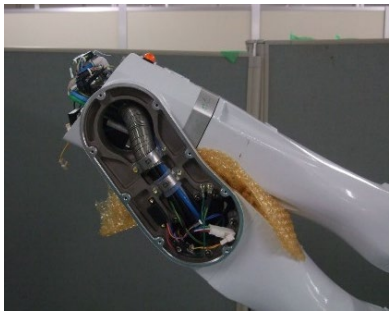
When pressing the arm, put a piece of cloth or a similar material between the arms to avoid contacting each other. This protects the arm surfaces from scratching and paint peeling off.

Removal: Joint #3 Motor

CAUTION	■ This procedure has possibility of hands and fingers being caught and/or damage or malfunction to the Manipulator. Be very careful when conducting maintenance. ■ Do not loosen the bolts while the Arm #3 is not tilted. It may cause the belt come off and the Arm #3 falls down, and it is extremely hazardous. Be sure to do the Removal steps 1 and 2 before removing the motor.

1. Turn ON the Controller power.
2. Release the Joint #3 brake. Tilt the Arm #3 and push it against the Arm #2.

   The Arm #3 falls by its weight when the Joint #3 motor unit is removed. Therefore, release the brake and tilt the Arm #3 in advance.



EPSON RC+ Command:

```
>brake off, 3
```

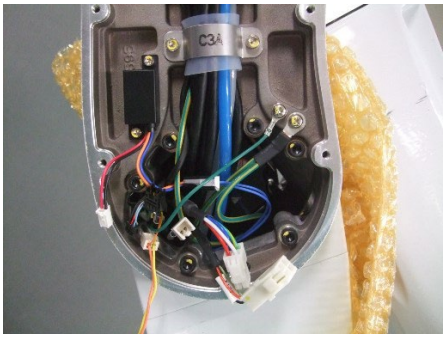
CAUTION	■ There is a possibility of hands and fingers being caught and/or damage or malfunction to the Manipulator. Be very careful when moving the Manipulator. Put a cloth between the Arm #2 and Arm #3 so that the arms do not touch each other.

3. Turn OFF the Controller power.
4. Remove the Arm #2 side cover.
   For details, refer to *C8 Maintenance: 3. Covers*.
5. Disconnect the following connectors.

   Connectors: X131, X031, BT3, BR031

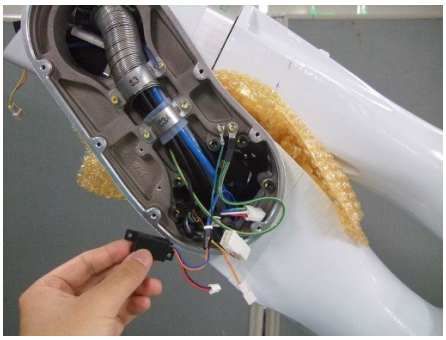
   (Hold the clip to remove.)

NOTE Be careful not to drop the removed connectors inside the Arm.



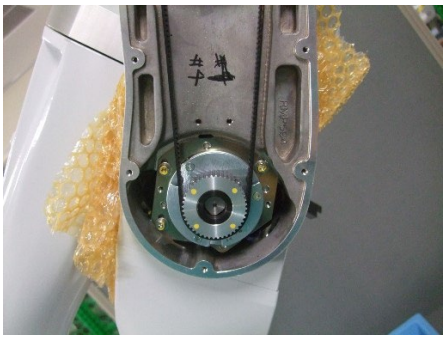
6. Remove the brake power supply.

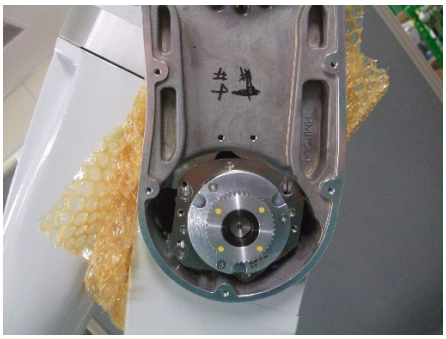
   Cross recessed head screws with captive washer: 2-M3×6



7. Loosen the bolts securing the Joint #3 motor unit and remove the belt.

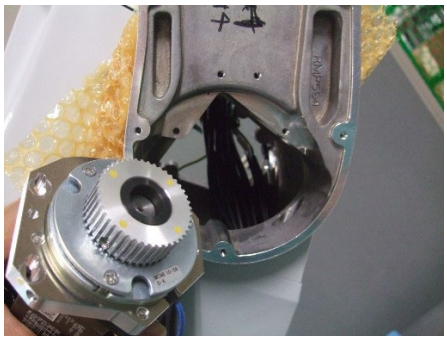
   Hexagon socket head cap bolts: 3-M4×20
   (with a plain washer)



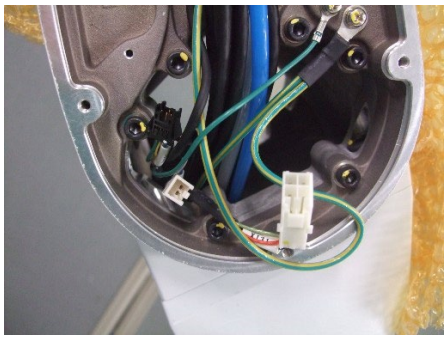


WARNING	■ Loosening the bolts while the Arm #3 is not bent may cause the belt come off and the Arm #3 falls down, and it is extremely hazardous. Be sure to do the Removal steps 1 and 2 before loosening the bolts.

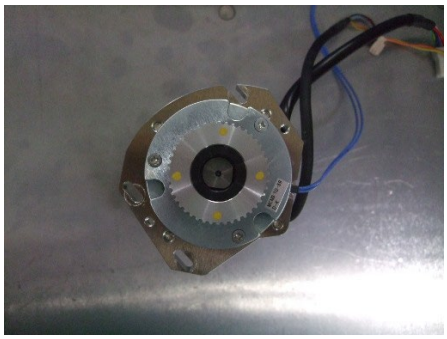
8. Remove the Joint #3 motor unit.



NOTE Be careful not to drop the removed connectors inside the Arm.



9. Remove the Joint #3 pulley 1 and the drive boss from the motor shaft of the Joint #3 motor unit.
Remove two screws at the flat (D-cut) part of the motor shaft when viewing from above. (A in the figure)



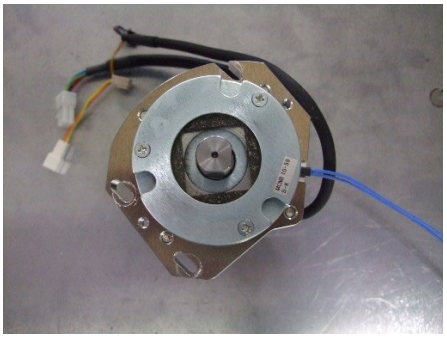
Pulley and motor shaft screws (A)
Hexagon socket set screws: 2-M5×12

NOTE Do not remove the pulley and drive boss screws (B in the figure.
There is a brass bushing on one of the set screws.
If you removed the screws (B), be careful not to lose the brass bushing.

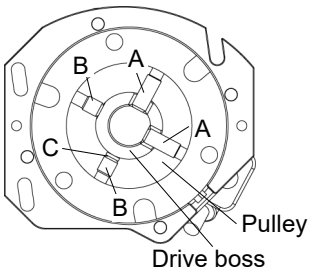
Pulley and drive boss screws (B)
Hexagon socket set screws: 2-M5×6
(with a brass bushing)

A: Pulley and motor shaft screws
(D-cut part of the motor shaft × 2)

B: Pulley and drive boss screws
Do not remove these screws.



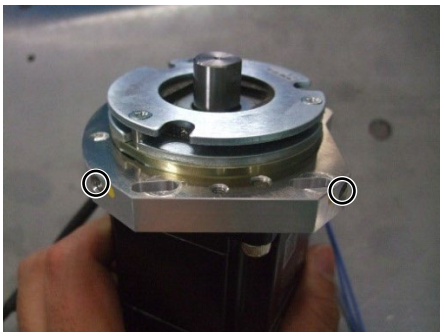
C: Bushing



10. Remove the Joint #3 electromagnetic brake.

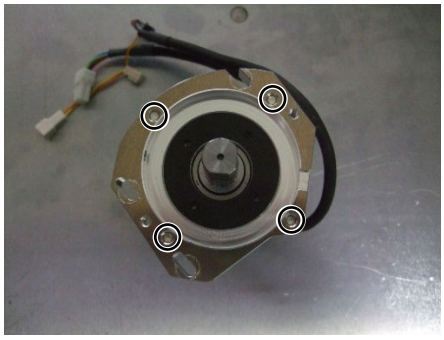
    Hexagon socket set screws: 2-M5×10 (with a brass bushing)

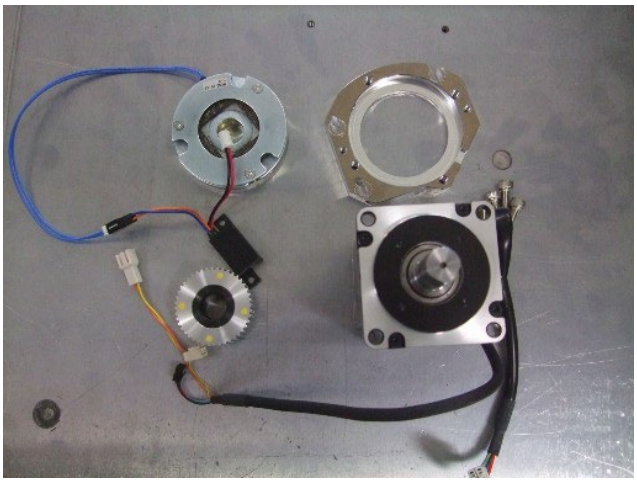
    The screws have a brass bushing.
    Be careful not to lose them.



11. Remove the motor plate from the Joint #3 motor.

    Hexagon socket head cap bolts: 4-M5×15



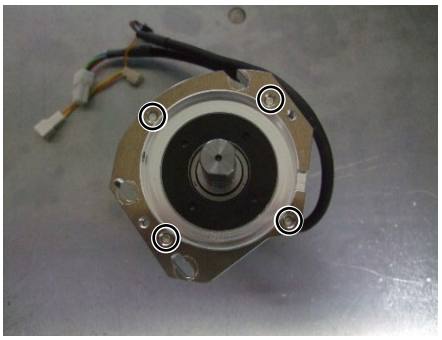


Installation: Joint #3 Motor

1. Install the motor plate to the Joint #3 motor.

   Hexagon socket head cap bolts: 4-M5×15

   Tightening torque: 8.0 ± 0.4 N·m

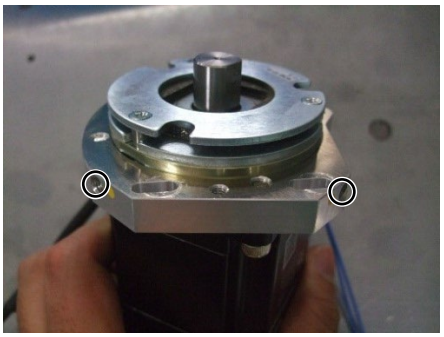


NOTE Be careful of the assembly direction of the motor plate. (See the figure.)

2. Mount the Joint #3 electromagnetic brake to the Joint #3 motor unit.

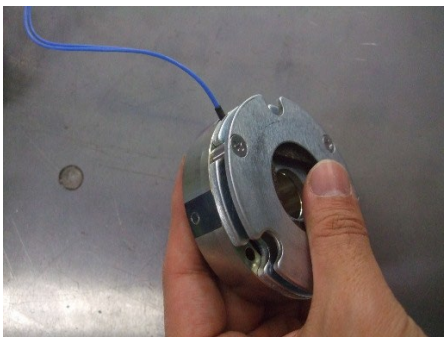
   Hexagon socket set screws: 2-M5×10 (with a brass bushing)

   Tightening torque: 3.9 ± 0.2 N·m

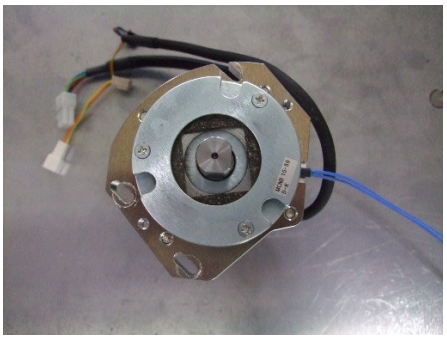


NOTE Be careful of the assembly direction of the Joint #3 electromagnetic brake. (See the photo.)

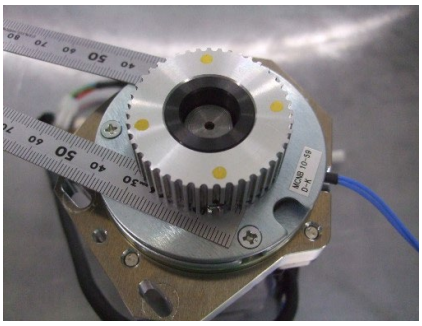
Fix the set screws while pressing the electromagnetic brake to the motor plate.
The brass bushing is not necessary for the screw for the flat surface (D-cut). Set the bushing to the other screw and then fix the screw.



NOTE If the screw positions are incorrect or the bushing is not set, it may cause damage on the side of the brake and may result in the part being unable to be removed.



3. Mount the drive boss and the pulley 1 to the Joint #3 motor unit.



Insert the pulley 1 so that the set screw is aligned to the flat surface of the motor shaft.

Fix the pulley 1 and the motor shaft.
Leave 0.5 mm between the pulley 1 and the electromagnetic brake.
The countersunk screw of the electromagnetic brake is projecting. Using the feeler gauge (0.5 mm), leave a space for the projection.

NOTE ☞ If there is no space for the projection, the parts may chafe while the motor is driving and it may result in breakage.

Hexagon socket set screws: 2-M5×12

Tightening torque: 3.9 ± 0.2 N·m

If the drive boss and the pulley 1 are removed:
Align the end faces of the drive boss and the pulley 1, and then fix them.

Hexagon socket set screw: 2-M5×6 (with a brass bushing)

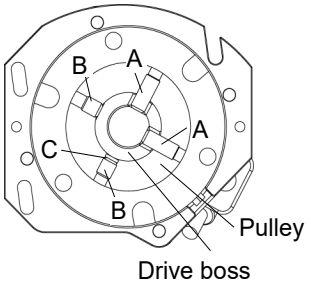
Tightening torque: 3.9 ± 0.2 N·m

Set the set screws to the positions indicated in the right figure.

A: Pulley and motor shaft screws
(D-cut part of the motor shaft × 2)

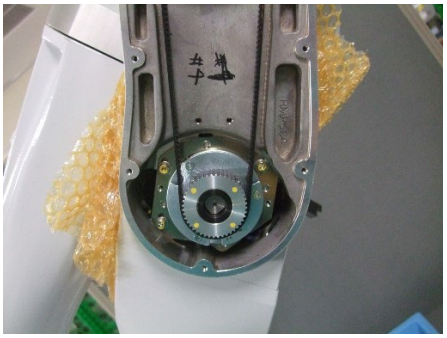
B: Pulley and drive boss screws
Do not remove these screws.

C: Bushing



NOTE ☞ If the screw positions are incorrect or the bushing is not set, it may cause damage on the side of the part and may result in the part being unable to be removed.

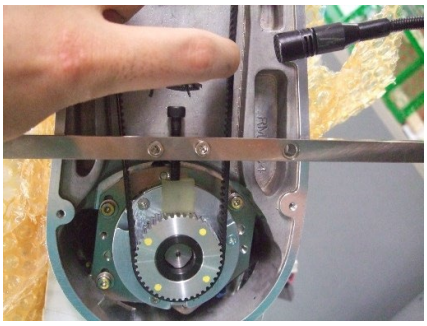
4. Put the Joint #3 motor unit in the Arm #2.



5. Set the timing belt around the pulley 1 and the pulley 2 and fix it temporarily.
Check that the teeth of the timing belt engage with these of the pulley.
As a rough guide of temporary fixing, check that the motor unit can be moved by hand, and it does not tilt when being pulled. If the belt is too loose or too tight, it will not have proper tension.

Hexagon socket set screws: 3-M4×20 (with a plain washer)

6. Apply tension to the Joint #3 timing belt and fix the Joint #3 motor unit.



Joint #3 timing belt tension: 25 to 85 N

Belt tension meter setting value

Weight: 2.5 g/mm width × m span, Width: 10 mm,
Span: 168 mm

Hexagon socket set screw: 3-M4×20 (with a plain washer)

Tightening torque: 4.0 ± 0.2 N·m

NOTE

Regarding belt tension:

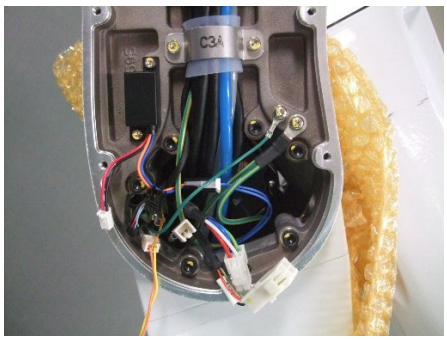
- Jumping (position gap) may occur if the value is below the lower limit
- Vibration (abnormal noise) or reduction of life of the parts may occur if the value exceeds the upper limit.
- When you replace with a new belt, belt extends and the belt tension may decrease in the initial stage. Make sure to operate the robot two to three days and check the belt tension again.

When using the belt tension tensile jig (maintenance part):

Fix the belt tension tensile jig (for J1, J2, J3) with the screws (2-M4×35) and push the rubber against the pulley.

Tension is applied by pushing the set screw (M6×25) with the rubber.

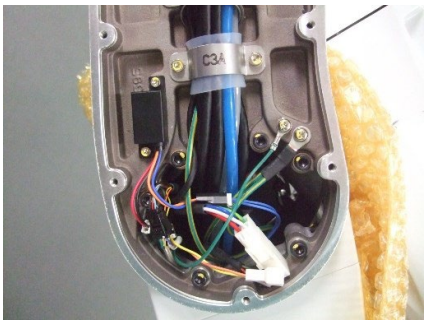
7. Install the brake power supply.



Cross recessed head screw with captive washer: 2-M3×6

Tightening torque: 0.45 ± 0.1 N·m

8. Connect the following connectors.



Connectors: X131, X031, BT3, BR031

9. Install the Arm #2 side cover.
For details, refer to *C8 Maintenance: 3. Covers.*

10. Perform the calibration.
For details, refer to *C8 Maintenance: 16. Calibration.*

7.2 Joint #3 - Replacing the Reduction Gear Unit

	Name		Qty.	Note
Maintenance Parts	Reduction gear unit (Joint #3)	C8-A701*** (C8) C8-A901*** (C8L)	1	1674607
		C8-A1401*** (C8XL)	1	1674608
	O-ring (Joint #3)	Arm #2 side	1	1263977
		Arm #3 side	1	1510528
	Belt tensile jig*		1	1674582
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts For M5 hexagon socket set screws
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolts
		width across flats: 5 mm	1	For M6 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Feeler gauge (0.5 mm)		2	For adjusting the pulley position
	Belt tension meter		1	Refer: Unitta U-505
	Cloth (cushioning)		1	For pressing arms

* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

When removing the Joint #3 timing belt, tilt the Arm #2 and press it against the Arm #2.
Reference: *C8 Maintenance: 7.1 Joint #3 - Replacing the Motor,* Removal step (2)

When pressing the arm, put a piece of cloth or a similar material between the arms to avoid contacting each other. This protects the arm surfaces from scratching and paint peeling off.

Removal: Joint #3 Reduction gear unit

1. Remove the Joint #3 timing belt.

   For details, refer to *C8 Maintenance 7.3 Joint #3 - Replacing the Timing Belt*, Removal steps (1) to (3).

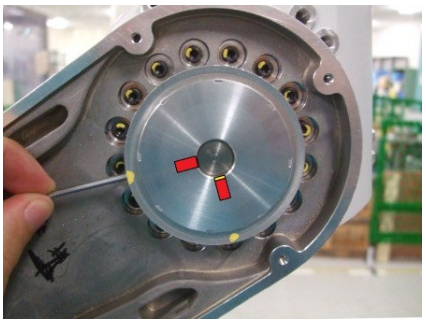
2. Remove the Arm #2 side arm fixing bolts.

   Hexagon socket head cap bolts: 6-M5×20 (with a plain washer)

3. Remove the Joint #3 pulley 2 from the Joint #3 shaft.

   Hexagon socket set screws
   C8, C8L: 2-M5×10
   C8XL: 2-M5×12

   There is a brass bushing on one of the set screws.
   Be careful not to lose it.



4. Remove the Arm #3.

   Hexagon socket head cap bolts: 16-M4×25 (with a plain washer)

   Remove a wave washer on the Arm #1 side.
   The wave washer will be used again. Be careful not to lose it.

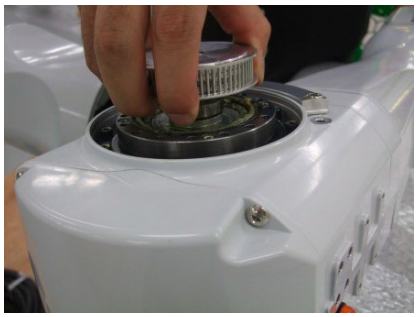
   Wipe grease on the parts while removing them.

⚠ CAUTION	■ By removing the bolts, the Arm #2 side arm, the Arm #3, #4, #5, and #6(end effector) can be separated. There is a possibility of hands and fingers being caught and/or damage or malfunction to the Manipulator. Be very careful when removing the arm. Have at least two workers so that one can support the Manipulator while the other worker is removing the bolts. ■ The Arms are connected by the internal cables. When replacing the parts, place the removed arm while not applying load on the cables. It may result in cable disconnection.

5. Remove the wave generator from the reduction gear unit.

   If the wave generator unit does not come off easily, set the pulley 2 as shown in the photo to the shaft and pull out the parts.

   Wipe grease on the wave generator while removing it.



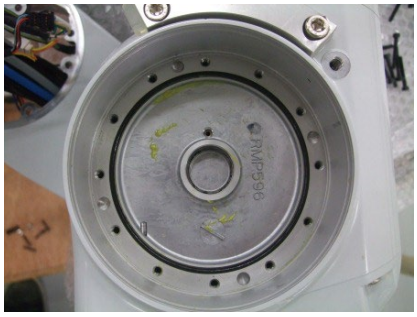
6. Remove the reduction gear unit from the Arm #3.

   Hexagon socket head cap bolts: 12-M4×30

   Wipe grease on the reduction gear unit while removing it.

7. Remove the O-ring from the groove on the Arm #3.

   Wipe grease on the O-ring while removing it.



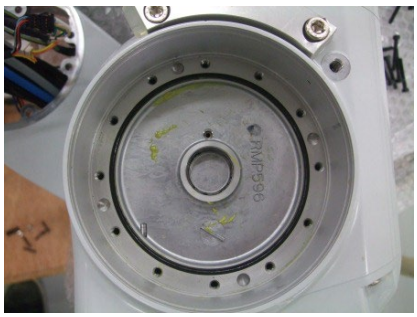
Installation: Joint #3 Reduction gear unit

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

1. Apply a thin coat of grease (SK-1A) to the O-ring.
   Fit the O-ring into the groove on the Arm #3.

   Do not allow the O-ring to come out of the groove.

   If the O-ring is swollen, damaged, or deteriorated, replace it with a new one.



2. Install the reduction gear unit to the Arm #3.

   Hexagon socket head cap bolts: 12-M4×30

   Tightening torque: 5.5 ± 0.2 N·m

   Installation face of the Arm #3 reduction gear unit has clearance holes.
   Install the reduction gear unit to match the screws and the clearance holes.

3. Grease the inner side of the flexspline.

   Grease: SK-1A

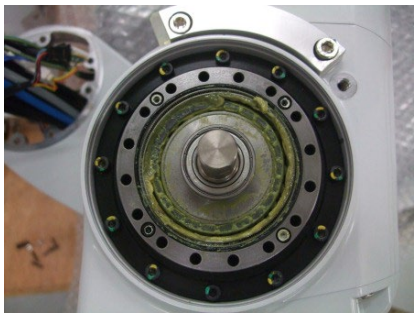
   Grease amount: 26 g

4. Insert the wave generator to the reduction gear unit and fix it.

5. Apply a thin coat of grease (SK-1A) to the O-ring.
Fit the O-ring into the groove on the reduction gear unit.

Do not allow the O-ring to come out of the groove.

If the O-ring is swollen, damaged, or deteriorated, replace it with a new one.



6. Temporarily fix the Arm #1 side arm to the Arm #2.
At this time, set the wave washer to the Arm #2.

Hexagon socket head cap bolts: 6-M5×20 (with a plain washer)

CAUTION	■ There is a possibility of hands and fingers being caught and/or damage or malfunction to the Manipulator. Be very careful when installing the arm. Have at least two workers so that one can support the Manipulator while the other worker is removing the bolts.

7. Fix the Arm #3.

Hexagon socket head cap bolts: 16-M4×25 (with a plain washer)

Tightening torque: 5.5 ± 0.2 N·m

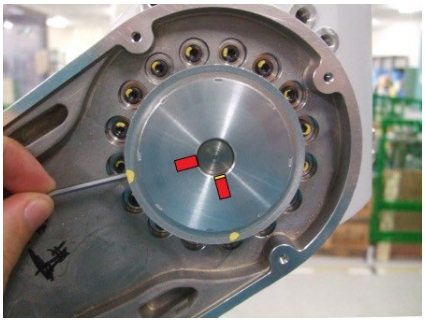
After fixing the Arm, check that there is no backlash or misalignment on the reduction gear unit by moving the Arm by hand.

8. After fixing the Arm #3, fix the Arm #2 side arm.

Hexagon socket head cap bolts: 6-M5×20 (with a plain washer)

Tightening torque: 10.0 ± 0.5 N·m

9. Install the Joint #3 pulley 2 to the Joint #3 shaft.



Hexagon socket head cap bolts (with 1 brass bushing)
C8, C8L: 2-M5×10
C8XL: 2-M5×12

Tightening torque: 3.9 ± 0.2 N·m

NOTE ☞ Insert the pulley 2 so that one of the set screws is at the flat face of the shaft. The brass bushing is not necessary for the screw for the flat surface. Set the bushing to the other screw and then fix the screw.

If the screw positions are incorrect or the bushing is not set, it may cause damage on the side of the brake and may result in the part being unable to be removed.

10. Install the Joint #3 timing belt.

For details, refer to *C8 Maintenance 7.3 Joint #2 – Replacing the Timing Belt*, Installation steps (1) to (2).

7.3 Joint #3 - Replacing the Timing Belt

	Name		Qty.	Note	
Maintenance Parts	Timing belt (Joint #3)	C8-A701*** (C8)	1	471 mm	1655915
		C8-A901*** (C8L)	1	480 mm	1655918
		C8-A1401*** (C8XL)	1	501 mm	1655919
	Belt tensile jig*		1	1674582	
Tools	Hexagonal wrench (width across flats: 3 mm)		1	For M4 hexagon socket head cap bolt	
	Cross-point screwdriver (#2)		1	For cross recessed head screws	
	Torque wrench		1	For tightening torque control	
	Cloth (cushioning)		1	For pressing arms	
	Belt tension meter		1	Refer: Unitta U-505	

* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

When removing the Joint #3 motor, tilt the Arm #2 and press it against the Arm #2.
Reference: *C8 Maintenance: 7.1 Joint #3 - Replacing the Motor,* Removal step (2)

When pressing the arm, put a piece of cloth or a similar material between the arms to avoid contacting each other. This protects the arm surfaces from scratching and paint peeling off.

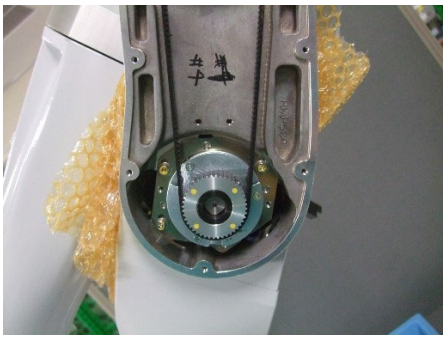
Removal: Joint #3 Timing belt

1. Follow Removal steps (1) through (4) of *C8 Maintenance: 7.1 Joint #3 – Replacing the Motor*.

2. Loosen the Joint #3 motor unit set screw.

   Hexagon socket head cap bolts: 3-M4×20
   (with a plain washer)

3. Remove the Joint #3 timing belt.



Installation: Joint #3 Timing belt

1. Pass the Joint #3 timing belt around the pulley 1 and the pulley 2 of the Joint #3.
   Pass the timing belt to the pulley 2 first, then, place the timing belt to the pulley 1.

2. Secure the Joint #2 motor unit.
   For details, refer to *C8 Maintenance: 7.1 Joint #3 – Replacing the Motor*, Installation steps (5) to (6) and (9) to (10).

7.4 Joint #3 - Replacing the Electromagnetic Brake

	Name		Qty.	Note
Maintenance Parts	Electromagnetic brake (Joint #3)		1	2172927
	Belt tensile jig*		1	1674582
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M5 hexagon socket set screw
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolt
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolt
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Feeler gauge (0.5 mm)		2	For adjusting the pulley position
	Belt tension meter		1	Refer: Unitta U-505
	Cloth (cushioning)		1	For pressing arms

* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

When removing the Joint #3 motor, tilt the Arm #2 and press it against the Arm #2.
Reference: *C8 Maintenance: 7.1 Joint #3 - Replacing the Motor,* Removal step (2)

When pressing the arm, put a piece of cloth or a similar material between the arms to avoid contacting each other. This protects the arm surfaces from scratching and paint peeling off.

Removal: Joint #3 Electromagnetic brake

1. Remove the Joint #3 electromagnetic brake.
   For details, refer to *C8 Maintenance: 7.1 Joint #3 – Replacing the Motor*, Removal steps (1) through (10).

Installation: Joint #3 Electromagnetic brake

1. Mount the Joint #3 electromagnetic brake to the Joint #3 motor unit.
   For details, refer to *C8 Maintenance: 7.1 Joint #3 – Replacing the Motor*, Installation steps (2) through (10).

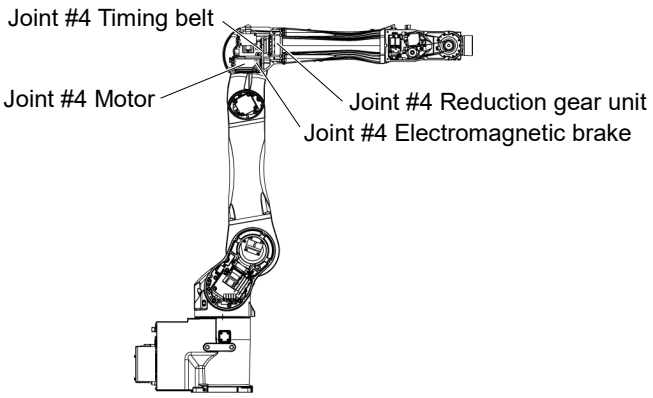
8. Joint #4

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 during replacement. The shock may shorten the life of the motors and encoder and/or damage them. ■ Never disassemble the motor and the encoder. Disassembled motor and encoder will cause a positional gap and cannot be used again.

After parts have been replaced (motors, reduction gear units, timing belts, etc.), the Manipulator cannot perform positioning properly because a gap exists between the origin stored in each motor encoder and its corresponding origin stored in the Controller.

Therefore, it is necessary to match these origins after replacing the parts.
The process of aligning the two origins is called “Calibration”.
Refer to *C8 Maintenance 16. Calibration* and perform the calibration after the parts replacement.



(Figure: C8-A1401* (C8XL))

8.1 Joint #4 - Replacing the Motor

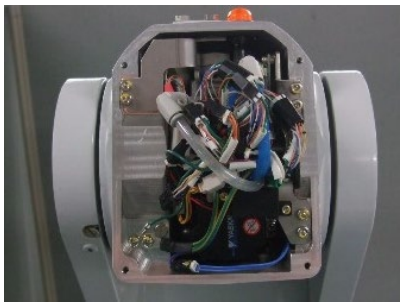
	Name		Qty.	Note
Maintenance Parts	AC servo motor 100 W		1	2172051 (common to Joints #4, #5, #6)
	Belt tensile jig*		1	1674582
Tools	Hexagonal wrench	width across flats: 2 mm	1	For M4 hexagon socket set screws
		width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Feeler gauge (0.5 mm)		2	For pulley position adjustment
	Belt tension meter		1	Refer: Unitta U-505

* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

NOTE ☞ The motors are common for Joints #4, #5, and #6.
The Joints #5 and #6 motors have an identification label for preventing misconnection of the connectors. The label is not necessary for the Joint #4 motor. (There is no connector identification label for the Joint #4.)

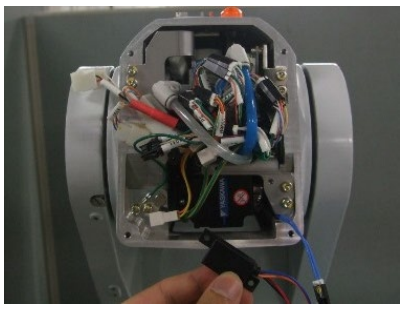
Removal: Joint #4 Motor



1. Turn OFF the Controller power.
2. Remove the following covers.
   Arm #3 cover
   Arm #3 maintenance cover
   Arm #2 side cover
   For details, refer to *C8 Maintenance: 3. Covers.*
3. Pull out the cables from the Arm #3 and disconnect the following connectors.

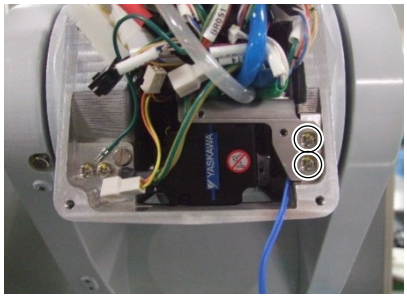
   Connector: X141, X041, BT4, BR041

   (Hold the clip to remove.)

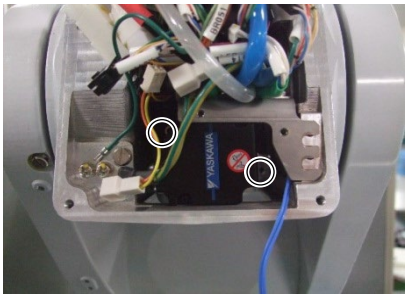


4. Remove the brake power supply.

   Cross recessed head screws with captive washer: 2-M3×6

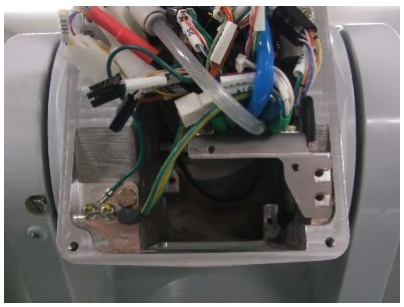


5. Remove the cable bracket.
   Hexagon socket head cap bolts: 2-M4×10

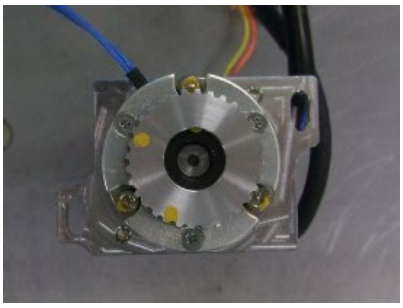


6. Remove the Joint #4 motor unit from the Arm #3.

   Hexagon socket head cap bolts: 2-M4×15
   (with a small plain washer)



7. Remove the Joint #4 pulley 1 and the drive boss from the motor shaft of the Joint #4 motor unit.



Pulley 1 and drive boss screws
Hexagon socket set screws: 2-M4×4 (with a brass bushing)

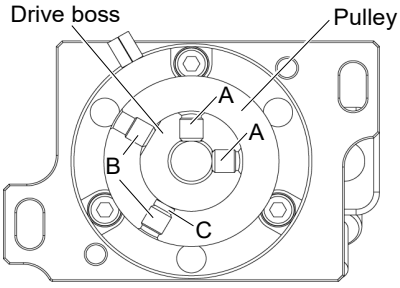
Drive boss and motor shaft screws
Hexagon socket set screws: 2-M4×4

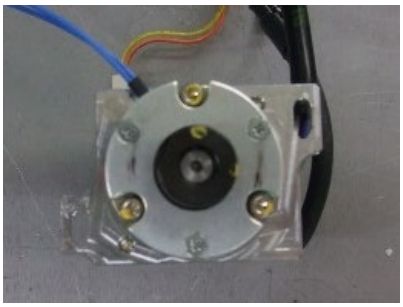
There is a brass bushing on one of the set screws fixing the drive boss and the pulley.　Be careful not to lose it.

A: Pulley and motor shaft screws

B: Pulley and drive boss screws

C: Bushing

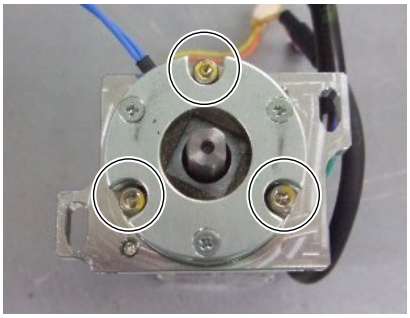




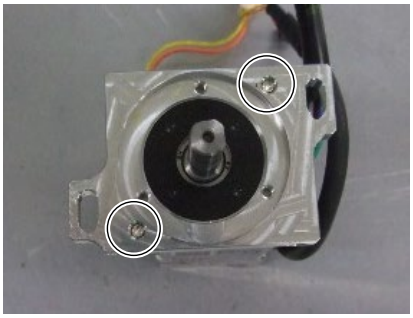
8. Remove the Joint #4 electromagnetic brake.

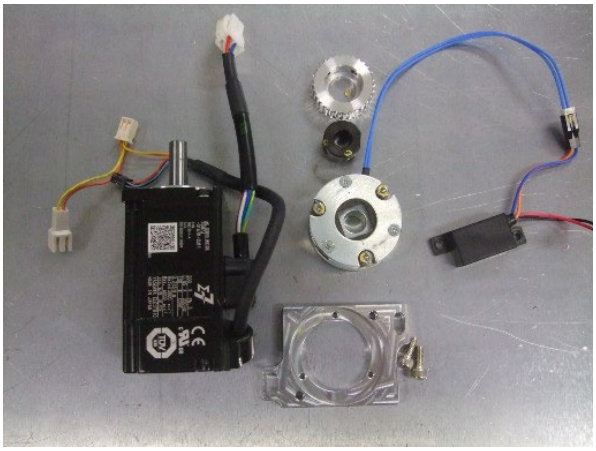
Hexagon socket set screws: 3-M3×15 (with a spacer)

Be careful not to lose the spacers.



9. Remove the motor plate from the Joint #4 motor.
Hexagon socket head cap bolts: 2-M4×10





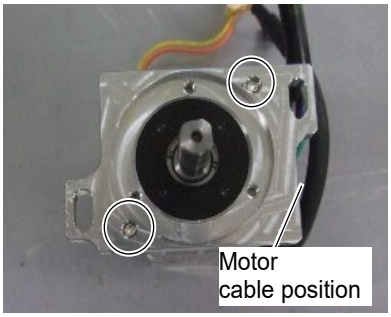
Installation: Joint #4 Motor

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

1. Install the motor plate to the Joint #4 motor.

   Hexagon socket head cap bolts: 2-M4×10

   Tightening torque: 4.0 ± 0.2 N·m

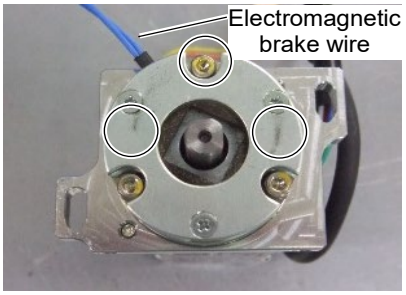


NOTE Be careful of the assembly direction of the motor plate. (See the photo.)

2. Mount the Joint #4 electromagnetic brake to the Joint #4 motor unit. Set the spacers between the hexagon socket set screws and the Joint #4 electromagnetic brake.

   Hexagon socket set screws: 3-M3×15 (with a spacer)

   Tightening torque: 2.0 ± 0.1 N·m



NOTE Be careful of the direction of the Joint #4 electromagnetic brake wire. (See the photo.)

3. Mount the drive boss and the pulley 1 to the Joint #4 motor unit.

   Fix the drive boss and the motor shaft.
   There is an uneven part for the feeler gauge (0.5 mm) on the boss.
   Use the uneven part to leave 0.5 mm space.

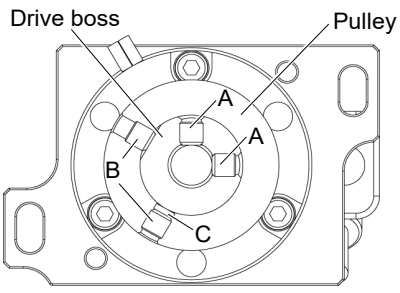
NOTE If there is no space, the parts may chafe while the motor is driving and it may result in breakage while the motor is moving.

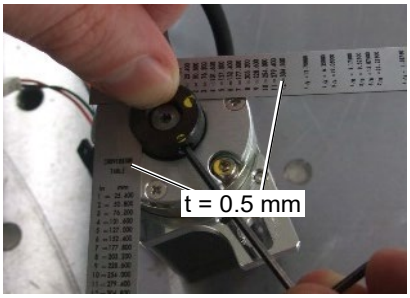
   Set the set screws to the positions indicated in the figure.

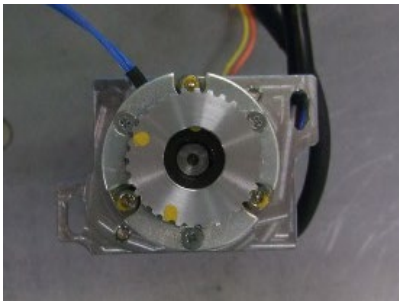
   A: Pulley and motor shaft screws

   B: Pulley and drive boss screws

   C: Bushing







NOTE If the screw positions are incorrect or the bushing is not set, it may cause damage on the side of the part and may result in the part being unable to be removed.

Drive boss and the motor shaft:

Hexagon socket set screws: 2-M4×4
Tightening torque: 2.5 ± 0.2 N·m

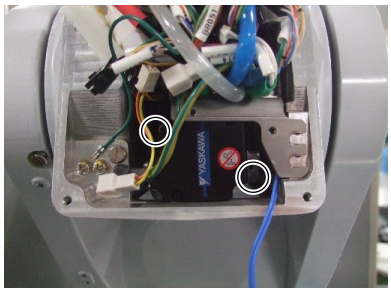
Align the screws to the two flat faces of the motor shaft and fix them.

Drive boss and the pulley 1:

Hexagon socket set screws: 2-M4×4 (with a brass bushing)
Tightening torque: 2.5 ± 0.2 N·m

Fix the set screws while pressing the pulley 1 to the drive boss.
The brass bushing is not necessary for the screw for the flat surface (D-cut). Set the bushing to the other screw and then fix the screw.

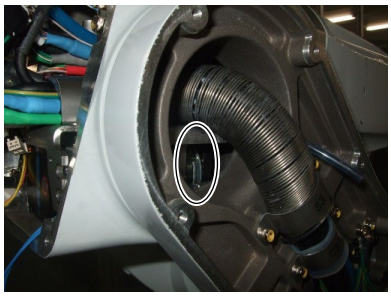
4. Put the Joint #4 motor unit inside the Arm #4.



5. Pass the timing belt around the pulley 1 and pulley 2 and temporarily fix it.

   Hexagon socket head cap bolts: 2-M4×15 (with a washer)

   Check that the teeth of the timing belt engage with these of the pulley.



   As a rough guide of temporary fixing, check that the motor unit can be moved by hand, and it does not tilt when being pulled.
   If the belt is too loose or too tight, it will not have proper tension.

6. Apply tension to the Joint #4 timing belt and fix the Joint #4 motor unit.

   Joint #4 timing belt tension: 15 to30 N

   Belt tension meter setting value

   Weight: 2.5 g/mm width × m span, Width: 6 mm, Span: 61 mm

   Hexagon socket head cap bolt: 2-M4×15 (with a plain washer)

   Tightening torque: 4.0 ± 0.2 N·m

Regarding belt tension:

NOTE

- Jumping (position gap) may occur if the value is below the lower limit.
- Vibration (abnormal noise) or reduction in life of the parts may occur if the value exceeds the upper limit.
- When you replace with a new belt, belt may stretch and the belt tension will decrease in the initial stage of operation. Make sure to operate the robot two to three days and check the belt tension again.

When using the belt tension tensile jig (maintenance part):

Fix the belt tension tensile jig (for J4) to the Joint #4 motor plate.

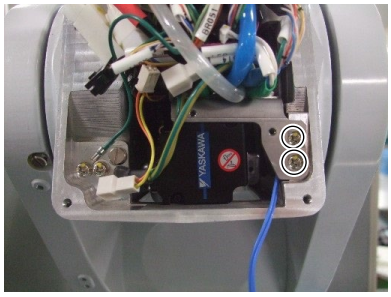
Hexagon socket head cap bolt: 2-M4×15

Push the belt tension tensile jig (for J4, J5, and J6) against the Arm #3 as shown in the photo. Insert the screw to the through hole at the center and fix it lightly to the hole for the belt tension tensile jig.

Hexagon socket head cap bolt: M4×15

Tension is applied as the Joint #4 motor unit is stretched by tightening the screw.

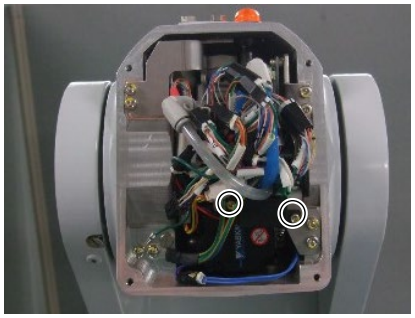
7. Install the plate for fixing the cables.
   Hexagon socket head cap bolts: 2-M4×10



8. Install the brake power supply to the plate.
   Install the brake power supply so that the cable is facing to the left.

   Cross recessed head screw with captive washer: 2-M3×6

   Tightening torque: 0.45 ± 0.1 N·m



9. Connect the following connectors.

   Connectors: X141, X041, BT4, BR041

10. Install the following cover.
    Arm #3 cover
    Arm #3 maintenance cover
    Arm #2 side cover
    For details, refer to *C8 Maintenance: 3. Covers*.

11. Calibrate the Joint #4.
    For details, refer to *C8 Maintenance: 16. Calibration*.

8.2 Joint #4 - Replacing the Reduction Gear Unit

	Name		Qty.	Note
Maintenance Parts	Reduction gear unit (Joint #4)	C8-A701*** (C8) C8-A1401*** (C8XL)	1	1674609
		C8-A901*** (C8L)	1	1675434
	Belt tensile jig*		1	1674582
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolts
		width across flats: 5 mm	1	For M6 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Belt tension meter		1	Refer: Unitta U-505

* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

Removal: Joint #4 Reduction gear unit

1. Turn OFF the Controller power.
2. Remove the Arm #4 side cover and Arm #3 cover.

   For details, refer to *C8 Maintenance 3. Covers*.

3. Remove the Joints #5 and #6 motors.

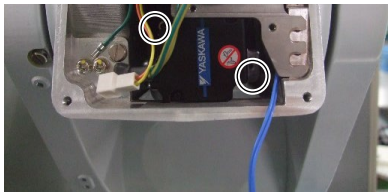
   For details, refer to the Removal steps in *C8 Maintenance 9.1 Joint #5 - Replacing the Motor* and *C8 Maintenance 10.1 Joint #6 - Replacing the Motor*.

4. Remove the cables passing through the Arm #4 as shown in the photo.

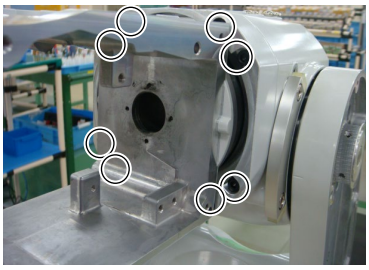
   For details, refer to the Removal steps in *C8 Maintenance 4.1 Cable Unit*.

5. Loosen the fixing bolts of the Joint #4 motor plate and remove the belt. (Do not remove the Joint #4 motor.)

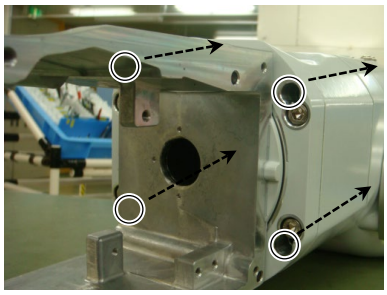
   Hexagon socket head cap bolts: 2-M4×15
   (with a small plain washer)



6. Remove the bolts fixing the J4 flange, and remove the Arm #4 from the Arm #3.
   To remove all bolts, change the position of the Joint #4 by rotating it.
   Hexagon socket head cap bolts: 8-M5×30

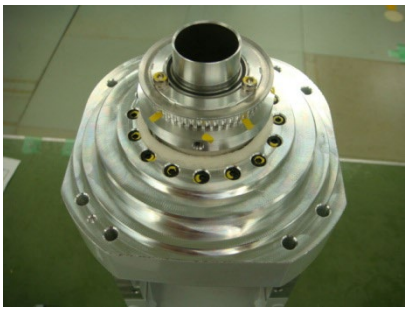


   C8L:
   The bolts can be removed from the four through holes on the extension flange of the Arm #4.



7. Remove the bolts fixing the J4 flange and the Joint #4 reduction gear unit.

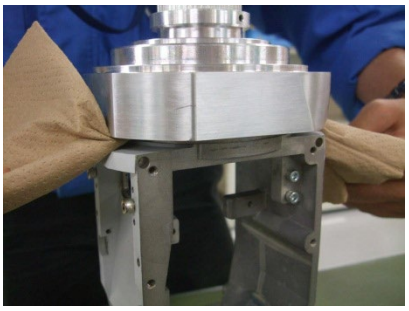
   Hexagon socket head cap bolts: 16-M3×20



8. Remove the wave generator of the Joint #4 reduction gear unit together with the J4 flange.

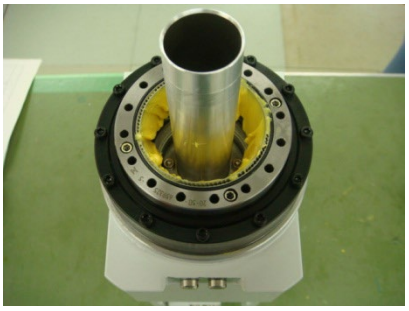
   If the wave generator does not come off easily, insert a tool in a gap between the J4 flange and the Arm and remove the wave generator little by little.

   Be careful not to damage the parts.



9. Remove the Joint #4 reduction gear unit.

   Hexagon socket head cap bolts: 12-M3×28

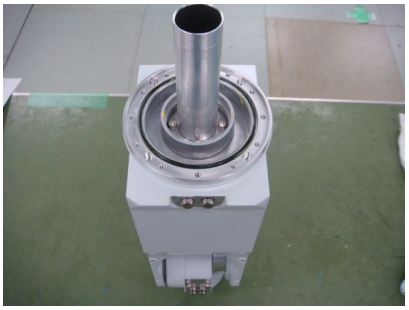


10. Remove the J4 sleeve holder.
    Then, remove the J4 sleeve.

    Hexagon socket head cap bolts: 4-M3×6

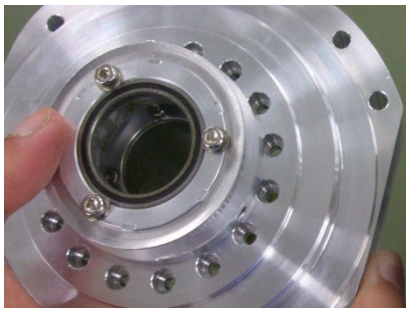
    The J4 sleeve is attached by gasket and may not be removed easily. If the part cannot be removed, pull the sleeve while rotating it.

    Handle the sleeve with care since it is thin and easy to deform.



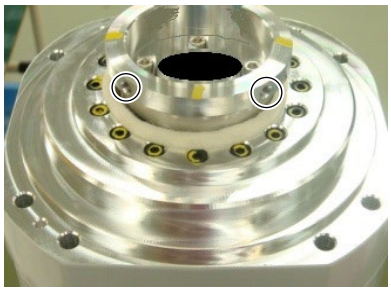
11. Remove the bolts of the bearing holder on the pulley.

    Hexagon socket head cap bolts: 3-M3×8 (with a plain washer)



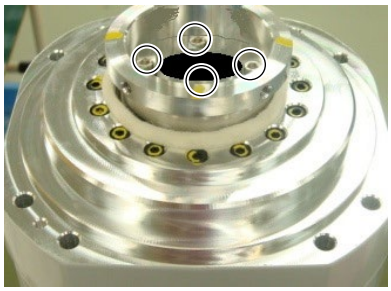
12. Remove the pulley from the pulley spacer.

    Hexagon socket set screws: 2-M4×4



13. Remove the pulley spacer from the wave generator.

    Hexagon socket head cap bolts: 4-M3×8



Installation: Joint #4 Reduction gear unit

NOTE

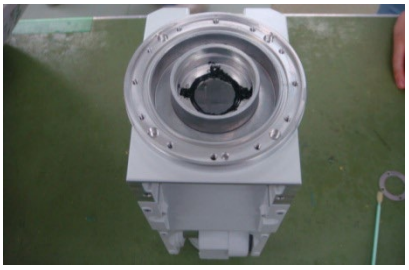
When tightening hexagon socket head cap bolts, refer to the *2.4 Tightening Hexagon Socket Head Cap Bolts.*

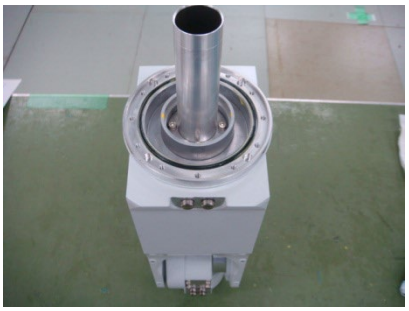
1. Apply grease to the mating surface of the sleeve and the fixing bolts. (for grease leakage prevention for the reduction gear unit)

   Fit the J4 sleeve and install the J4 sleeve holder.

   Hexagon socket head cap bolts: 4-M3×6

   Tightening torque: 2.0 ± 0.1 N·m

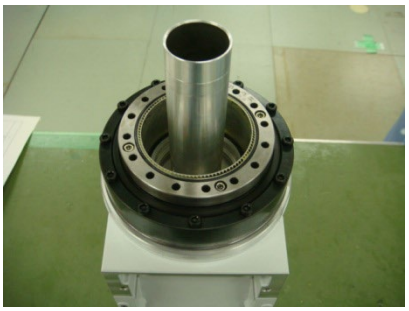




2. Install the O-ring to the O-ring groove.
   Install the Joint #4 reduction gear unit.

   Hexagon socket head cap bolts: 12-M3×28

   Tightening torque: 2.4 ± 0.1 N·m

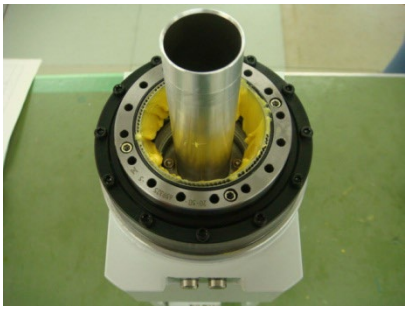


3. Apply grease to the Joint #4 reduction gear unit.

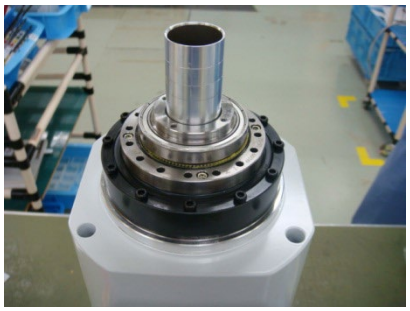
   Grease: SK-1A

   Grease amount: 20 g

   Apply 10g of grease to the wave generator.
   Apply the remaining 10 g to the inner side of the flexspline as shown in the photo.



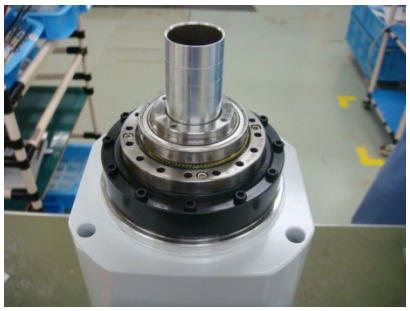
4. Install the wave generator of the Joint #4 reduction gear unit.

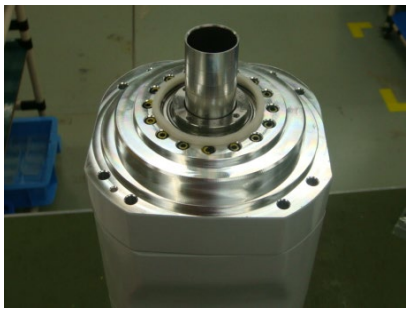


5. Set the O-ring attached to the reduction gear unit to the O-ring groove on the Joint #4 reduction gear unit.
   Then, install the J4 flange.

   Hexagon socket head cap bolts: 16-M3×20

   Tightening torque: 2.4 ± 0.1 N·m

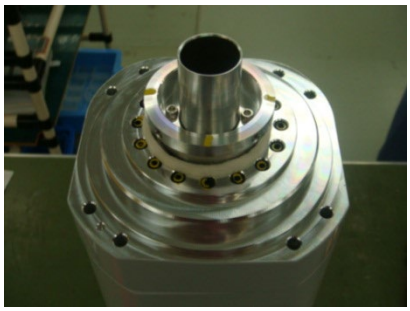




6. Fix the pulley spacer to the wave generator of the Joint #4 reduction gear unit.

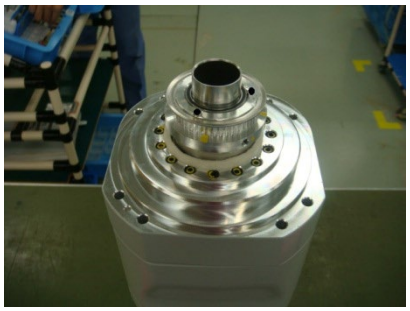
   Hexagon socket head cap bolts: 4-M3×8

   Tightening torque: 2.0 ± 0.1 N·m



7. Fix the J4 pulley to the J4 pulley spacer.

   Hexagon socket set screws: 2-M4×4



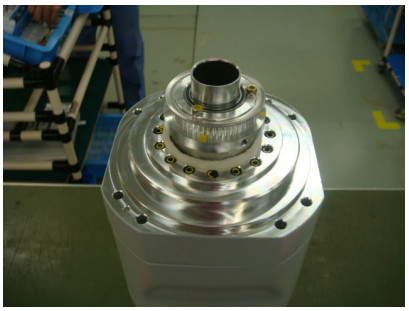
8. Apply adhesive to the following parts of the J4 pulley.
   Bearing mating part
   Inner ring (J4 sleeve)
   Outer ring (J4 pulley)

   Adhesive: Loctite 641

   Install the J4 pulley bearing, and tighten the bearing bolt.

   Hexagon socket head cap bolts: 3-M3×8 (with a plain washer)

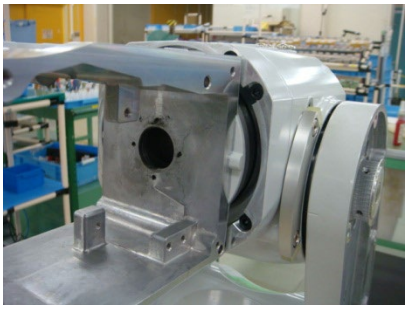
   Tightening torque: 2.0 ± 0.1 N·m



9. Install the Arm #4 to the Arm #3.
   To fix all bolts, change the position of the Joint #4 by rotating it.

   Hexagon socket head cap bolts: 8-M5×30

   Tightening torque: 10.0 ± 0.5 N·m



10. Install the Joint #4 timing belt with a proper tension.

    For details, refer to *C8 Maintenance 8.1 Joint #4 – Replacing the Motor*, Installation steps (5) and (6).

11. Pass the cables to the Arm #4.

    For details, refer to Installation steps in *C8 Maintenance 4.1 Cable Unit*.

12. Install the Joint #5 and #6 motors.

    For details, refer to Installation steps of *C8 Maintenance 9.1 Joint #5 – Replacing the Motor* and *C8 Maintenance 10.1 Joint #6 – Replacing the Motor*.

13. Install the removed covers.

    For details, refer to *C8 Maintenance 3. Covers*.

14. Perform the calibration.

    For details, refer to *C8 Maintenance 16. Calibration*.

8.3 Joint #4 - Replacing the Timing Belt

	Name		Qty.	Note
Maintenance Parts	Timing belt (Joint #4)		1	1655931
	Belt tensile jig		1	1674582
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolt
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolt
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Belt tension meter		1	Refer: Unitta U-505
	Nippers		1	For cutting the wire tie
	Masking tape		1	For protecting the connector clips
	Wire tie (AB100 or equivalent)		As needed	For passing the cables
	Braid tube (600 mm or longer)		1	For passing the cables

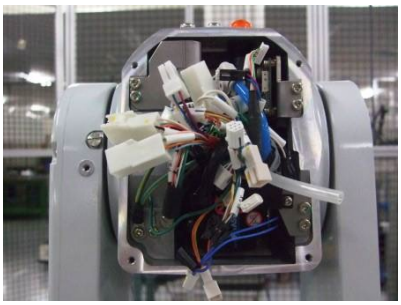
* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

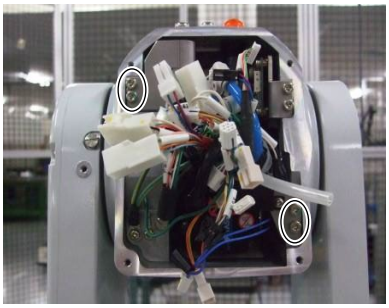
Removal: Joint #4 Timing belt

1. Remove the Joint #4 motor unit.
   For details, refer to *C8 Maintenance: 8.1 Joint #4 – Replacing the Motor*, Installation steps (1) through (6).

2. Remove the connectors inside the Arm #3 and the air tube (transparent).
   Connectors:
   X71, X72, X041,
   BR041, BR051, PS,
   BT4, BT51, X141, X151, X161



3. Remove the cable bracket inside the Arm #3.
   Hexagon socket head cap bolts: 4-M4×10



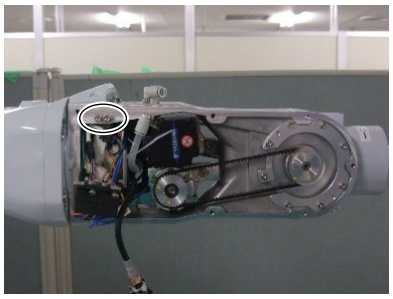
4. Remove the Arm #3 cable bracket and cable protection sheet.
   Hexagon socket head cap bolts: 2-M3×6

   The Arm #3 cable bracket and cable protection sheet will be used again. Be careful not to lose them.

5. Remove the Arm #4 side cover.
   For details, refer to *C8 Maintenance: 3 Covers.*

6. Remove the cable protection plate attached to the Arm #4.

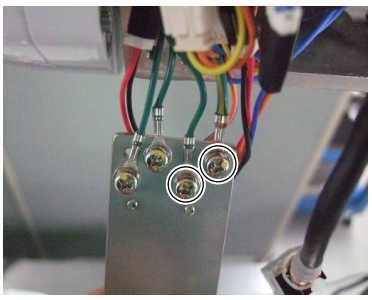
   Hexagon socket head cap bolts: 2-M4×10



7. Remove the green/yellow ground wire and the green ground wire connected to X052 and X062 from the cable protection plate.

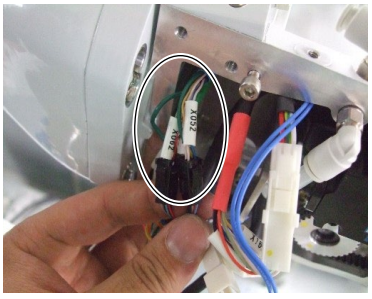
   Cross recessed head screws with captive washer: 2-M4×8

   Positions of the ground wire terminals may differ from the photo. Check which connector the terminal is connected to.



8. Remove the following connectors.

   Connector: X052, X062

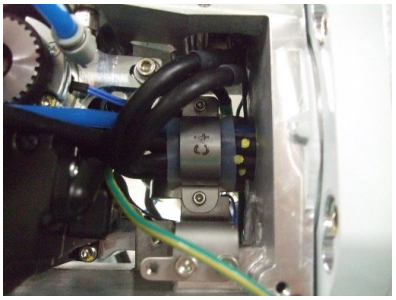


9. Remove the Arm #4 cable bracket and the cable protection sheet.

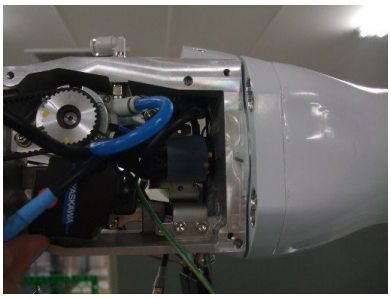
   Hexagon socket head cap bolts: 2-M3×6

   The Arm #4 cable bracket and cable protection sheet will be used again. Be careful not to lose them.

   C8XL:
   The cable protection tube is used instead of the cable protection sheet.



10. Remove the air tube (blue) from the fitting.



C8XL:

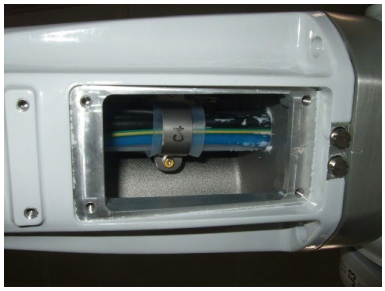
11. Remove the Arm #4 maintenance cover.
    For details, refer to *C8 Maintenance: 3 Covers*.

C8XL:

12. Remove the Arm #4 cable bracket and the cable protection sheet.

    Hexagon socket head cap bolts: 2-M3×6

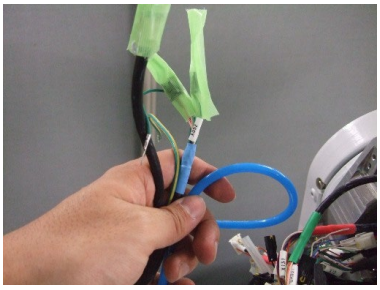
    The Arm #4 cable bracket and cable protection sheet will be used again. Be careful not to lose them.



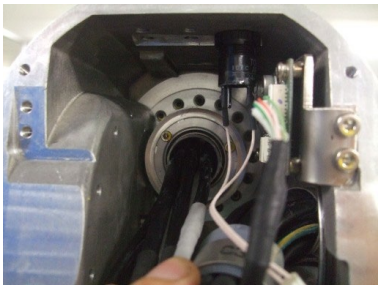
13. Pull the following parts from the Arm #4 to the Arm #3.
    LAN cable
    X052 and X062 cables
    Ground wire
    Air tube (blue)

    Protect the connectors with masking tapes.

    - To protect the connector's clips
    - To avoid adherence of cable grease



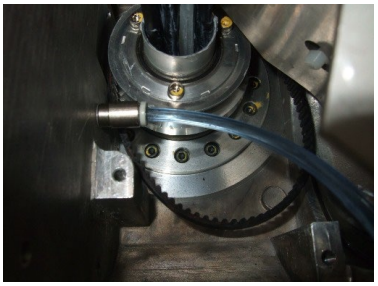
14. Remove the Joint #4 timing belt.



Installation: Joint #4 Timing belt

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

1. Pass the Joint #4 timing belt around the Joint #4 pulley 2



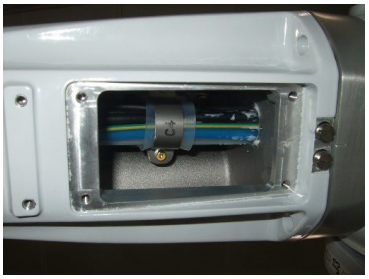
2. Install the Joint #4 motor unit.
   For details, refer to *C8 Maintenance: 8.1 Joint #4 – Replacing the Motor*, Installation steps (4) through (6).
3. Pass the following parts from the Arm #3 to the Arm #4.
   X052 and X062 cables
   LAN cable
   Ground wire
   Air tube (blue)

   How to pass the cables:
   First pass the braid tube from the Arm #4 side to the Arm #3 side. Insert the connectors through the braid tube, as shown in the photo, and fix the tube with the wire tie so that connectors are not to be pulled out. Then, pull the braid tube from the Arm #4 side while pushing the cables from the Arm #3 side to pass the cables through. (See the photo.)

NOTE
Pulling the cables forcibly may cause falling off or breakage of the connectors and disconnection of the cables.
If it is difficult to pass the cables, pass the cables one by one in the following order.
X052 and X062 cables LAN cable Ground wire Air tube (blue)

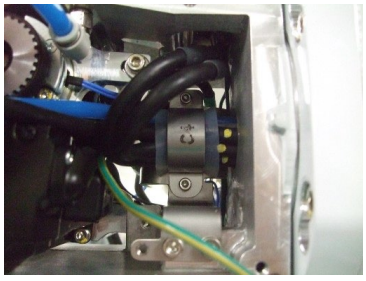
C8XL:

4. Wrap the cables inside the Arm #4 extension part with a cable protection sheet and install the Arm #4 cable bracket.



   Hexagon socket head cap bolts: 2-M3×6
   Tightening torque: 2.0 ± 0.1 N·m

5. Wrap the cables inside the Arm #4 with a cable protection sheet and install the Arm #4 cable bracket.



   C8XL:
   Install the Arm #4 cable bracket on the cable protection tube.
   Hexagon socket head cap bolts: 2-M3×6
   Tightening torque: 2.0 ± 0.1 N·m

6. Wrap the cables inside the Arm #3 with a cable protection sheet and install the Arm #3 cable bracket.

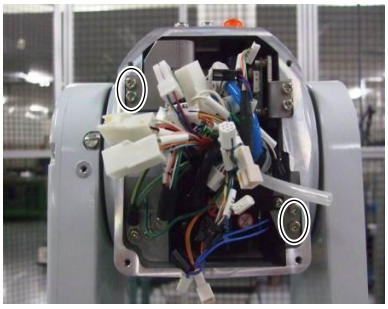
   Hexagon socket head cap bolts: 2-M3×6

   Tightening torque: 2.0 ± 0.1 N·m

7. Install the cable bracket inside the Arm #3.

   Hexagon socket head cap bolts: 4-M4×10

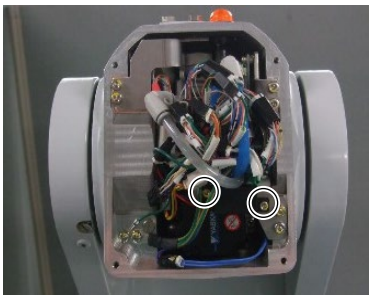
   Tightening torque: 4.0 ± 0.2 N·m



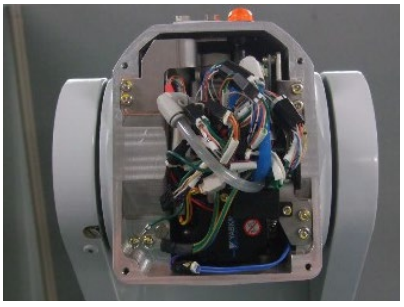
8. Install the brake power supply to the plate.
   Install the brake power supply so that the cable is facing to the left.

   Cross recessed head screws with captive washer: 2-M3×6

   Tightening torque: 0.45 ± 0.1 N·m



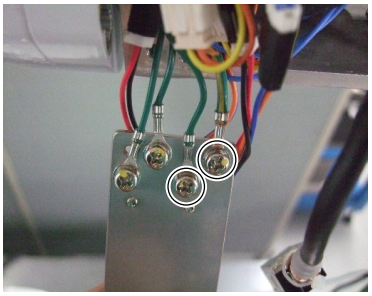
9. Connect the connectors inside the Arm #3 and the air tube (transparent).
   Connector:
   X71, X72, X041,
   BR041, BR051, PS,
   BT4, BT51, X141, X151, X161



10. Connect the ground wire terminals inside the Arm #4 to the Arm #4 cable protection bracket.

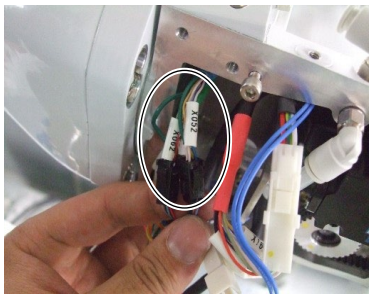
    Cross recessed head screws with captive washer: 2-M4×8

    Tightening torque: 0.45 ± 0.1 N·m



11. Connect the connectors inside the Arm #4.

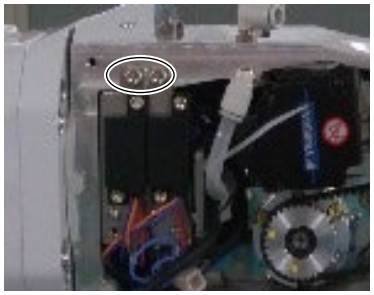
    Connector:
    X052, X062



12. Fix the cable protection bracket to the Arm #4.

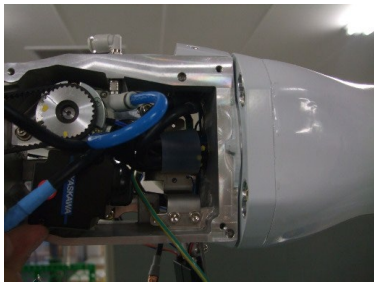
    Hexagon socket head cap bolts: 2-M4×10

    Tightening torque: 4.0 ± 0.2 N·m



NOTE Be careful not to get the cables caught.
It may cause cable breakage.

13. Install the air tube (blue) to the fitting.



14. Install the following covers.

    Arm #3 cover
    Arm #3 maintenance cover
    Arm #4 side cover
    Arm #4 maintenance cover : C8XL only

    For details, refer to *C8 Maintenance 3. Covers*.

8.4 Joint #4 - Replacing the Electromagnetic Brake

	Name		Qty.	Note
Maintenance Parts	Electromagnetic brake		1	2172928 (common for Joints #4, #5, #6)
	Belt tensile jig		1	1674582
Tools	Hexagonal wrench	width across flats: 2 mm	1	For M4 hexagon socket set screws
		width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Feeler gauge (0.5 mm)		1	For adjusting the drive boss position
	Belt tension meter		1	Refer: Unitta U-505

* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

NOTE ☞ The electromagnetic brakes are common for Joints #4, #5, and #6.
The Joints #5 and #6 electromagnetic brakes have an identification label for preventing misconnection of the connectors. The label is not necessary for the Joint #4 electromagnetic brake. (There is no connector identification label for the Joint #4.)

Removal: Joint #4 Electromagnetic brake

1. Remove the Joint #4 electromagnetic brake.
   For details, refer to *C8 Maintenance: 8.1 Joint #4 – Replacing the Motor*, Removal steps (1) through (8).

Installation: Joint #4 Electromagnetic brake

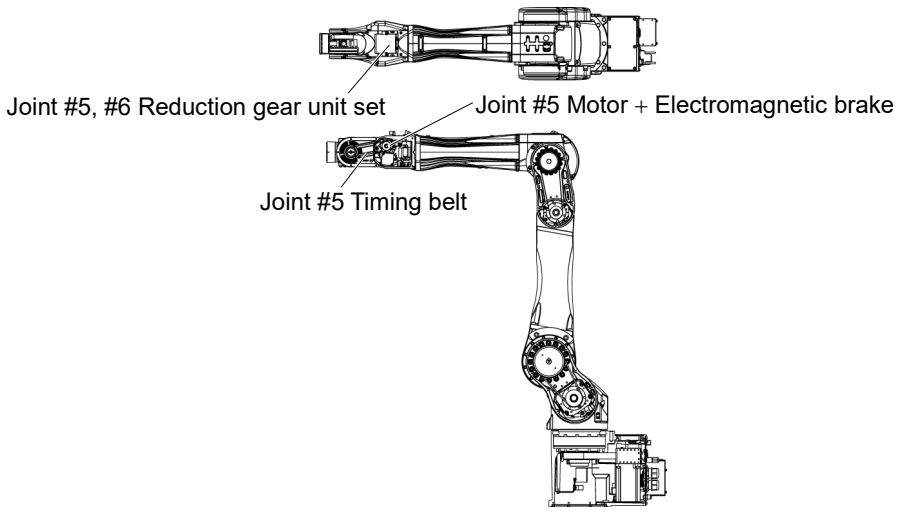
1. Mount the Joint #4 electromagnetic brake to the Joint #4 motor unit.
   For details, refer to *C8 M*aintenance: *8.1 Joint #4 – Replacing the Motor*, Installation steps (2) through (11).

9. Joint #5

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 during replacement. The shock may shorten the life of the motors and encoder and/or damage them. ■ Never disassemble the motor and the encoder. Disassembled motor and encoder will cause a positional gap and cannot be used again.

After parts have been replaced (motors, reduction gear units, electromagnetic brakes, timing belts, etc.), the Manipulator cannot perform positioning properly because a gap exists between the origin stored in each motor encoder and its corresponding origin stored in the Controller.
Therefore, it is necessary to match these origins after replacing the parts.
The process of aligning the two origins is called “Calibration”.
Refer to *C8 Maintenance 16. Calibration* and perform the calibration after the parts replacement.



(Figure: C8-A1401* (C8XL))

9.1 Joint #5 - Replacing the Motor

	Name		Qty.	Note
Maintenance Parts	AC servo motor 100 W		1	2172051 (Common for Joints #4, #5, #6)
	Belt tensile jig *		1	1674582
Tools	Hexagonal wrench	width across flats: 2 mm	1	For M4 hexagon socket set screws
		width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Spanner (width across flats: 8 mm)		1	For air tube fitting
	Feeler gauge (0.5 mm)		2	For adjusting the drive boss position
	Belt tension meter		1	Refer: Unitta U-505

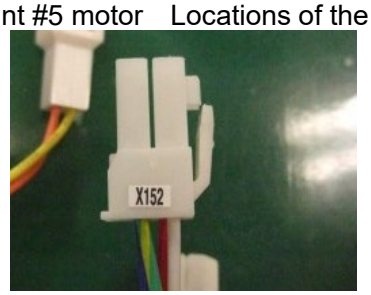
* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

Attaching the labels

The motors are common for Joints #4, #5, and #6.
In order to prevent misconnection of the connectors, attach the label for the motor as shown in the photos.

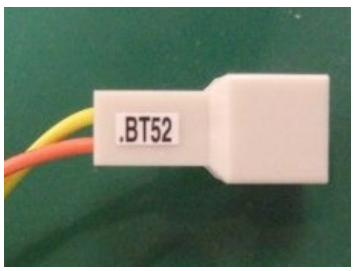
Joint #5 motor Locations of the connector labels



X152

X052

BT52

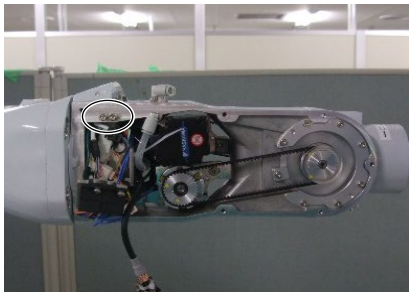


_BT52

Removal: Joint #5 Motor

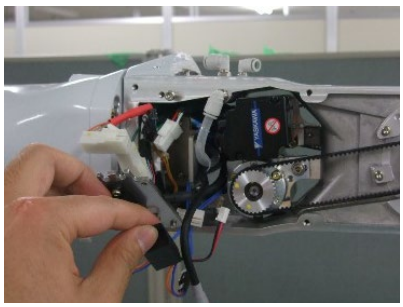
1. Turn OFF the Controller power.
2. Remove the Arm #4 side cover.
   For details, refer to *C8 Maintenance: 3. Covers*.
3. Loosen the screws fixing the cable protection bracket on the Arm #4 and pull out the cables.

   Hexagon socket head cap bolts: 2-M4×10



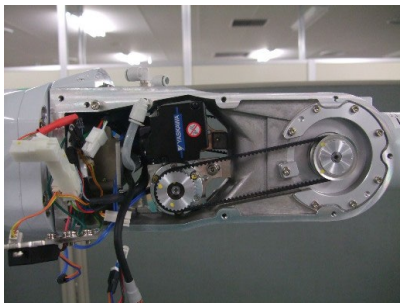
4. Remove the brake power supply connected to the connector (BR052) from the plate.

   Cross recessed head screw with captive washer: 2-M3×6

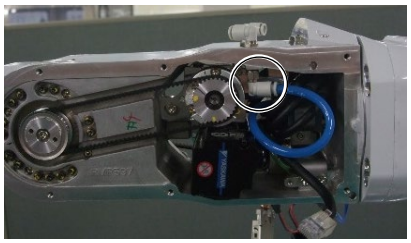


5. Disconnect the following connectors.

   Connector: X052, X152, BT52, BR052

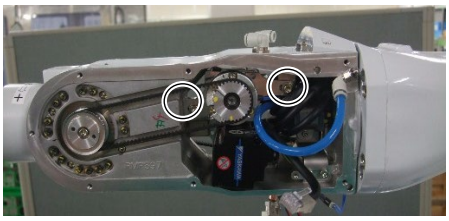


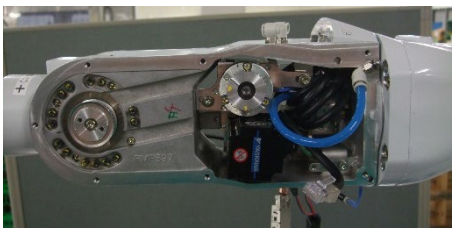
6. Remove the air tube fitting located in the front of the Joint #5 motor unit.



7. Loosen the screws fixing the Joint #5 motor unit and remove the belt.

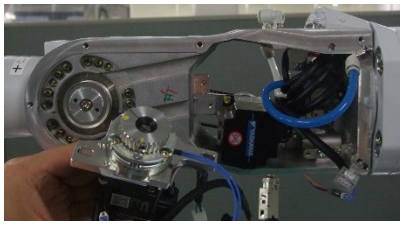
   Hexagon socket head cap bolts:
   2-M4×15 (with a plain washer)





8. Remove the Joint #5 motor unit.

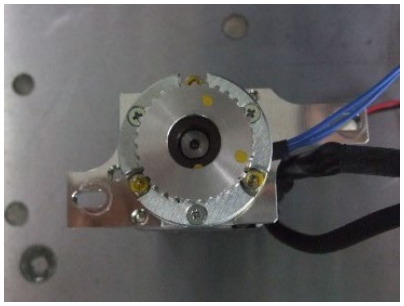
   Hexagon socket head cap bolts:
   2-M4×15 (with a plain washer)



9. Remove the Joint #5 pulley 1 and the drive boss from the motor shaft of the Joint #5 motor unit.

   Pulley 1 and drive boss screws
   Hexagon socket set screws: 2-M4×4 (with a brass bushing)

   Drive boss and motor shaft screws
   Hexagon socket set screws: 2-M4×4

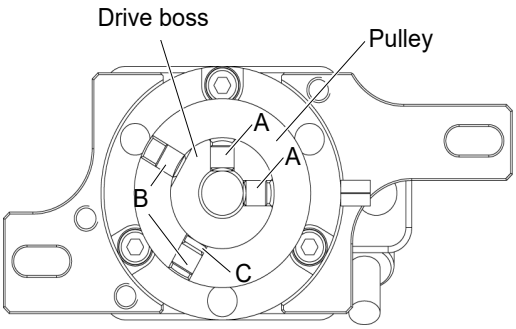


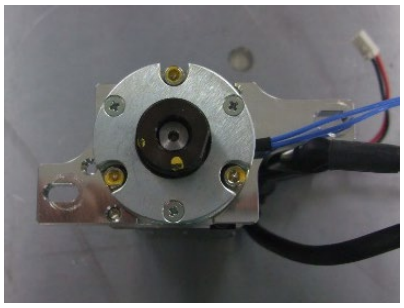
   There is a brass bushing on one of the set screws fixing the drive boss and the pulley.　Be careful not to lose it.

   A: Pulley and motor shaft screws

   B: Pulley and drive boss screws

   C: Bushing

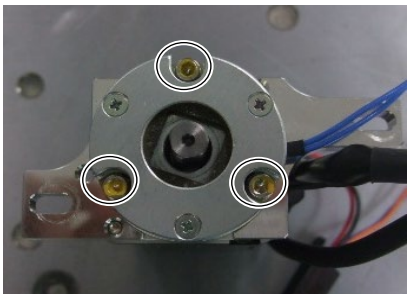




10. Remove the Joint #5 electromagnetic brake.

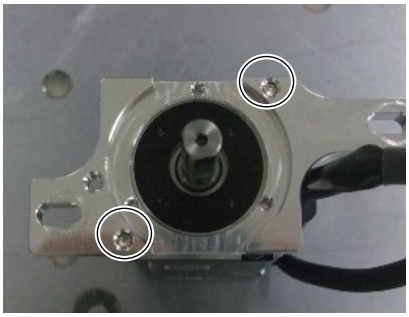
    Hexagon socket head cap bolts: 3-M3×15 (with a spacer)

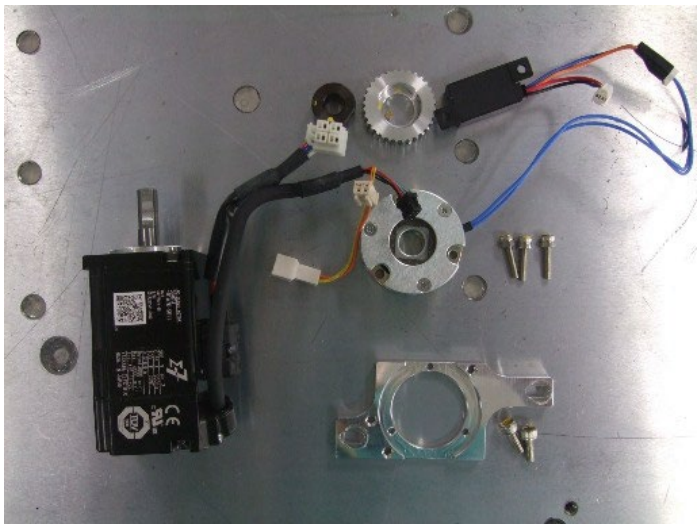
    Be careful not to lose the spacers.



11. Remove the motor plate from the Joint #5 motor.

    Hexagon socket head cap bolts: 2-M4×10





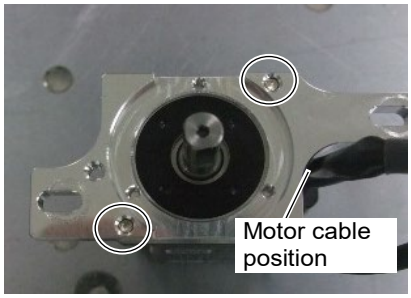
Installation: Joint #5 Motor

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

1. Install the motor plate to the Joint #5 motor.

   Hexagon socket head cap bolts: 2-M4×10

   Tightening torque: 4.0 ± 0.2 N·m

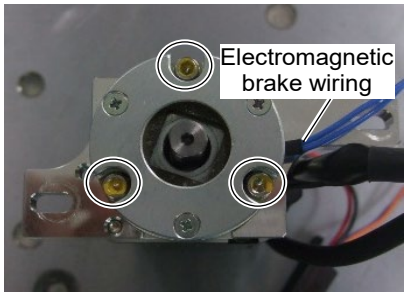


NOTE Be careful of the assembly direction of the motor plate. (See the photo.)

2. Mount the Joint #5 electromagnetic brake to the Joint #5 motor unit. Insert the spacers between the hexagon socket set screws and the Joint #5 electromagnetic brake.

   Hexagon socket set screws: 3-M2.5×10 (with a spacer)

   Tightening torque: 2.0 ± 0.1 N·m



NOTE Be careful of the assembly direction of the Joint #5 electromagnetic brake wiring. (See the photo.)

3. Mount the drive boss and the pulley 1 to the Joint #5 motor unit.

   Fix the drive boss and the motor shaft.
   There is an uneven part for the feeler gauge (0.5 mm) on the boss.
   Use the uneven part to leave 0.5 mm space.

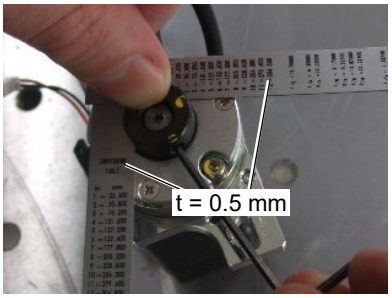
NOTE If there is no space, the parts may chafe while the motor is driving and it may result in breakage while the motor is moving.

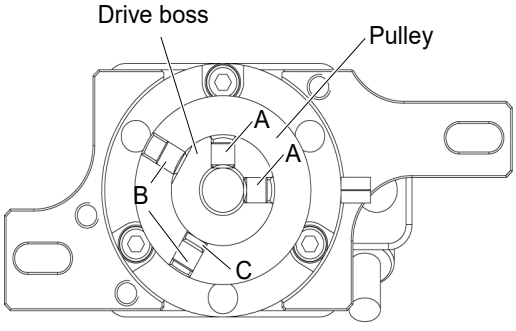
   Set the set screws to the positions indicated in the figure.

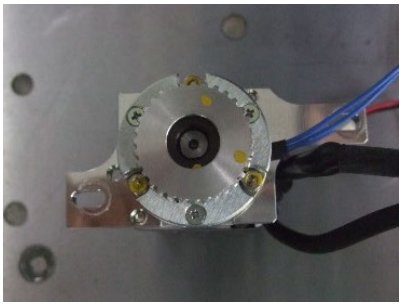
   A: Pulley and motor shaft screws

   B: Pulley and drive boss screws

   C: Bushing







NOTE If the screw positions are incorrect or the bushing is not set, it may cause damage on the side of the part and may result in the part being unable to be removed.

Drive boss and the motor shaft:

Hexagon socket set screws: 2-M4×4

Tightening torque: 2.5 ± 0.2 N·m

Align the screws to the two flat faces of the motor shaft and fix them.

Drive boss and the pulley 1:

Hexagon socket set screws: 2-M4×4 (with a brass bushing)

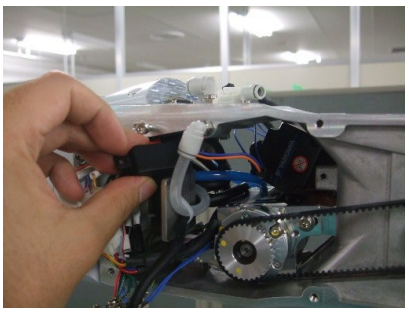
Tightening torque: 2.5 ± 0.2 N·m

Fix the set screws while pressing the pulley 1 to the drive boss.

The brass bushing is not necessary for the screw for the flat surface (D-cut). Set the bushing to the other screw and then fix the screw.

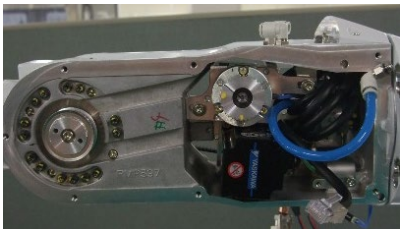
4. Put the Joint #5 motor unit inside the Arm #4.

   Pass the cables of the Joint #5 motor unit to the Joint #6 motor unit side so that the cables can be stored in the storage space.
   (See the photo)



5. Pass the timing belt around the pulley 1 and pulley 2 and fix it temporarily.
   Make sure that the teeth of the timing belt engage with these of the pulley.

   As a rough guide of temporary fixing, check that the motor unit can be moved by hand, and it does not tilt when being pulled.
   If the belt is too loose or too tight, it will not have proper tension



6. Apply tension to the Joint #5 timing belt and fix the Joint #5 motor unit.

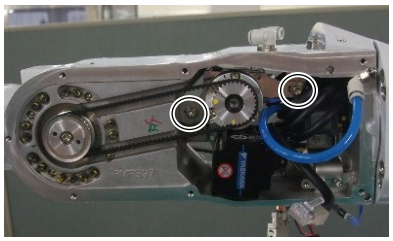
   Joint #5 Timing belt tension: 15 to 30 N

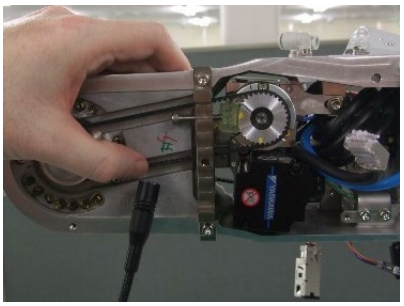
   Bet tension meter setting value

   Weight: 2.5 g/mm width × m span, Width: 6 mm, Span: 117 mm

   Hexagon socket head cap bolts: 2-M4×15 (with a plain washer)

   Tightening torque: 4.0 ± 0.2 N·m





NOTE

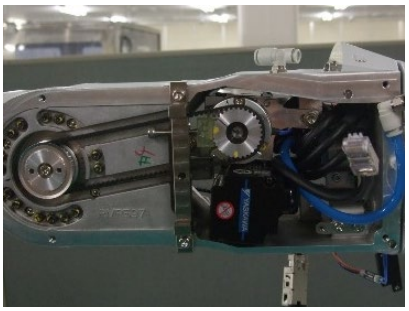
Regarding belt tension:

- Jumping (position gap) may occur if the value is below the lower limit.
- Vibration (abnormal noise) or reduction in life of the parts may occur if the value exceeds the upper limit.
- When you replace with a new belt, belt extends and the belt tension may decrease in the initial stage. Make sure to operate the robot two to three days and check the belt tension again.

When using the belt tension tensile jig (maintenance part):

Fix the belt tension tensile jig (for J4, J5, and J6) with the screws (2-M4×15) and push the rubber against the pulley.

Tension is applied as the set screw (M6×15) is pushed by the rubber.



7. Install the air tube fitting in the front of the Joint #5 motor unit.

   After tightening by hand, tighten one sixth to quarter of a turn.

NOTE Tightening of the fitting:

Fitting is too tight:
It may cause air leakage due to screw breakage or gasket deformation.

Fitting is too loose:
It may cause loose screws and air leakage.

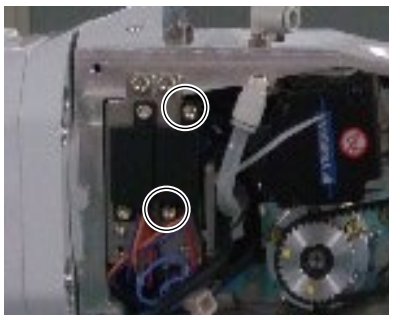
8. Connect the following connectors.

   Connectors: X052, X152, BT52, BR052

9. Install the brake power supply to the plate.

   Cross recessed head screw with captive washer: 2-M3×6

   Tightening torque: 0.45 ± 0.1 N·m



10. Fix the cable protection bracket to the Arm #4.

    Hexagon socket head cap bolts: 2-M4×10

    Tightening torque: 4.0 ± 0.2 N·m

NOTE Be careful not to get the cables caught. It may result in cable breakage.

11. Install the Arm #4 side cover.
    For details, refer to *C8 Maintenance: 3. Covers*.

12. Perform the calibration.
    For details, refer to *C8 Maintenance: 16. Calibration*.

9.2 Joint #5 - Replacing the Reduction Gear Unit (Replacing the Joint #5, #6 Reduction Gear Unit Set)

For replacement of the Joint #5 and Joint #6 reduction gear unit, replace the Joints #5, #6 reduction gear unit set.

The Joints #5 and #6 reduction gear unit set is adjusted in advance.

	Name		Qty.	Note
Maintenance Parts	Joints #5, #6 Reduction gear unit set		1	1674610 (common to C8 series)
	Belt tensile jig*		1	1674582
Tools	Hexagonal wrench	width across flats: 2 mm	1	For M4 hexagon socket set screws
		width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolts
		width across flats: 5 mm	1	For M6 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Spanner (width across flats: 8 mm)		1	For air fittings
	Feeler gauge (0.5 mm)		2	For drive boss position adjustment
	Belt tension meter		1	Refer: Unitta U-505

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

Removal: Joints #5, #6 Reduction gear unit set

1. Turn OFF the Controller power.
2. Remove the Arm #4 side cover and Arm #3 cover.

   For details, refer to *C8 Maintenance 3. Covers*.

3. Remove the Joints #5 and #6 motors.

   For details, refer to the Removal steps in *C8 Maintenance 9.1 Joint #5 - Replacing the Motor* and *C8 Maintenance 10.1 Joint #6 - Replacing the Motor*.

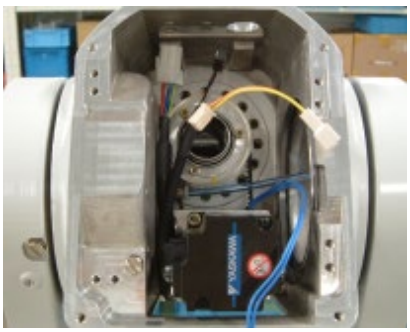
4. Remove the cables passing through the Arm #4 as shown in the photo.

   For details, refer to the Removal steps in *C8 Maintenance 4.1 Cable Unit*.

5. Remove the Joints #5, #6 reduction gear unit.

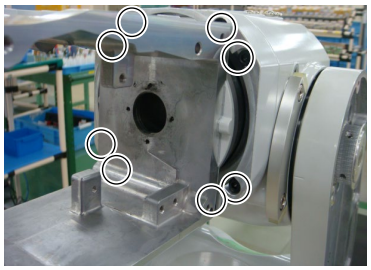
   C8:
   Loosen the fixing bolts of the Joint #4 motor plate and remove the belt. (Do not remove the Joint #4 motor.)

   Hexagon socket head cap bolts: 2-M4×15
   (with a small plain washer)



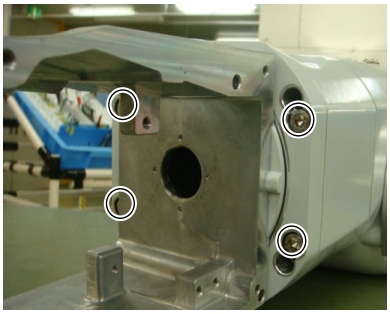
   Remove the bolts fixing the J4 flange, and remove the Joints #5 and #6 reduction gear unit (with the Joint #4 reduction gear unit) from the Arm #3.

   Hexagon socket head cap bolts: 8-M5×30

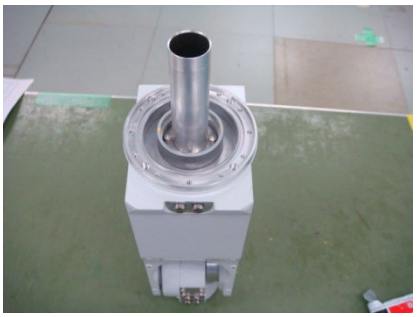


   C8L, C8XL:
   Remove the bolts fixing the Arm #4 extension flange, and remove the Joints #5 and #6 reduction gear unit from the Arm #4 extension part.

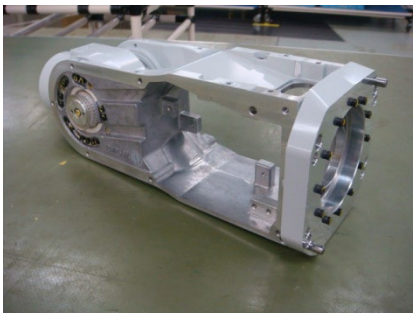
   Hexagon socket head cap bolts: 4-M6×20



6. Follow the following steps according to the model.



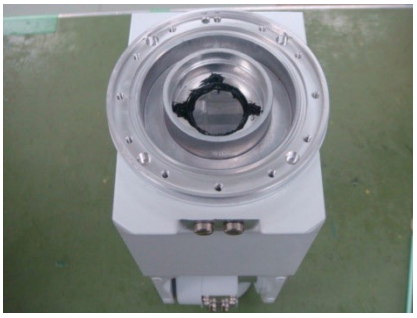
C8: Remove the Joint #4 reduction gear unit.
For details, refer to Removal steps in *C8 Maintenance 8.2 Joint #4 – Replacing the Reduction Gear Unit*.



C8L, C8XL:
Remove the Arm #4 extension flange.
C8XL does not have the J4 sleeve on the Arm #4.

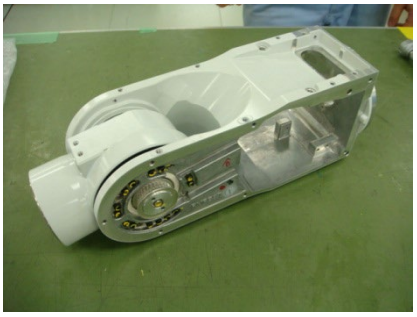
Hexagon socket head cap bolts: 12-M3×18

7. C8, C8L:
First, remove the J4 sleeve holder.
Then, remove the J4 sleeve.



Hexagon socket head cap bolts: 4-M3×6

The J4 sleeve is adhered with gasket and may not be removed easily.
If the part cannot be removed, pull the sleeve while rotating it.
Handle the sleeve with care since it is thin and easy to deform.



Installation: Joints #5, #6 Reduction gear unit set

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

1. C8, C8L:
   Apply grease to the mating part of the sleeve and the fixing bolts.
   (for grease leakage prevention for the reduction gear unit)
   Fit the J4 sleeve and install the J4 sleeve holder.

   Hexagon socket head cap bolts: 4-M3×6

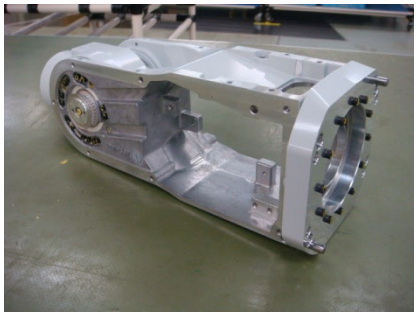
   Tightening torque: 2.0 ± 0.1 N·m

2. C8:
   Install the Joint #4 reduction gear unit.
   For details, refer to Installation steps in *C8 Maintenance 8.2 Joint #4 – Replacing the Reduction Gear Unit*.

   C8L, C8XL:
   Install the Arm #4 extension flange.
   (C8XL does not have the sleeve.)

   Hexagon socket head cap bolts: 12-M3×18

   Tightening torque: 2.4 ± 0.1 N·m



3. Install the Joints #5 and #6 reduction gear unit.

   C8:
   Install the J4 flange to the Arm #3.

   Hexagon socket head cap bolts: 8-M5×30

   Tightening torque: 10.0 ± 0.5 N·m

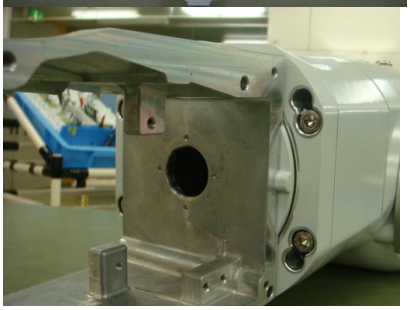
   Apply proper tension to the Joint #4 timing belt and fix the Joint #4 motor unit.

   For details, refer to *C8 Maintenance 8.1 Joint #4 – Replacing the Motor*, Installation steps (6).

C8L,C8XL:
Install the Arm #4 extension flange to the Arm #4 extension part.

C8L:
Apply adhesive to the J4 sleeve and the J4 pulley bearing mating part (indicated by a yellow mark in the right photo)

Adhesive: Loctite641



Hexagon socket head cap bolts: 4-M6×20

Tightening torque: 13.0 ± 0.6 N·m

4. Pass the cables to the Arm #4.

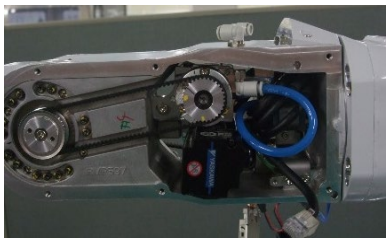
Connect all the connectors inside the Arm #3 and bind them together.

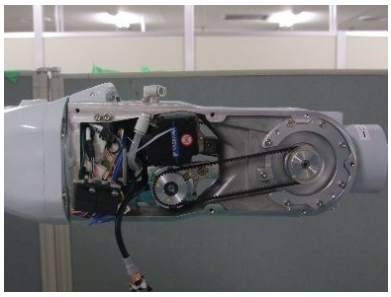
Fix the cables inside the Arm #4, and connect the D-sub to the Arm #4.

For details, refer to Installation steps in *C8 Maintenance 4.1 Cable Unit*.

5. Install the Joints #5 and #6 motors.

   For details, refer to Installation steps in *C8 Maintenance 9.1 Joint #5 – Replacing the Motor* and *C8 Maintenance 10.1 Joint #6 – Replacing the Motor*.





6. Install the removed covers.

   For details, refer to *C8 Maintenance 3. Covers*.

7. Perform the calibration.

   For details, refer to *C8 Maintenance 16. Calibration*.

9.3 Joint #5 - Replacing the Timing Belt

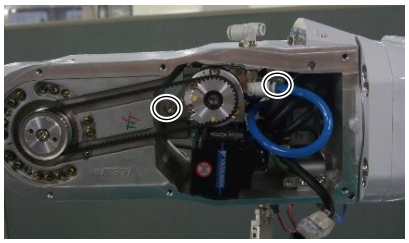
	Name		Qty.	Note
Maintenance Parts	Joint #5 timing belt	330 mm	1	1655932
	Belt tensile jig		1	1674582
Tools	Hexagonal wrench (width across flats: 3 mm)		1	For M4 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Belt tension meter		1	Refer: Unitta U-505

* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

Removal: Joint #5 Timing belt

1. Turn OFF the Controller power.
2. Remove the Arm #4 side cover.
   For details, refer to *C8 Maintenance: 3. Covers*.
3. Loosen the Joint #5 motor unit set screws.
   Hexagon socket head cap bolts: 2-M4×15
   (with a plain washer)



4. Remove the Joint #5 timing belt.

Installation: Joint #5 Timing belt.

1. Pass the Joint #5 timing belt around the pulley 1 and the pulley 2 of the Joint #5.
2. Secure the Joint #5 motor unit.
   For details, refer to *C8 Maintenance: 9.1 Joint #5 – Replacing the Motor*, Installation steps (5) to (6) and (11) to (12).

9.4 Joint #5 - Replacing the Electromagnetic Brake

	Name		Qty.	Note
Maintenance Parts	Electromagnetic brake		1	2172928 (Common for Joints #4, #5, #6)
	Belt tensile jig		1	1674582
Tools	Hexagonal wrench	width across flats: 2 mm	1	For M4 hexagon socket set screws
		width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Spanner (width across flats: 8 mm)		1	For air tube fitting
	Feeler gauge (0.5 mm)		1	For adjusting the pulley position
	Belt tension meter		1	Refer: Unitta U-505

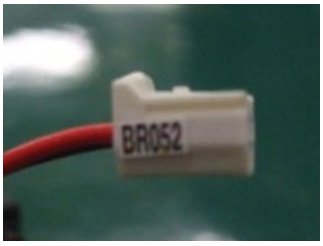
* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

Attaching the labels

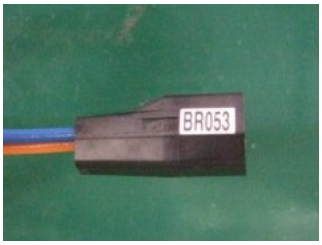
The electromagnetic brakes are common for Joints #4, #5, and #6.
In order to prevent misconnection of the connectors, attach the label for the electromagnetic brakes as shown in the photos.

Joint #5 electromagnetic brakes Locations of the connector labels



BR052
Cable (red/black)

BR053
Cable (blue/blue)



BR053
Cable(blue/orange)

NOTE ☞ BR053 is connected at the time of shipment. Before attaching the label, disconnect the connector.

One side of BR052 and BR053 have the same shape. Identify the connectors by color.

Removal: Joint #5 Electromagnetic brake

1. Remove the Joint #5 electromagnetic brake.

   For details, refer to *C8 Maintenance: 9.1 Joint #5 – Replacing the Motor*, Removal steps (1) through (10).

Installation: Joint #5 Electromagnetic brake

1. Mount the Joint #5 electromagnetic brake to the Joint #5 motor unit.

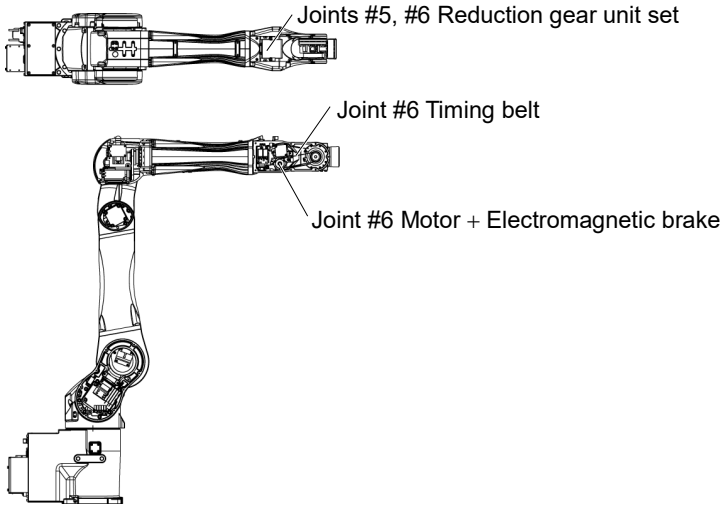
   For details, refer to *C8 Maintenance: 9.1 Joint #5 – Replacing the Motor*, Installation steps (2) through (12).

10. Joint #6

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 during replacement. The shock may shorten the life of the motors and encoder and/or damage them. ■ Never disassemble the motor and the encoder. Disassembled motor and encoder will cause a positional gap and cannot be used again.

After parts have been replaced (motors, reduction gear units, electromagnetic brakes, timing belts, etc.), the Manipulator cannot perform positioning properly because a gap exists between the origin stored in each motor encoder and its corresponding origin stored in the Controller.
Therefore, it is necessary to match these origins after replacing the parts.
The process of aligning the two origins is called “Calibration”.
Refer to *C8 Maintenance 16. Calibration* and perform the calibration after the parts replacement.



(Figure: C8-A1401* (C8XL))

10.1 Joint #6 - Replacing the Motor

	Name		Qty.	Note
Maintenance Parts	AC servo motor 100 W		1	2172051 (common to Joints #4, #5, #6)
	Belt tensile jig *		1	1674582
Tools	Hexagonal wrench	width across flats: 2 mm	1	For M4 hexagon socket set screws
		width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Feeler gauge (0.5 mm)		2	For adjusting the drive boss position
	Belt tension meter		1	Refer: Unitta U-505

* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

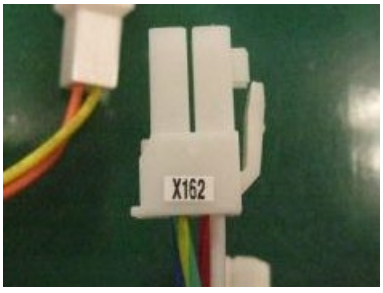
The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

Attaching the labels

The motors are common to Joints #4, #5, and #6.

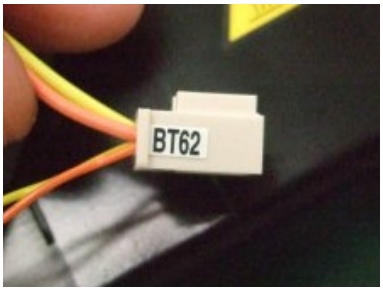
In order to prevent misconnection of the connectors, attach the label for the motor as shown in the photos.

Joint #6 motor Locations of the connector labels

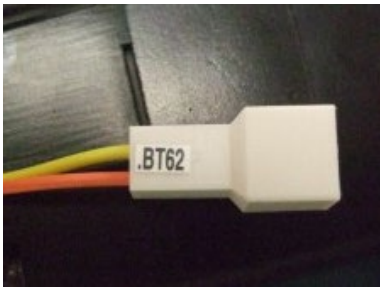


X162

X062



BT62

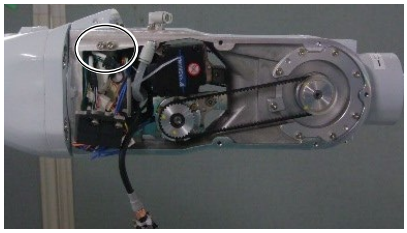


_BT62

Removal: Joint #6 Motor

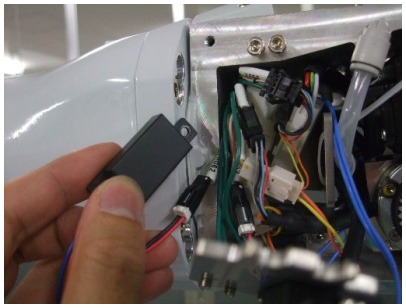
1. Turn OFF the Controller power.
2. Remove the Arm #4 side cover.
   For details, refer to *C8 Maintenance: 3. Covers*.
3. Loosen the screws fixing the cable protection plate on the Arm #4 and pull out the cables.

   Hexagon socket head cap bolts: 2-M4×10



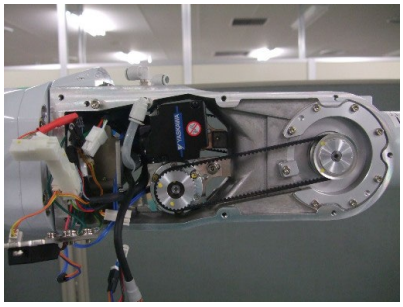
4. Remove the brake power supply connected to the connector (BR062) from the protection plate.

   Cross recessed head screw with captive washer: 2-M3×6



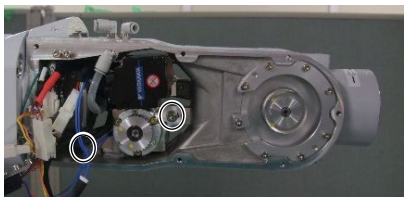
5. Pull out the cables from the Arm #4 and disconnect the following connectors.

   Connectors: X062, X162, BT62, BR062



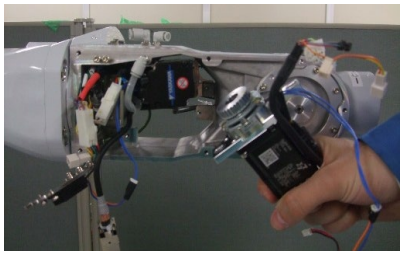
6. Loosen the bolts securing the Joint #6 motor unit and remove the belts.

   Hexagon socket head cap bolts: 2-M4×15 (with a plain washer)

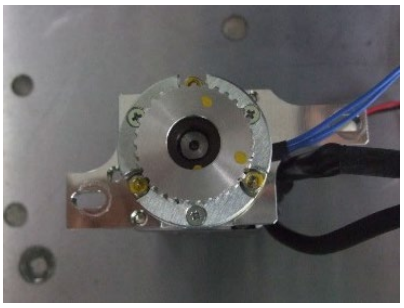


7. Remove the Joint #6 motor unit.

   Hexagon socket head cap bolts: 2-M4×15 (with a plain washer)



8. Remove the Joint #6 motor pulley 1 and the drive boss from the Joint #6 motor unit.



Pulley 1 and drive boss screws
Hexagon socket set bolts: 2-M4×4 (with a brass bushing)

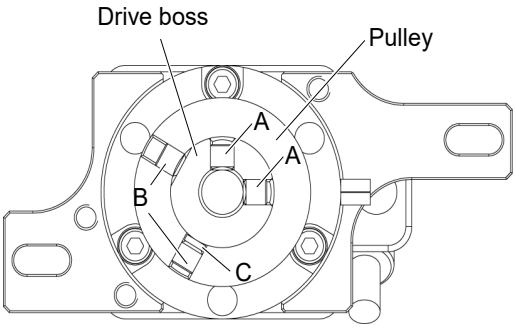
Drive boss and motor shaft screws
Hexagon socket set bolts: 2-M4×4

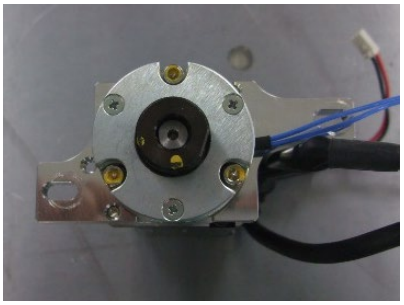
There is a brass bushing on one of the set screws fixing the drive boss and the pulley. Be careful not to lose it.

A: Pulley and motor shaft screws

B: Pulley and drive boss screws

C: Bushing

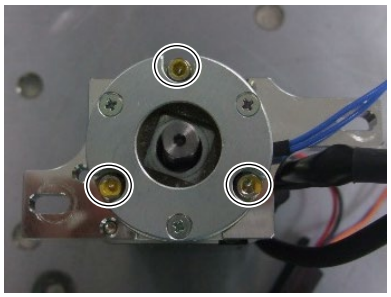




9. Remove the Joint #6 electromagnetic brake.

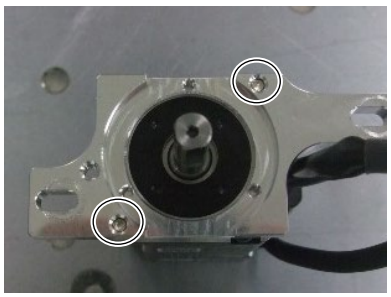
Hexagon socket set bolts: 3-M3×15 (with a spacer)

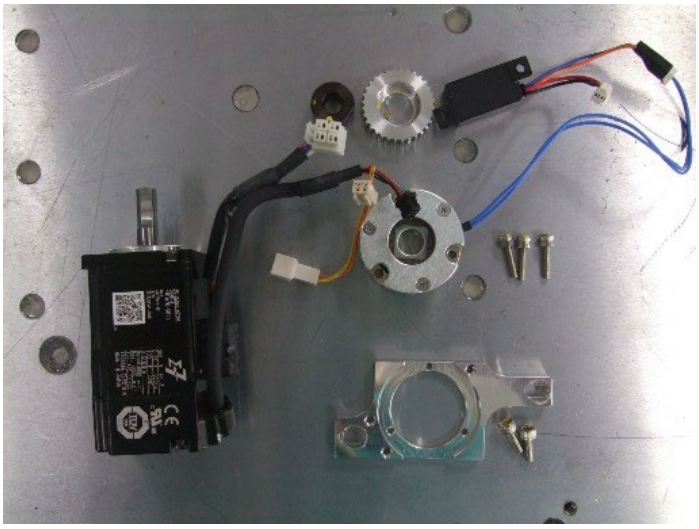
Be careful not to lose the spacers.



10. Remove the motor plate from the Joint #6 motor.

Hexagon socket head cap bolts: 2-M4×10





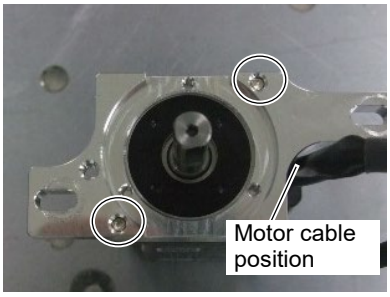
Installation: Joint #6 motor

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

1. Install the motor plate to the Joint #6 motor.

   Hexagon socket head cap bolts: 2-M4×10

   Tightening torque: 4.0 ± 0.2 N·m

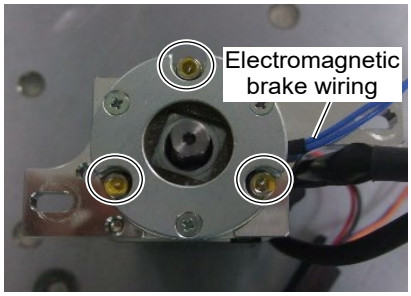


NOTE Be careful of the assembly direction of the motor plate. (See the photo.)

2. Mount the Joint #6 electromagnetic brake to the Joint #6 motor unit. Insert the spacers between the hexagon socket set screws and the Joint #6 electromagnetic brake.

   Hexagon socket set screws: 3-M3×15 (with a spacer)

   Tightening torque: 2.0 ± 0.1 N·m

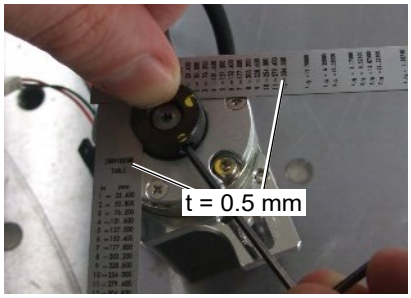


NOTE Be careful of the assembly direction of the Joint #5 electromagnetic brake wiring. (See the photo.)

3. Mount the drive boss and the pulley 1 to the Joint #6 motor unit.

   Fix the drive boss and the motor shaft.
   There is an uneven part for the feeler gauge (0.5 mm) on the boss. Use the uneven part to leave 0.5 mm space.

NOTE If there is no space, the parts may chafe while the motor is driving and it may result in breakage while the motor is moving.

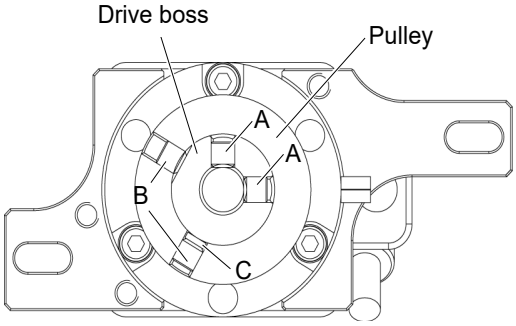


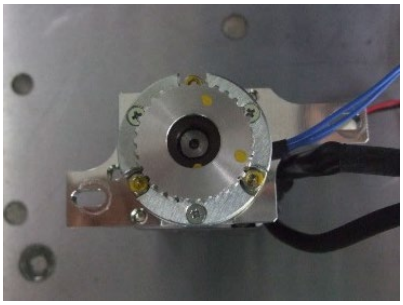
Set the set screws to the positions indicated in the figure.

A: Pulley and motor shaft screws

B: Pulley and drive boss screws

C: Bushing





NOTE If the screw positions are incorrect or the bushing is not set, it may cause damage on the side of the part and may result

in the part being unable to be removed.

Drive boss and the motor shaft:

Hexagon socket set screws: 2-M4×4

Tightening torque: 2.5 ± 0.2 N·m

Align the screws to the two flat faces of the motor shaft and fix them.

Drive boss and the pulley 1:

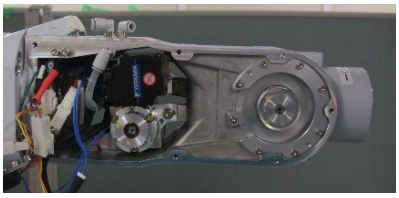
Hexagon socket set screws: 2-M4×4 (with a brass bushing)

Tightening torque: 2.5 ± 0.2 N·m

Fix the set screws while pressing the pulley 1 to the drive boss.

The brass bushing is not necessary for the screw for the flat surface (D-cut). Set the bushing to the other screw and then fix the screw.

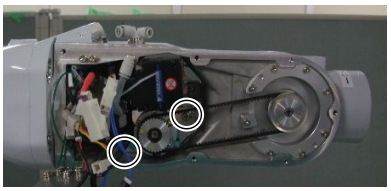
4. Put the Joint #6 motor unit inside the Arm #4.



5. Pass the timing belt around the pulley 1 and pulley 2 and fix it temporarily.
   Make sure that the teeth of the timing belt engage with these of the pulley.

As a rough guide of temporary fixing, check that the motor unit can be moved by hand, and it does not tilt when being pulled. If the belt is too loose or too tight, it will not have proper tension.

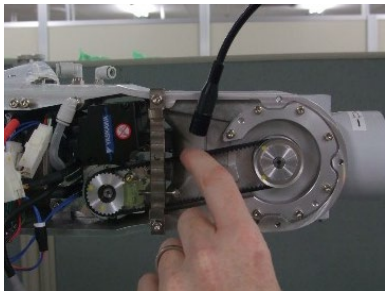
6. Apply tension to the Joint #6 timing belt and fix the Joint #6 motor unit.



Joint #6 timing belt tension: 15 to 30 N

Belt tension meter setting value

Weight: 2.5 g/mm width × m span, Width: 6 mm,
Span: 122 mm



Hexagon socket head cap bolt: 2-M4×15 (with a plain washer)

Tightening torque: 4.0 ± 0.2 N·m

NOTE

Regarding belt tension:

- Jumping (position gap) may occur if the value is below the

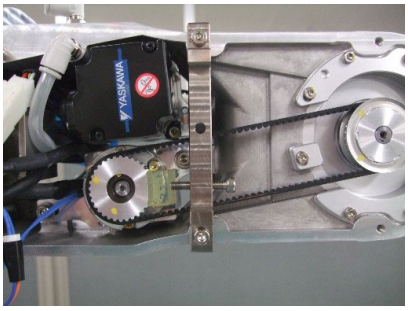
lower limit.

- Vibration (abnormal noise) or reduction in life of the parts may occur if the value exceeds the upper limit
- When you replace with a new belt, belt may stretch and the belt tension will decrease in the initial stage of operation. Make sure to operate the robot two to three days and check the belt tension again.

When using the belt tension tensile jig (maintenance part):

Fix the belt tension tensile jig (for Joints #4, #5, and #6) with the screws (2-M4×15) and push the rubber against the pulley.

Tension is applied as the set screw (M6×15) is pushed by the rubber.



7. Connect the following connectors.

   Connectors: X062, X162, BT62, BR062

8. Install the brake power supply to the plate.

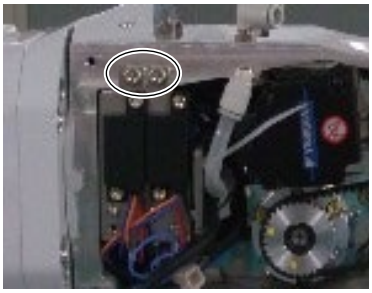
   Cross recessed head screw with captive washer: 2-M3×6

   Tightening torque: 0.45 ± 0.1 N·m

9. Fix the cable protection plate to the Arm #4.

   Hexagon socket head cap bolt: 2-M4×10

   Tightening torque: 4.0 ± 0.2 N·m



NOTE Be careful not to get the cables caught. It may result in cable breakage.

10. Install the Arm #4 side cover.
    For details, refer to *C8 Maintenance: 3. Covers*.

11. Perform the calibration.
    For details, refer to*C8 Maintenance: 16. Calibration*.

10.2 Joint #6 - Replacing the Reduction Gear Unit (Replacing the Joints #5, #6 Reduction Gear Unit Set)

For replacement of the Joint #5 and Joint #6 reduction gear unit, replace the Joints #5, #6 reduction gear unit set.

The Joints #5 and #6 reduction gear unit set is adjusted in advance.

	Name		Qty.	Note
Maintenance Parts	Joints #5, #6 Reduction gear unit set		1	1674610 (common to C8 series)
	Belt tensile jig*		1	1674582
Tools	Hexagonal wrench	width across flats: 2 mm	1	For M4 hexagon socket set screws
		width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolts
		width across flats: 5 mm	1	For M6 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Spanner (width across flats: 8 mm)		1	For air fittings
	Feeler gauge (0.5 mm)		2	For drive boss position adjustment
	Belt tension meter		1	Refer: Unitta U-505

For details of the replacement procedure, refer to *C8 Maintenance 9.2 Joint #5 - Replacing the Reduction Gear Unit (Replacing the Joints #5, #6 Reduction Gear Unit)*.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

10.3 Joint #6 - Replacing the Timing Belt

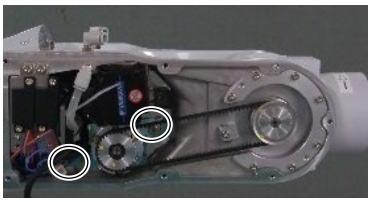
	Name		Qty.	Note
Maintenance Parts	Joint #6 timing belt	339 mm	1	1655933
	Belt tensile jig		1	1674582
Tools	Hexagonal wrench (width across flats: 3 mm)		1	For M4 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Belt tension meter		1	Refer: Unitta U-505

* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

Removal: Joint #6 Timing belt

1. Turn OFF the Controller power.
2. Remove the Arm #4 side cover.
   For details, refer to *C8 Maintenance: 3. Covers*.
3. Loosen the Joint #6 motor unit set screw.
   Hexagon socket head cap bolt: 2-M4×15 (with a plain washer)



4. Remove the Joint #6 timing belt.

Installation: Joint #6 Timing belt

1. Place the Joint #6 timing belt around the pulley 1 and 2 of the Joint #6.
2. Secure the Joint #6 motor unit.
   For details, refer to *C8 Maintenance: 10.1 Joint #6 – Replacing the Motor*, Installation steps (5) to (6) and (10) to (11).

10.4 Joint #6 - Replacing the Electromagnetic Brake

	Name		Qty.	Note
Maintenance Parts	Electromagnetic brake		1	2172928 (Common to Joints #4, #5, #6)
	Belt tensile jig		1	1674582
Tools	Hexagonal wrench	width across flats: 2 mm	1	For M4 hexagon socket set screws
		width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Feeler gauge (0.5 mm)		1	For adjusting the pulley position
	Belt tension meter		1	Refer: Unitta U-505

* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

Attaching the labels

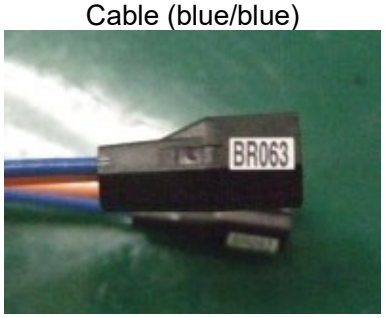
The electromagnetic brakes are common to Joints #4, #5, and #6.
In order to prevent misconnection of the connectors, attach the label for the electromagnetic brakes as shown in the photos.

Joint #6 electromagnetic brakes

BR062
Cable (red/black)

Locations of the connector labels

BR063
Cable (blue/blue)



BR063
Cable(blue/orange)

NOTE

BR063 is connected at the time of shipment. Before attaching the label, disconnect the connector.

One side of BR062 and BR063 have the same shape. Identify the connectors by color.

Removal: Joint #6 Electromagnetic brake

1. Remove the Joint #6 electromagnetic brake.

   For details, refer to *C8 Maintenance: 10.1 Joint #6 – Replacing the Motor*, Removal steps (1) through (9).

Installation: Joint #6 Electromagnetic brake

1. Mount the Joint #6 electromagnetic brake to the Joint #6 motor unit.

   For details, refer to *C8 Maintenance: 10.1 Joint #6 – Replacing the Motor*, Installation steps (2) through (11).

11. Replacing the Battery 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.

WARNING	■ Take meticulous care when handling the lithium battery. Improper handling of the lithium battery as mentioned below is extremely hazardous and may result in heat generation, leakage, explosion, or inflammation. It also may cause serious safety problems. <Improper Handling> Attempting to charge / Deforming by pressure Disassembling / Short-circuit (Polarity; Positive/Negative) Connecting batteries improperly / Heating (85 °C or more) Exposing to fire / Soldering the terminal of the lithium battery directly Forcing discharge ■ When disposing the battery, consult with the professional disposal services or comply with the local regulation. Make sure that the battery terminal is insulated, even for a used buttery. 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

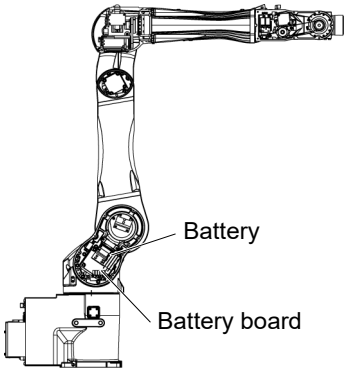
For the EPSON RC+ 7.0 Ver. 7.2.x or later (firmware Ver.7.2.x.x or later), the recommended replacement time for the battery can be checked in the [Maintenance] dialog box of the EPSON RC+ 7.0.
For details, refer to the following manual.
RC700 Series Maintenance Manual 6. Alarm

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.

Designated parts must be used for the lithium battery and battery board.

Be careful of the battery polarity to connect it correctly.

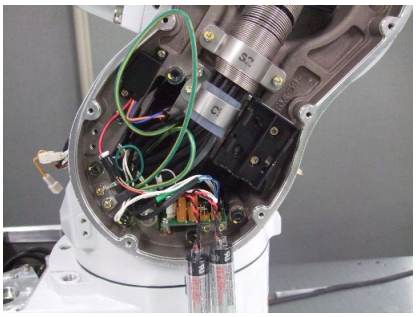


(Figure: C8-A1401** (C8XL))

	Name	Qty.	Note
Maintenance Parts	Battery unit (Lithium battery)	1	2172925 (Two lithium batteries for replacement)
	Battery board	1	2173216
Tools	Cross-point screwdriver (#2)	1	For cross recessed head screws
	Hexagonal wrench (width across flats: 3 mm)	1	For M4 hexagon socket head cap bolts

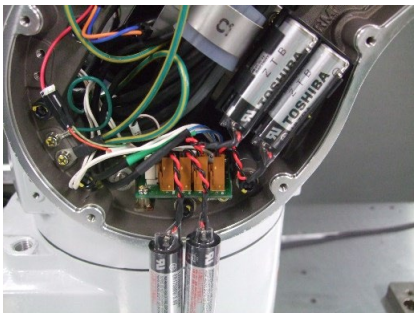
11.1 Replacing the Battery Unit (Lithium Battery)

1. Turn OFF the Controller power.
2. Remove the Arm #1 side cover.
   For details, refer to *C8 Maintenance: 3. Covers*.
3. Remove the battery from the battery box.

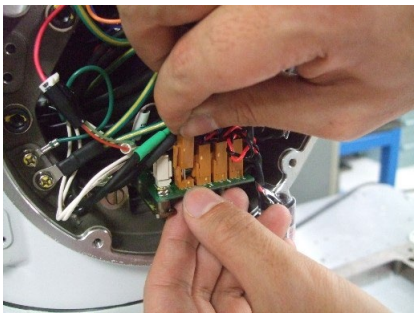


NOTE If you removed all the batteries before connecting the new ones, the calibration data will be deleted and you will need to perform calibration. Follow the steps below to remove the lithium batteries.

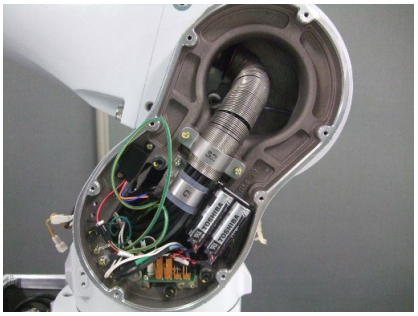
4. Connect the two new batteries to the connectors of the battery board which are not connected to anything.



5. Remove the old batteries.
   Hold the board by hand and pull the battery cable upward to remove the connector.



6. Install the battery to the battery box.



7. Install the Arm #1 side cover.
   For details, refer to *C8 Maintenance: 3. Covers*.

8. Turn ON the Controller power.

9. Check operation to see if the Manipulator's position and posture are out of position.
   Move the Manipulator to two or three points (poses) of the registered points.

10. If the Manipulator is out of position, calibrate all the joints and axes.
    For details, refer to *C8 Maintenance: 16. Calibration*.

11.2 Replacing the Battery Board

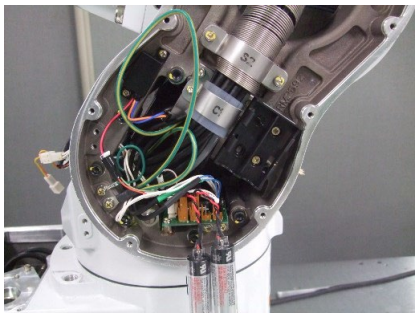
After parts have been replaced (motors, reduction gear units, brakes, timing belts, etc.), the Manipulator cannot perform positioning properly because a gap exists between the origin stored in each motor encoder and its corresponding origin stored in the Controller.
Therefore, it is necessary to match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

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

Refer to *C8 Maintenance 16. Calibration* and perform the calibration after the parts replacement.

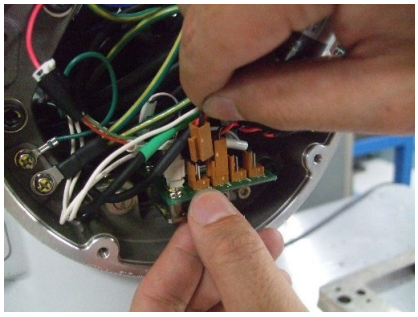
Removal: Battery board

1. Turn OFF the Controller power.
2. Remove the Arm #1 side cover.
   For details, refer to *C8 Maintenance: 3. Covers*.
3. Remove the battery from the battery box.



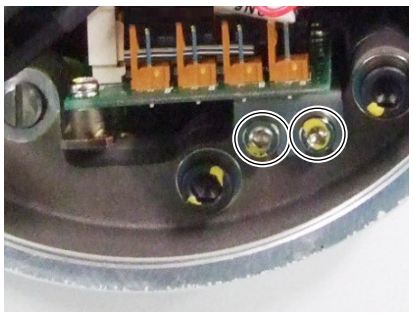
4. Remove the battery connectors.

NOTE Hold the board by hand and pull the battery cable upward to remove the connector.



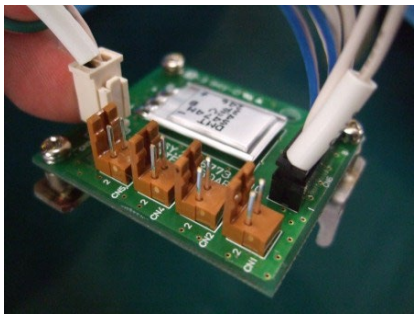
5. Remove the plate where the battery box is fixed to.

   Hexagon socket head cap bolts: 2-M4×10



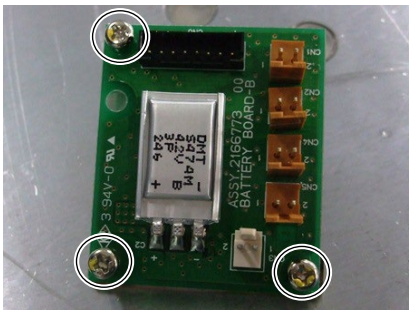
6. Remove the connectors.

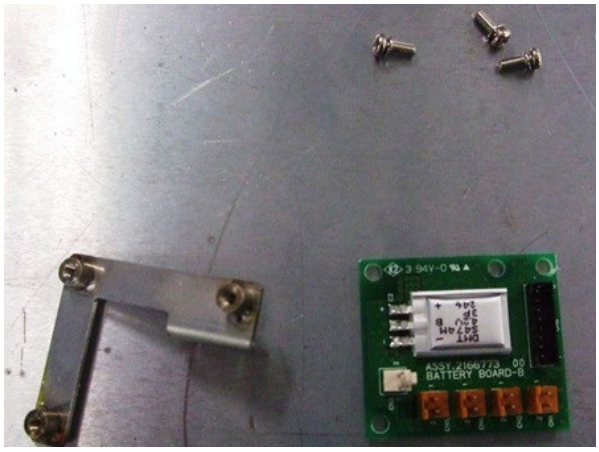
   Connectors: CN3, CN6



7. Remove the battery board fixed to the plate.

   Cross recessed head screws: 3-M3×6





Installation: Battery board

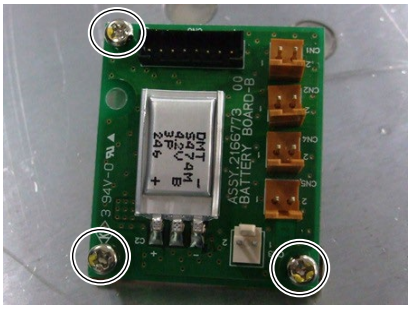
NOTE

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

1. Install the battery board to the plate.

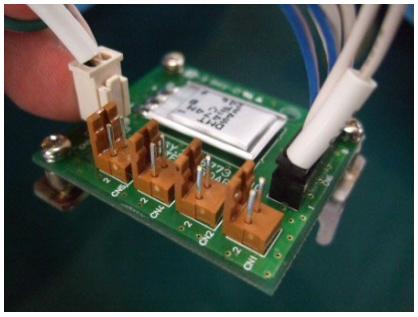
   Cross recessed head screws: 3-M3×6

   Tightening torque: 0.45 ± 0.1 N·m



2. Connect the connectors to the battery board.

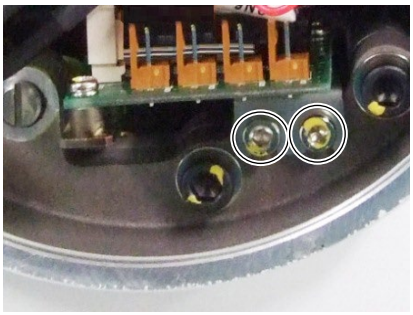
   Connector: CN3, CN6



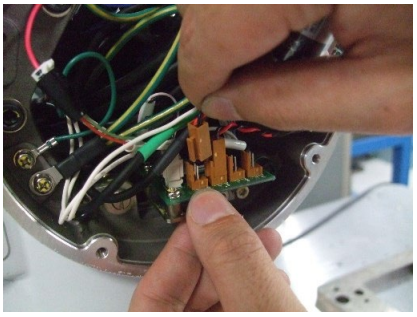
3. Install the plate where the battery board is installed to.

   Hexagon socket head cap bolts: 2-M4×10

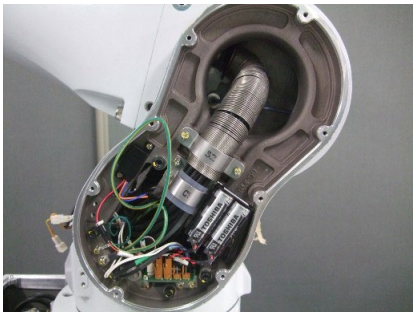
   Tightening torque: 4.0 ± 0.2 N·m



4. Connect the battery connectors.



5. Install the battery to the battery box.



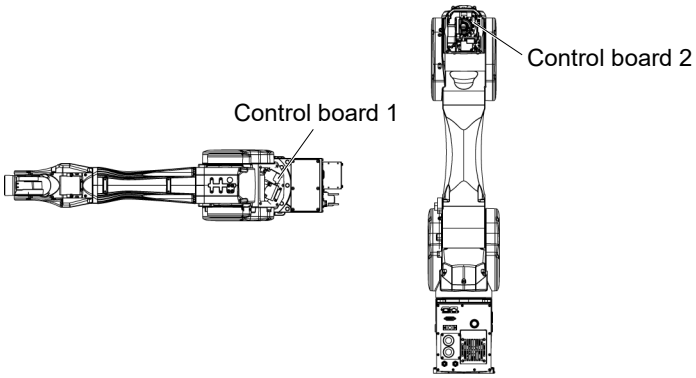
6. Install the Arm #1 side cover.
   For details, refer to *C8 Maintenance: 3. Covers*.

7. Perform the calibration.
   For details, refer to *C8 Maintenance: 16. Calibration*.

12. Replacing the Control Board

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.

Designated parts must be used for the control board.



(Figure: C8-A1401** (C8XL))

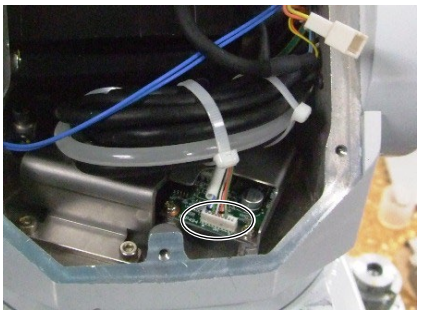
	Name	Qty.	Note
Maintenance Parts	Control board (1, 2)	1	2138032
Tools	Hexagonal wrench (width across flats: 3 mm)	1	For M4 hexagon socket head cap bolts
	Spanner (width across flats: 5.5 mm)	1	For spacers
	Cross-point screwdriver	1	For cross recessed head screws

12.1 Replacing the Control Board 1

Removal: Control board 1

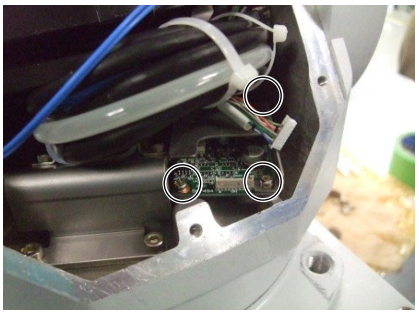
1. Turn OFF the Controller.
2. Remove the Arm #1 center cover.
   For details, refer to *C8 Maintenance 3. Covers*.
3. Remove the connector connected to the control board 1.

   Connector: GS01



4. Remove the control board 1 fixed to the Arm #1.

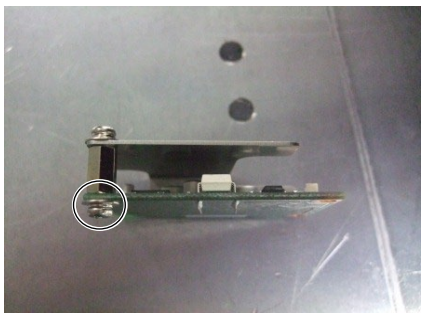
   Cross recessed head screws: 3-M3×8

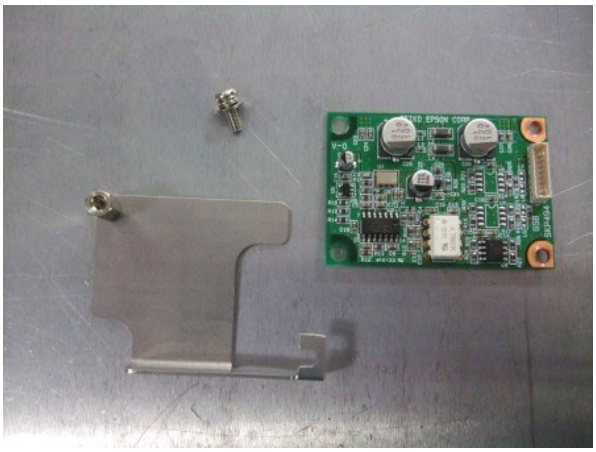


NOTE Be careful not to drop the screws inside the Manipulator while removing them.

5. Remove the control board 1 protection plate.
   Cross recessed head screws with captive washer: M3×6

   It is not necessary to remove the spacer from the plate.



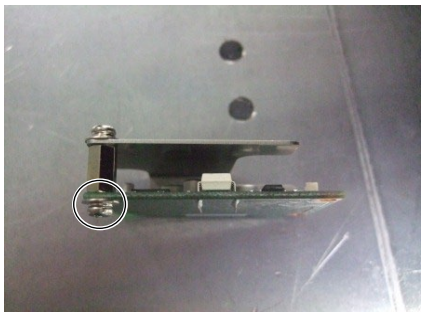


Installation: Control board 1

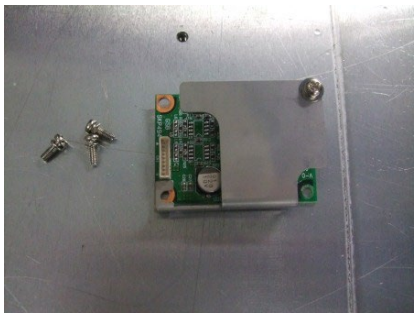
1. Install the control board 1 protection plate.

   Cross recessed head screws with captive washer: M3×6

   Tightening torque: 0.45 ± 0.1 N·m



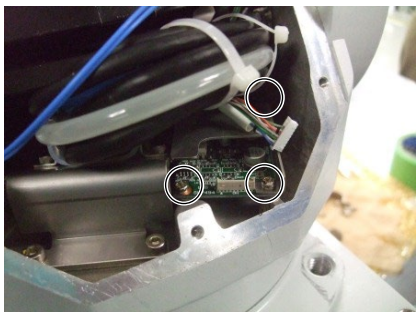
NOTE Be careful of the assembly direction of the protection plate. (See the photo)



2. Install the control board 1 to the Arm #1.

   Cross recessed head screws: 3-M3×8

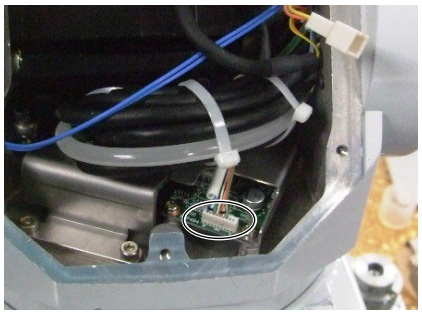
   Tightening torque: 0.45 ± 0.1 N·m



NOTE Be careful not to drop the screws inside the Manipulator while removing them.

3. Connect the connector to the control board 1.

   Connector: GS01



4. Install the Arm #1 center cover.
   For details, refer to *C8 Maintenance: 3. Covers*.
5. Check operation to see if the Manipulator's position and posture are out of position.
   Move the Manipulator to two or three points (poses) of the registered points.
6. If the Manipulator is out of position, calibrate all the joints and axes.
   For details, refer to *C8 Maintenance: 16. Calibration.*

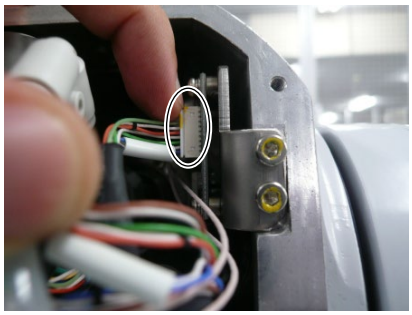
12.2 Replacing the Control Board 2

Removal: Control board 2

1. Turn OFF the Controller power.
2. Remove the Arm #3 cover.

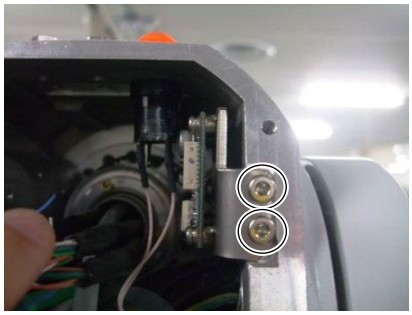
   For details, refer to *C8 Maintenance: 3. Covers*.
3. Remove the connector connected to the control board 2.

   Connector: GS02



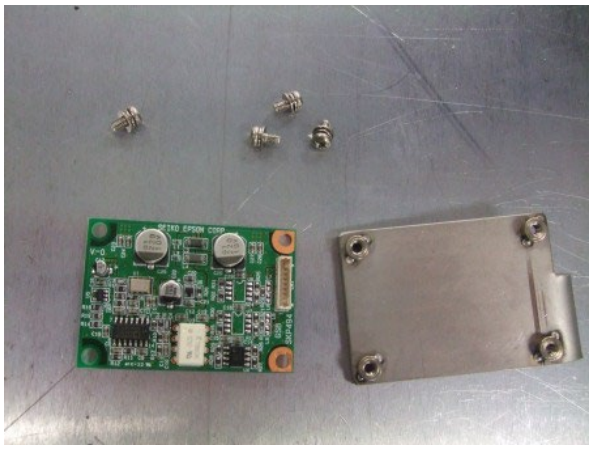
4. Remove the plate fixed to the Arm #3.

   Hexagon socket head cap bolts: 2-M4×10



5. Remove the control board 2 fixed to the plate.

   Cross recessed head screws: 4-M3×8



Installation: Control board 2

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

1. Install the control board 2 to the plate.

   Cross recessed head screws: 4-M3×8

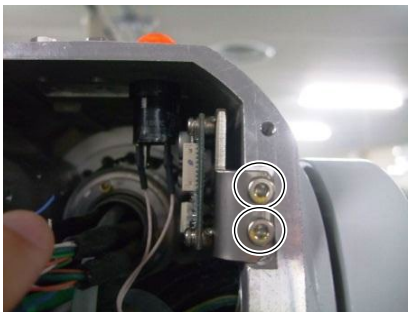
   Tightening torque: 0.45 ± 0.1 N·m

NOTE
Be careful of the assembly direction of the control board 2.
(See the photo.)

2. Install the plate with the control board 2 to the Arm #3.

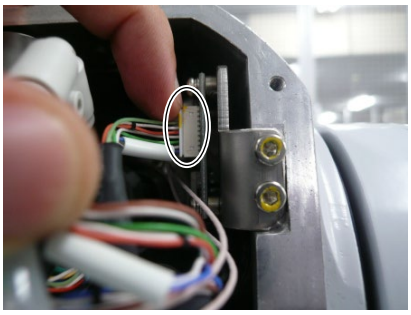
   Hexagon socket head cap bolts: 2-M4×10

   Tightening torque: 4.0 ± 0.2 N·m



3. Connect the connector to the control board 2.

   Connector: GS02



4. Install the Arm #3 cover.

   For details, refer to *C8 Maintenance: 3. Covers*.

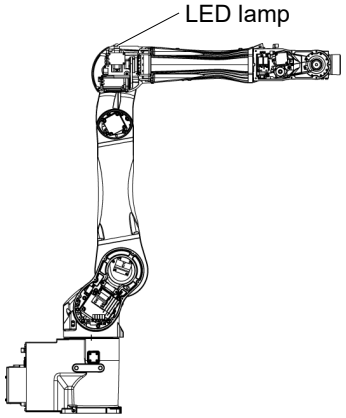
5. Turn ON the Controller power.

6. Check operation to see if the Manipulator's position and posture are out of position.
   Move the Manipulator to two or three points (poses) of the registered points.

7. If the Manipulator is out of position, calibrate all the joints and axes.
   For details, refer to *C8 Maintenance: 16. Calibration*.

13. Replacing the 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.



(Figure: C8-A1401** (C8XL))

	Name	Qty.	Note
Maintenance Parts	LED lamp	1	1668127 (Standard, Clean-room models)
Tools	Cross-point screwdriver (#2)	1	For cross recessed head screws

For Protection model, please contact the supplier of your region.

Removal: LED lamp

1. Turn OFF the Controller power.

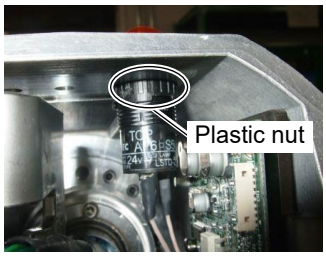
2. Remove the Arm #3 cover.
   For details, refer to *C8 Maintenance: 3. Covers*.

3. Remove the connector connected to the LED lamp.
   The connector for the LED lamp (LED) is under the Arm #3 cover.

   Connector: LED

4. Remove the LED lamp from the Arm #3.

   Turn the plastic nut securing the LED lamp in the Arm #3 counterclockwise.



Installation: LED lamp

1. Install the LED lamp to the Arm #3.
   Remove the plastic nut from the LED lamp.
   Pass the lamp from the inside of the Arm #3.
   Turn the nut clockwise and secure the lamp to the Arm #3.

2. Connect the following connector.

   Connector: LED

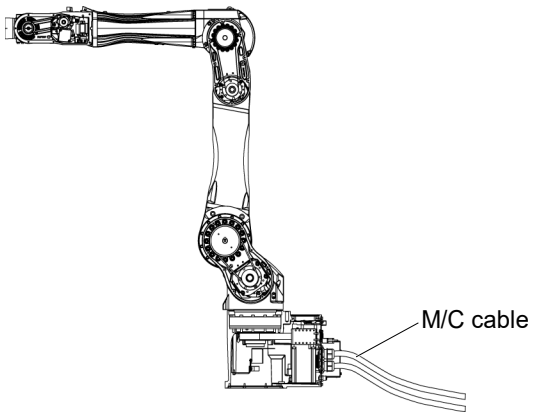
3. Install the Arm #3 cover.
   For details, refer to *C8 Maintenance: 3. Covers*.

14. Replacing the M/C Cable

Each motor is fed power by the battery for backup. Therefore, position data is held even after turning OFF the Controller. The position data will be lost when the cable connector connected to the battery is disconnected. And the EPSON RC+ will display the error message of encoder alarm occurrence when the Controller is turned ON.

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	■ When disconnecting the connectors during the replacement of the cable unit, be sure to reconnect the connectors to their proper positions. Improper connection of the connectors may result in improper function of the robot system. For details on the connections, please contact the supplier of your region. ■ When installing 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. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check 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.) Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system.



(Figure: C8-A1401** (C8XL))

	Name			Qty.	Note
Maintenance Parts	M/C cable	3 m	Straight	1	R12NZ900S1
			L-shaped	1	R12NZ900S5
		5 m	Straight	1	R12NZ900S2
			L-shaped	1	R12NZ900S6
		10 m	Straight	1	R12NZ900S3
			L-shaped	1	R12NZ900S7
		15 m	Straight	1	R12NZ900YC
			L-shaped	1	R12NZ900YB
		20 m	Straight	1	R12NZ900S4
			L-shaped	1	R12NZ900S8
	M/C cable (flexible)	3 m	Straight	1	R12NZ900S9
			L-shaped	1	R12NZ900SD
		5 m	Straight	1	R12NZ900SA
			L-shaped	1	R12NZ900SE
		10 m	Straight	1	R12NZ900SB
			L-shaped	1	R12NZ900SF
		15 m	Straight	1	R12NZ900YE
			L-shaped	1	R12NZ900YD
		20 m	Straight	1	R12NZ900SC
			L-shaped	1	R12NZ900SG
Tools	Hexagonal wrench (width across flats: 3 mm)			1	For M4 hexagon socket head cap bolts

Removal: M/C cable

1. Turn OFF the Controller power.

2. Disconnect the following connectors from the Controller.
   Power cable connector
   Signal cable connector

3. Remove the connector plate.
   For details, refer to *C8 Maintenance: 3. Covers*.

NOTE
Do not pull the connector plate forcibly.

Do not disconnect the M/C cable from the connector plate.

4. Remove the connectors.
   Connectors: X11, X12, X14, BR010, X010, X020, X040, LED, GS01

NOTE
Each connector is numbered and has a different shape.
Do not disconnect the battery connector (BT1*). Otherwise, calibration will be required.
For details, refer to *C8 Maintenance: 16. Calibration*.

5. Remove the connector sub plate.
   For details, refer to *C8 Maintenance: 3. Covers*.

Installation: M/C cable

1. Install the connector sub plate.
   For details, refer to *C8 Maintenance: 3. Covers*.

2. Connect the connectors of the new M/C cable to these of the cable unit.
   Connector: X11, X12, X14, BR010, X010, X020, X040, LED, GS01

3. Install the connector plate.
   For details, refer to *C8 Maintenance: 3. Covers*.

4. Connect the following connectors to the Controller.
   Power cable connector
   Signal cable connector

5. Turn ON the Controller power.

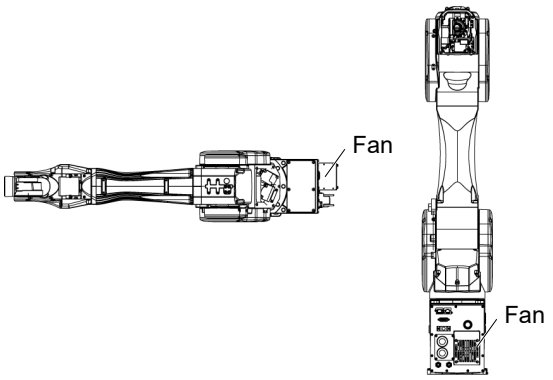
6. Check operation to see if the Manipulator's position and posture are out of position.
   Move the Manipulator to two or three points (poses) of the registered points.

7. If the battery connector (BT1*) was disconnected, calibrate the Joint #1.
   For details, refer to *C8 Maintenance: 16. Calibration*.

8. If the Manipulator is off position, calibrate all the joints and axes.
   For details, refer to *C8 Maintenance: 16. Calibration*.

15. Replacing the Fan

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.



(Figure: C8-A1401** (C8XL))

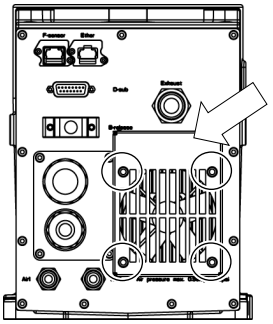
	Name	Qty.	Note
Maintenance Part	Fan	1	2177465 (standard, cleanroom models) 2178399 (protection model)
Tool	Cross-point screwdriver	1	For cross recessed head screws

(Figure: Cable backward model)

Removal: Fan

1. Remove the fan cover screws while supporting the cover.

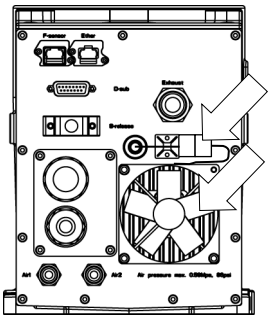
   Cross recessed head screws with washer: 4-M4×35



NOTE The cover falls when the screws are removed.
When removing the screws, be sure to support the cover.

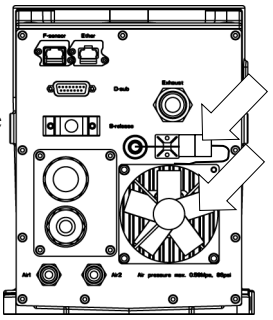
2. Remove the fan cover.

3. Remove the fan connectors.
4. Remove the fan.

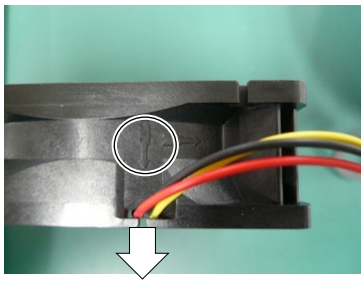


Installation: Fan

1. Install the fan.



NOTE Be careful of the installation direction of the fan.
The arrow on the fan (indicated with the arrow in the photo) should point the heat sink, and the cables should come to the upper side of the fan.

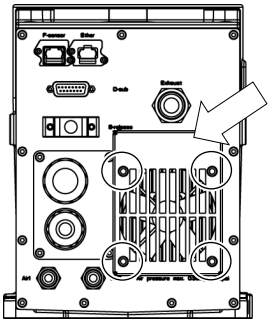


2. Connect the fan connectors.

3. Install the fan cover.

   Cross recessed head screws with washer: 4-M4×35

   Tightening torque: 0.9 ± 0.1 N·m



16. Calibration

16.1 Overview

After parts have been replaced (motors, reduction gear units, timing belts, etc.), the Manipulator cannot perform positioning properly because a gap exists between the origin stored in each motor encoder and its corresponding origin stored in the Controller.
Therefore, it is necessary to match these origins after replacing the parts.
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 the *Installation and Design Precautions* in the *Safety* chapter of the *EPSON RC+ User’s Guide*. ■ 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.

In EPSON RC+, a coordinate point including the arm pose is defined as “point” and its data is called “point data”.

There are two methods to move the Manipulator during calibration.
- Releasing the electromagnetic brake and moving the arms manually.
  For details, refer to the *C Series Manual C8 Manipulator 1.5 How to Move Arms with the Electromagnetic Brake*.
- Moving the Manipulator using Jog & Teach.

Moving the Manipulator while releasing the electromagnetic brake involves risk as described below.
It is recommended to move the Manipulator using Jog & Teach.

 CAUTION	■ Normally, release the brake of joints one by one. Take extra care if you need to release the brakes of two or more joints simultaneously. Releasing the brakes of two or more joints simultaneously may cause hands and fingers to be caught and/or equipment damage to or malfunction of the Manipulator as the arms of the Manipulator may move in unexpected directions. ■ After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

Also, pay attention to the following points at the encoder initialization.

CAUTION	■ The Joint #1 and Joint #4 have no mechanical stops and they may be rotated more than 360 degrees. If the encoder initialization is performed with improper posture, the Manipulator moves outside the operation range. If the Manipulator was moved outside the operation range, the internal wiring may be damaged by being twisted or pinched and it may result in Manipulator malfunction.

NOTE

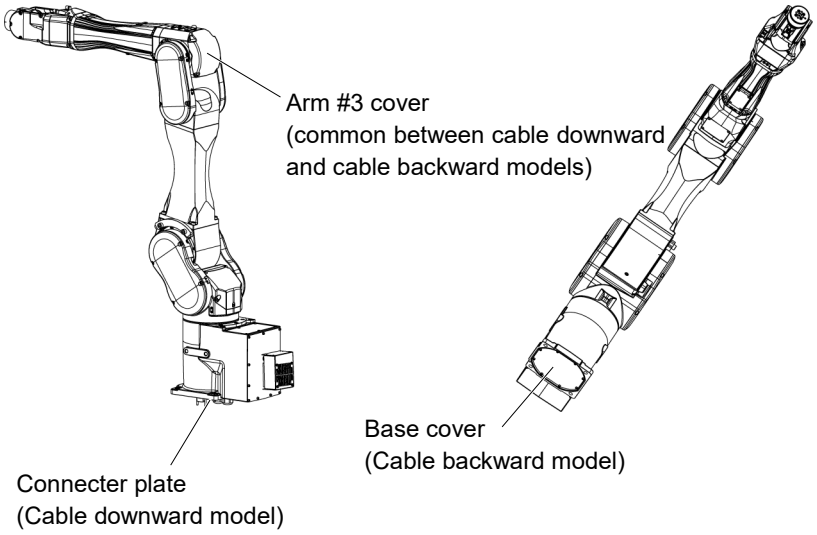
When the home positions of the Joints #1 and #4 are uncertain, check torsion of the internal cables. The home positions are where the Manipulator has the internal cables not twisted at the basic orientation described in *C Series Manual C8 Manipulator 3.7 Checking the Basic orientation*.

Torsion of the internal cables can be checked by removing the following covers.

Joint #1 : Base cover (Cable backward model)

: Connecter plate (Cable downward model)

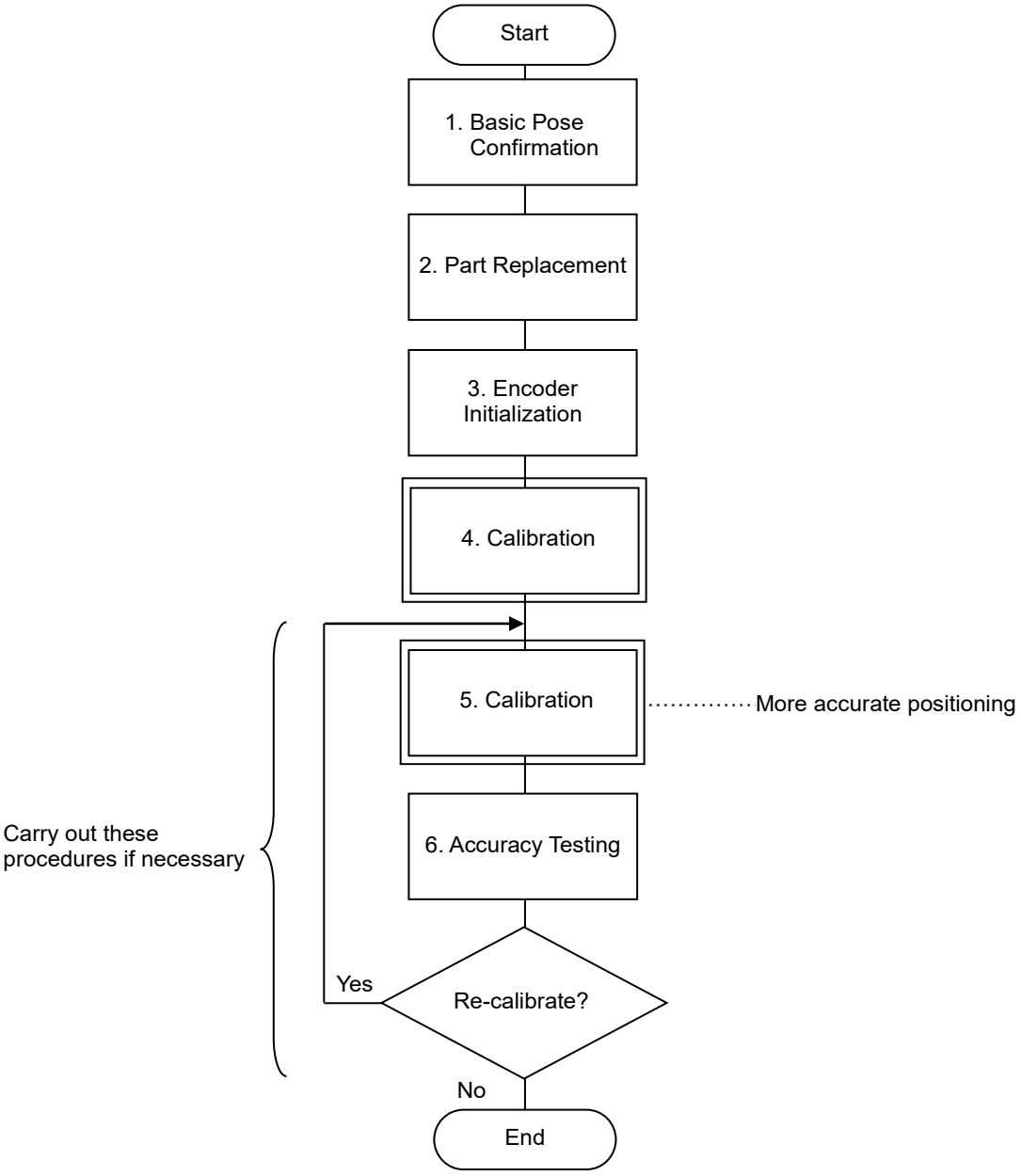
Joint #4 : Arm #3 cover
(common between cable downward and cable backward models)



For details on Jog & Teach, refer to the following manual.
EPSON RC+ User's Guide
5.12.1 Robot Manager Command Tools: Robot Manager: Jog and Teach Page.

NOTE
- For details about the basic orientation, refer to *C Series Manual C8 Manipulator 3.7 Checking the Basic orientation.*
- Whenever possible, calibrate one joint at a time. (Also, replace parts of one joint at a time whenever possible.) If you calibrate the origins for multiple joints simultaneously, it will be more difficult to verify their origins and obtain the origin correct positions.
  However, joint #5 cannot be calibrated alone due to the structure of the Manipulator. Make sure you calibrate joint #5 and #6 at the same time.

Calibration Flowchart



16.2 Calibration Procedure

Command Input

Command execution is required in some calibration procedures.
Select the EPSON RC+ menu-[Tools]-[Command Window].

This step is omitted in the calibration procedures.

Jog Motion

Setting of the jog motion is required in some calibration procedures.
Select EPSON RC+ menu-[Tools]-[Robot Manager] and select the [Jog & Teach] page.

The panel, window, and page above are indicated as [Jog & Teach] in the calibration procedures.

Follow steps 1 to 6 to calibrate the Manipulator.

1. Basic Pose Confirmation

   Pose data (Point data) prior to the part replacement (motors, reduction gear unit, or belt) is necessary for the calibration.

   Verify the recorded pulse values of the basic pose obtained in the *Setup & Operation 3.7 Checking the Basic orientation*.

2. Part Replacement

   Replace parts as instructed in this manual.
   Be careful not to injure yourself or damage parts during part replacement.

3. Encoder Initialization

   Turn ON the Controller while all joints are in the motion range.

   The error message “Encoder alarm has occurred. Check robot battery. EPSON RC+ must be restarted.” will be displayed.

   Initialize the encoder at the current position and reset the error.

   Initialize the encoder using one of the following procedures.

   Execute the following command at the [Monitor Window].

   EPSON RC+

   `>Encreset` [The joint number (1 to 6) of the encoder to be reset]

   Select EPSON RC+ menu-[Tools]-[Controller], then click <Reset Controller>.

After resetting the error, the motor encoder of the joint whose parts have been replaced will be initialized.
Set the jog mode to “Joint” in [Jog & Teach] and operate the Manipulator in jog motion to match the home position marks (0 pulse position) of the joint accurately.

When the joint cannot move to the home position, operate the Manipulator to match the tram mark placed in *Setup & Operation 3.7 Checking the Basic Orientation* as accurate as possible.

Initialize the encoder when the joint matches the home position or the tram mark.

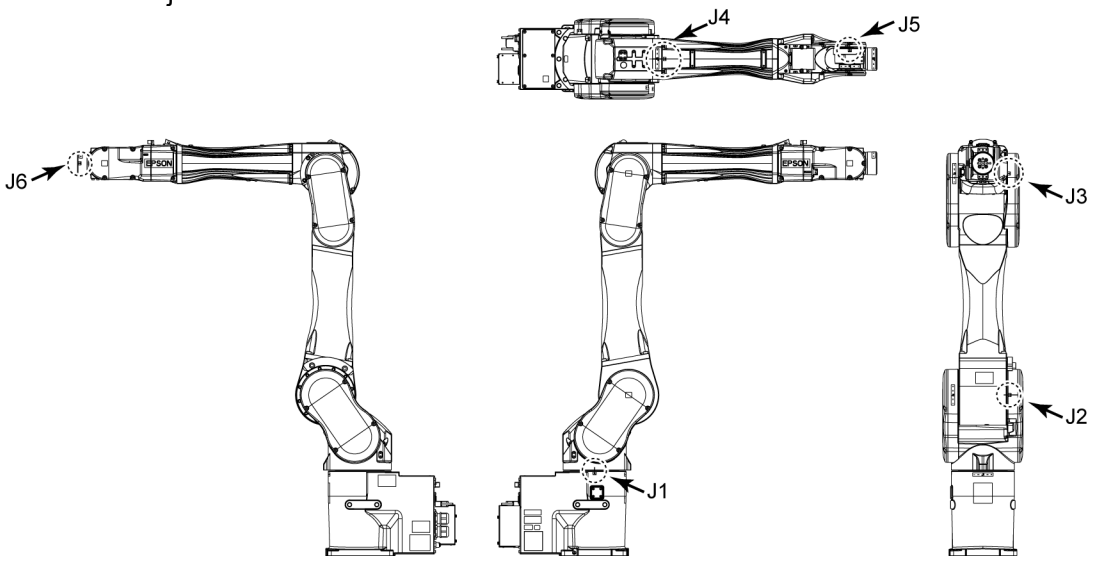
For the encoder initialization, refer to the procedure indicated above.

NOTE

When the origin of the Joint #5 is calibrated, the Joint #6 will be out of position. (Due to the structure of the Manipulator, any offset in the position of the Joint #5 affects the Joint #6.)
Calibrate the origin of the Joint #6 together when calibrating the Joint #5.

4. Calibration

Calibration marks of each joint



(Figure: C8-A1401** (C8XL))

4-1 Move the arm you want to calibrate to the position of the calibration mark.

EPSON RC+

Select menu-[Tool]-[Robot Manager]-[Jog & Teach] panel to move the Manipulator.

If an error occurs after replacing the motor and you cannot use the [Jog & Teach] panel or “Brake OFF, *” does not work (* is an axis number to calibrate.), go through the steps (4) and (5) now.

Then, [Jog & Teach] panel and “Brake OFF, *” will be available. Move the arm you want to calibrate to the position of the calibration mark.

4-2 Reset the encoder.

EPSON RC+

Execute one of the following commands to reset the encoder of the joint you want to calibrate from the menu-[Tool]-[Command Window].

Joint #1 `>Encreset 1`
Joint #2 `>Encreset 2`
Joint #3 `>Encreset 3`
Joint #4 `>Encreset 4`
Joint #5 `>Encreset 5, 6`
Joint #6 `>Encreset 6`

4-3 Reboot the Controller.

EPSON RC+

Click EPSON RC+ menu-[Tool]-[Controller]-<Reset Controller>.

4-4 Input the command in the Command window and execute it.

EPSON RC+

Execute one of the following commands to reset the encoder of the joint you want to calibrate from the menu-[Tool]-[Command Window].

```
>calpls 0,0,0,0,0,0
```
* Manipulator does not move.

4-5 Perform the calibration.

EPSON RC+

Execute one of the following commands to reset the encoder of the joint you want to calibrate from the menu-[Tool]-[Command Window].

Joint #1 `>calib 1`
Joint #2 `>calib 2`
Joint #3 `>calib 3`
Joint #4 `>calib 4`
Joint #5 `>calib 5,6`
Joint #6 `>calib 6`

Move the arm to several points to check if the arm moves to the original positions properly.

Teach points if fine adjustment is necessary.

5. Calibration (More accurate positioning)

EPSON RC+

Move the Manipulator to the selected point data by jogging in [Jog & Teach].

Move the joint* which is not calibrated to the specified point by motion command.

*When the Joint #5 is being calibrated, move the Joints #1 - #4 to the home positions.

For example, when the selected point data is “P1”, execute “Motor On” in [Control Panel] and execute “Go P1” in [Jog & Teach].

Position the calibrating joint* to the selected point data position accurately by jog command.

* When the Joint #5 is being calibrated, move the Joint #5 and #6 to the home positions.

Select the “Joint” jog mode from [Jog & Teach] to operate in the jog motion.

Enter the command below in the command window and execute it.

Execute the command below in the menu -[Tools]-[Command Window].

```
>calpls ppls(P1,1), ppls(P1,2), ppls(P1,3), ppls(P1,4),
ppls(P1,5), ppls(P1,6)
```

*The Manipulator will not move.

Perform the calibration. Input one of the following commands according to the joint being calibrated.

Joint #1 : `>calib 1`
Joint #2 : `>calib 2`
Joint #3 : `>calib 3`
Joint #4 : `>calib 4`
Joint #5 : `>calib 5,6`
Joint #6 : `>calib 6`

6. Accuracy Testing

Move the Manipulator to a different pose (point) to verify whether it moves back to the original position. If accuracy is inadequate, it is necessary to re-calibrate the origin using a different pose (point). You must set the pose (point) again if the Manipulator does not move back to the original position after re-calibration.

17. C8 Maintenance Parts List

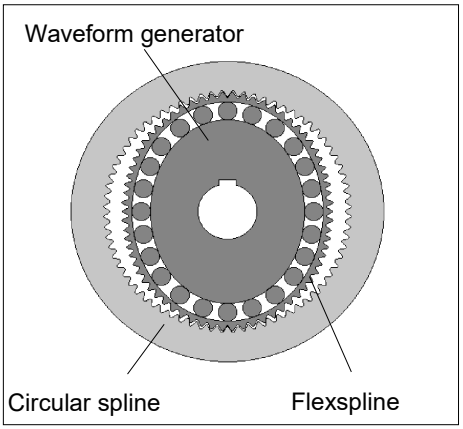
Name			Code	Note		Reference	Overhaul **
AC servo motor	Joint #1 unit	C8, C8L	2172921	1000 W, unit		5.1.1, 5.2.1	✓
		C8XL	2172922				✓
	Joint #2		2168683	750 W, single item		6.1	✓
	Joint #3		2168684	400 W, single item		7.1	✓
	Joints #4, 5, 6		2172051	100 W, single item		8.1, 9.1, 10.1	✓
Reduction gear unit*	Joint #1	C8	1674602	Unit For standard /Clean-room models		5.1.2, 5.2.2	✓
		C8L	1674603				✓
		C8XL	1674604				✓
	Joint #2	C8, C8L	1674605			6.2	✓
		C8XL	1674606				✓
	Joint #3	C8, C8L	1674607			7.2	✓
		C8XL	1674608				✓
	Joint #4	C8, C8XL	1674609			8.2	✓
		C8L	1675434				✓
	Joints #5, 6		1674610			9.2, 10.2	✓
Electromagnetic brake	Joints #1, 2		2172926	A set of brake and power supply		5.1.4, 5.2.4, 6.4	✓
	Joint #3		2172927			7,4	✓
	Joints #4, 5, 6		2172928			8.4, 9.4, 10.4	✓
J1 brake positioning jig			1675081	Assembly tool		5.1.4, 5.2.4	
Timing belt	Joint #1	C8	1655928	Width 20 mm	560mm	5.1.3, 5.2.3	✓
		C8L	1655929		580mm		✓
		C8XL	1655930		595 mm		✓
	Joint #2	C8	1655920	Width 14 mm	475mm	6.3	✓
		C8L	1655924		485mm		✓
		C8XL	1655927		540 mm		✓
	Joint #3	C8	1655915	Width 10 mm	471 mm	7.3	✓
		C8L	1655918		480 mm		✓
		C8XL	1655919		501 mm		✓
	Joint #4		1655931	Width 6 mm	243 mm	8.3	✓
	Joint #5		1655932		330 mm	9.3	✓
	Joint #6		1655933		339 mm	10.3	✓
Belt tensile jig			1674582	Assembly tool		5, 6, 7, 8, 9, 10	
Battery unit			2172925	(2 lithium batteries for replacement)		11.1	
Battery board			2173216			11.2	

** Overhaul
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 *C8 Maintenance 2.2 Overhaul*.

* Reduction Gear Unit: A reduction gear unit consists of the following three parts. When replacing the reduction gear unit, be sure to replace these parts all together as a set.

Waveform generator

The waveform generator consists of an ellipsoidal cam and ball bearings on outer circumference. The inner ring of the bearings is secured to the cam, while the outer ring is capable of flexible deformation through the ball bearings.



Flexspline

A thin, elastic, hat-shaped metal body with gear teeth around the outer circumference of the opening.

Circular spline

A rigid, ring-shaped body with gear teeth on the inner circumference. The circular spline has two more teeth than the flexspline does.

The splines are greased. Be sure to keep the grease from being attaching to the clothes.

Name		Code	Note	Reference
Grease **	Joints #1, #2, #3, #4, #5 : SK-1A	-	For purchasing grease, liquid gasket, and adhesive, please contact the supplier of your region.	2.3, 5.1.2, 5.2.2, 7.2, 8.2, 9.2
	Joint #6, Bevel gear : SK-2	-		2.3, 10.2
	Cable : GPL-224	-		4
Liquid gasket **	For protection model : 1207B	-		3
Adhesive	LOCTITE641	-		8.2, 9.2
Grease-up kit		1674592	Set of grease gun, nipple, an extension tool	2.3
Grease plug		1656158		2.3

** Regarding purchase of grease, liquid gasket and adhesive

Due to the chemicals regulations of individual countries (the UN GHS), we are requesting our customers to purchase grease and other materials required for maintenance from the manufacturers listed in the table below as of April 2015.

Regarding purchase of grease and other materials, please contact the following manufacturers. If there is anything unclear, please contact the supplier of your region.

Product name	Manufacturer	URL
Harmonic Grease SK-1A Harmonic Grease SK-2	Harmonic Drive Systems Inc.	https://www.harmonicdrive.net/
Krytox®GPL-224	Chemours	https://www.chemours.com/en/brands-and-products
1207B	ThreeBond Co.,Ltd	https://www.threebond.com
LOCTITE641	LOCTITE	https://loctite.com/

Name			Code	Note	Reference
Control board 1, 2	Arms #1, #3		2138032		12
O ring	Joint #2	C8, C8L	1263978	Arm #1 side	6.2
			1656161	Arm #2 side	
		C8XL	1670635	Arm #1 side	
			1656140	Arm #2 side	
	Joint #3		1263977	Arm #2 side	7.2
			1510528	Arm #3 side	
	Joint #4		1263976	Arm #3 side	8.2
			1520370	Arm #4 side	
	Grease inlet		1657289	Base, Arm #5	2.3, 11
LED lamp			1668127	Standard/Clean-room model	13
M/C cable	3 m	Straight	R12NZ900S1		14
		L-shaped	R12NZ900S5		
	5 m	Straight	R12NZ900S2		
		L-shaped	R12NZ900S6		
	10 m	Straight	R12NZ900S3		
		L-shaped	R12NZ900S7		
	15 m	Straight	R12NZ900YC		
		L-shaped	R12NZ900YB		
	20 m	Straight	R12NZ900S4		
		L-shaped	R12NZ900S8		
M/C cable (flexible)	3 m	Straight	R12NZ900S9		
		L-shaped	R12NZ900SD		
	5 m	Straight	R12NZ900SA		
		L-shaped	R12NZ900SE		
	10 m	Straight	R12NZ900SB		
		L-shaped	R12NZ900SF		
	15 m	Straight	R12NZ900YE		
		L-shaped	R12NZ900YD		
	20 m	Straight	R12NZ900SC		
		L-shaped	R12NZ900SG		
Cable unit	C8		2172929	Standard/Clean-room model	4
			2172932	Protection model	
	C8L		2172930	Standard/Clean-room model	
			2172933	Protection model	
	C8XL		2172931	Standard/Clean-room model	
			2172934	Protection model	
Wire tie	AB100		1675753	1 bag (100 pcs: white)	4
	AB150		1675754	1 bag (100 pcs: white)	
	AB350		1697428	1 bag (50 pcs: white)	5.1, 5.2
Felt sheet	For Arm #3		1673981	Square	8
	For Arm #3 maintenance cover		1673980	Square	8
	For Joint #4		1673979	Round	8
	For Joint #5		1673978	Round	9
Fan (C8XL only)			2177465	Standard/Clean-room model	15
			2178399	Protection model	
Heat radiation sheet	For heat radiation block		1694609		5.1, 5.2
	For Motor		1655043	Joint #1, 2 common	5.1, 5.2, 6.2

Name			Code	Note	Reference
Cover	Arm #1	Center cover	1675435	Metal cover Common to Standard/ Clean-room models	3
		Side cover	1674537	Standard model Plastic cover	3
	Arm #2	Side cover (left)	1655114		
		Side cover (right)	1674542		
	Arm #3	Cover	1674543		
	Arm #4	Side cover	1674547		
	Arm #1	Side cover	1674548	Clean-room model Plating cover	3
	Arm #2	Side cover (left)	1655127		
		Side cover (right)	1674550		
	Arm #3	Cover	1674551		
	Arm #4	Side cover	1674553		
Gasket	Arm #1	Center gasket	1665238	Protection model	3
		Side gasket	1665240		
	Arm #2	Side gasket	1665241		
	Arm #3	Cover gasket	1665242		
		Maintenance gasket	1665254		
	Arm #4	Side gasket	1665243		
		Maintenance gasket	1665257		
		D-sub attachment gasket	1665255		
	Base	Rear gasket	1665244		
		Bottom gasket	1665247		
		Maintenance gasket	1665248		
		Sub plate gasket	1665246		
		Installation gasket	1668377		
		Gasket For Heat sink	1694610	Clean-room model Protection model	3
Seal washer		M4 (for sub plate)	1665882	Protection model	3
Air plug		For M6	1657011		4

18. C8 Option Parts List

Name		Code	Note	Reference *
Brake release unit (with M/C short connector)		R12NZ900N4	For Europe	6.1
		R12NZ900N5	For U.S. & Japan	
MC short connector		R12NZ900N7	For brake release unit	
Camera plate unit		R12NZ9003F (Common to C3 and C4)	Old Code: R12B031922	6.2
Tool adapter (ISO flange)		R12NZ900LQ		6.3
Adjustable mechanical stop	J1	R12NZ900LR		6.4
	C8/C8L_J2	R12NZ900N6		
	C8XL_J2	R12NZ900LT		
	J3	R12NZ900LU		
Fittings for customer use	ø6 straight	R12NZ900LV		6.5
	ø6 elbow	R12NZ900LW		
Standard user connector kit	D-sub	R12NZ900LX		
Waterproof user connector kit	D-sub	R12NZ900LY		
	Ethernet	R12NZ900LZ		

* Refer to each manipulator's page of C series manual.

C12 Maintenance

This volume contains maintenance procedures with safety precautions for C12 series Manipulators.

1. Safety Maintenance

Please read this chapter, this manual, and other relevant manuals carefully to understand safe maintenance procedures before performing any maintenance.

Only authorized personnel who have taken maintenance training held by the manufacturer or dealer should be allowed to perform the robot maintenance.

 WARNING	■ Do not remove any parts unless otherwise instructed by this manual. Follow the maintenance procedure strictly as described. Improper removal of parts or improper maintenance may cause not only malfunction of the robot system but serious safety problems. ■ If you have not received training, keep away from the Manipulator while the power is ON. 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. ■ When connecting / replacing the brake release unit or the external short connector, turn OFF the power to the Controller and the brake release unit. Connecting or disconnecting the connector while the power is ON may result in electrical shock.

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.) It may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. ■ If the Manipulator is operated without connecting the brake release unit or the external short connector, the brakes cannot be released and it may cause damage on them. After using the brake release unit, be sure to connect the external short connector to the Manipulator, or check connection of the connector for the brake release unit. ■ The Manipulator arms may become hot after the Manipulator operation due to heat generation of the motors. Be careful when performing maintenance.
	■ When operating maintenance of manipulator, secure about 50 cm of empty space around the manipulator.

2. General Maintenance

This chapter describes maintenance inspection procedures. Performing maintenance inspection properly is essential to prevent trouble and ensure 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.

	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						√

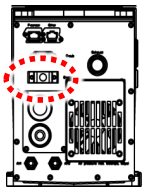
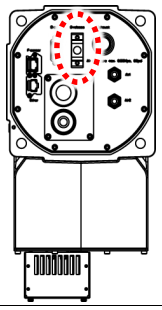
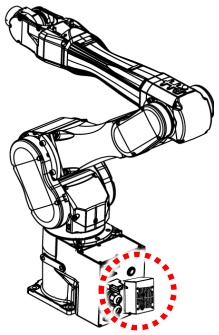
h = hour

2.1.2 Inspection Point

Inspection Point

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 either the external short connector or the brake release unit connector is connected.	The external short connector on the back side of the Manipulator, or the brake release unit connector.	√	√	√	√	√
Check the break operation	Joint #1 to 6 break	√	√	√	√	√
Check whether unusual sound or vibration occurs.	Whole	√	√	√	√	√
Check if the fan is running (C8-A1401***(C8XL) only)	Fan	√	√	√	√	√

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 either the external short connector or the brake release unit connector is connected.	Check whether external short connector or break release connector is connected. When neither is connected, connect either one. M/C Cable backward  M/C Cable downward 
Check the break operation	Check that the arm does not fall when in MOTOR OFF. If the arm falls when in MOTOR OFF and the brake is not released, 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.
Check if the fan is running (C8-A1401***(C8XL) only)	Check that the fan is running when in MOTOR ON. If the fan is not running when in MOTOR ON, 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 EPSON RC+ 7.0 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 Maintenance 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 box-[Motor On Hours].

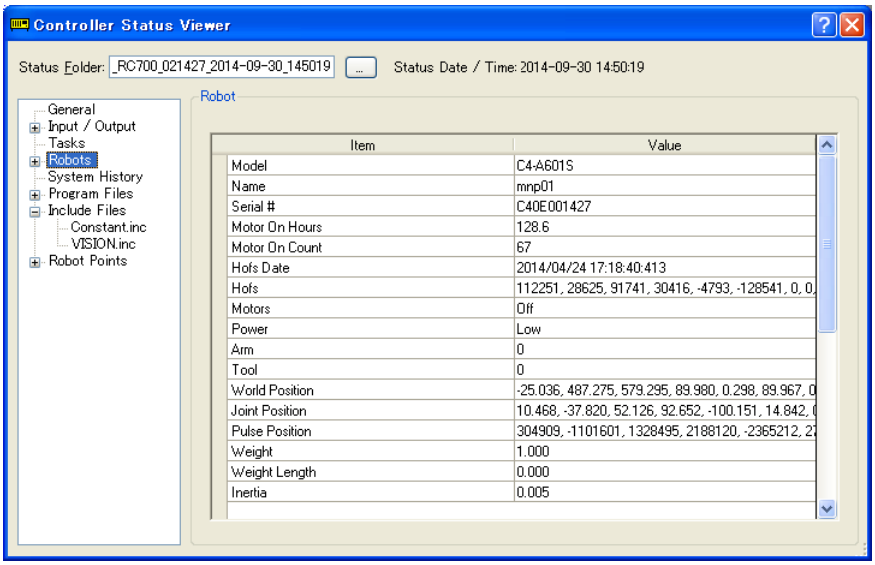
(1) Select EPSON RC+ menu-[Tools]-[Controller] to open the [Controller Tools] dialog box.

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

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

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

(5) Select [Robot] from the tree menu on the left side.



For the parts subject to overhaul, refer to *C12 Maintenance 17. 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 reduction gear units and the bevel gear need greasing regularly. Only use the grease specified in the following table.

 WARNING	■ Before greasing, 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	■ Keep enough grease in the Manipulator. Operating the Manipulator with insufficient grease will cause the noise or 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. ■ 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
Joints #1, 2, 3, 4, 5	Reduction gear units	Overhaul timing	SK-1A
Joint # 6			SK-2
Joint # 6	Bevel gear	Overhaul timing	SK-2

Joint #1, 2, 3, 4, 5, 6 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.

	Name	Qty.	Note
Maintenance parts	Grease up kit	1	1674592 (A set of grease gun, nipple, and extension jig)
	Grease plug	1	1656158
	O-ring for grease inlet	1	1657289
Tools	Hexagonal wrench (width across flats: 2 mm)	1	For M3 hexagon socket countersunk head bolts
	Hexagonal wrench (width across flats: 2.5 mm)	1	For M3 hexagon socket head cap bolts
	Cross-point screwdriver (#2)	1	For cross-recessed head screws
	Flat head screwdriver	1	For grease plug

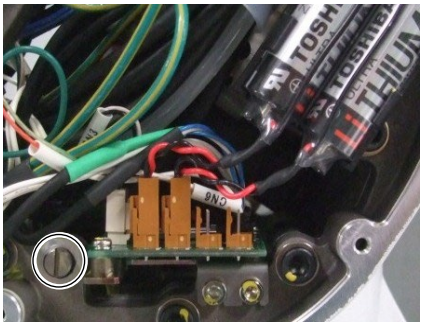
NOTE
☞ Before greasing, move the Manipulator so that the grease inlet is not directed down.
Do not remove the grease plug while the grease inlet is directed down. Otherwise the oil content separated from the grease may leak out.

NOTE
☞ Do not use any tool to install and remove the grease nipple and grease line extension jig.
Always handle them directly by your hand.
If the grease nipple or grease line extension jig is installed or removed with a tool such as wrench, they may be damaged.

2.3.1 Joint #1 Reduction Gear Unit

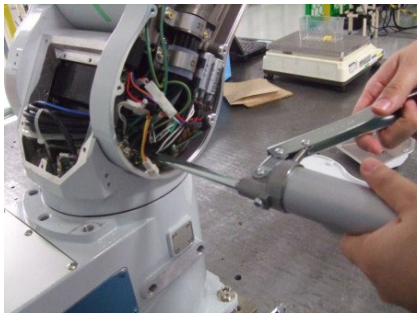
Greasing

1. Remove the Arm #1 side cover.
   For details, refer to *C12 Maintenance: 3. Covers*.
2. Remove the grease plug from the Joint #1 grease inlet located inside the Arm #1.
3. Attach the grease nipple to the Joint #1 grease inlet.

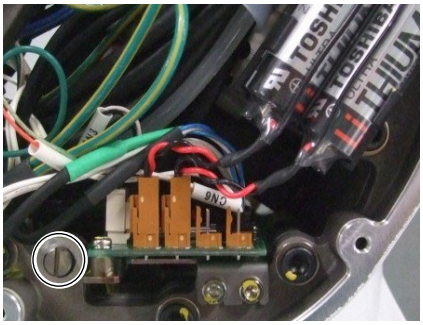


4. Inject grease from the grease nipple using a grease gun

   Grease: SK-1A
   Grease amount: 11g



5. Remove the grease nipple from the Joint #1 grease inlet.
6. Attach the grease plug to the Joint #1 grease inlet.
   If the grease plug is damaged or deteriorated, replace it with a new one.

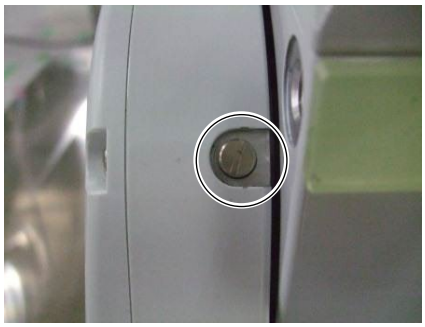


7. Install the Arm #1 side cover.
   For details, refer to *C12 Maintenance: 3. Covers*.

2.3.2 Joint #2 Reduction Gear Unit

Greasing

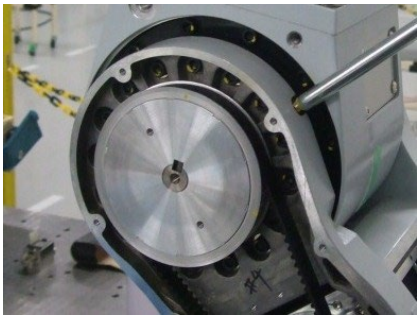
1. Remove the grease plug from the Joint #2 grease inlet of the Arm #1.



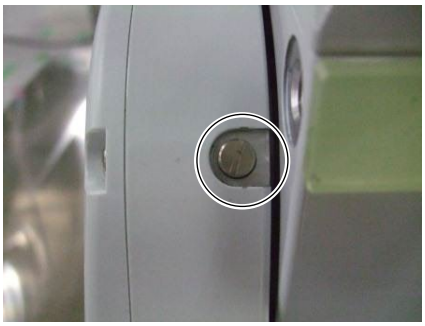
2. Attach the grease nipple to the Joint #2 grease inlet.

3. Inject grease from the grease nipple using a grease gun

   Grease: SK-1A
   Grease amount: 12g



4. Remove the grease nipple from the Joint #2 grease inlet.



5. Attach the grease plug to the Joint #2 grease inlet.

   If the grease plug is damaged or deteriorated, replace it with a new one.

2.3.3 Joint #3 Reduction Gear Unit

Greasing

1. Remove the grease plug from the Joint #3 grease inlet of the Arm #2.

2. Attach the grease nipple to the Joint #3 grease inlet.

3. Inject grease from the grease nipple using a grease gun

   Grease: SK-1A
   Grease amount: 3g

4. Remove the grease nipple from the Joint #3 grease inlet.

5. Attach the grease plug to the Joint #3 grease inlet.

   If the grease plug is damaged or deteriorated, replace it with a new one.

2.3.4 Joint #4 Reduction Gear Unit

Greasing

1. Remove the grease plug from the Joint #4 grease inlet of the Arm #4.

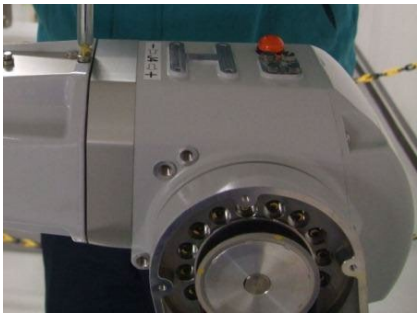
2. Attach the grease nipple to the Joint #4 grease inlet.

NOTE

The grease plug attaching hole located near the label with “4” printed is the Joint #4 grease inlet.
The grease inlet position differs depending on the model. Carefully identify the correct position.

3. Inject grease from the grease nipple using a grease gun

   Grease: SK-1A
   Grease amount: 2g



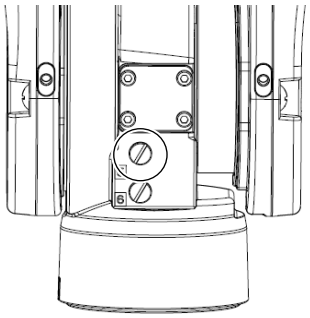
4. Remove the grease nipple from the Joint #4 grease inlet.

5. Attach the grease plug to the Joint #4 grease inlet.

   If the grease plug is damaged or deteriorated, replace it with a new one.

2.3.5 Joint #5 Reduction Gear Unit

Greasing

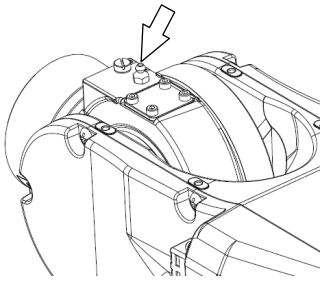


1. Remove the grease plug from the Joint #5 grease inlet of the Arm #5.

2. Attach the grease nipple to the Joint #5 grease inlet.

NOTE

The grease plug attaching hole located near the label with "5" printed is the Joint #5 grease inlet.
Be careful not to confuse it with the Joint #6 grease inlet.

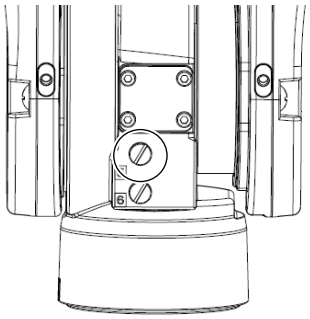


3. Inject grease from the grease nipple using a grease gun.

   Grease: SK-1A
   Grease amount: 1g

NOTE

Be careful not to mix with the grease used in the Joint #6 (SK-2).



4. Remove the grease nipple from the Joint #5 grease inlet.

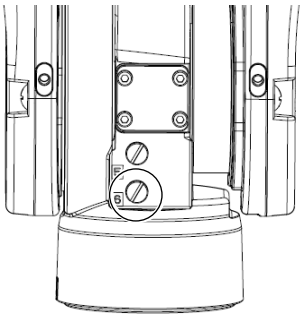
5. Attach the grease plug to the Joint #5 grease inlet.

   If the grease plug is damaged or deteriorated, replace it with a new one.

2.3.6 Joint #6 Reduction Gear Unit

Greasing

1. Remove the grease plug from the Joint #6 grease inlet of the Arm #5.



2. Attach the grease nipple to the Joint #6 grease inlet.

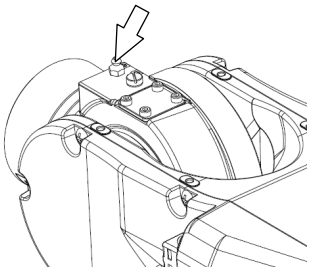
NOTE

The grease plug attaching hole located near the label with "6" printed is the Joint #6 grease inlet.
Be careful not to confuse it with the Joint #5 grease inlet.

3. Inject grease from the grease nipple using a grease gun.

   Grease: SK-2

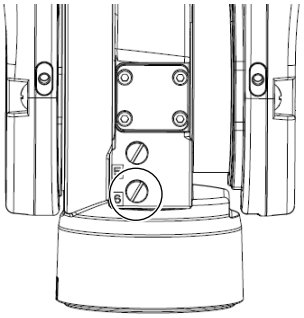
   Grease amount: 0.5g



NOTE

Be careful not to mix with the grease used in the Joint #5 (SK-1A).

4. Remove the grease nipple from the Joint #6 grease inlet.



5. Attach the grease plug to the Joint #6 grease inlet.

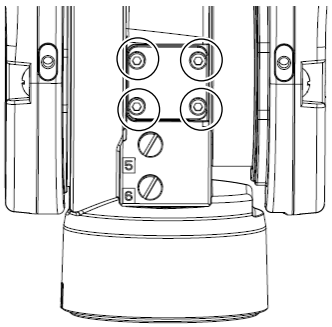
   If the grease plug is damaged or deteriorated, replace it with a new one.

2.3.7 Joint #6 Bevel Gear

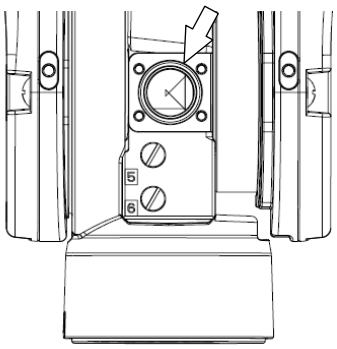
Greasing

1. Remove the Arm #5 grease inlet cover.

   Hexagon socket head cap bolts: 4-M3×6



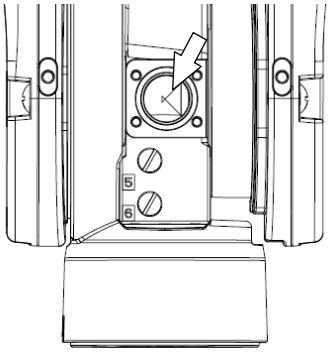
2. Remove the O-ring located in the base groove.



3. Apply grease to the mating surface of the bevel gear inside the Arm #5.

   Grease: SK-2

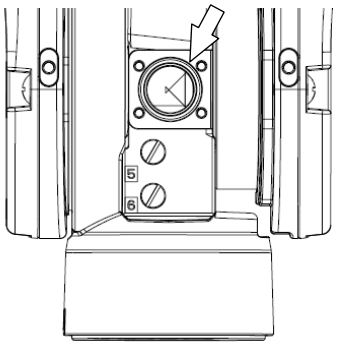
   Grease amount: 2g



4. Apply a thin coat of grease (SK-2) to the O-ring. Fit the O-ring into the base groove.

   Do not allow the O-ring to come out of the groove.

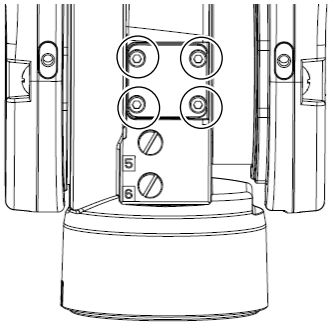
   If the O-ring is swollen, damaged, or deteriorated, replace it with a new one.



5. Install the Arm #5 grease inlet cover.

   Hexagon socket head cap bolts: 4-M3×6

   Tightening torque: 2.0 ± 0.1 N·m



2.4 Tightening Hexagon Socket Head Bolts

Hexagon socket head cap bolts (hereinafter, “bolts”) are used in places where mechanical strength is required. These bolts are fastened with the tightening torque shown in the following tables.

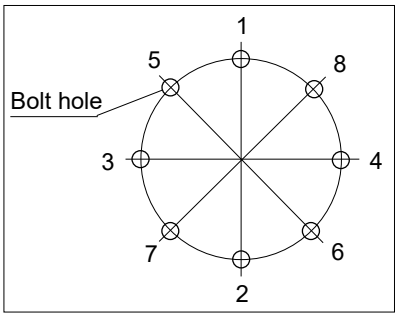
When it is required to refasten the bolts in some procedures in this manual (except special cases as noted), use a torque wrench so that the bolts are fastened with appropriate tightening torque as shown below.

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)

See below for the set screw.

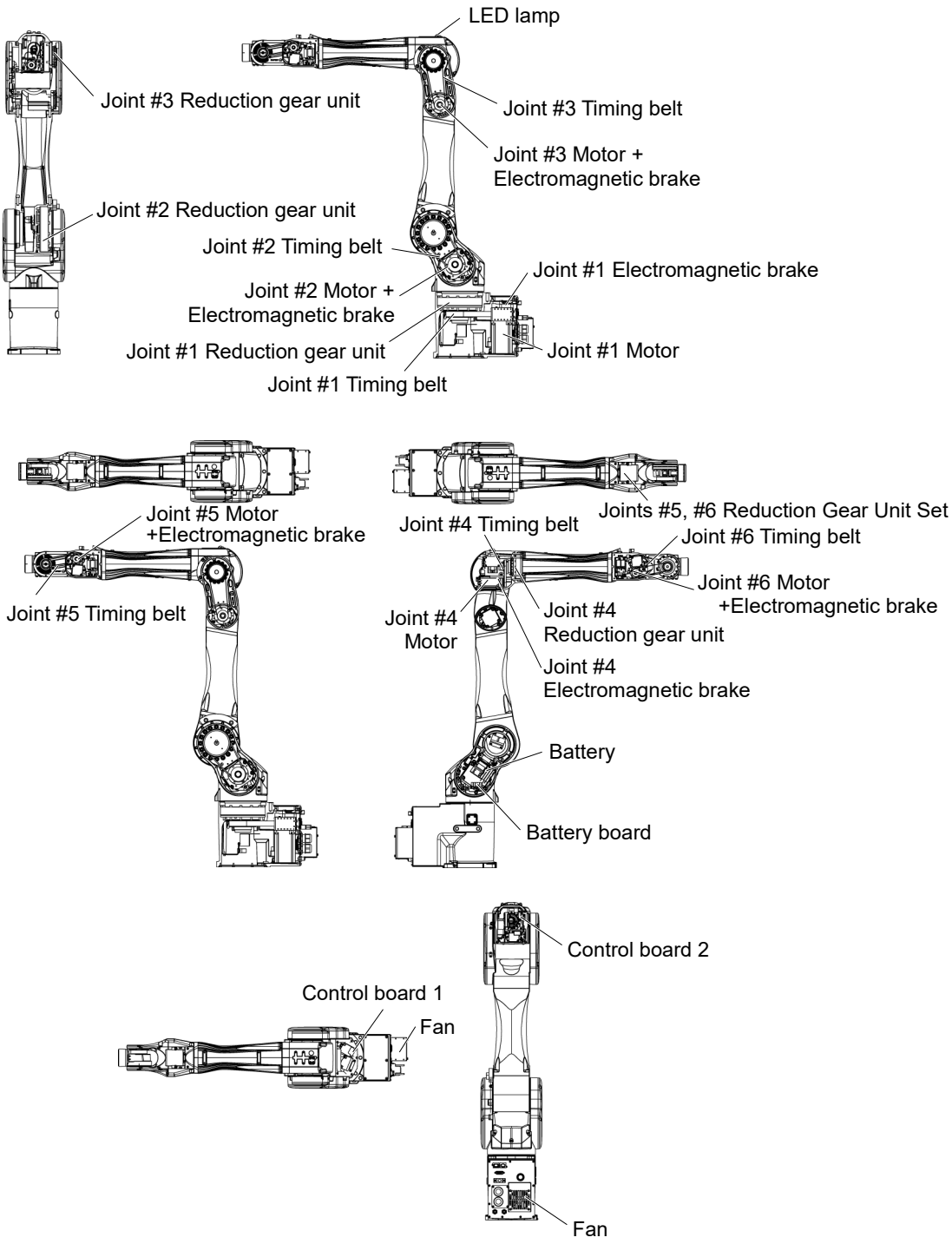
Set Screw	Tightening Torque
M4	2.4 ± 0.1 N·m (26 ± 1 kgf·cm)
M5	3.9 ± 0.2 N·m (40 ± 2 kgf·cm)
M6	8.0 ± 0.4 N·m (82 ± 4 kgf·cm)

It is recommended to fasten the bolts aligned on a circumference in a crisscross pattern as shown in the figure below.



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

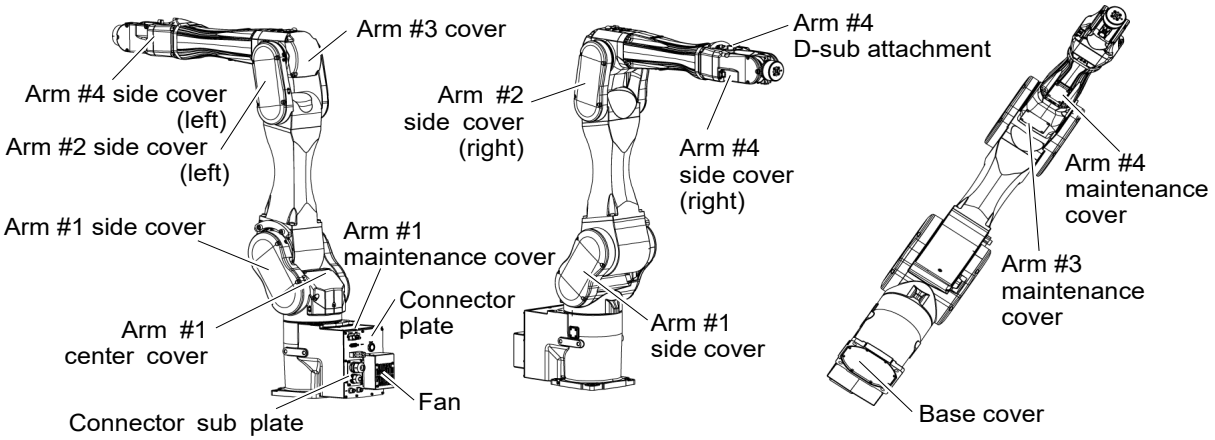
2.5 Layout of Maintenance Parts



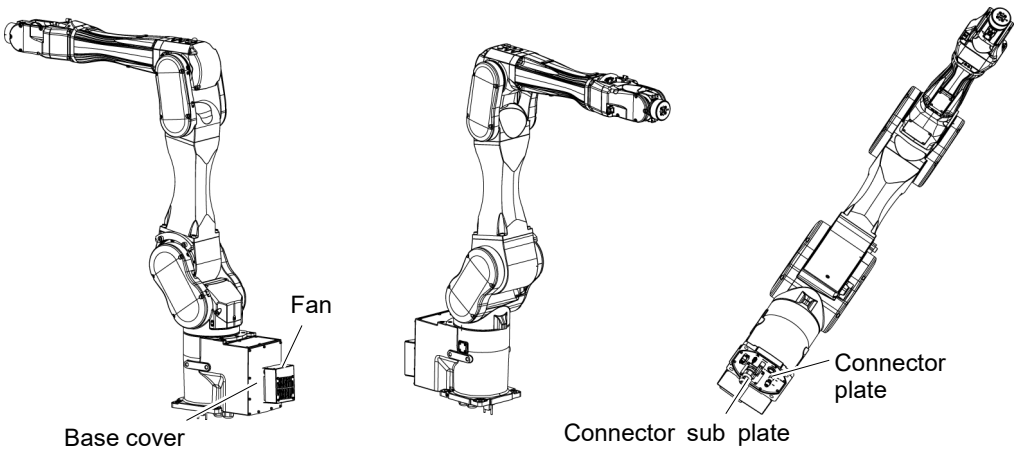
3. Covers

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.

Cable backward model



Cable downward model



	Name			Qty.	Note	
Maintenance parts	Cover	Arm #1	Center cover	1	1675435	Metal cover Common to Standard/ Clean-room models
			Side cover	2	1674537	Standard model Plastic cover
		Arm #2	Side cover (left)	1	1655114	
			Side cover (right)	1	1674542	
		Arm #3	Cover	1	1674543	
		Arm #4	Side cover (left)	1	1822063	
			Side cover (right)	1	1822064	
		Arm #1	Side cover	2	1674548	Cleanroom model Plating cover
		Arm #2	Side cover (left)	1	1655127	
			Side cover (right)	1	1674550	
		Arm #3	Cover	1	1674551	
		Arm #4	Side cover (left)	1	1822065	
			Side cover (right)	1	1822066	
	Gasket	Base	Gasket for heat sink	1	1694610	Cleanroom model
Tools	Hexagonal wrench	width across flats: 2.5 mm		1	For M3 hexagon socket head cap bolts	
		width across flats: 3 mm		1	For M4 hexagon socket head cap bolts	
	Cross-point screwdriver (#2)			1	For cross recessed screws	

3.1 Arm #1 Center Cover

CAUTION	■ When mounting the cover, be careful not to get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the cover. Be sure to place the cables back to their original locations.

Removal

Remove the screws and then remove the Arm #1 center cover.

Cross recessed truss head small screws: 5-M4×10

Installation

Install the Arm #1 center cover to the Manipulator.

Cross recessed truss head small screws: 5-M4×10
Tightening torque: 0.9 ± 0.1 N·m

NOTE

Be careful not to get the cables caught between the cover and the Manipulator.

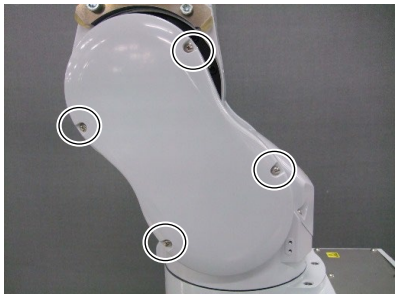
3.2 Arm #1 Side Cover

CAUTION	■ When mounting the cover, be careful not to get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the cover. Be sure to place the cables back to their original locations.

Removal

Remove the screws and then remove the Arm #1 side cover.

Cross recessed truss head small screws:
4-M4×10 (one side)



Installation

Install the Arm #1 side cover to the Manipulator.

Cross recessed truss head small screws:
4-M4×10 (one side)

Tightening torque: 0.9 ± 0.1 N·m

NOTE

Be careful not to get the cables caught between the cover and the Manipulator body.

When replacing the side cover for the right side of the Arm #1, attach the electrical shock warning label to the place indicated in the photo.

3.3 Arm #2 Side Cover

CAUTION	■ When mounting the cover, be careful not to get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the cover. Be sure to place the cables back to their original locations.

Removal

Remove the screws and then remove the Arm #2 side cover.

Cross recessed truss head small screws:
4-M4×10 (one side)

NOTE

Note that the Arm #2 side covers and Arm #2 side gaskets are different between right and left.

Installation

Install the Arm #2 side cover to the Manipulator.

Cross recessed truss head small screws: 4-M4×10 (one side)
Tightening torque: 0.9 ± 0.1 N·m

NOTE

Be careful not to get the cables caught between the cover and the Manipulator body.

3.4 Arm #3 Cover

CAUTION	■ When mounting the cover, be careful not to get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the cover. Be sure to place the cables back to their original locations.

Removal

Remove the screws and then remove the Arm #3 head cover.

Cross recessed truss head small screws: 4-M4×10

Installation

Install the Arm #3 cover to the Manipulator.

Cross recessed truss head small screws: 4-M4×10
Tightening torque: 0.9 ± 0.1 N·m

NOTE

Be careful not to get the cables caught between the cover and the Manipulator body.

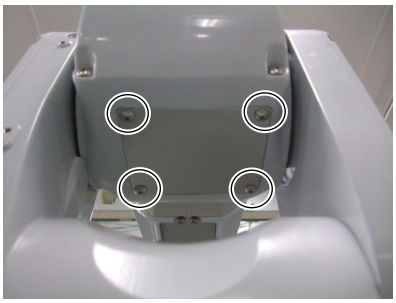
3.5 Arm #3 Maintenance Cover

CAUTION	■ When mounting the cover, be careful not to get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the cover. Be sure to place the cables back to their original locations.

Removal

1. Before removing the Arm #3 maintenance cover, move the arm to the position where you can remove the cover easily.

2. Remove the screws and then remove the Arm #3 maintenance cover.
   Cross recessed truss head small screws: 4-M4×8



Installation

Install the Arm #3 maintenance cover to the Manipulator.

Cross recessed truss head small screws: 4-M4×8

Tightening Torque: 0.9 ± 0.1 N·m

NOTE

Be careful not to get the cables caught between the cover and the Manipulator body.

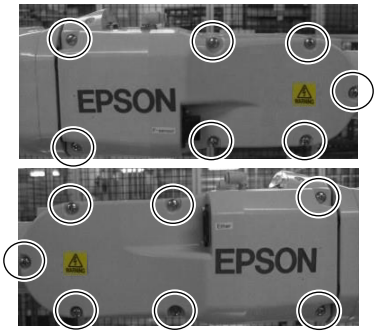
3.6 Arm #4 Side Cover

CAUTION	■ When mounting the cover, be careful not to get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the cover. Be sure to place the cables back to their original locations.

Removal

1. Remove the screws and then remove the Arm #4 side cover.

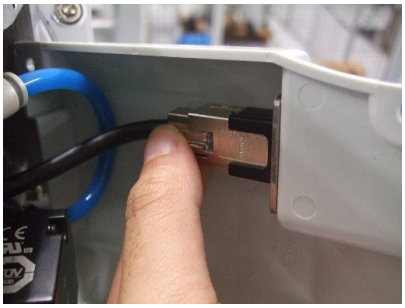
   Cross recessed truss head small screws:
   7-M4×10 (one side)



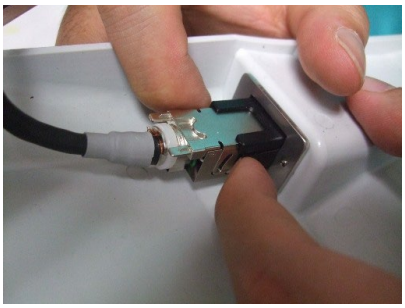
NOTE The Arm #4 side cover and Arm #4 side are the same between right and left.

2. Remove the connectors.

   RJ45 connector (left):
   Remove the RJ45 connector from the connector on the cover.



   F-sensor connector (right):
   Open the two plastic clips of the connector on the cover and pull out the metallic connector.



Installation

1. Insert the connectors.

   RJ45 connector:
   Insert the RJ45 connector to the connector on the cover.

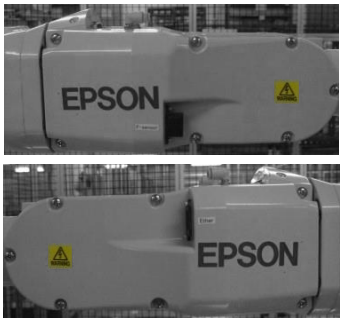
   F-sensor connector:
   Insert the metallic connector to the connector on the cover.

2. Install the Arm #4 side cover to the Manipulator.
   Cross recessed truss head small screws: 7-M4×10 (one side)
   Tightening torque: 0.9 ± 0.1 N·m

NOTE

Be careful not to get the cables caught between the cover and the Manipulator body.

When replacing the cover, attach the electrical shock warning label and other labels to the places indicated in the photos.



3.7 Arm #4 Maintenance Cover

CAUTION	■ When mounting the cover, be careful not to get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the cover. Be sure to place the cables back to their original locations.

Removal

1. Before removing the Arm #4 maintenance cover, move the arm to the position where you can remove the cover easily.
2. Remove the screws and then remove the Arm #4 maintenance cover.

   Cross recessed truss head small screws:
   4-M4×10

Installation

Install the Arm #4 maintenance cover to the Manipulator.

Cross recessed truss head small screws: 4-M4×10

Tightening torque: 0.9 ± 0.1 N·m

NOTE

Be careful not to get the cables caught between the cover and the Manipulator body.

3.8 Arm #4 D-sub Attachment

CAUTION	■ Do not remove the D-sub attachment forcibly. Removing it 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 D-sub attachment, be careful not to get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the D-sub attachment. Be sure to place the cables back to their original locations.

Removal

Remove the screws and then remove the D-sub attachment.

Hexagon socket head cap bolts: 2-M4×10

Installation

Install the D-sub attachment.

Hexagon socket head cap bolts: 2-M4×10

Tightening torque: 4.0 ± 0.2 N·m

NOTE

Be careful not to get the cables caught between the cover and the Manipulator body.

3.9 Base Cover

3.9.1 M/C Cable Backward

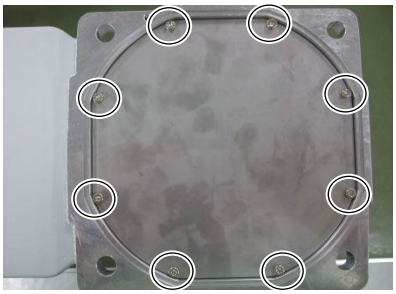
CAUTION	■ When mounting the cover, be careful not to get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the cover. Be sure to place the cables back to their original locations.

The base cover of the M/C cable backward model is located on the bottom face of the base.

Removal

Remove the bolts and then remove the base cover.

Hexagon socket head cap bolts: 8-M4×10



Installation

Install the base cover to the Manipulator.

Hexagon socket head cap bolts: 8-M4×10
Tightening Torque: 4.0 ± 0.2 N·m

NOTE

Be careful not to get the cables caught between the cover and the Manipulator body.

3.9.2 M/C Cable Downward

CAUTION	■ When mounting the cover, be careful not to get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the cover. Be sure to place the cables back to their original locations.

The base cover of the M/C cable downward model is located on the backside of the base.

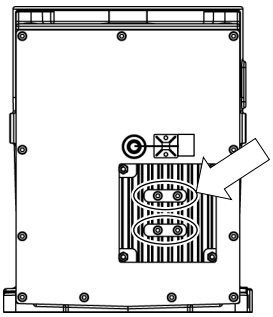
Removal

1. Remove the fan.
   For details, refer to *C12 Maintenance 15. Replacing the Fan.*

2. Remove the bolts on the heat sink.

   Hexagon socket head cap bolts: 4-M4×15

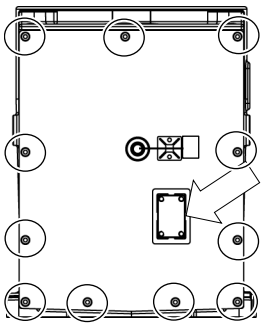
3. Remove the heat sink.



NOTE For cleanroom model, remove the gasket between the heat sink and the base cover.

4. Remove the bolts, and then remove the base cover and the base rear gasket.

   Hexagon socket head cap bolts: 11-M4×10

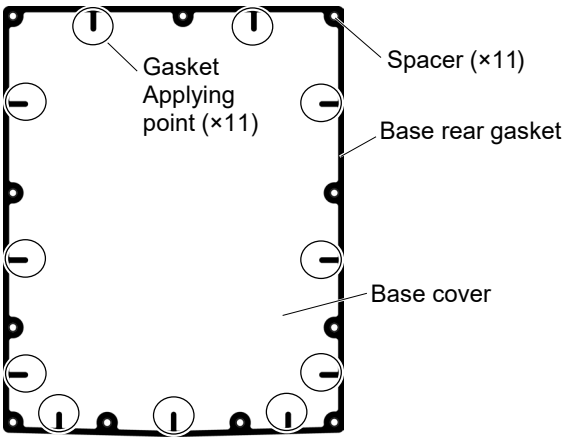


NOTE The gasket has the spacers. Be careful not to lose them.

Installation

1. Install the spacers to the holes on the gasket.
(11 places)

2. Apply the liquid gasket to the base rear gasket.
Install the base rear gasket to the base cover.
(See the figure for gasket applying points)

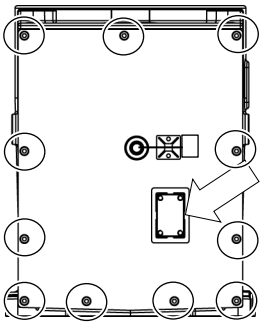


NOTE After applying the liquid gasket, leave the gasket until the liquid gasket becomes solid and the gasket is fixed.

3. Install the base cover to the Manipulator.

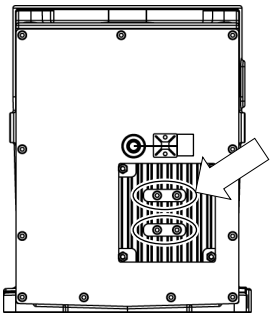
Hexagon socket head cap bolts: 11-M4×10

Tightening torque: 4.0 ± 0.2 N·m



NOTE Be careful not to get the gasket and cables caught between the cover and the Manipulator body.
Replace the gasket if there are flaws or deteriorations.

NOTE For cleanroom model, install the gasket between the heat sink and the base cover.



4. Install the heat sink.

Hexagon socket head cap bolts: 4-M4×15

Tightening torque: 4.0 ± 0.2 N·m

5. Install the fan.
For details, refer to *C12 Maintenance 15. Replacing the Fan.*

3.10 Base Maintenance Cover

CAUTION	■ When mounting the cover, be careful not to get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the cover. Be sure to place the cables back to their original locations.

Removal

Remove the screws and then remove the base maintenance cover.

Cross recessed truss head small screws: 6-M4×10

Installation

Install the base maintenance cover to the Manipulator.

Hexagon socket head cap bolts: 6-M4×10

Tightening Torque: 0.9 ± 0.1 N·m

NOTE

Be careful not to get the cables caught between the cover and the Manipulator body.

3.11 Connector Plate

3.11.1 M/C Cable Backward

CAUTION

- Do not remove the connector plate forcibly. It may result in damage to the cables, disconnection, and/or contact failure. These are 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 get the cables caught in it or bend them forcibly to push into the cover.
  Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system.
  When routing the cables, check the cable locations at removing the connector plate. Be sure to place the cables back to their original locations.

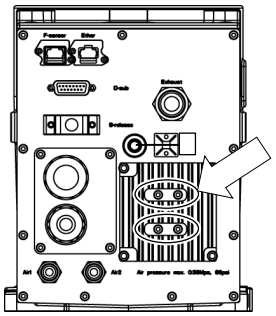
Removal

1. Remove the fan.
   For details, refer to *C12 Maintenance 15. Replacing the Fan.*

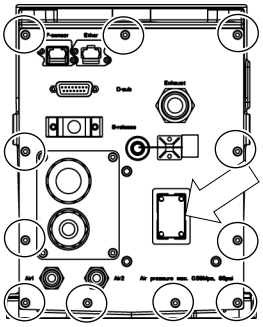
2. Remove the bolts on the heat sink

   Hexagon socket head cap bolts: 4-M4×15

3. Remove the heat sink.



NOTE For cleanroom model, remove the gasket between the heat sink and the connecter plate.



4. Remove the bolts, and then remove the connecter plate. and the base rear gasket.

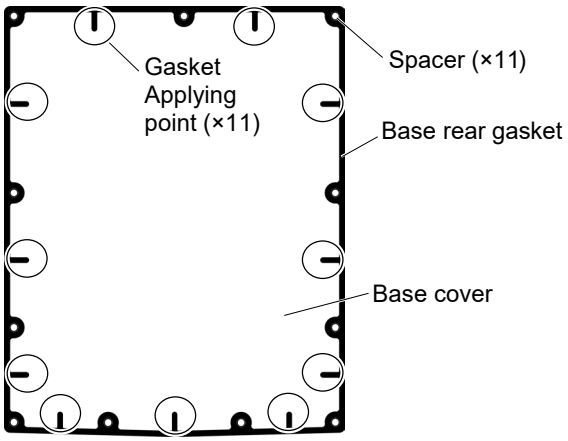
   Hexagon socket head cap bolts: 11-M4×10

NOTE The gasket has the spacers. Be careful not to lose them.

Installation

1. Install the spacers to the holes on the gasket.
(11 places)

2. Apply the liquid gasket to the base rear gasket.
Install the base rear gasket to the base cover.
(See the figure for gasket applying points)

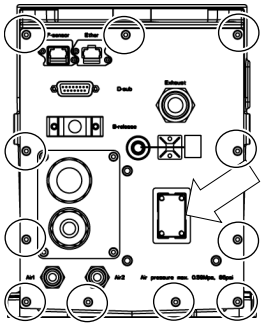


NOTE After applying the liquid gasket, leave the gasket until the liquid gasket becomes solid and the gasket is fixed.

3. Install the connecter plate to the Manipulator.

Hexagon socket head cap bolts: 11-M4×10

Tightening torque: 4.0 ± 0.2 N·m



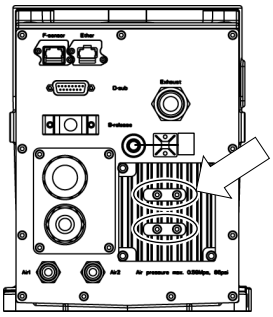
NOTE Be careful not to get the gasket and cables caught between the cover and the Manipulator body.
Replace the gasket if there are flaws or deteriorations.

NOTE For cleanroom model, install the gasket between the heat sink and the connector plate.

4. Install the heat sink.

Hexagon socket head cap bolts: 4-M4×15

Tightening torque: 4.0 ± 0.2 N·m



5. Install the fan.
For details, refer to *C12 Maintenance 15. Replacing the Fan.*

3.11.2 M/C Cable Downward

CAUTION	■ Do not remove the connector plate forcibly. It may result in damage to the cables, disconnection, and/or contact failure. These are 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 get the cables caught in it or bend them forcibly to push into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check the cable locations at removing the connector plate. Be sure to place the cables back to their original locations.

Removal

Remove the bolts and then remove the connector plate.

Hexagon socket head cap bolts: 8-M4×10

Installation

Install the connector plate to the Manipulator.

Hexagon socket head cap bolts: 8-M4×10

Tightening Torque: 4.0 ± 0.2 N·m

3.12 Connector Sub Plate

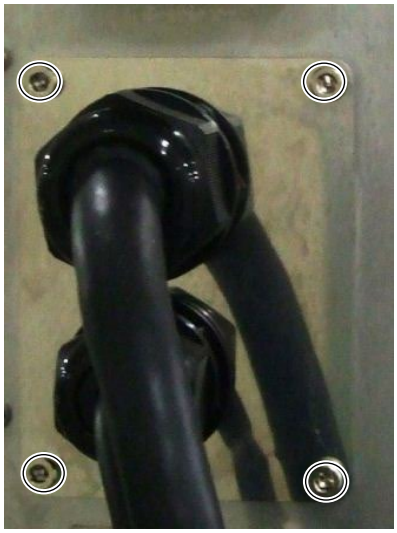
CAUTION

- Do not remove the connector sub plate forcibly. It may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system.
- When removing the connector sub plate, make sure to remove all connectors of the connector plate and the M/C cable. Removing only the connector sub plate may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system.
- When installing the connector sub plate, be careful not to get the cables caught in it or bend them forcibly to push into the cover.
  Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system.
  When routing the cables, check the cable locations at removing the connector sub plate. Be sure to place the cables back to their original locations.

Removal

Remove the bolts and then remove the connector sub plate.

Hexagon socket head cap bolts: 4-M4×10



NOTE

Be careful not to lose the seal washers and spacers.

Installation

Install the connector sub plate to the Manipulator.

Hexagon socket head cap bolts: 4-M4×10

Tightening Torque: 4.0 ± 0.2 N·m

NOTE

Be careful not to get the cables caught between the cover and the Manipulator body.

4. Cable Unit

4.1 Replacing the Cable Unit

 WARNING	■ 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. ■ 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. ■ Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source. To shut off power to the robot system, disconnect the power plug from the power source. Performing any work while connecting the AC power cable to a factory power source 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 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.) Unnecessary strain on the cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. ■ 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.

CAUTION

■ When disconnecting the connectors during the replacement of the cable unit, be sure to reconnect the connectors to their proper positions.
Improper connection of the connectors may result in improper function of the robot system.
For details on the connections, refer to the *C12 Maintenance 4.2 Connector Pin Assignments.*

■ Carefully use alcohol and adhesive following respective instructions and also instructions below. Otherwise, it may cause a fire and/or safety problems.

- Never put alcohol or adhesive close to fire.
- Use alcohol or adhesive while ventilating the room.
- Wear protective gear including a mask, protective goggles, and oil-resistant gloves.
- If alcohol or adhesive gets on your skin, wash the area thoroughly with soap and water.
- If alcohol or adhesive gets into your eyes or mouth, flush your eyes or wash out your mouth with clean water thoroughly, and then see a doctor immediately.

■ Wear protective gear including a mask, protective goggles, and oil-resistant gloves during grease up. 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.

4.1.1 Replacing the Cable Unit (M/C Cable Backward)

	Name		Qty.	Note
Maintenance Parts	Cable unit		1	2172931
	Belt tensile jig*		1	1674582
	J1 brake positioning jig*		1	1675081
	Wire tie	AB100	1	1675753
		AB150	1	1675754
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolts
		width across flats: 5 mm	1	For M6 hexagon socket head cap bolts
	Box wrench	width across flats: 5 mm	1	For D-Sub connector
	Long nose pliers		1	For removing an air tube
	Nippers		1	For cutting a wire tie
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Torque rench		1	For tightening torque control
	Belt tension meter		1	Refer: Unitta U-505

* The belt tensile jig is an assembly jig. Use this jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

When removing the Joint #2 motor, tilt the Arm #2 and press it against the Arm #1.
Reference: *C12 Maintenance: 6.1 Joint #2 - Replacing the Motor,* Removal step (2)

When removing the Joint #3 motor, tilt the Arm #2 and press it against the Arm #2.
Reference: *C12 Maintenance: 7.1 Joint #3 - Replacing the Motor,* Removal step (2)

When pressing the arm, put a piece of cloth or a similar material between the arms to avoid contacting each other. This protects the arm surfaces from scratching and paint peeling off.

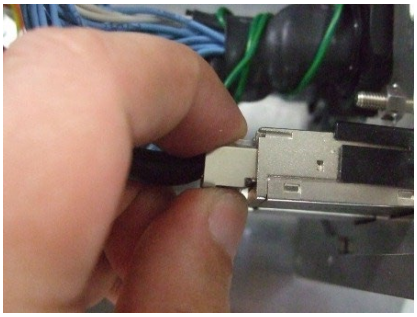
Removal: Cable unit (M/C cable backward)

1. Move the Manipulator to the origin posture (0 pulse position).
2. Turn OFF the Controller.
3. Remove the following covers and plate.
   For details, refer to *C12 Maintenance: 3. Covers*.
   - Arm #4 side covers (both sides)
   - Arm #4 maintenance cover
   - Arm #3 cover
   - Arm #3 maintenance cover
   - Arm #2 side covers (both sides)
   - Arm #1 side covers (both sides)
   - Arm #1 center cover
   - Base maintenance cover
   - Connector plate (M/C cable backward)
4. Remove the two air tubes inside the base.
5. Remove the two D-sub connectors.
6. Disconnect the cables from the base and disconnect the following connectors.

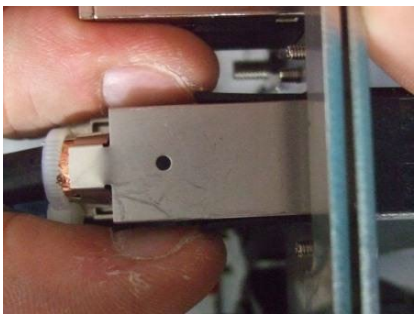
   Connectors: X11, X12, X14, BR010, BR011, X010, X020, X040, LED, GS01, BT1
   (Hold the clip to remove.)

7. Disconnect the following connectors.

   RJ45 connector:
   Hold the clip to remove.

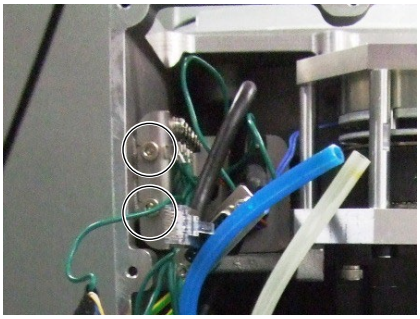


   F-sensor connector:
   Open the clips on the both ends of the connector and pull it out.



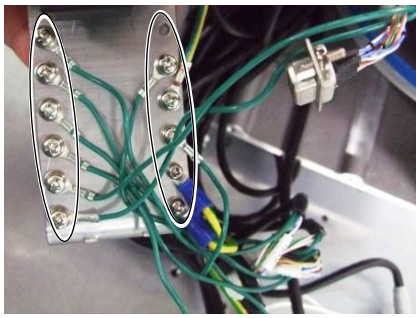
8. Remove the ground wire plate (M/C cable backward).

   Hexagon socket head cap bolts: 2-M4×10



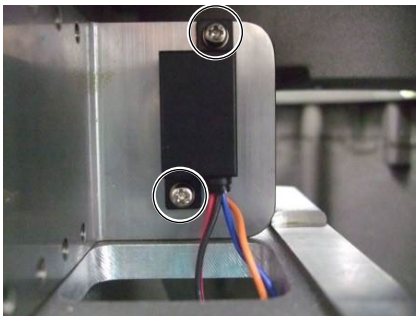
9. Remove the ground wire terminals.

   Cross recessed head screws with washer
   : 9-M4×8, 2-M3×6



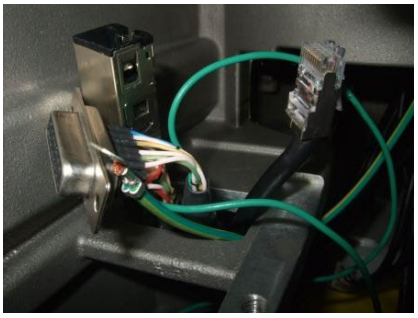
10. Remove the brake power supply.

    Cross recessed head screws with washer: 2-M3×6



11. Disconnect the following cables through the opening of the base.

    D-sub cable
    Ground wire
    RJ45 connector
    F-sensor connector

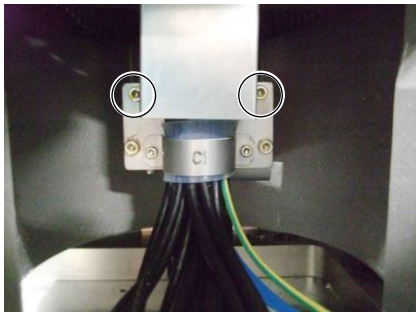


12. Remove the Joint #1 motor unit.

    For details, refer to *C12 Maintenance: 5.1.1 Joint #1 - Replacing the Motor (M/C Cable Backward,* Removal steps (6) and (7).

13. Remove the plate for preventing cable interference.

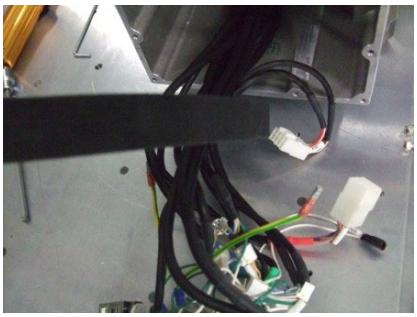
    Hexagon socket head cap bolts: 2-M3×6



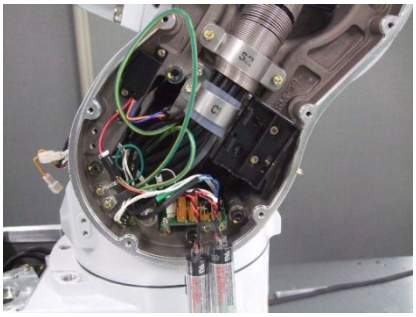
14. Remove the base cable bracket (C1) and the cable protection sheet.

    Hexagon socket head cap bolts: 2-M3×6

15. Remove the Joint #1 timing belt.

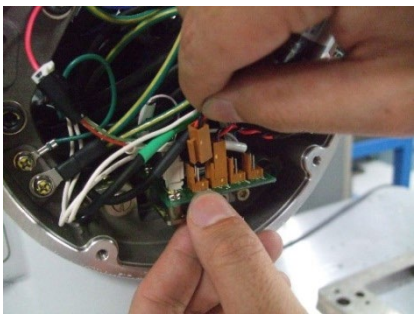


16. Remove the battery from the battery box.



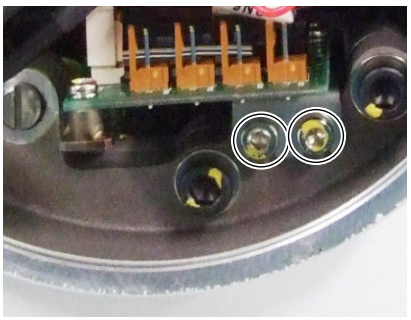
17. Disconnect the battery connector.

NOTE Hold the board by hand and pull up the battery cable to disconnect the connector.



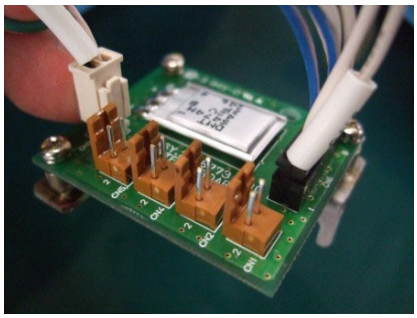
18. Remove the plate to which the battery board is fixed.

    Hexagon socket head cap bolts: 2-M4×10



19. Disconnect the battery connectors.

    Connectors: CN3, CN6



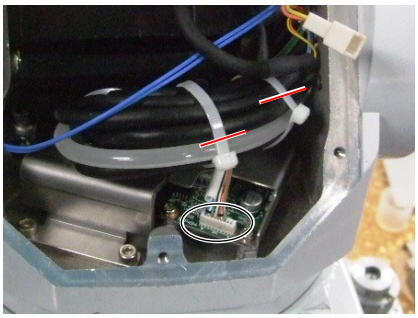
20. Remove the two ground wire terminals from the Arm #1.

    Cross recessed head screws with washer: 2-M4×8

21. Remove the Joint #2 motor unit.
    For details, refer to *C12 Maintenance: 6.1 Joint #2 - Replacing the Motor,* Removal steps (1) to (3) and (5) to (9).

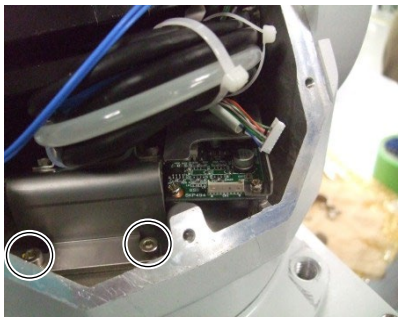
22. Cut off the wire tie that binds the cables inside the Arm #1 and remove the connector connected to the control board 1.

    Connector: GS01



23. Remove the Joint #1 cable fixing plate (Arm #1 side).

    Hexagon socket head cap bolts: 2-M4×10



24. Disconnect the internal cables from the base side to the Arm #1 side. Protect the connectors with masking tapes.

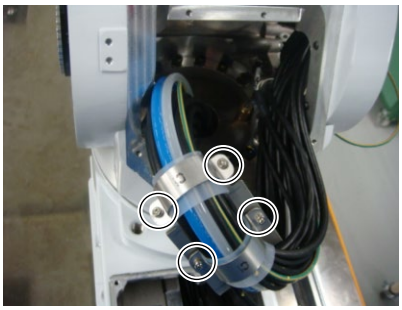
    - To protect the connector's clips

    - To avoid adherence of cable grease

NOTE ☞ Disconnect the connectors one by one in order from the smallest connector to the largest one.

25. Remove the Arm #1 cable brackets (C1: 2 pieces) and cable protection tube.

    Hexagon socket head cap bolts: 4-M3×6

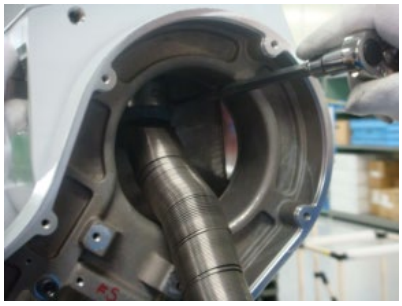


26. Remove the Arm #1 cable brackets (C2 and S2: one each) and cable protection tube.

    Hexagon socket head cap bolts: 2-M3×6 (C2)
    2-M4×10 (S2)

27. Remove the Arm #2 cable bracket (C2) and cable protection tube.

    Hexagon socket head cap bolts: 2-M3×6



28. Remove the Arm #2 cable fixing plate.

    Hexagon socket head cap bolts: 2-M4×10

29. Cut off the wire tie that binds the cable protection coils inside the Arm #2.

30. Remove the two ground wire terminals from the Arm #2.

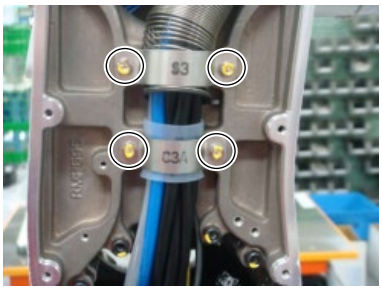
    Cross recessed head screws with washer: 2-M4×8

31. Remove the Joint #3 motor unit.

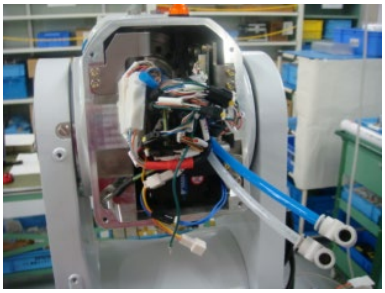
    For details, refer to *C12 Maintenance: 7.1 Joint #3 - Replacing the Motor,* Removal steps (1) to (3) and (5) to (8).

32. Remove the two Arm #2 cable brackets (C3A and S3).

    Hexagon socket head cap bolts:　2-M4×8 (C3A)
    2-M4×8 (S3)

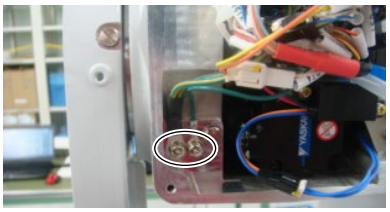


33. Remove the two air tubes inside the Arm #3.
    Remove the air tube fittings from the air tubes.
    The air tube fittings will be used again.　Be careful not to lose them.



34. Remove the two ground wire terminals from the Arm #3.

    Cross recessed head screws with washer: 2-M4×8

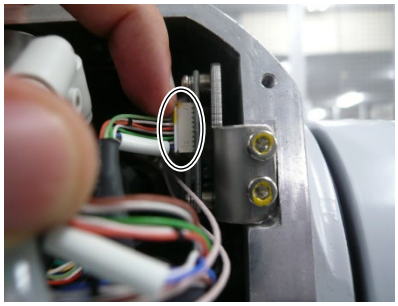


35. Disconnect the connectors inside the Arm #3.

    Connectors: X141, X151, X161, BR041, BR051, X041, X71, X72, PS, LED, BT51, BT4
    (Hold the clip to remove.)

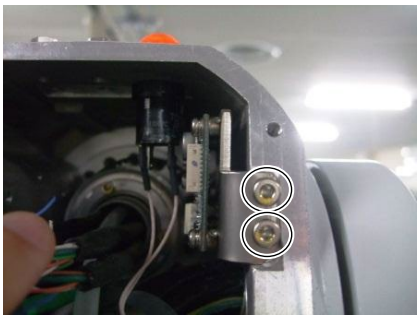
36. Remove the connector connected to the control board 2.

    Connector: GS02



37. Remove the fixing plate of the Arm #3 control board 2.

    Hexagon socket head cap bolts: 2-M4×10

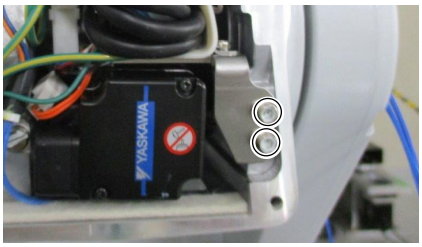


38. Remove the Arm #3 cable bracket (C3B).

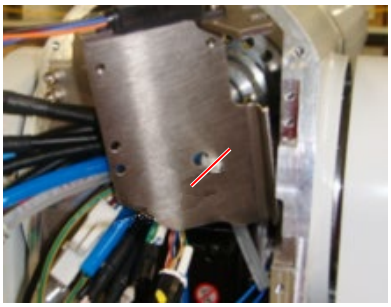
    Hexagon socket head cap bolts: 2-M3×6

39. Remove the Arm #3 cable fixing plate 1.

    Hexagon socket head cap bolts: 2-M4×10



40. Cut off the wire tie that binds the cable protection coils inside the Arm #3.



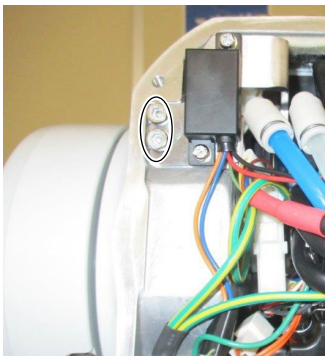
41. Disconnect the cables from the Arm #3 side to the Arm #2 side.

42. Pull out the separated cable unit (base side) from the Arm #1 side to the Arm #2 side.

    To protect the connectors and facilitate the work, first cover the connectors with a plastic bag.　Then, pass the cable unit through the arm.

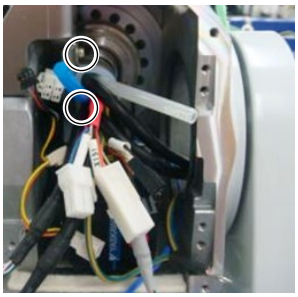
43. Remove the Arm #3 cable fixing plate 2.

    Hexagon socket head cap bolts: 2-M4×10



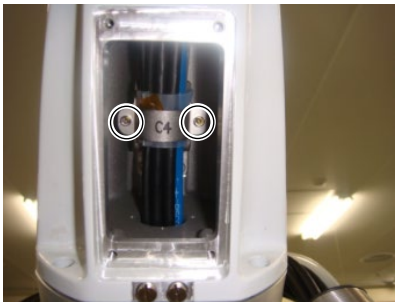
44. Remove the Arm #3 cable bracket (C4) and the cable protection sheet.

    Hexagon socket head cap bolts: 2-M3×6



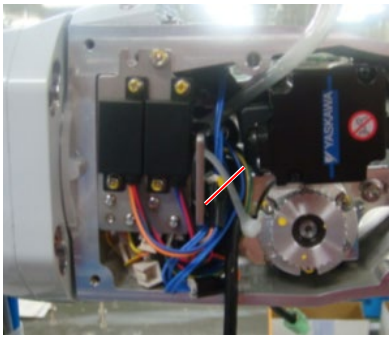
    Remove the cable bracket (C4) and the cable protection sheet at the Arm #4 maintenance cover.

    Hexagon socket head cap bolts: 2-M3×6



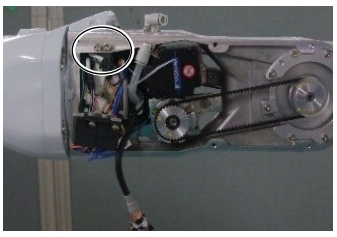
45. Remove the two air tubes inside the Arm #4.

46. Cut off the wire tie that binds the cables of the Arm #4.



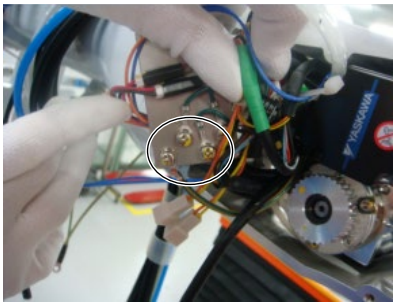
47. Loosen the bolts that fix the cable protection plate attached on the Arm #4, and disconnect the cables.

    Hexagon socket head cap bolts: 2-M4×10



48. Remove the ground wire terminals from the cable protection plate.

    Cross recessed head screws with washer: 4-M4×8



49. Remove the Joints #5 and #6 motor units.
    For details, refer to *C12 Maintenance: 9.1 Joint #5 - Replacing the Motor*, Removal steps (4) to (8), and *C12 Maintenance: 10.1 Joint #6 - Replacing the Motor,* Removal steps (4) to (7).

    The air tube fittings removed together with the Joint #5 motor unit will be used again. Be careful not to lose them.

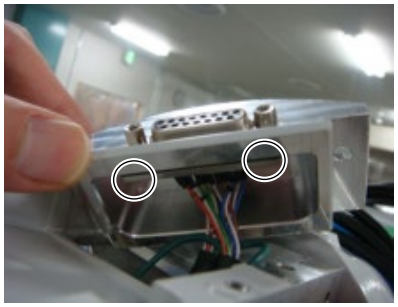
50. Remove the Arm #4 D-sub attachment.

    Hexagon socket head cap bolts: 2-M4×10

    For details, refer to *C12 Maintenance: 3. Covers*.

51. Remove the following parts from the Arm #4 D-sub attachment.

    D-sub connector
    D-sub connector fixing plate



52. Remove the Arm #4 cable fixing plate.

    Hexagon socket head cap bolts: 2-M4×10

53. Remove the cable bracket (C4).

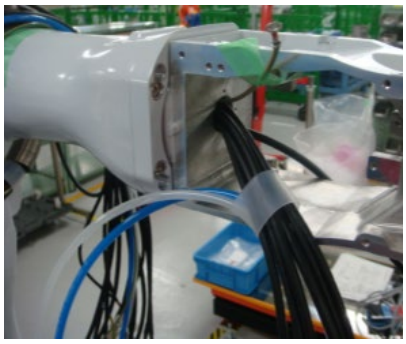
    Hexagon socket head cap bolts: 2-M3×6

54. Disconnect the following cables that have no relays from the Arm #4 side to the Arm #3 side.

    Ethernet cable

    X052/X062 cable

    Ground wire (green/yellow)



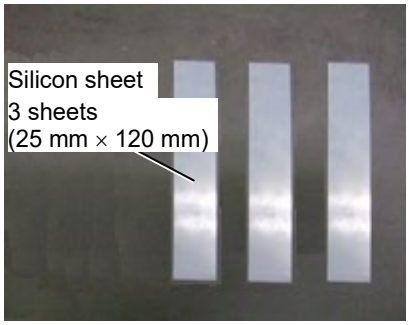
Installation: Cable unit (M/C cable backward)

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

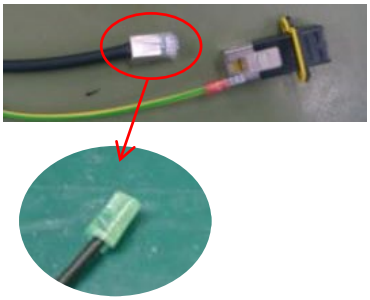
1. Check if the cable unit contains the following parts.

   Silicone sheet: 3 sheets (25 mm × 120 mm)

   F-sensor connector housing 2 pieces



2. Remove the Ethernet cable from the connector.
   Protect the cable ends with masking tapes to prevent the clip from damage.



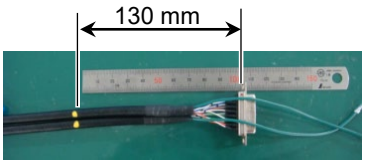
3. Remove the locking screws and nuts of the D-sub connector.

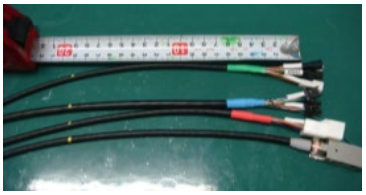
   The screws and nuts will be used again for fixing the connector.
   Be careful not to lose them.

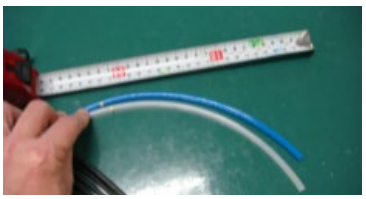
4. Disconnect the following connectors to separate the cables.

   Connectors:
   X051, X061, X151, X161, XGND, BR051, BR061,
   BT51, BT61, X71, X72, SW1

5. Place a mark at the fixing position of each cable you are going to pass through the Arm #4.







D-sub	: 130 mm from the connector end
Other cables	: 190 mm from the connector end
Air tube	: 210 mm from the end

6. Pass the separated cable unit (base side) from the Arm #2 to the Arm #1.

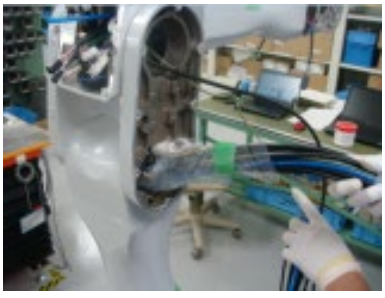
To protect the connectors and facilitate the work, first cover the connectors with a plastic bag. Then, pass the cable unit through the arm.

Pass the following cables that have no relays through the arm to the Arm #3 side.

Ethernet cable

X052/X062 cable

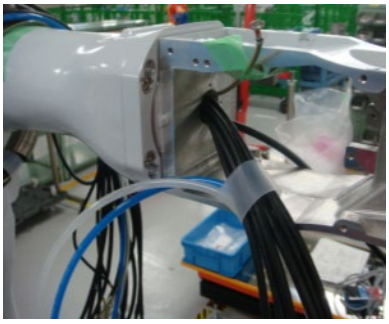
Ground wire (green/yellow)



Leave out the other connector cables for a certain length, as shown in the photo, in order to store them in the Arm #3.

7. Pass the Ethernet cable, X052/X062 cable, and ground wire (green/yellow) from the Arm #3 side to the Arm #4 side.
   First pass the braid tube from the Arm #4 side to the Arm #3 side. Insert the connectors through the braid tube, as shown in the photo, and fix the tube with the wire tie so that connectors are not to be pulled out. Then, pull the braid tube from the Arm #4 side while pushing the cables from the Arm #3 side to pass the cables through.
   (See the photo.)

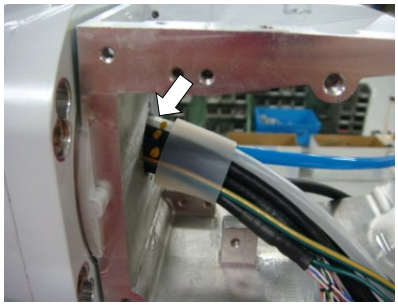
8. Pass the separated cable unit (Arm #4 side) from the Arm #4 to the Arm #3.
   Silicone tube is provided. Leave out the silicone tube on the Arm #4 side.
   Pass the following cables through the silicone tube: Ethernet cable, X052/X062 cable, and ground wire (green/yellow) that have been passed from the Arm #3 side.



NOTE

As shown in the photo, disconnect the Ethernet cable and air tube (blue) at one side of the Arm #4.
Disconnect the remaining cables at the other side.

Align the marked positions and the position on the Arm #4 indicated with the arrow in the photo.



9. Install the cable fixing plate to the Arm #4.

   Hexagon socket head cap bolts: 2-M4×10

   Tightening torque: 4.0 ± 0.2 N·m

10. Use a cable bracket (C4) to fix the cables.

    Hexagon socket head cap bolts: 2-M3×6

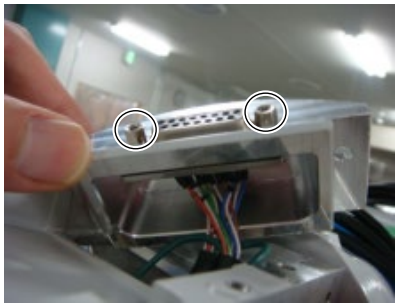
    Tightening torque: 2.4 ± 0.1 N·m

Place the silicone tube to the position where it is fixed with a cable bracket.
Use a cable bracket to fix the silicone tube.

11. Install the D-sub connector to the D-sub attachment of the Arm #4.

    D-sub connector fixing plate is provided.

    Hold the D-sub connector between the D-sub attachment of the Arm #4 and the D sub connector fixing plate, and fix them with the locking screws removed in step 3 above.
    (The nuts and washers are not used.)



12. Install the D-sub attachment to the Arm #4.

    Hexagon socket head cap bolts: 2-M4×10

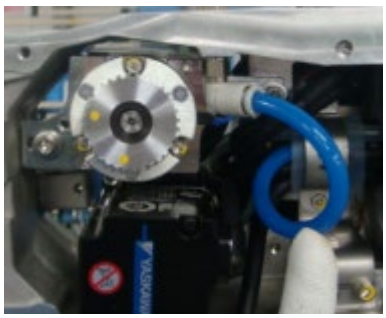
    Tightening torque: 4.0 ± 0.2 N·m

NOTE

Do not to let the cables caught in the attachment.

For details, refer to *C12 Maintenance: 3. Covers*.

13. Install the motors for the Joints #5 and #6.
    Connect the cables and air tube and store them inside.



Upper photo: Joint #5 motor side
Place the Ethernet cable and the air tube (blue) on the near side.

Lower photo: Joint #6 motor side
Place the other cables and the air tube (clear) on the front side.

Fix the cables by binding them with a wire tie (INSULOC AB150 or equivalent) inserted through the hole of the cable fixing plate so that the cables do not interfere with the Joint #6 motor pulley.

Pay attention so that no connector is installed incorrectly and no cable is caught between components.

For details, refer to *C12 Maintenance: 9.1 Joint #5 - Replacing the Motor,* Installation steps (4) to (8), and *C12 Maintenance: 10.1 Joint #6 - Replacing the Motor,* Installation steps (4) and (7).

NOTE

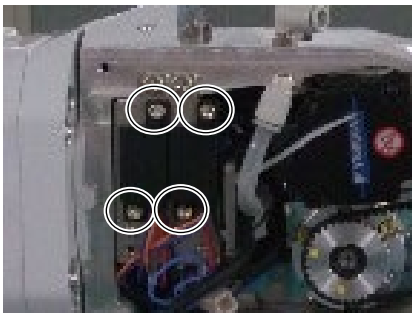
Use the air tube fittings removed in the cable removal steps again.

14. Mount the brake power supply to the plate.
    Mount the brake power supply so that the cables are directed down.

    Cross recessed head screws with washer: 4-M3×6

    Tightening torque: 0.45 ± 0.1 N·m

    Installation locations:
    Brake power supply for Joint #5: right side
    Brake power supply for Joint #6: left side



15. Fix the cable protection plate to the Arm #4.

    Hexagon socket head cap bolts: 2-M4×10

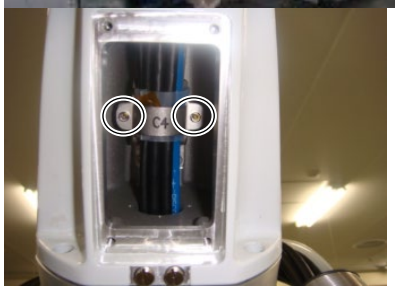
    Tightening torque: 4.0 ± 0.2 N·m

NOTE Be careful not to get the cables caught.
It may cause cable breakage.

16. Fix the cables to the Arm #4 maintenance cover using a cable bracket (C4).

    Wrap the cables with the attached silicone sheet.
    Use a cable bracket to fix the wrapped silicone sheet.

    Hexagon socket head cap bolts: 2-M3×6
    Tightening torque: 2.4 ± 0.1 N·m

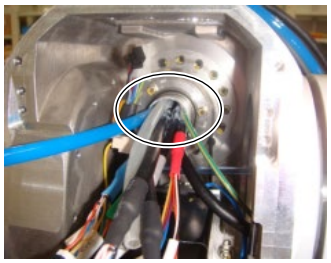


17. Apply grease to the cables in the sleeve.

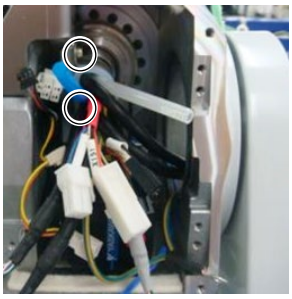
    Grease:　Krytox
    Amount:　approximately 3g

    Divide the above grease into halves and apply each half from the Arm #4 side and the Arm #3 side respectively.

    Pay attention so that the grease does not get into the cable fixing area in the Arm #3 and connectors.



18. Use a cable bracket (C4) to fix the cables to the Arm #3 cable fixing plate 2.

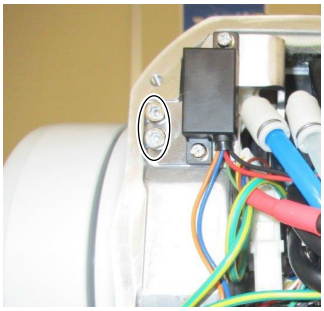


Wrap the cables with the attached silicone sheet.
Use a cable bracket to fix the wrapped silicone sheet.

Hexagon socket head cap bolts: 2-M3×6

Tightening torque: 2.4 ± 0.1 N·m

19. Install the Arm #3 cable fixing plate 2 to the Arm #3.



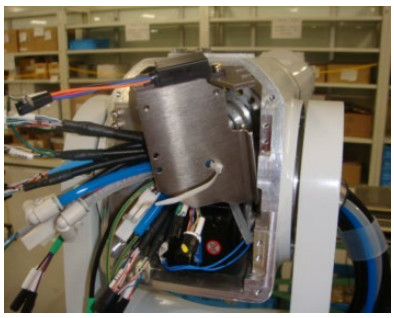
Hexagon socket head cap bolts: 2-M4×10

Tightening torque: 4.0 ± 0.2 N·m

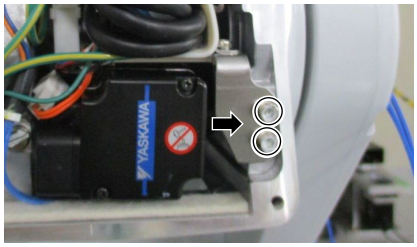
20. Use the cable protection spring to bind cables at the Arm #3 cable fixing plate 1.

Type of wire tie: AB100

Number of wire ties: 4



21. Install the Arm #3 cable fixing plate 1 to the Arm #3.



Hexagon socket head cap bolts: 2-M4×10

Tightening torque: 4.0 ± 0.2 N·m

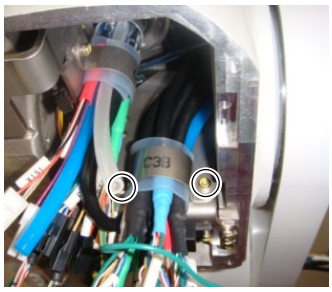
NOTE

When installing the Arm #3 cable fixing plate, see the picture on the right side and push the plate to the arrow direction.

22. Use a cable bracket (C3B) to fix the cables.
    Place the two air tubes at the bottom part of the cables.
    Place the silicone tube to the position where it is fixed with a cable bracket.
    Use a cable bracket to fix the silicone tube.

    Hexagon socket head cap bolts: 2-M3×6

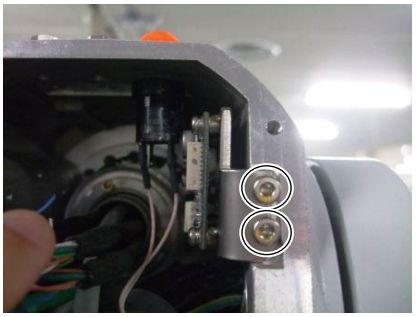
    Tightening torque: 2.4 ± 0.1 N·m



23. Install the control board 2 fixing plate to the Arm #3.

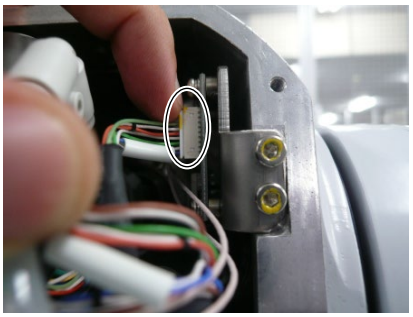
    Hexagon socket head cap bolts: 2-M4×10

    Tightening torque: 4.0 ± 0.2 N·m



24. Connect the connector to the control board 2.

    Connector: GS02



25. Connect the cable connectors inside the Arm #3.

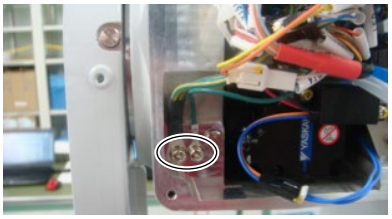
    Connectors: X141, X151, X161, BR041, BR051, X041, X71, X72, PS, LED, BT51, BT4
    (Hold the clip to remove.)

26. Install the two ground wire terminals to the Arm #3.

    Green/yellow: Left side　　Green: Right side

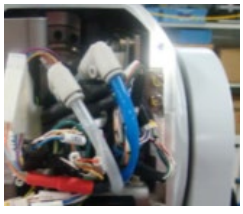
    Cross recessed head screws with washer: 2-M4×8

    Tightening torque: 0.9 ± 0.1 N·m



27. Use air tube fittings (elbows) to connect air tubes of the same color.

    Remove the air tube fittings from the old cables to use them again.

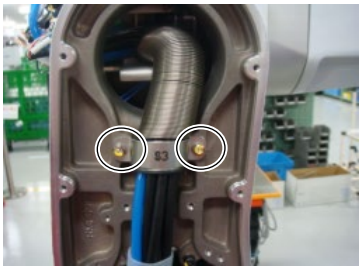


Adjust the connector protrusion so that the cover can be installed.

28. Use brackets (S3) to fix the cable protection spring to the Arm #2.

    Hexagon socket head cap bolts: 2-M4×8

    Tightening torque: 4.0 ± 0.2 N·m

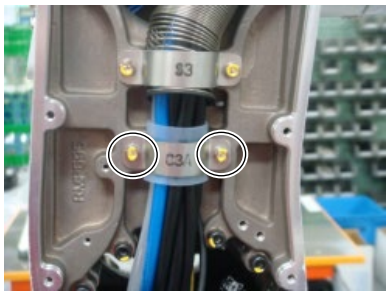


29. Use cable brackets (C3A) to fix the cables to the Arm #2 temporarily.

    Place the silicone tube to the position where it is fixed with a cable bracket.
    Use a cable bracket to fix the silicone tube temporarily.

    Hexagon socket head cap bolts: 2-M4×8

    Rough guide of temporary fixing:
    The cables can be pushed up even after fixing the cables.

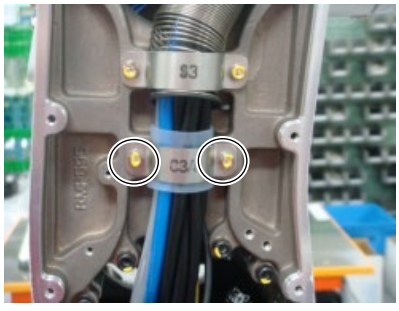


30. Push up the whole cables by 10 mm to the direction indicated with the arrow in the photo to allow for some space.

31. Fix the cables to the Arm #2 by fixing the cable brackets (C3A). Check that the silicone tube is not shifted away from the fixed position.

    Hexagon socket head cap bolts: 2-M4×8

    Tightening torque: 4.0 ± 0.2 N·m



32. Install the Joint #3 motor unit.
    For details, refer to *C12 Maintenance: 7.1 Joint #3 - Replacing the Motor,* Installation steps (4) and (8).

33. Fix the two ground wire terminals to the Arm #2.

    Green: Right side　　Green/yellow: Left side

    Cross recessed head screws with washer: 2-M4×8

    Tightening torque: 0.9 ± 0.1 N·m

34. Use the cable protection spring to bind cables at the Arm #2 cable fixing plate.

    Type of wire tie: AB100

    Number of wire ties: 4

    Be careful of the orientation of the Arm #2 cable fixing plate.
    The side with two U-shaped grooves should be placed down.

35. Use cable brackets (C2) to fix the cables to the Arm #2 cable fixing plate temporarily.

    Place the silicone tube to the position where it is fixed with a cable bracket.
    Use a cable bracket to fix the silicone tube temporarily.

    Hexagon socket head cap bolts: 2-M3×6

    Rough guide of temporary fixing:
        The cables can be pushed up even after fixing the cables.

36. Install the Arm #2 cable fixing plate to the Arm #2.
    After fitting the two U-shaped grooves to the fixing bolts, tighten the bolts.

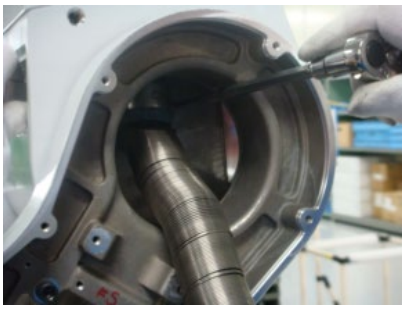
    Hexagon socket head cap bolts: 2-M4×10

    Tightening torque: 4.0 ± 0.2 N·m

37. Fix the cables to the Arm #2 cable fixing plate.
Check that the silicone tube is not shifted away from the fixed position.

Hexagon socket head cap bolts: 2-M3×6

Tightening torque: 2.4 ± 0.1 N·m



38. Use brackets (S2) to fix the cable protection spring to the Arm #1.

Hexagon socket head cap bolts: 2-M4×8

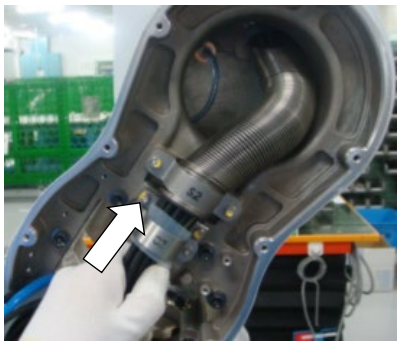
Tightening torque: 4.0 ± 0.2 N·m

39. Use cable brackets (C2) to fix the cables to the Arm #2 temporarily.
Place the silicone tube to the position where it is fixed with a cable bracket.
Use a cable bracket to fix the silicone tube temporarily.

Hexagon socket head cap bolts: 2-M3×6

Rough guide of temporary fixing:
The cables can be pushed up even after fixing the cables.

40. Push up the whole cables by 10 mm to the direction indicated with the arrow in the photo to allow for some space.



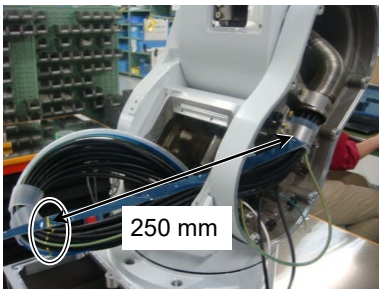
41. Fix the cables to the Arm #1.

Check that the silicone tube is not shifted away from the fixed position.

Hexagon socket head cap bolts: 2-M3×6

Tightening torque: 2.4 ± 0.1 N·m

42. Place a mark at a position 250 mm from the cable bracket (C2).



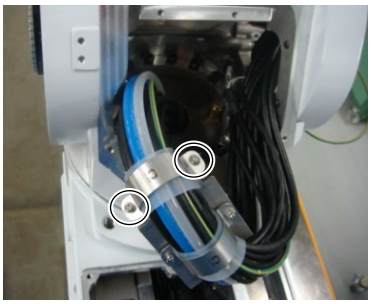
43. For the GS01 cable to be installed on the control board 1, place a mark at a position 130 mm from the connector.

44. For the X021, X121, BR021, and CN3 cables, place a mark at a position 160 mm from the connector respectively.

45. Use cable brackets (C1) to fix the cables to the Arm #1 cable fixing plate temporarily (2 positions).
Temporarily fix the silicone tube by aligning its end to the mark.

Hexagon socket head cap bolts: 4-M3×6

Rough guide of temporary fixing:
The cables can be pushed up even after fixing the cables.



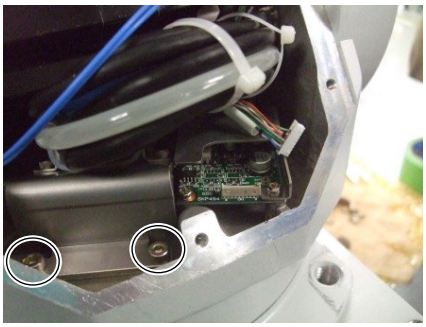
46. Fix the Arm #1 cable fixing plate temporarily to the Arm #1 and finely adjust the cable length.

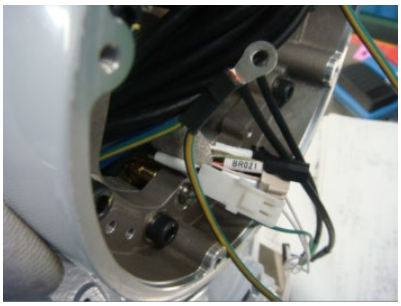
    Hexagon socket head cap bolts: 2-M4×10

    Rough guide of temporary fixing: The plate should not move.

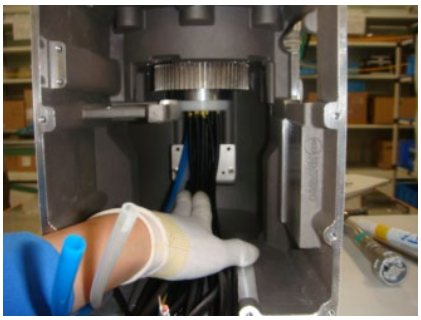
    Notes for fine adjustment:

    - No excess looseness or tension on the cables.
      The cables should not be pressed strongly against the arm edge.
    - The X021, X121, BR021, and CN3 connectors should reach the end face of the Arm #1 when they are pulled out.
      The cables should not be too long.





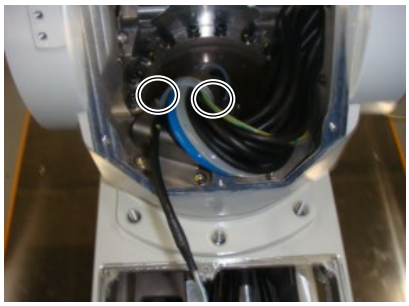
47. Place a mark on the cables at the sleeve outlet on the base side.



48. Fix the cable bracket (C1)-A on the near side so that the cable positions do not change.

    Hexagon socket head cap bolts: 2-M3×6

    Tightening torque: 2.4 ± 0.1 N·m



49. Remove the Arm #1 cable fixing plate fixed temporarily, and fix another cable bracket (C1)-B.

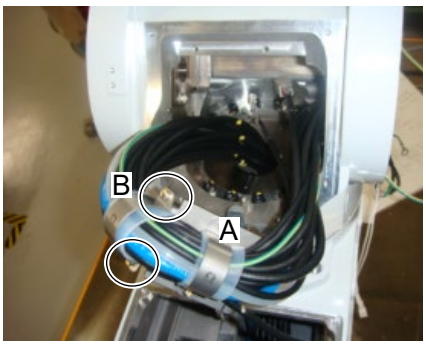
    Removing Arm #1 cable fixing plate:

    Hexagon socket head cap bolts: 2-M4×10

    Fixing cable bracket (C1)-B:

    Hexagon socket head cap bolts: 2-M3×6

    Tightening torque: 2.4 ± 0.1 N·m



50. Apply grease to the cables inside the J1 sleeve.

    Grease: Krytox

    Amount: Approximately 7.5g

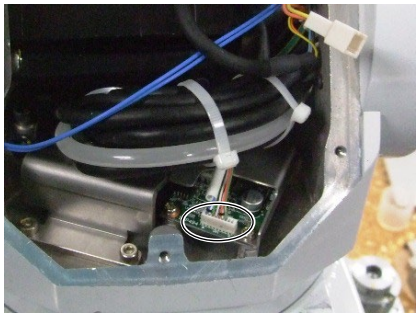
    Application position:
    Between fixing section of the bracket (C1) and the mark on the base side

51. Fix the Arm #1 cable fixing plate to the Arm #1.

    Hexagon socket head cap bolts: 2-M4×10

    Tightening torque: 4.0 ± 0.2 N·m

52. Install the connector GS01 to the control board 1.



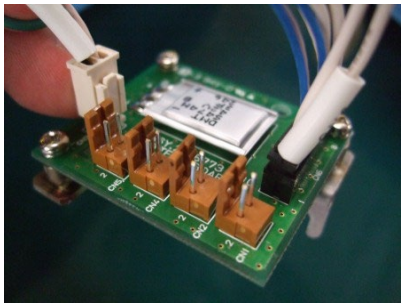
53. Install the Joint #2 motor and connect the connector.
    For details, refer to *C12 Maintenance: 6.1 Joint #2 - Replacing the Motor,* Installation steps (4) and (9).

54. Fix the two ground wire terminals to the Arm #2.

    Green: Right side Green/yellow: Left side

55. Connect the battery connectors.

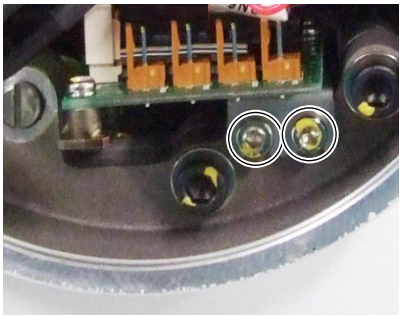
    Connectors: CN3, CN6



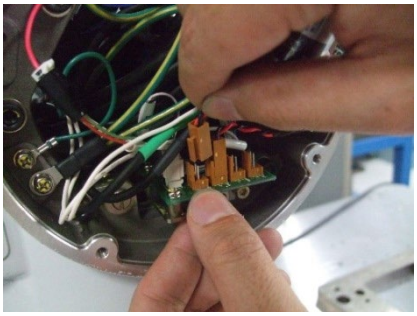
56. Install the battery board fixing plate.

    Hexagon socket head cap bolts: 2-M4x10

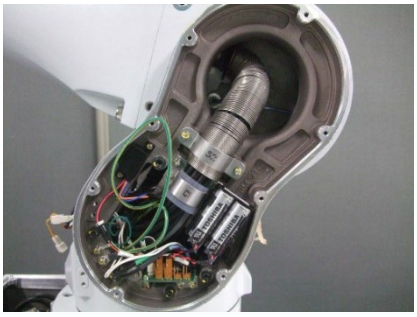
    Tightening torque: 4.0 ± 0.2 N·m



57. Connect the battery connectors.



58. Install the battery to the battery box.



59. Pass the Joint #1 timing belt through the cable.

60. Use cable brackets (C1) to fix the cables to the base cable fixing plate.

    Wrap the cables with the attached silicone sheet.
    Use a cable bracket to fix the wrapped silicone sheet.

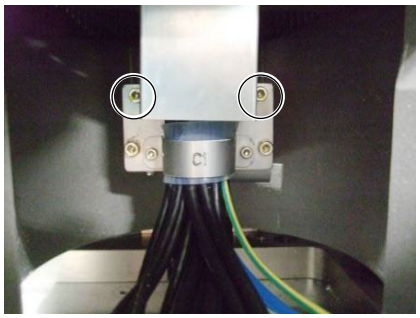
    Hexagon socket head cap bolts: 2-M3×6

    Tightening torque: 2.0 ± 0.1 N·m

61. Install the plate for preventing cable interference.

    Hexagon socket head cap bolts: 2-M3×6

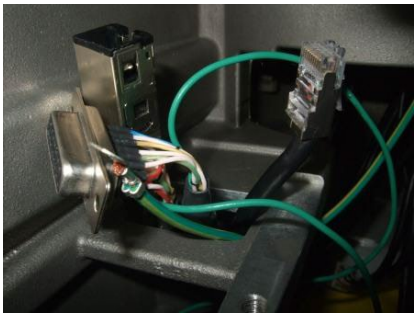
    Tightening torque: 2.0 ± 0.1 N·m



62. Install the Joint #1 motor unit.
    For details, refer to *C12 Maintenance: 5.1.1 Joint #1 - Replacing the Motor (M/C Cable Backward),* Installation steps (1) to (4).

63. Push out the following cables upward through the opening of the base.

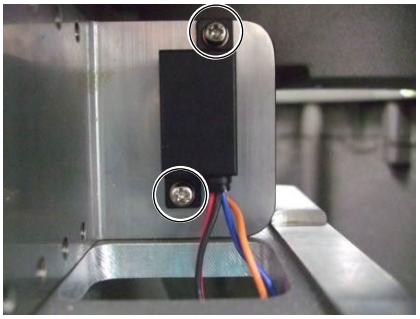
    D-sub cable
    Ground wire
    RJ45 connector
    F-sensor connector



64. Install the brake power supply to the plate.
    The cables should be located in the direction as shown in the photo. (See the photo.)

    Cross recessed head screws with washer: 2-M3×6

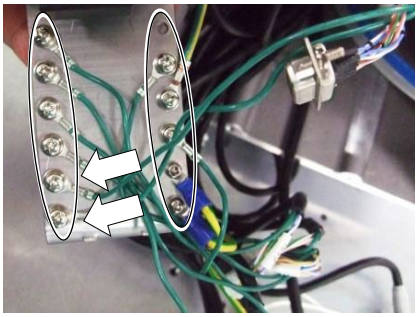
    Tightening torque: 0.45 ± 0.1 N·m



65. Install the ground wire terminals to the plate.

    Cross recessed head screws with washer:
    9-M4×8, 2-M3×6

    Tightening torque : 0.9 ± 0.1N·m (M4×8)
    0.45 ± 0.1 N·m (M3×6)

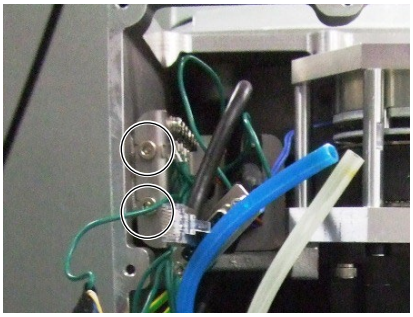


NOTE ☞ The installation positions of the D-sub cable ground terminals are predetermined. Make sure to install them to the two screw holes on the backside of the Manipulator (indicated with arrows in the photo).

66. Install the ground wire plate (M/C cable backward).

    Hexagon socket head cap bolts: 2-M4×10

    Tightening torque: 4.0 ± 0.2 N·m



67. Install the following connectors according to the marks on the connector plate.

    RJ45 connector: Ether
    F-sensor connector: F-sensor

68. Connect the M/C cable connectors.

    Connectors: X11, X12, X14, BR010, BR011, X010, X020, X040, LED, GS01, BT1

69. Install the D-sub connectors according to the marks on the connector plate.

    Left: D-sub connector for brake release (with a wire marker: SW1): B-release

    Right: D-sub connector for user wiring (without a wire marker: With round terminal): D-sub

70. Install the two air tubes according to the marks on the connector plate.

    Air1: Clear
    Air2: Blue

NOTE

    Install the air tube with the correct color.

71. Install the covers and plate indicated below.

Arm #4 side covers (both sides)	Arm #4 maintenance cover
Arm #3 cover	Arm #3 maintenance cover
Arm #2 side covers (both sides)	Arm #1 side covers (both sides)
Arm #1 center cover	Base maintenance cover
Connector plate (M/C cable backward)	

    For details, refer to *C12 Maintenance: 3. Covers*.

72. Perform calibration.

    For details, refer to *C12 Maintenance: 16. Calibration*.

4.1.2 Replacing the Cable Unit (M/C Cable Downward)

	Name		Qty.	Note
Maintenance Parts	Cable unit		1	2172931
	Belt tensile jig*		1	1674582
	J1 brake positioning jig*		1	1675081
	Wire tie	AB100	1	1675753
		AB150	1	1675754
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolts
		width across flats: 5 mm	1	For M6 hexagon socket head cap bolts
	Box wrench	width across flats: 5 mm	1	For D-Sub connector
	Long nose pliers		1	For removing an air tube
	Nippers		1	For cutting a wire tie
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Torque rench		1	For tightening torque control
	Belt tension meter		1	Refer: Unitta U-505

* The belt tensile jig is an assembly jig. Use this jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

When removing the Joint #2 motor, tilt the Arm #2 and press it against the Arm #1.
Reference: *C12 Maintenance: 6.1 Joint #2 - Replacing the Motor,* Removal step (2)

When removing the Joint #3 motor, tilt the Arm #3 and press it against the Arm #2.
Reference: *C12 Maintenance: 7.1 Joint #3 - Replacing the Motor,* Removal step (2)

When pressing the arm, put a piece of cloth or a similar material between the arms to avoid contacting each other. This protects the arm surfaces from scratching and paint peeling off.

Removal: Cable unit (M/C cable downward)

1. Move the Manipulator to the origin posture (0 pulse position).
2. Turn OFF the Controller.
3. Turn the Manipulator laterally.

CAUTION	■ When turning the Manipulator laterally, there must be two or more people to work on it so that at least one of them can support the arm while the others are removing the bolts. Removing the bolts without supporting the arm may result in the arm falling, bodily injury, and/or malfunction of the robot system.

4. Remove the covers and plate indicated below.

Arm #4 side covers (both sides)	Arm #4 maintenance cover
Arm #3 cover	Arm #3 maintenance cover
Arm #2 side covers (both sides)	Arm #1 side covers (both sides)
Arm #1 center cover	Base cover (M/C cable downward)
Base maintenance cover	Connector plate (M/C cable downward)

   For details, refer to *C12 Maintenance: 3. Covers*.

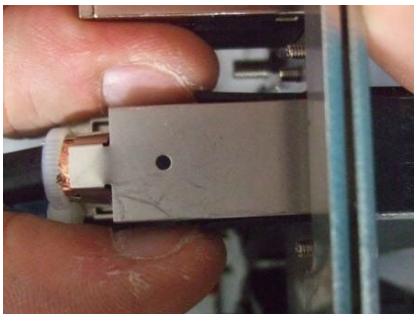
5. Remove the two air tubes in the base.
6. Remove the two D-sub connectors.
7. Disconnect the cable from the base and disconnect the following connectors.

   Connectors: X11, X12, X14, BR010, BR011, X010, X020, X040, LED, GS01, BT1
   (Hold the clip to remove.)

8. Disconnect the following connectors.

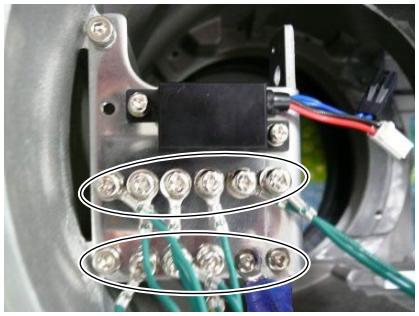
   RJ45 connector (Hold the clip to remove.)

F-sensor connector:
Open the clips on the both ends of the connector and pull it out.



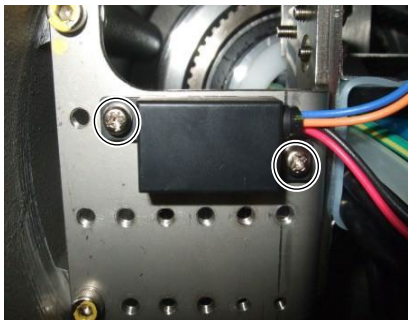
9. Remove the ground wire terminals.

   Cross recessed head screws with washer:
   : 9-M4×8, 2-M3×6



10. Remove the brake power supply.

    Cross recessed head screws with washer: 2-M3×6



11. The subsequent steps are the same as those for the M/C cable (backward).

    For details, refer to *C12 Maintenance: 4.1.1 Replacing the Cable Unit (M/C Cable Backward),* Removal steps (13) to (54).

Installation: Cable unit (M/C cable downward)

1. Perform the installation steps (1) to (62) of
   C12 Maintenance: 4.1.1 Replacing the Cable Unit (M/C Cable Backward).

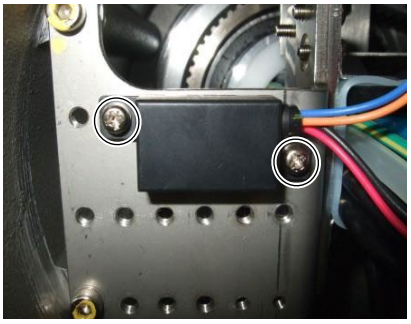
2. Turn the Manipulator laterally.

CAUTION	■ When turning the Manipulator laterally, there must be two or more people to work on it so that at least one of them can support the arm while the others are removing the bolts. Removing the bolts without supporting the arm may result in the arm falling, bodily injury, and/or malfunction of the robot system.

3. Install the brake power supply to the plate.
   The cables should be located in the direction as shown in the photo.
   (See the photo.)

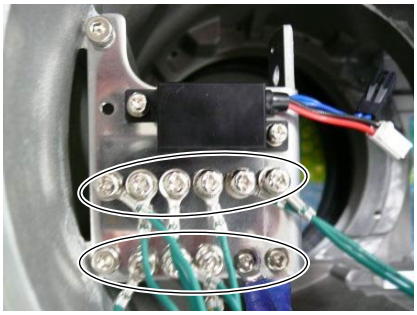
   Cross recessed head screws with washer: 2-M3×6

   Tightening torque: 0.45 ± 0.1N·m



4. Install the ground wire terminals to the plate.

   Cross recessed head screws with washer:
   : 9-M4×8, 2-M3×6
   Tightening torque : 0.9 ± 0.1N·m (M4×8)
   0.45 ± 0.1 N·m (M3×6)



5. Install the following connectors according to the marks on the connector plate.

   RJ45 connector: Ether
   F-sensor connector: F-sensor

6. Connect the M/C cable connectors.

   Connectors: X11, X12, X14, BR010, BR011, X010, X020, X040, LED, GS01, BT1

7. Install the D-sub connectors according to the marks on the connector plate.

   Left: D-sub connector for brake release (with a wire marker: SW1): B-release

   Right: D-sub connector for user wiring (without a wire marker: With round terminal): D-sub

8. Install the two air tubes according to the marks on the connector plate.

   Air1: Clear
   Air2: Blue

NOTE

Install the air tube with the correct color.

9. Install the following covers and plate.

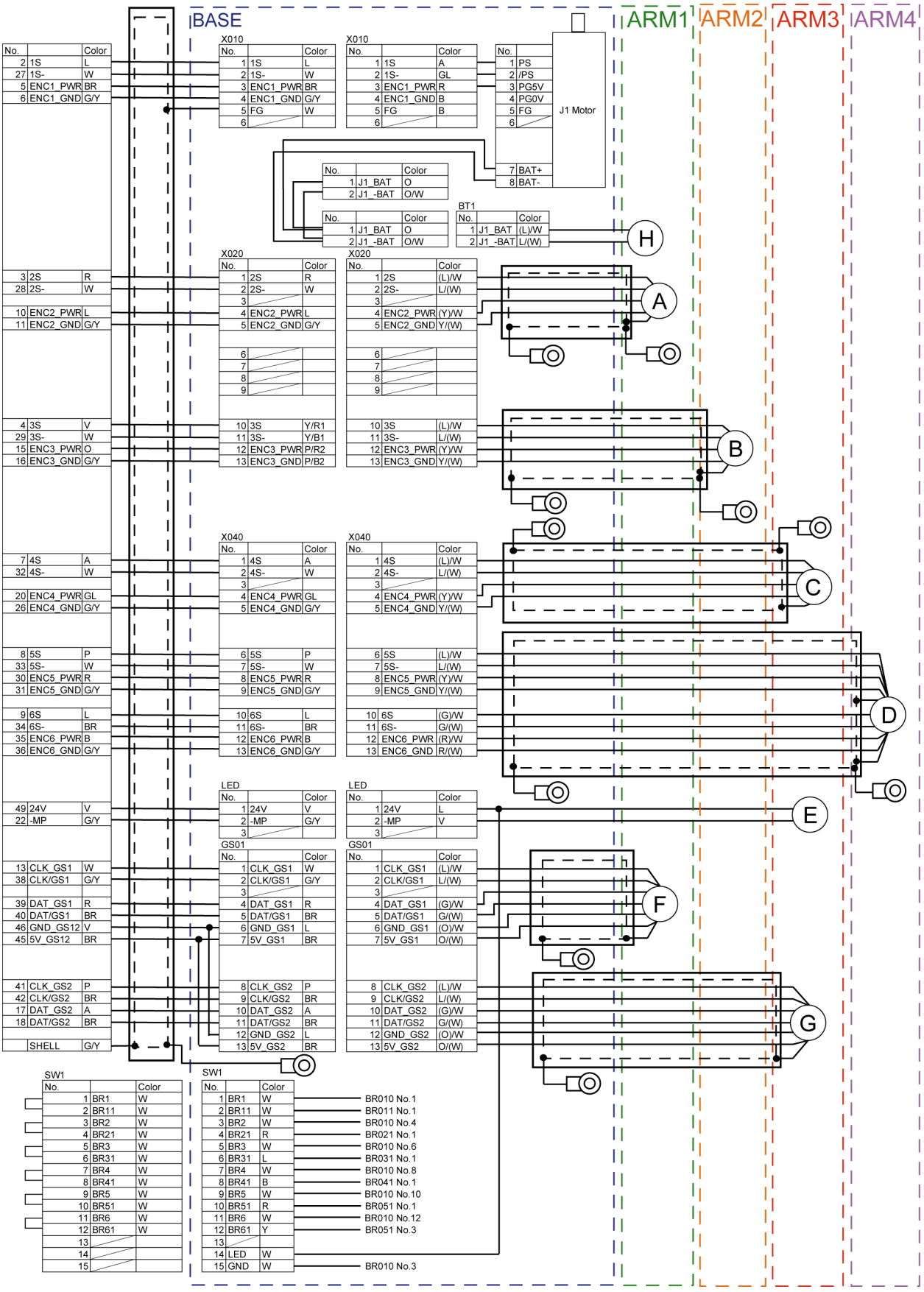
Arm #4 side covers (both sides)	Arm #4 maintenance cover
Arm #3 cover	Arm #3 maintenance cover
Arm #2 side covers (both sides)	Arm #1 side covers (both sides)
Arm #1 center cover	Base cover (M/C cable downward)
Base maintenance cover	Connector plate (M/C cable downward)

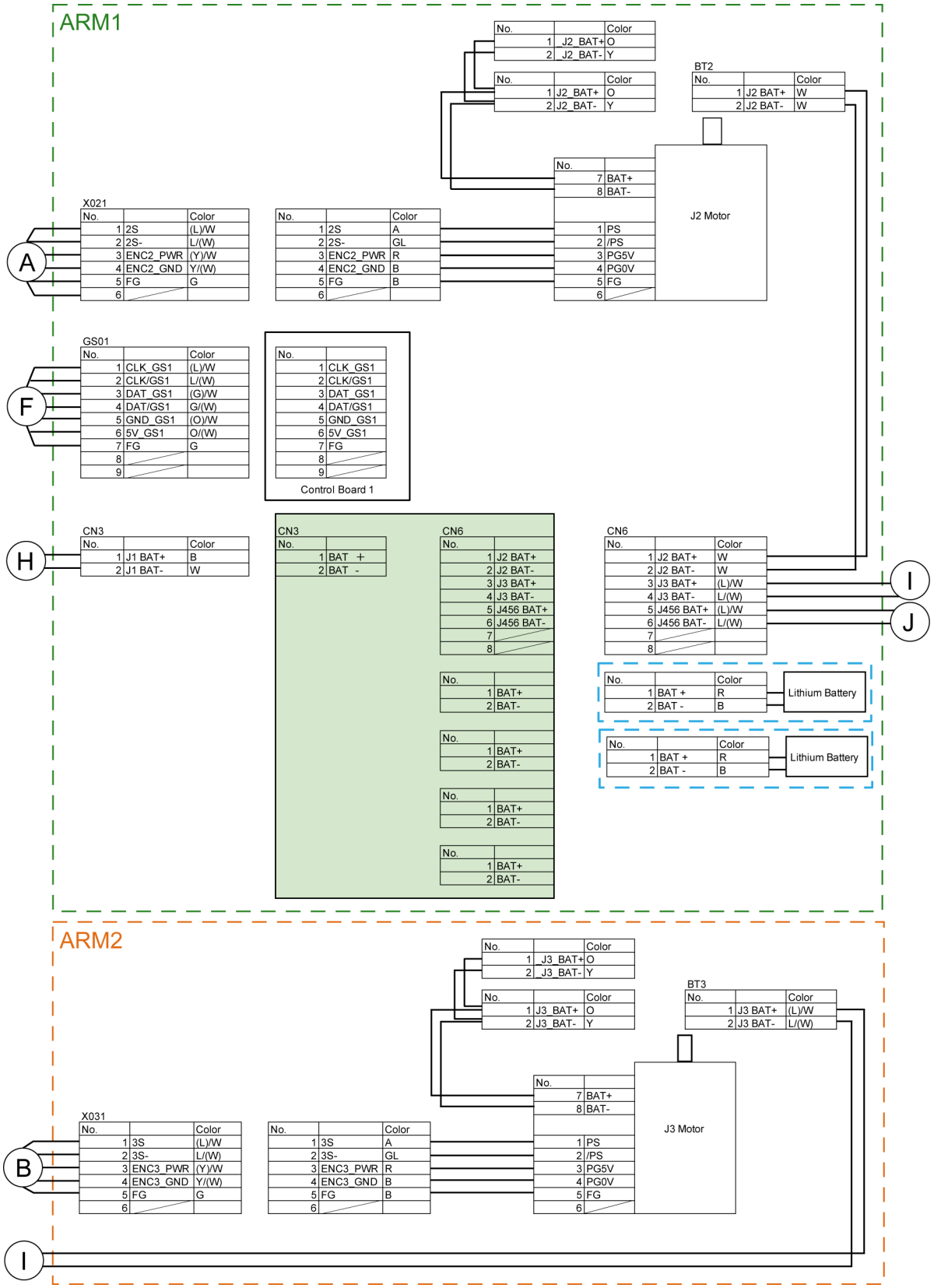
   For details, refer to *C12 Maintenance: 3. Covers*.

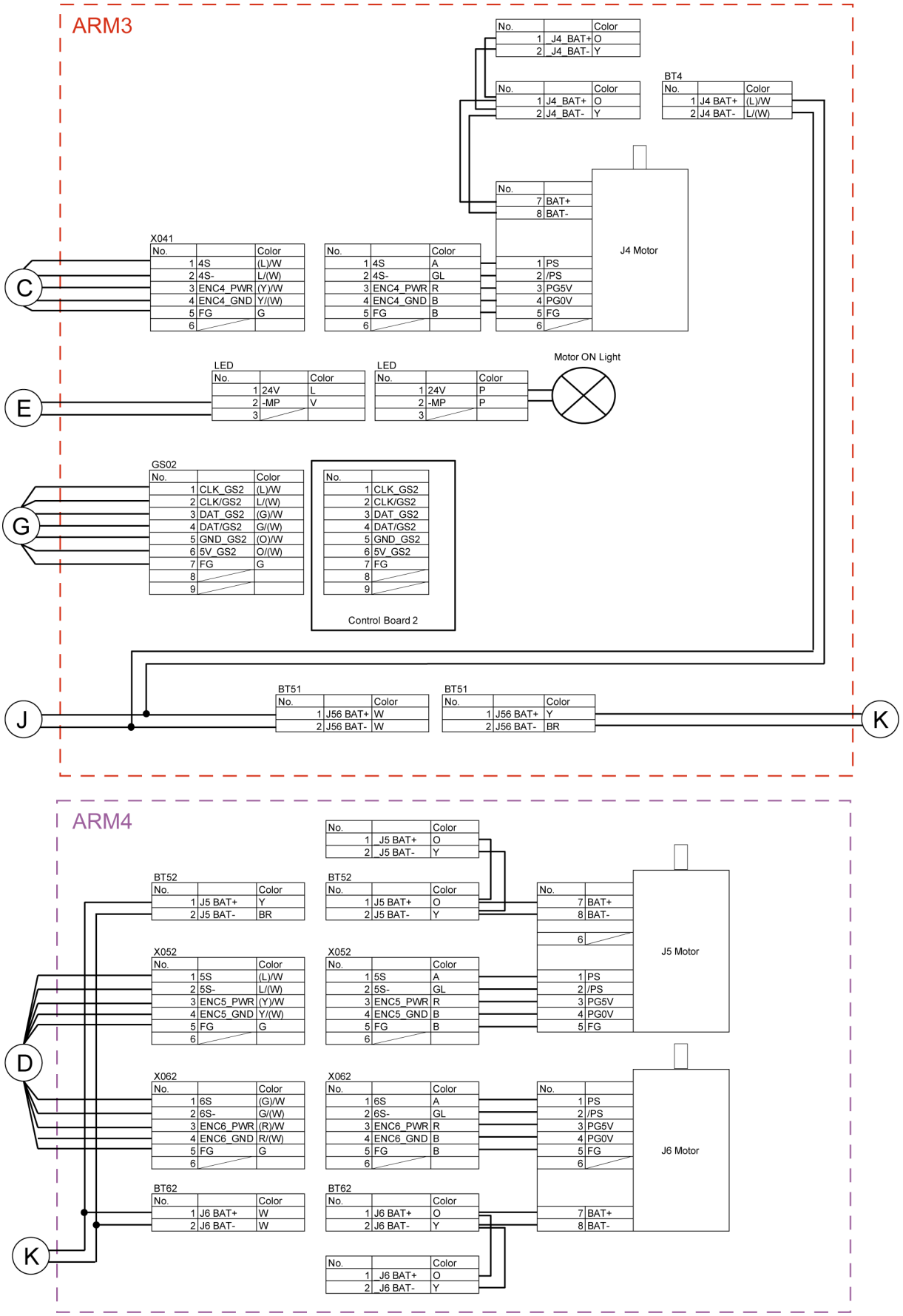
10. Perform calibration.
    For details, refer to *C12 Maintenance: 16. Calibration*.

4.2 Connector Pin Assignment

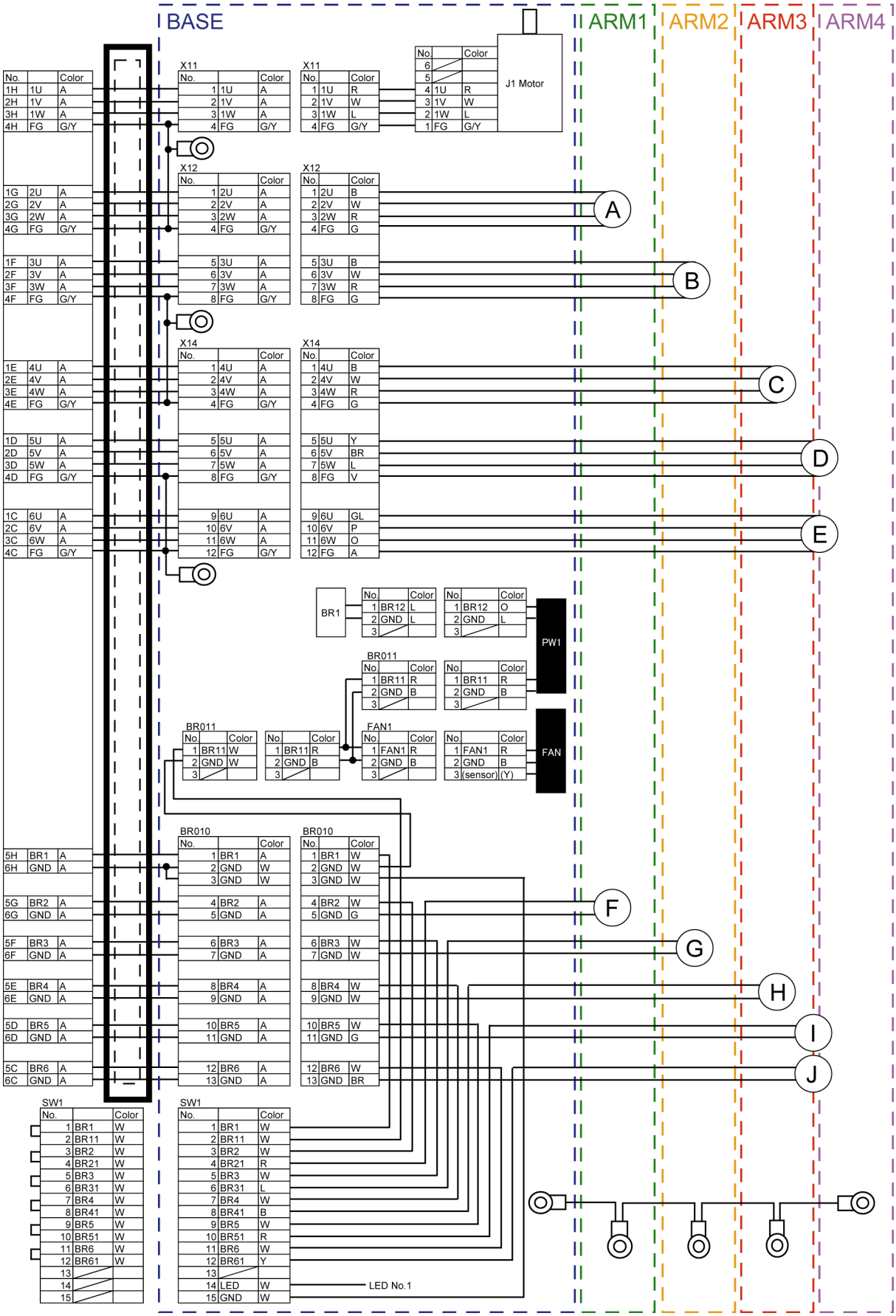
4.2.1 Signal Cable

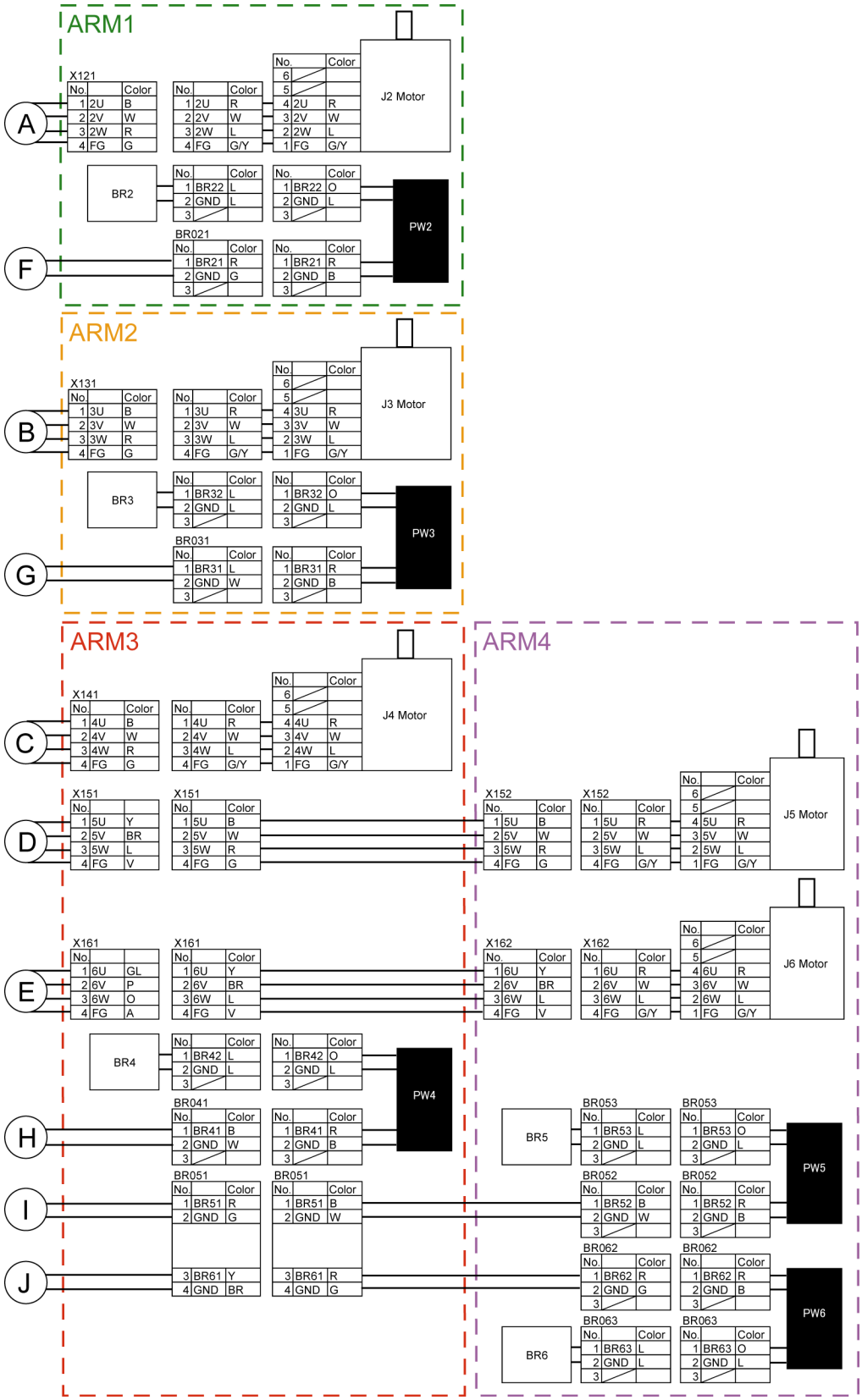



ARM1
No. Color
1 J2_BAT+ O
2 J2_BAT- Y
No. Color
1 J2_BAT+ O
2 J2_BAT- Y
BT2
No. Color
1 J2 BAT+ W
2 J2 BAT- W
No.
7 BAT+
8 BAT-
1 PS
2 /PS
3 PG5V
4 PG0V
5 FG
6
J2 Motor
X021
No. Color
1 2S (L)/W
2 2S- L/(W)
3 ENC2_PWR (Y)/W
4 ENC2_GND Y/(W)
5 FG G
6
No. Color
1 2S A
2 2S- GL
3 ENC2_PWR R
4 ENC2_GND B
5 FG B
6
A
GS01
No. Color
1 CLK_GS1 (L)/W
2 CLK/GS1 L/(W)
3 DAT_GS1 (G)/W
4 DAT/GS1 G/(W)
5 GND_GS1 (O)/W
6 5V_GS1 O/(W)
7 FG G
8
9
F
No.
1 CLK_GS1
2 CLK/GS1
3 DAT_GS1
4 DAT/GS1
5 GND_GS1
6 5V_GS1
7 FG
8
9
Control Board 1
CN3
No. Color
1 J1 BAT+ B
2 J1 BAT- W
H
CN3
No.
1 BAT +
2 BAT -
CN6
No.
1 J2 BAT+
2 J2 BAT-
3 J3 BAT+
4 J3 BAT-
5 J456 BAT+
6 J456 BAT-
7
8
No.
1 BAT+
2 BAT-
No.
1 BAT+
2 BAT-
No.
1 BAT+
2 BAT-
No.
1 BAT+
2 BAT-
CN6
No. Color
1 J2 BAT+ W
2 J2 BAT- W
3 J3 BAT+ (L)/W
4 J3 BAT- L/(W)
5 J456 BAT+ (L)/W
6 J456 BAT- L/(W)
7
8
I
J
No. Color
1 BAT + R
2 BAT - B
Lithium Battery
No. Color
1 BAT + R
2 BAT - B
Lithium Battery
ARM2
No. Color
1 J3_BAT+ O
2 J3_BAT- Y
No. Color
1 J3_BAT+ O
2 J3_BAT- Y
BT3
No. Color
1 J3 BAT+ (L)/W
2 J3 BAT- L/(W)
No.
7 BAT+
8 BAT-
1 PS
2 /PS
3 PG5V
4 PG0V
5 FG
6
J3 Motor
X031
No. Color
1 3S (L)/W
2 3S- L/(W)
3 ENC3_PWR (Y)/W
4 ENC3_GND Y/(W)
5 FG G
6
No. Color
1 3S A
2 3S- GL
3 ENC3_PWR R
4 ENC3_GND B
5 FG B
6
B
I

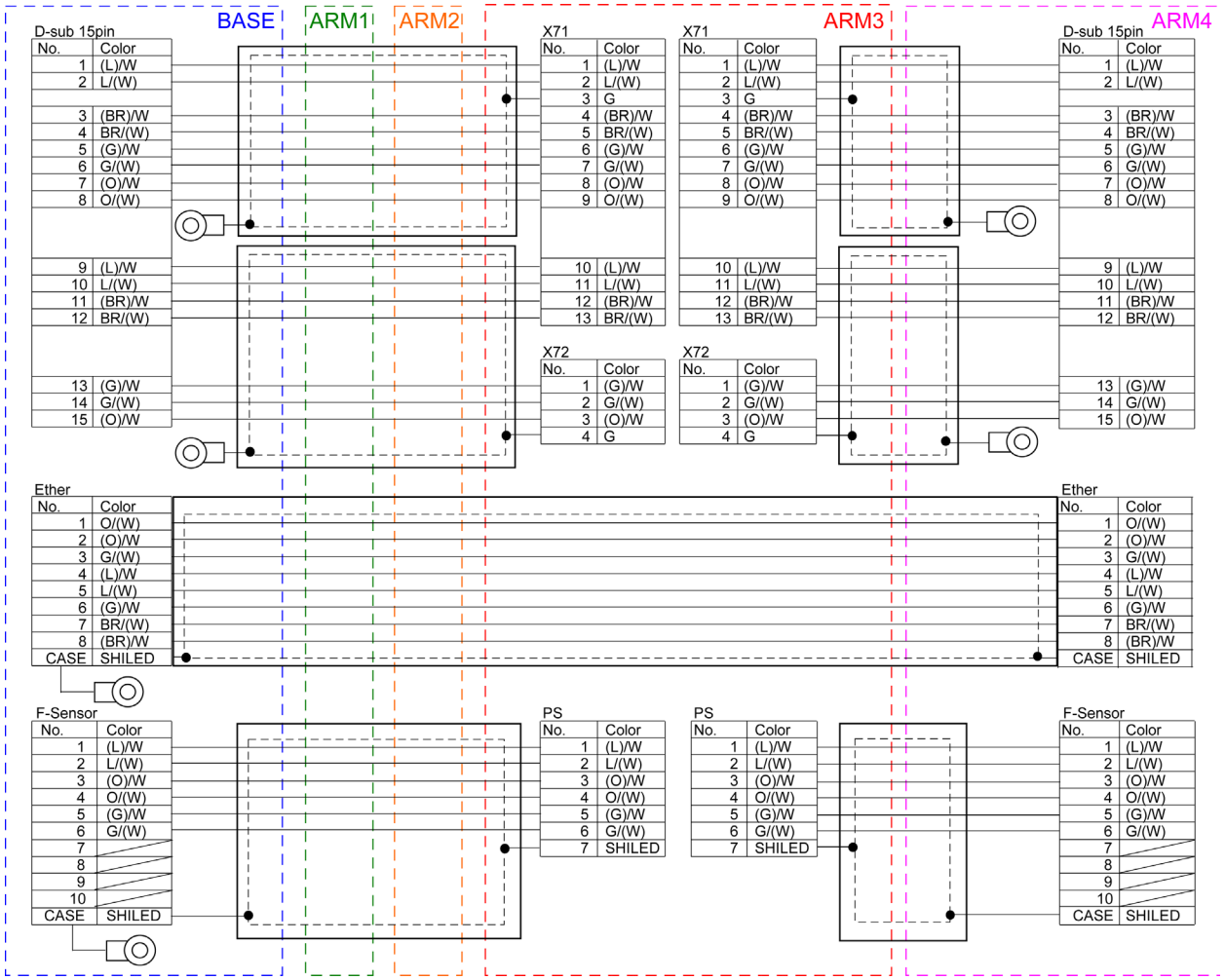

ARM3
No. Color
1 J4_BAT+ O
2 J4_BAT- Y
No. Color
1 J4_BAT+ O
2 J4_BAT- Y
BT4
No. Color
1 J4 BAT+ (L)/W
2 J4 BAT- L/(W)
No.
7 BAT+
8 BAT-
J4 Motor
X041
No. Color
1 4S (L)/W
2 4S- L/(W)
3 ENC4_PWR (Y)/W
4 ENC4_GND Y/(W)
5 FG G
6
No. Color
1 4S A
2 4S- GL
3 ENC4_PWR R
4 ENC4_GND B
5 FG B
6
No.
1 PS
2 /PS
3 PG5V
4 PG0V
5 FG
6
C
LED
No. Color
1 24V L
2 -MP V
3
LED
No. Color
1 24V P
2 -MP P
3
Motor ON Light
E
GS02
No. Color
1 CLK_GS2 (L)/W
2 CLK/GS2 L/(W)
3 DAT_GS2 (G)/W
4 DAT/GS2 G/(W)
5 GND_GS2 (O)/W
6 5V_GS2 O/(W)
7 FG G
8
9
No.
1 CLK_GS2
2 CLK/GS2
3 DAT_GS2
4 DAT/GS2
5 GND_GS2
6 5V_GS2
7 FG
8
9
Control Board 2
G
BT51
No. Color
1 J56 BAT+ W
2 J56 BAT- W
BT51
No. Color
1 J56 BAT+ Y
2 J56 BAT- BR
J
K
ARM4
No. Color
1 J5 BAT+ O
2 J5 BAT- Y
BT52
No. Color
1 J5 BAT+ Y
2 J5 BAT- BR
BT52
No. Color
1 J5 BAT+ O
2 J5 BAT- Y
No.
7 BAT+
8 BAT-
6
J5 Motor
X052
No. Color
1 5S (L)/W
2 5S- L/(W)
3 ENC5_PWR (Y)/W
4 ENC5_GND Y/(W)
5 FG G
6
X052
No. Color
1 5S A
2 5S- GL
3 ENC5_PWR R
4 ENC5_GND B
5 FG B
6
No.
1 PS
2 /PS
3 PG5V
4 PG0V
5 FG
D
X062
No. Color
1 6S (G)/W
2 6S- G/(W)
3 ENC6_PWR (R)/W
4 ENC6_GND R/(W)
5 FG G
6
X062
No. Color
1 6S A
2 6S- GL
3 ENC6_PWR R
4 ENC6_GND B
5 FG B
6
No.
1 PS
2 /PS
3 PG5V
4 PG0V
5 FG
6
J6 Motor
BT62
No. Color
1 J6 BAT+ W
2 J6 BAT- W
BT62
No. Color
1 J6 BAT+ O
2 J6 BAT- Y
No.
7 BAT+
8 BAT-
No. Color
1 J6 BAT+ O
2 J6 BAT- Y
K

4.2.2 Power Cable




ARM1
X121
J2 Motor
A
BR2
PW2
BR021
F
ARM2
X131
J3 Motor
B
BR3
PW3
BR031
G
ARM3
X141
J4 Motor
C
X151
D
BR4
PW4
BR041
H
BR051
I
J
ARM4
X152
J5 Motor
X162
J6 Motor
BR5
BR053
PW5
BR052
BR6
BR062
BR063
PW6

4.2.3 User Cable



4.2.4 Color of Cables

The following table shows the codes and cable colors indicated in the pin assignments

4.2.1 Signal Cable

4.2.2 Power Cable

4.2.3 User Cable

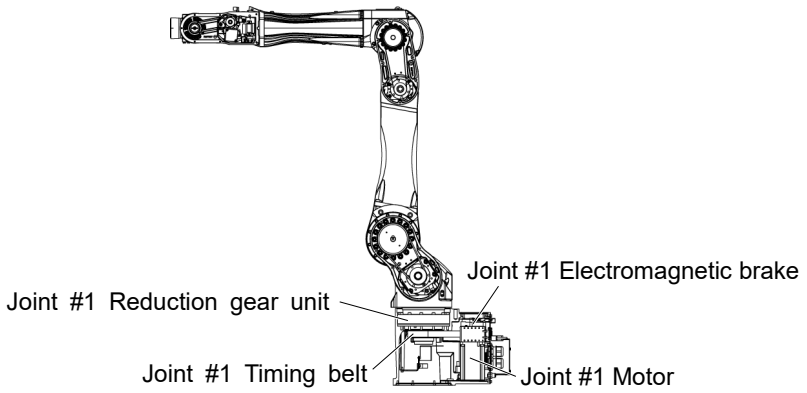
Code	Cable color
B	Black
W	White
R	Red
G	Green
Y	Yellow
BR	Brown
L	Blue
V	Violet
A	Azure
O	Orange
GL	Gray
P	Pink

5. Joint #1

WARNING	■ 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. ■ 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. ■ Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source. To shut off power to the robot system, disconnect the power plug from the power source. Performing any work while connecting the AC power cable to a factory power source 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 during replacement procedures. The shock may shorten the life of the motors and encoder and/or damage them. ■ Never disassemble the motor and encoder. Disassembled motor and encoder will cause a positional gap and cannot be used again.

After parts have been replaced (motors, reduction gear units, timing belts, etc.), the Manipulator cannot perform positioning properly because a gap exists between the origin stored in each motor encoder 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 *C12 Maintenance 16. Calibration* and follow the steps to perform calibration.



Maintenance procedures differ depending on the installation type of the M/C cable.

5.1 M/C Cable Backward (Joint #1)

5.2 M/C Cable Downward (Joint #1)

5.1 M/C Cable Backward (Joint #1)

5.1.1 Joint #1 - Replacing the Motor (M/C Cable Backward)

	Name		Qty.	Note
Maintenance Parts	Motor unit (Joint #1)		1	2172922
	Belt tensile jig*		1	1674582
	J1 brake positioning jig*		1	1675081
	Wire tie	AB100	-	1675753
		AB350	-	1697428
Tools	Hexagonal wrench	width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolts
		width across flats: 5 mm	1	For M6 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Nippers		1	For cutting the wire tie
	Pliers		1	For tightening the wire tie
	Belt tension meter		1	Refer: Unitta U-505

* The belt tensile jig and J1 brake positioning jig are assembly jigs. Use these jigs in relevant maintenance steps.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

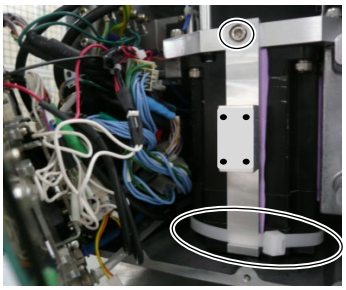
Removal: Joint #1 Motor (M/C Cable Backward)

1. Turn OFF the Controller.
2. Remove the base maintenance cover.

   For details, refer to *C12 Maintenance: 3. Covers*.
3. Remove the connector plate (M/C cable backward).

   For details, refer to *C12 Maintenance: 3. Covers*.
4. Disconnect the cables from the base and disconnect the connectors.

   Connector: X11, X010, BT1, BR011
   (Hold the clip to remove.)



NOTE When replacing only the brake, do not disconnect the connector BT1. If the connector is disconnected, perform calibration.

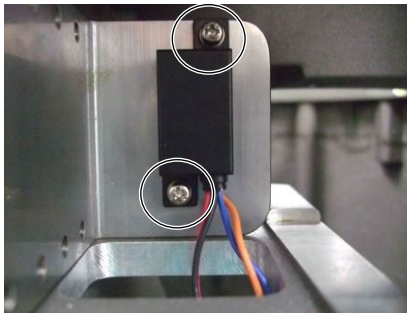
Remove the heat radiation block

1. Remove the wire tie and the bolts to remove the heat radiation block
   Hexagon socket head cap bolts: M5×15
   Wire tie: AB350
2. Remove the heat radiation sheet between the heat radiation block and the motor.

NOTE The heat radiation block, the heat radiation sheet, and the bolts will be used again. Be careful not to lose them.
Be careful not to tear the heat radiation sheet.

5. Remove the brake power supply.

   Cross recessed head screws with washer: 2-M3×6



6. Remove the Joint #1 brake plate from the Joint #1 motor unit.

   Hexagon socket head cap bolts: 3-M4×20

7. Remove the Joint #1 motor unit from the base.

   Hexagon socket head cap bolts: 3-M6×30 (with a plain washer)

   Be careful not to tear and lose the heat radiation sheet attached to the motor.

Installation: Joint #1 Motor (M/C Cable Backward)

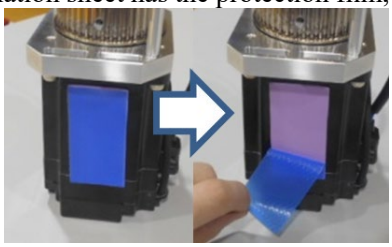
NOTE ☞ When tightening hexagon socket head cap bolts, refer to the *2.4 Tightening Hexagon Socket Head Cap Bolts.*

1. Put the Joint #1 timing belt on the Joint #1 pulley 2 of the Joint #1.

   Hold the belt so as not to drop it.

2. Check that the heat radiation sheet is attached on the right side of the motor (when seeing from the rear side of the Manipulator).

NOTE ☞ If the Manipulator is operated without the heat radiation sheet, the motor generates heat and the error may occur.
If the heat radiation sheet has the protection film, remove the film.



Pass the pulley 1 of the Joint #1 motor unit to the Joint #1 timing belt and loosely secure it to the base.

Hexagon socket head cap bolts: 3-M6×30 (with a plain washer)

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

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

3. Apply proper tension to the Joint #1 motor unit and secure it.
When securing the motor unit, attach the heat dissipation sheet to the right side of the base (when seeing from the rear side of the Manipulator).

Joint #1 timing belt tension: 89 to 149 N

Belt tension meter setting values

Weight: 4.0 g/mm width × m span, Width: 20 mm, Span: 160 mm

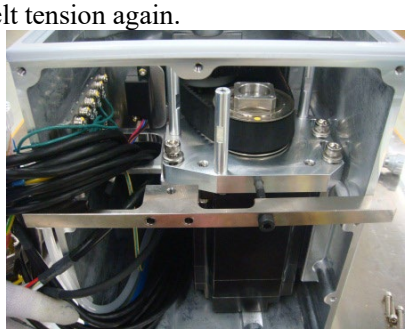
Hexagon socket head cap bolts: 3-M6×30 (with a plain washer)

Tightening torque: 13.0 ± 0.6 N·m

NOTE Regarding belt tension:

- Jumping (position gap) may occur if the value is below the lower limit.
- Vibration (abnormal noise) or reduction in life of the parts may occur if the value exceeds the upper limit.
- When you replace with a new belt, belt extends and the belt tension may decrease in the initial stage. Make sure to operate the robot two to three days and check the belt tension again.

When using the belt tension tensile jig (maintenance part):
Fix the belt tension tensile jig (for J1, J2, J3) to the Joint #1 motor plate.



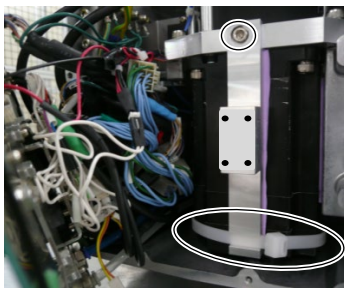
Hexagon socket head cap bolts: M5×45

Use the belt tension tensile jig (for J1, J2, J3) as shown in the photo to apply a specified tension.

As the screw is tightened, the Joint #1 motor unit will be pulled and tension will be applied.

Install the heat radiation block

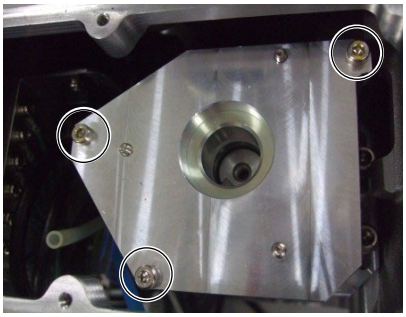
For details, refer to the *Heat radiation block Installation*



4. Install the Joint #1 electromagnetic brake / brake plate to the Joint 1 motor unit.

   Hexagon socket head cap bolts: 3-M4×20

   Tightening torque: 4.0 ± 0.2 N·m

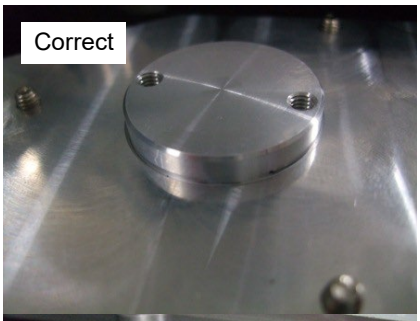


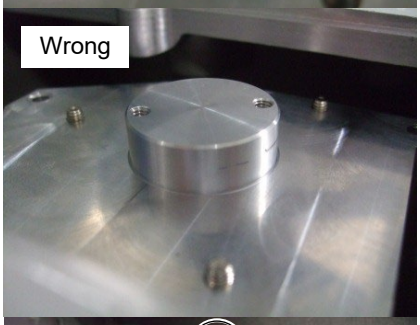
   Check that the motor and the brake core are aligned.

   Regarding brake misalignment:
   - Misalignment of the brake core may cause abnormal sound or apply abnormal torque on the brake. It may result in breakdown of the brake.

   When using the J1 brake positioning jig (maintenance part):

   Using the J1 brake positioning jig, check that the motor and the brake core are aligned when fixing the brake.
   If the J1 brake positioning jig cannot be inserted all the way, the motor and the brake core may be misaligned. In such a case, use the brake release unit (option part) to release the brake, and then align the brake.

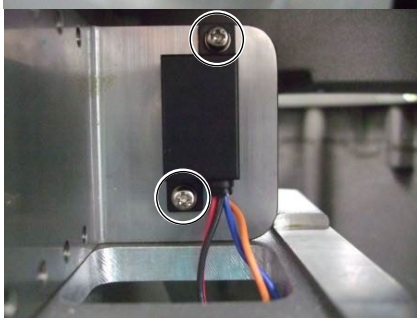




5. Install the brake power supply to the plate. Make sure to install the brake power supply so that the cables will be in the direction as shown in the photo.

   Cross recessed head screws with washer: 2-M3×6

   Tightening torque: 0.45 ± 0.1 N·m

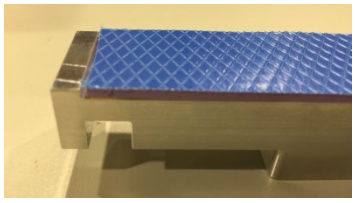


6. Connect the following connectors.
   Connectors: X11, X010, BT1, BR011
7. Mount the connector plate (M/C cable backward).
   For details, refer to *C12 Maintenance: 3. Covers*.
8. Mount the base maintenance cover.
   For details, refer to *C12 Maintenance: 3. Covers*.
9. Calibrate the Joint #1.
   For details, refer to *C12 Maintenance: 16. Calibration*.

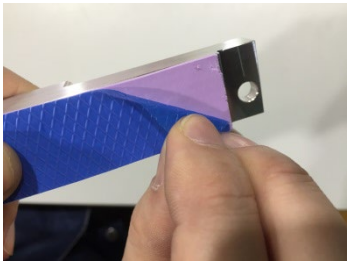
Heat radiation block Installation

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

1. Check that the heat radiation sheet is attached on the heat radiation block.



NOTE If the Manipulator is operated without the heat radiation sheet, the motor generates heat and the error may occur.
If the heat radiation sheet has the protection film, remove the film.

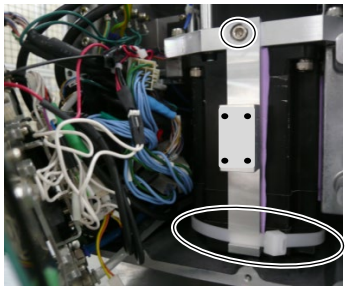


(Image of the protection film)

2. Fix the upper part of the heat radiation block to the Joint #1 motor plate with the bolts.

   Hexagon socket head cap bolts: M5×15

   Tightening torque: 4.0 ± 0.2 N·m

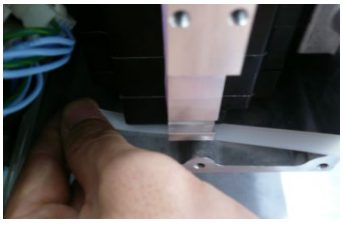


3. Fix the lower part of the heat radiation block to the motor with the wire tie.

   Wire tie: AB350

   3-1 Insert the wire tie under the motor.

   3-2 Hold the end of the wire tie.



3-3 While holding the end of the wire tie, push the wire tie to the direction as indicated with the arrow in the photo.

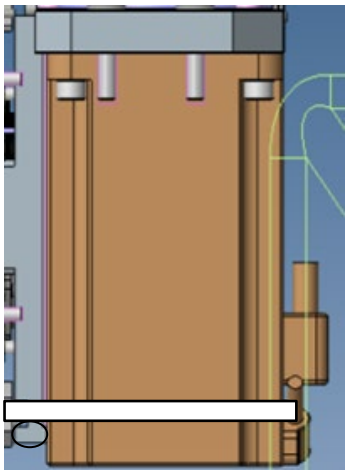
3-4 Wrap the wire tie around the motor.

3-5 Tighten the wire tie to hold the heat radiation sheet firmly.

Make sure that the heat radiation sheet sticks out of the heat radiation block.

NOTE

Do not tighten the wire tie too much. It may result in cable breakage.



5.1.2 Joint #1 - Replacing the Reduction Gear Unit (M/C Cable Backward)

	Name		Qty.	Note
Maintenance Parts	Reduction gear unit (Joint #1)		1	1674604
	Belt tensile jig*		1	1674582
	J1 brake positioning jig*		1	1675081
	Wire tie (AB100)		1	1675753
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolts
		width across flats: 5 mm	1	For M6 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Belt tension meter		1	Refer: Unitta U-505
	Cloth (cushioning)		1	For pressing arms

* The belt tensile jig and J1 brake positioning jig are assembly jigs. Use the jigs when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

When removing the Joint #2 motor unit, tilt the Arm #2 and press it toward the Arm #1.
Reference: *C12 Maintenance 6.1 Joint #2 - Replacing the Motor,* Removal step (2)

When pressing the arm, put a piece of cloth or a similar material between the arms to avoid contacting each other. This protects the arm surfaces from scratching and paint peeling off.

Removal: Joint #1 Reduction gear unit (M/C Cable Backward)

⚠ CAUTION	■ This procedure has possibility of hands and fingers being caught and/or damage or malfunction to the Manipulator. Be very careful when performing maintenance. ■ Do not loosen the bolts while the Arm #2 is not tilted. It may cause the belt come off and the Arm #2 falls down, and it is extremely hazardous. Be sure to do the Removal steps (1) and (2) in *C12 Maintenance 6.1 Joint #2 - Replacing the Motor* before removing the motor. ■ When removing the Arm #1, there must be two or more people to work on it so that at least one of them can support the arm while the others are removing the bolts. Removing the bolts without supporting the arm may result in the arm falling, bodily injury, and/or malfunction of the robot system.

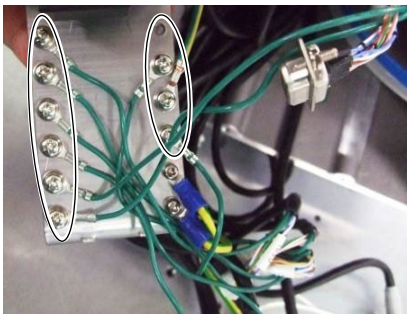
1. Remove the following parts.

   Connector plate
   Connector
   Cable grounding plate
   Brake power supply

   For details, refer to *C12 Maintenance 5.1.3 Joint #1 - Replacing the Timing Belt (M/C Cable Backward)*, Removal steps (1) to (9).

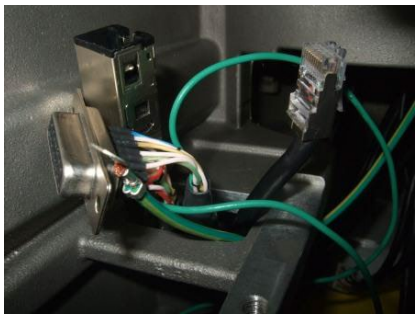
2. Remove the ground terminals.

   Cross recessed head screws with washer: 9-M4×8, 2-M3×6



3. Disconnect the following parts from the hole inside the base.

   D-sub cable
   Ground wire
   RJ45 connector
   F-sensor connector

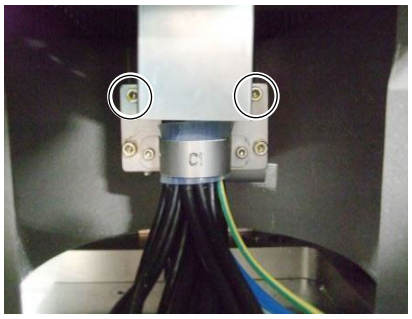


4. Remove the Joint #1 motor unit.

   For details, refer to *C12 Maintenance 5.1.1 Joint #1 – Replacing the Motor Unit (M/C Cable Backward)*, Removal steps (6) to (7).

5. Remove the cable interference prevention plate.

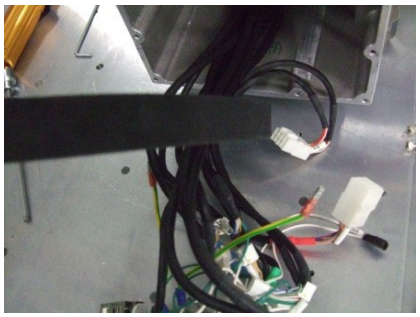
   Hexagon socket head cap bolts: 2-M3×6



6. Remove the base cable bracket (C1).

   Hexagon socket head cap bolts: 2-M3×6

7. Remove the Joint #1 timing belt.



8. Remove the Joint #2 motor unit.

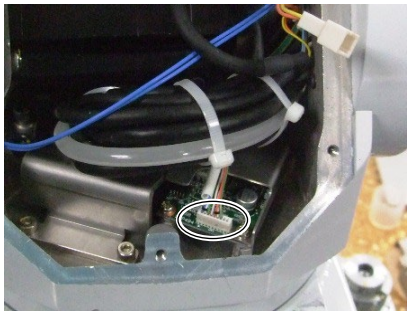
   For details, refer to *C12 Maintenance 6.1 Joint #2 - Replacing the Motor*, Removal steps (1) to (9).

9. Remove the Joint #1 cable fixing plate (Arm #1 side).

   Hexagon socket head cap bolts: 2-M4×10

10. Remove the connector connected to the control board 1.

    Connector: GS01



11. Disconnect the internal cables from the base to the Arm #1 side. Protect the connectors with masking tapes.

    - To protect the connector's clips
    - To avoid adherence of cable grease

NOTE

Disconnect the cables one by one in order from the smallest connector to the largest one.
Do not attempt to pull all connectors at once.
Doing so may damage the cables.

12. Pull out the grease tube (between the base and the Arm #1) on the Arm #1 side from the fitting.

13. Remove the Arm #1 from the base.

    Hexagon socket head cap bolts: 15-M6×30 (with a plain washer)

CAUTION	■ By removing the bolts, the Arm #1, #2, #3, #4, #5, and #6(end effector) can be separated. There is a possibility of hands and fingers being caught and/or damage or malfunction to the Manipulator. Be very careful when removing the arm. Have at least two workers so that one can support the Manipulator while the other worker is removing the bolts.

14. Remove the Joint #1 reduction gear unit.

    Hexagon socket head cap bolts: 12-M6×50

Installation: Joint #1 Reduction gear unit (M/C Cable Backward)

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

1. Install the Joint #1 reduction gear unit.

   Hexagon socket head cap bolts: 12-M6×50

   Tightening torque: 18.0 ± 0.9 N·m

   Installation face of the base reduction gear unit has clearance holes.
   Install the reduction gear unit to match the screws and the clearance holes.

2. Install the Arm #1 to the base.

   Hexagon socket head cap bolts: 15-M6×30 (with a plain washer)

   Tightening torque: 18.0 ± 0.9 N·m

CAUTION	■ There is a possibility of hands and fingers being caught and/or damage or malfunction to the Manipulator. Be very careful when installing the arm. Have at least two workers so that one can support the Manipulator while the other worker is removing the bolts.

3. Connect the grease tube for the Arm #1 side to the fitting.

4. Pass the internal cables from the Arm #1 side to the base.
   Protect the connectors with masking tapes.

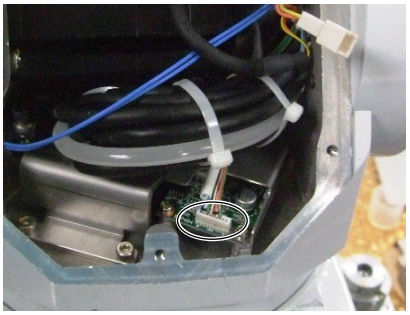
   - To protect the connector's clips
   - To avoid adherence of cable grease

NOTE Disconnect the cables one by one in order from the largest connector to the smallest one.

Do not attempt to pull all connectors at once.
Doing so may damage the cables.

5. Connect the connector to the control board 1.

   Connector: GS01



6. Install the Joint #1 cable bracket (Arm #1 side).

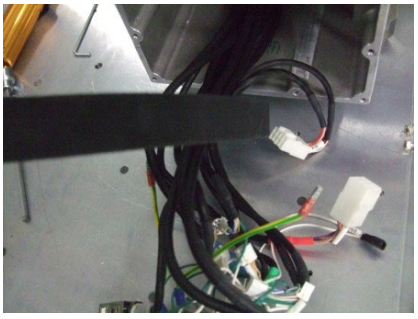
   Hexagon socket head cap bolts: 2-M4×10

   Tightening torque: 4.0 ± 0.2 N·m

7. Install the Joint #2 motor unit.

   For details, refer to *C12 Maintenance 6.1 Joint #2 - Replacing the Motor*, Installation steps (4) to (9).

8. Pass the cables and the air tube inside the Joint #1 timing belt.



9. Mount the base cable bracket (C1).

   Wrap the cables with the attached silicone sheet.
   Use a cable bracket to fix the wrapped silicone sheet.

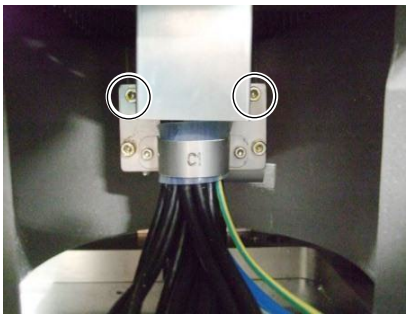
   Hexagon socket head cap bolts: 2-M3×6

   Tightening torque: 2.0 ± 0.1 N·m

10. Install the cable interference prevention plate.

    Hexagon socket head cap bolts: 2-M3×6

    Tightening torque: 2.0 ± 0.1 N·m

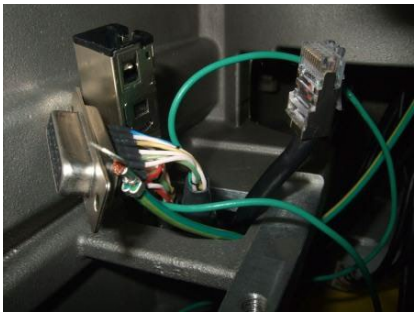


11. Install the Joint #1 motor unit.

    For details, refer to *C12 Maintenance 5.1.1 Joint #1 – Replacing the Motor (M/C Cable Backward)*, Removal steps (1) to (4).

12. Pass the following parts through the hole inside the base to the upper part of the base.

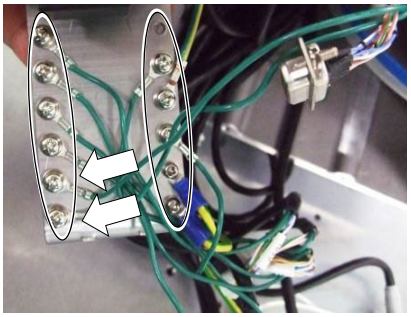
    D-sub cable
    Ground wire
    RJ45 connector
    F-sensor connector



13. Connect the ground wires.

    Cross recessed head screws with washer: 9-M4×8, 2-M3×6

    Tightening torque : 0.9 ± 0.1N·m (M4×8)
    0.45 ± 0.1 N·m (M3×6)



NOTE ☞ The ground terminals of the D-sub cables have fixed installation positions. Install them to the two screw holes. (Photo: indicated by the arrows).

14. Install the following parts.

    Connector plate

    Connector

    Cable grounding plate

    Brake power supply

    For details, refer to *C12 Maintenance 5.1.3 Joint #1 – Replacing the Timing Belt (M/C Cable Backward)*, Installation steps (6) to (14).

5.1.3 Joint #1 - Replacing the Timing Belt (M/C Cable Backward)

	Name		Qty.	Note
Maintenance Part	Timing belt (Joint #1) 595 mm		1	1655930
	Belt tensile jig *		1	1674582
	J1 brake positioning jig*		1	1675081
	Wire tie AB100		1	1675753
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolt
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolt
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolt
		width across flats: 5 mm	1	For M6 hexagon socket head cap bolt
	Box wrench	width across flats: 5 mm	1	For D-Sub connector
	Long nose pliers		1	For removing the air tube
	Cross-point screwdriver		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Belt tension meter		1	Refer: Unitta U-505

* The belt tensile jig and J1 brake positioning jig are assembly jigs. Use these jigs in relevant maintenance steps.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

m from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. The brake does not work during replacement. Be careful when performing maintenance work.

Removal: Joint #1 Timing belt (M/C Cable Backward)

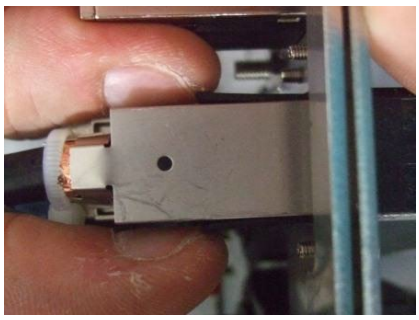
1. Turn OFF the Controller.
2. Remove the base maintenance cover.
   For details, refer to *C12 Maintenance 3. Covers*.
3. Remove the connector plate (M/C cable backward).
   For details, refer to *C12 Maintenance 3. Covers*.
4. Remove two air tubes inside the base.
5. Remove two D-sub connectors.
6. Disconnect the cables from the base and disconnect the connectors.

   Connector: X11, X12, X14, BR010, BR011, X010, X020, X040, LED, GS01, BT1
   (Hold the clip to remove.)

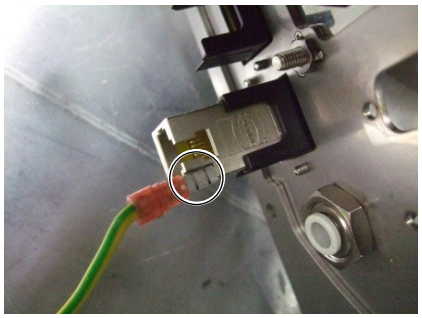
7. Disconnect the following connectors.

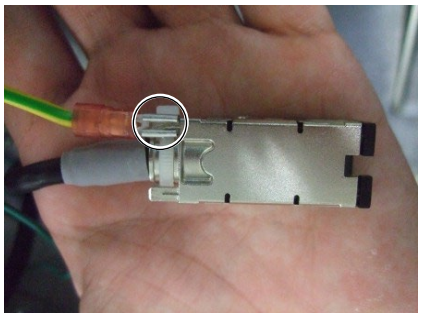
   RJ45 connector:
   Hold the clip to remove.

   F-sensor connector:
   Open the clips on the both ends of the connector and pull it out.



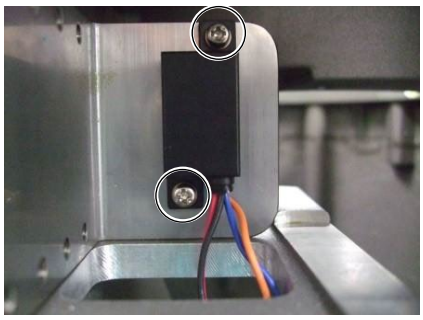
Remove the ground wire from each connector.
To remove the ground wire, hold the connector by hand and pull the ground wire.





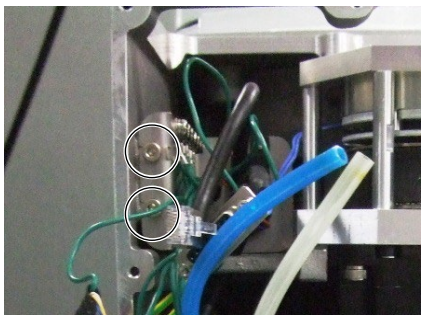
8. Remove the brake power supply.

   Cross recessed head screws with washer: 2-M3×6



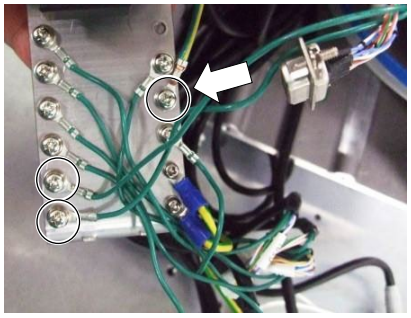
9. Remove the ground wire plate (M/C cable backward).

   Hexagon socket head cap bolts: 2-M4×10



10. Remove the following ground wire terminals.
    D-sub cable ground wire terminals (×2)
    Ground wire (green/yellow) terminal (×1) indicated by an arrow

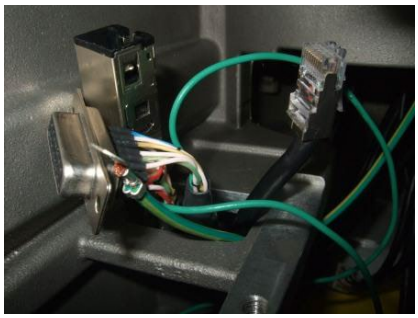
    Cross recessed head screws with washer: 3-M4×8



NOTE ☞ Positions of the ground wire (green/yellow) terminals may differ from the photo. Check the positions of the terminals before removing them.

11. Disconnect the following parts downward from the hole inside the base.

    D-sub cable
    Ground wire
    RJ45 connector
    F-sensor connector

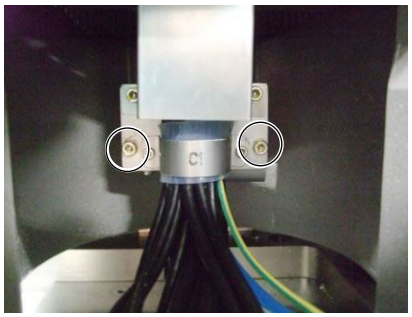


12. Remove the Joint #1 motor unit.
    For details, refer to *C12 Maintenance: 5.1.1 Joint #1-Replacing the Motor (M/C Cable Backward)*, Removal steps (6) to (7).

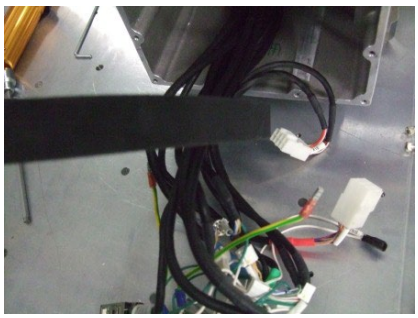
13. Remove the Joint #1 cable fixing plate.

    Hexagon socket head cap bolts: 2-M3×6

    Do not remove the base cable bracket (C1)



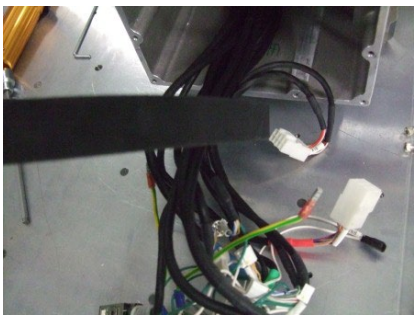
14. Remove the Joint #1 timing belt.



Installation: Joint #1 Timing belt (M/C Cable Downward)

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

1. Pass the cables and air tubes to the Joint #1 timing belt.



2. Mount the Joint #1 cable fixing plate.

   Hexagon socket head cap bolts: 2-M3×6

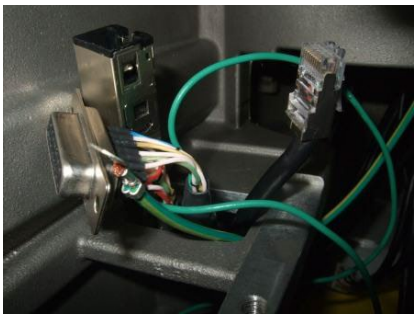
   Tightening torque: 2.0 ± 0.1 N·m

3. Mount the Joint #1 motor unit.

   For details, refer to *C12 Maintenance: 5.1.1 Joint #1-Replacing the Motor (M/C Cable Backward)*, Installation steps (1) to (4).

4. Disconnect the following parts from the hole inside the base to the upper side of the base.

   D-sub cable
   Ground wire
   RJ45 connector
   F-sensor connector

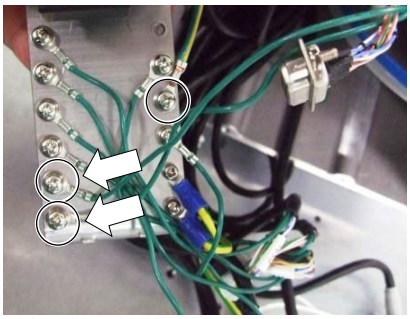


5. Install the terminals of the D-sub cable ground wire and ground wire (green/yellow).

   D-sub cable ground wire terminals (×2) indicated by arrows
   Ground wire (green/yellow) terminal (×1)

   Cross recessed head screws with washer: 3-M4×8

   Tightening torque: 0.9 ± 0.1 N·m

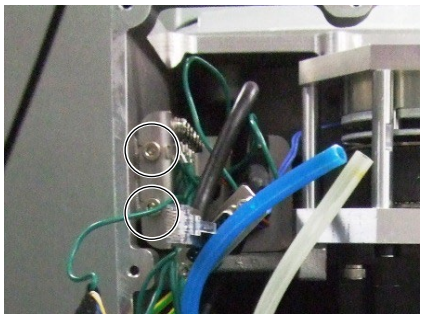


NOTE ☞ The installation positions of the D-sub cable ground terminals are fixed. Make sure to install them to the two screw holes on the backside of the Manipulator (as indicated by arrows in the photo).

6. Mount the ground wire plate (M/C cable backward).

   Hexagon socket head cap bolts: 2-M4×10

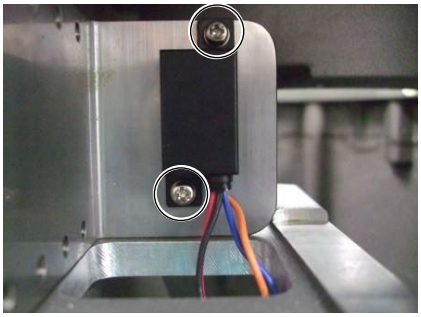
   Tightening torque: 4.0 ± 0.2 N·m



7. Install the brake power supply to the plate. Make sure to install the brake power supply so that the cables will be in the direction as shown in the photo.

   Cross recessed head screws with washer: 2-M3×6

   Tightening torque: 0.45 ± 0.1 N·m



8. Install the following connectors in accordance with the indications on the connector plates.

   RJ45 connector: Ether

   F-sensor connector: F-sensor

   Install the ground wire to each connector. To connect the ground wire, insert it while holding the connector by hand.

9. Connect the M/C cable connectors.

   Connector: X11, X12, X14, BR010, BR011, X010, X020, X040, LED, GS01, BT1

10. Install the D-sub connectors in accordance with the indications on the connector plates.

    Left: D-sub for brake release (with a wire marker: SW1) : B-release

    Right: D-sub for user wiring (no wire marker: with a round terminal): D-sub

11. Install two air tubes in accordance with the indications on the connector plates.
    Air1: Semitransparent
    Air2: Blue

NOTE

Be careful not to install the air tube of wrong color.

12. Install the connector plate (M/C cable backward).

    For details, refer to *C12 Maintenance: 3 Covers*.

13. Install the base maintenance cover.

    For details, refer to *C12 Maintenance: 3 Covers*.

14. Calibrate the Joint #1.
    For details, refer to *C12 Maintenance: 16. Calibration*.

5.1.4 Joint #1 - Replacing the Electromagnetic Brake (M/C Cable Backward)

	Name	Qty.	Note
Maintenance Parts	Electromagnetic brake (Joints #1, #2)	1	2172926
	J1 brake positioning jig *	1	1675081
	Wire tie (AB100)	1	1675753
Tools	Hexagonal wrench (width across flats: 3 mm)	1	For M4 hexagon socket head cap bolt
	Cross-point screwdriver (#2)	1	For cross recessed head screws
	Torque wrench	1	For tightening torque control

* The belt tensile jig and J1 brake positioning jig are assembly jigs. Use these jigs in relevant maintenance steps.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

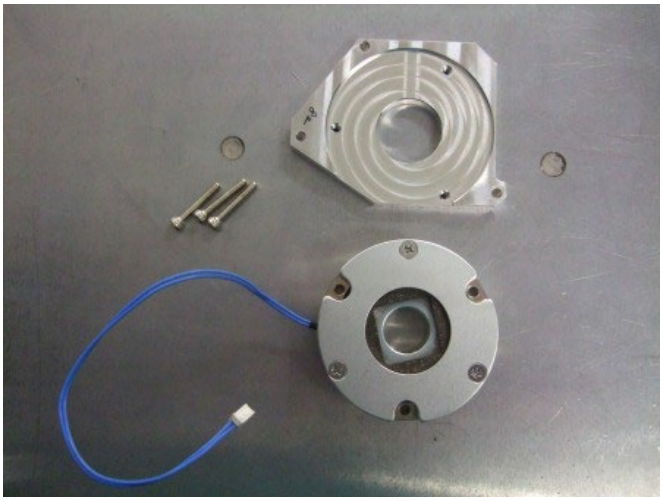
Removal: Joint #1 Electromagnetic brake (M/C Cable Backward)

1. Remove the Joint #1 electromagnetic brake from the Joint #1 motor unit.
   For details, refer to *C12 Maintenance: 5.1.1 Joint #1-Replacing the Motor (M/C Cable Backward)*, Removal steps (1) to (6).

NOTE
Do not disconnect the connector BT1. If the connector is disconnected, perform calibration.

2. Remove the Joint #1 brake from the brake plate.

   Hexagon socket head cap bolts: 3-M4×25



Installation: Joint #1 Electromagnetic brake (M/C Cable Backward)

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

1. Install the Joint #1 brake to the brake plate.

   Hexagon socket head cap bolts: 3-M4×25

   Tightening torque: 4.0 ± 0.2 N·m

   Be careful of the assembly direction of the Joint #1 electromagnetic brake. (See the photo)

2. Mount the Joint #1 brake plate to the Joint #1 motor unit.
   For details, refer to *C12 Maintenance: 5.1.1 Joint #1-Replacing the Motor (M/C Cable Backward)*, Installation steps (4) to (8).

NOTE
If you disconnected the connector BT1 in the removal steps, perform calibration.

5.2 M/C Cable Downward (Joint #1)

5.2.1 Joint #1 - Replacing the Motor (M/C Cable Downward)

	Name		Qty.	Note
Maintenance Parts	Motor unit (Joint #1)		1	2172922
	Belt tensile jig*		1	1674582
	J1 brake positioning jig*		1	1675081
	Wire tie	AB100	1	1675753
		AB350	1	1697428
Tools	Hexagonal wrench	width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolts
		width across flats: 5 mm	1	For M6 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Nippers		1	For cutting the wire tie
	Pliers		1	For tightening the wire tie
	Belt tension meter		1	Refer: Unitta U-505

* The belt tensile jig and J1 brake positioning jig are assembly jigs. Use these jigs in relevant maintenance steps.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

Removal: Joint #1 Motor (M/C Cable Downward)

1. Turn OFF the Controller.
2. Turn the Manipulator laterally.

CAUTION	■ When turning the Manipulator laterally, there must be two or more people to work on it so that at least one of them can support the arm while the others are removing the bolts. Removing the bolts without supporting the arm may result in the arm falling, bodily injury, and/or malfunction of the robot system.

3. Remove the following covers.

   Base maintenance cover
   Base cover (M/C cable downward)
   Connector plate (M/C cable downward)

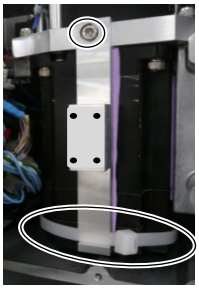
   For details, refer to *C12 Maintenance: 3 Covers*.

4. Disconnect the cables from the base and disconnect the following connectors.
   Connector: X11, X010, BT1, BR011
   (Hold the clip to remove.)

NOTE When only replacing the brake, do not disconnect the connector BT1. If the connector is disconnected, perform calibration.

Remove the heat radiation block.

1. Remove the wire tie and the bolts to remove the heat radiation block.
   Hexagon socket head cap bolts: M5×15
   Wire tie: AB350

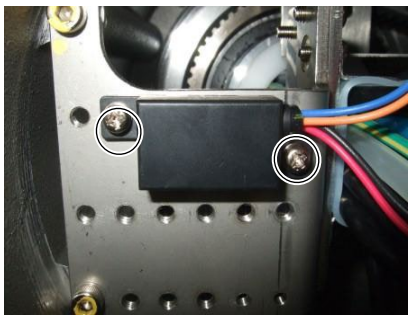


2. Remove the heat radiation sheet between the heat radiation block and the motor.

NOTE The heat radiation block, the heat radiation sheet, and the bolts will be used again.
Be careful not to lose them.
Be careful not to tear the heat radiation sheet.

5. Remove the brake power supply.

   Cross recessed head screws with washer: 2-M3×6



6. Remove the Joint #1 brake plate from the Joint #1 motor unit.

   Hexagon socket head cap bolts: 3-M4×20

7. Remove the Joint #1 motor unit from the base.

   Hexagon socket head cap bolts: 3-M6×30 (with a plain washer)

   Be careful not to tear and lose the heat radiation sheet attached to the motor.

Installation: Joint #1 Motor (M/C Cable Downward)

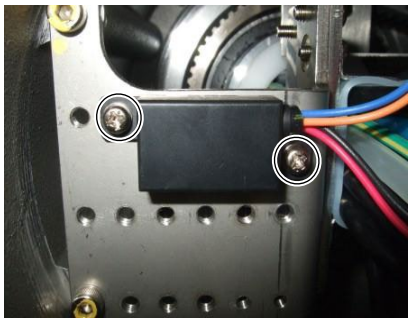
1. Mount the Joint #1 motor unit to the base.

   For details, refer to *C12 Maintenance: 5.1.1 Joint #1-Replacing the Motor (M/C Cable Backward)*, Removal steps (1) to (4).

2. Install the brake power supply to the plate. Make sure to install the brake power supply so that the cables will be in the direction as shown in the photo.

   Cross recessed head screws with washer: 2-M3×6

   Tightening torque: 0.45 ± 0.1 N·m



3. Connect the following connectors.

   Connector: X11, X010, BT1, BR011

4. Install the following covers.

   Connector plate (M/C cable downward).
   Base cover (M/C cable downward)
   Base maintenance cover

   For details, refer to *C12 Maintenance: 3 Covers*.

5. Calibrate the Joint #1.

   For details, refer to *C12 Maintenance: 16. Calibration*.

5.2.2 Joint #1 - Replacing the Reduction Gear Unit (M/C Cable Downward)

	Name		Qty.	Note
Maintenance Parts	Reduction gear unit (Joint #1)		1	1674604
	Belt tensile jig*		1	1674582
	J1 brake positioning jig*		1	1675081
	Wire tie AB100		1	1675753
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolts
		width across flats: 5 mm	1	For M6 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Belt tension meter		1	Refer: Unitta U-505
	Cloth (cushioning)		1	For pressing arms

* The belt tensile jig and J1 brake positioning jig are assembly jigs. Use the jigs when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

When removing the Joint #2 motor unit, tilt the Arm #2 and press it toward the Arm #1.

Reference: *C12 Maintenance 6.1 Joint #2 - Replacing the Motor,* Removal step (2)

When pressing the arm, put a piece of cloth or a similar material between the arms to avoid contacting each other. This protects the arm surfaces from scratching and paint peeling off.

Removal: Joint #1 Reduction gear unit (M/C cable downward)

⚠ CAUTION	■ This procedure has possibility of hands and fingers being caught and/or damage or malfunction to the Manipulator. Be very careful when performing maintenance. ■ Do not loosen the bolts while the Arm #2 is not tilted. It may cause the belt come off and the Arm #2 falls down, and it is extremely hazardous. Be sure to do the Removal steps (1) and (2) in *C12 Maintenance 6.1 Joint #2 - Replacing the Motor* before removing the motor. ■ When removing the Arm #1, there must be two or more people to work on it so that at least one of them can support the arm while the others are removing the bolts. Removing the bolts without supporting the arm may result in the arm falling, bodily injury, and/or malfunction of the robot system.

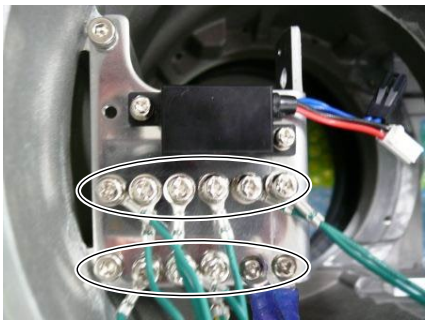
1. Remove the following parts.

   Connector plate
   Connector
   Brake power supply

   For details, refer to *C12 Maintenance 5.2.3 Joint #1 - Replacing the Timing Belt (M/C Cable Downward)*,
   Removal steps (1) to (8).

2. Remove the ground terminals.

   Cross recessed head screws with washer : 9-M4×8, 2-M3×6



3. Remove the Joint #1 reduction gear unit.

   For details, refer to *C12 Maintenance 5.1.2 Joint #1 - Replacing the Reduction Gear Unit (M/C Cable Backward)*, Removal steps (4) to (14).

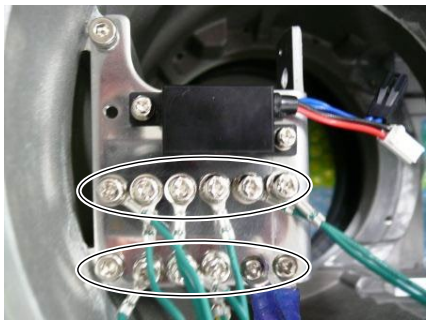
Installation: Joint #1 Reduction gear unit (M/C Cable Downward)

1. Install the Joint #1 reduction gear unit.

   For details, refer to *C12 Maintenance 5.1.2 Joint #1- Replacing the Reduction Gear Unit (M/C Cable Backward)*, Installation steps (1) to (11).

2. Install the ground terminals to the plate.

   Cross recessed head screws with washer: 9-M4×8, 2-M3×6



3. Install the following parts.

   Connector plate
   Connector
   Brake power supply

   For details, refer to *C12 Maintenance 5.2.3 Joint #1 - Replacing the Timing Belt (M/C Cable Downward),*
   Installation steps (4) to (10).

5.2.3 Joint #1 - Replacing the Timing Belt (M/C Cable Downward)

	Name		Qty.	Note
Maintenance Part	Timing belt (Joint #1) 595 mm		1	1655930
	Belt tensile jig*		1	1674582
	J1 brake positioning jig*		1	1675081
	Wire tie AB100		1	1675753
Tools	Hexagonal wrench	width across flats: 3 mm	1	For M4 hexagon socket head cap bolt
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolt
		width across flats: 5 mm	1	For M6 hexagon socket head cap bolt
	Box wrench	width across flats: 5 mm	1	For D-Sub connector
	Long nose pliers		1	For removing the air tube
	Cross-point screwdriver		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Belt tension meter		1	Refer: Unitta U-505

* The belt tensile jig and J1 brake positioning jig are assembly jigs. Use these jigs in relevant maintenance steps.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

Removal: Joint #1 Timing belt (M/C Cable Downward)

1. Turn OFF the Controller.

2. Turn the Manipulator laterally.

CAUTION	■ When turning the Manipulator laterally, there must be two or more people to work on it so that at least one of them can support the arm while the others are removing the bolts. Removing the bolts without supporting the arm may result in the arm falling, bodily injury, and/or malfunction of the robot system.

3. Remove the following covers.

   Base maintenance cover
   Base cover (M/C cable downward)
   Connector plate (M/C cable downward)

   For details, refer to *C12 Maintenance: 3 Covers*.

4. Disconnect the cables from the base and disconnect the following connectors.

   Connector: X11, X12, X14, BR010, BR011, X010, X020, X040,
   LED, GS01, BT1
   (Hold the clip to remove.)

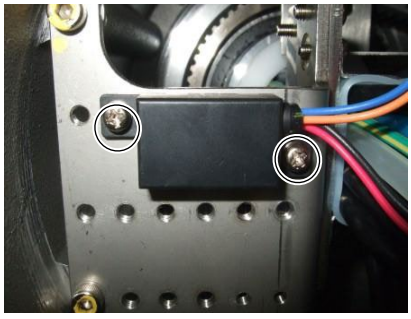
5. Disconnect the following parts.

   Air tubes
   RJ45 connector
   F-sensor connector
   D-sub connector

   For details, refer to *C12 Maintenance: 5.1.3 Joint #1-Replacing the Timing Belt (M/C Cable Backward)*, Removal steps (4) to (5), and (7).

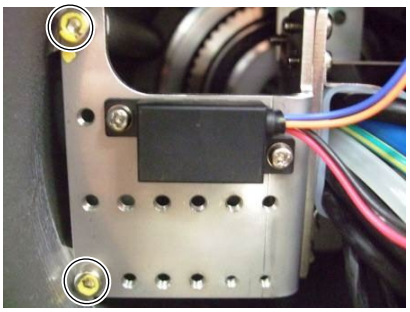
6. Remove the brake power supply.

   Cross recessed head screws with washer: 2-M3×6



7. Remove the ground wire plate (M/C cable downward).

   Hexagon socket head cap bolts: 2-M4×12



8. Remove the Joint #1 motor unit.

   For details, refer to *C12 Maintenance: 5.1.1 Joint #1-Replacing the Motor (M/C cable backward)*, Removal steps (6) to (7).

9. Remove the Joint #1 motor unit.

Installation: Joint #1 Timing belt (M/C Cable Downward)

NOTE

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

1. Pass the cables and the air tubes to the Joint #1 timing belt.

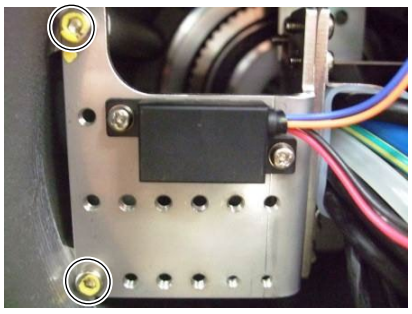
2. Mount the Joint #1 motor unit.

   For details, refer to *C12 Maintenance: 5.1.1 Joint #1-Replacing the Motor (M/C Cable Backward)*, Installation steps (1) to (4).

3. Mount the ground wire plate (M/C cable downward).

   Hexagon socket head cap bolts: 2-M4×12

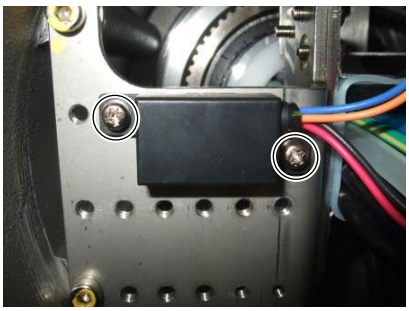
   Tightening torque: 4.0 ± 0.2 N·m



4. Install the brake power supply to the plate. Make sure to install the brake power supply so that the cables will be in the direction as shown in the photo.

   Cross recessed head screws with washer: 2-M3×6

   Tightening torque: 0.45 ± 0.1 N·m



5. Connect the following connectors in accordance with the indications on the connector plates.

   RJ45 connector: Ether

   F-sensor connector: F-sensor

   Install the ground wire to each connector. To connect the ground wire, insert in while holding the connector by hand.

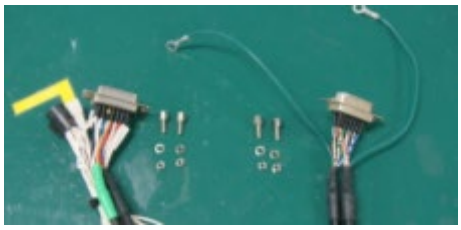
6. Connect the M/C cable connectors.

   Connector: X11, X12, X14, BR010, BR011, X010, X020, X040, LED, GS01, BT1

7. Install the D-sub connector in accordance with the indications on the connector plates.

   Left: D-sub for brake release (with a wire marker: SW1): B-release

   Right: D-sub for user wiring (no wire marker: with a round terminal): D-sub



8. Install two air tubes in accordance with the indications on the connector plates.
   Air1: Semitransparent
   Air2: Blue

NOTE

Be careful not to install the air tube of wrong color.

9. Install the following covers.

   Connector plate (M/C cable downward)
   Base cover (M/C cable downward)
   Base maintenance cover

   For details, refer to *C12 Maintenance: 3 Covers*.

10. Calibrate the Joint #1.

    For details, refer to *C12 Maintenance: 16. Calibration*.

5.2.4 Joint #1 - Replacing the Electromagnetic Brake (M/C Cable Downward)

	Name	Qty.	Note
Maintenance Parts	Electromagnetic brake (Joints #1, #2)	1	2172926
	J1 brake positioning jig *	1	1675081
	Wire tie AB100	1	1675753
Tools	Hexagonal wrench (width across flats: 3 mm)	1	For M4 hexagon socket head cap bolt
	Cross-point screwdriver (#2)	1	For cross recessed head screws
	Torque wrench	1	For tightening torque control

* The J1 brake positioning jig is an assembly jig. Use the jig in relevant maintenance steps.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

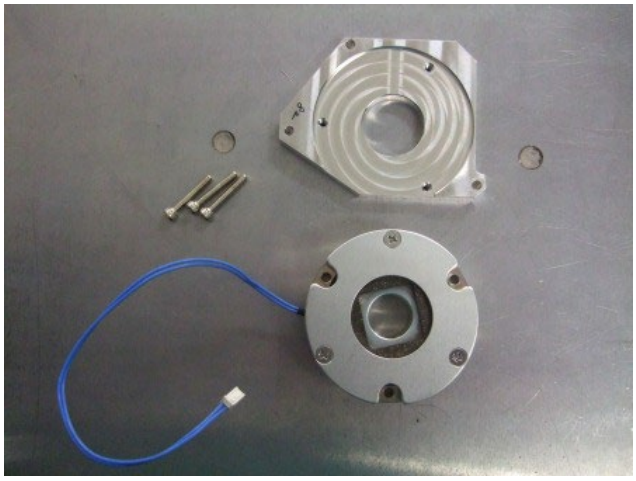
Removal: Joint #1 Electromagnetic brake (M/C Cable Downward)

1. Remove the Joint #1 brake plate from the Joint #1 motor unit.
   For details, refer to *C12 Maintenance: 5.2.1 Joint #1-Replacing the Motor (M/C Cable Downward)*, Removal steps (1) to (6).

NOTE
Do not disconnect the connector BT1. If the connector is disconnected, perform calibration.

2. Remove the Joint #1 brake from the brake plate.

   Hexagon socket head cap bolts: 3-M4×25



Installation: Joint #1 Electromagnetic brake (M/C Cable Downward)

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

1. Install the Joint #1 brake to the brake plate.

   Hexagon socket head cap bolts: 3-M4×25

   Tightening torque: 4.0 ± 0.2 N·m

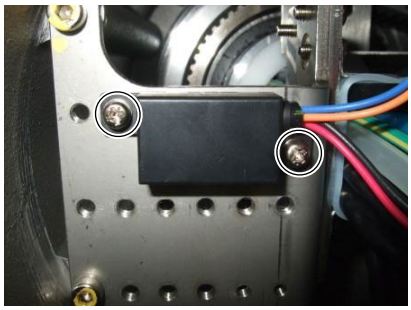
   Be careful of the assembly direction of the Joint #1 electromagnetic brake. (See the photo)

2. Mount the Joint #1 brake plate to the Joint #1 motor unit.
   For details, refer to *C12 Maintenance: 5.1.1 Joint #1 - Replacing the Motor (M/C Cable Backward)*, Installation step (4).

3. Install the brake power supply to the plate.
   Make sure to install the brake power supply so that the cables will be in the direction as shown in the photo.

   Cross recessed head screws with washer: 2-M3×6

   Tightening torque: 0.45 ± 0.1 N·m



4. Connect the M/C cable connectors.
   Connector: X11, X010, BT1, BR011

5. Install the following covers.

   Connector plate (M/C cable downward)
   Base cover (M/C cable downward)
   Base maintenance cover

   For details, refer to *C12 Maintenance: 3 Covers*.

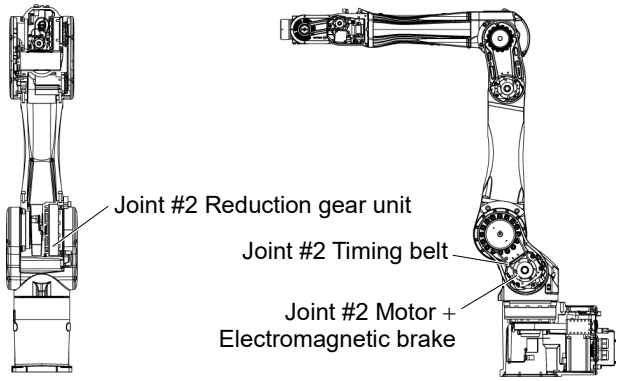
NOTE
If you disconnected the connector BT1 in the removal steps, perform calibration.

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 during replacement. It may shorten the life of the motors and encoder and/or damage them. ■ Never disassemble the motor and the encoder. Disassembled motor and encoder will cause a positional gap and cannot be used again.

After parts have been replaced (motors, reduction gear units, timing belts, etc.), the Manipulator cannot perform positioning properly because a gap exists between the origin stored in each motor encoder and its corresponding origin stored in the Controller.
Therefore, it is necessary to match these origins after replacing the parts.
The process of aligning the two origins is called “Calibration”.
Refer to *C12 Maintenance 16. Calibration* and perform the calibration after the parts replacement.



6.1 Joint #2 - Replacing the Motor

	Name		Qty.	Note
Maintenance Parts	AC servo motor 750 W		1	2168683
	Belt tensile jig*		1	1674582
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M5 hexagon socket set screw
		width across flats: 3 mm	1	For M6 hexagon socket head cap bolt
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolt
		width across flats: 5 mm	1	For M6 hexagon socket head cap bolt
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Thickness gauge (0.5 mm)		2	For pulley position adjustment
	Belt tension meter		1	Refer: Unitta U-505
	Cloth (cushioning)		1	For pressing arms

* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

When removing the Joint #2 motor, tilt the Arm #2 and press it against the Arm #1.

Reference: *C12 Maintenance: 6.1 Joint #2 - Replacing the Motor,* Removal step (2)

When pressing the arm, put a piece of cloth or a similar material between the arms to avoid contacting each other. This protects the arm surfaces from scratching and paint peeling off.

Removal: Joint #2 Motor

CAUTION	■ This procedure has possibility of hands and fingers being caught and/or damage or malfunction to the Manipulator. Be very careful when performing maintenance. ■ Do not loosen the bolts while the Arm #2 is not tilted. It may cause the belt come off and the Arm #2 falls down, and it is extremely hazardous. Be sure to do the Removal steps 1 and 2 before removing the motor.

1. Turn ON the Controller power.
2. Release the Joint #2 brake. Tilt the Arm #2 and push it against the Arm #1.

   The Arm #2 falls by its weight when the Joint #2 motor unit is removed. Therefore, release the brake and tilt the Arm #2 in advance.
   Put a cloth between the Arm #1 and Arm #2 so that the arms do not touch each other.

EPSON RC+

Command:

```
>brake off, 2
```

CAUTION	■ There is a possibility of hands and fingers being caught and/or damage or malfunction to the Manipulator. Be very careful when moving the Manipulator.

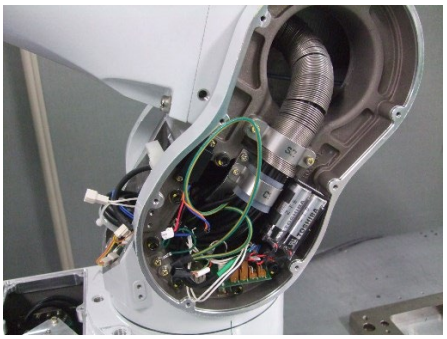
3. Turn OFF the Controller power.
4. Remove the Arm #1 center cover and the Arm #1 side cover.

   For details, refer to *C12 Maintenance: 3. Covers*.

5. Disconnect the following connectors of the motor.

   Connector:　X121, X021, BT2, BR021

   (Hold the clip to remove.)

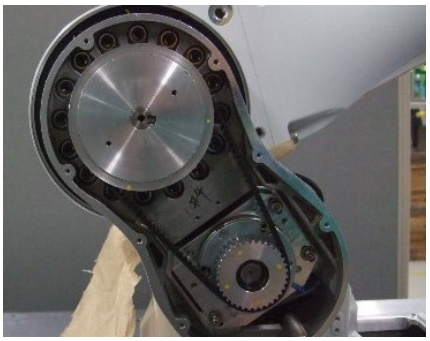


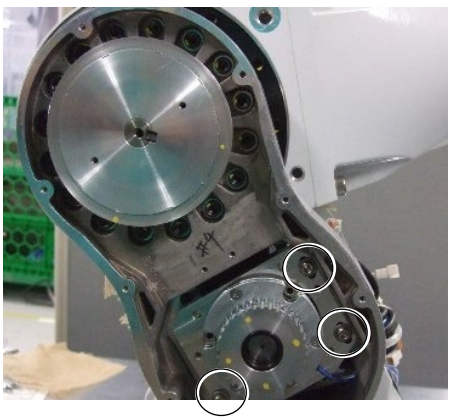
6. Remove the brake power supply.

   Cross recessed head screws with captive washer: 2-M3×6

7. Loosen the bolts securing the Joint #2 motor unit and remove the belt.

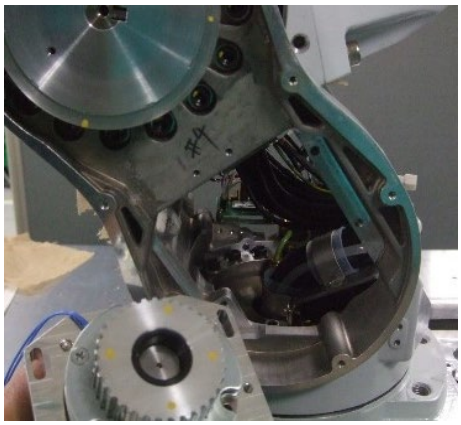
   Hexagon socket head cap bolts: 3-M5×25
   (with a plain washer)





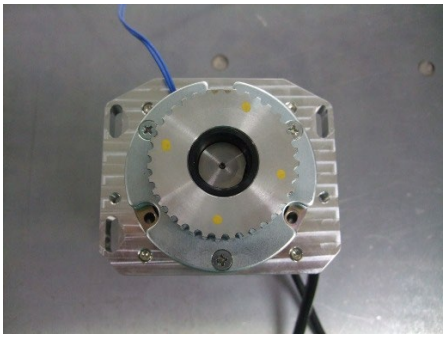
WARNING	■ Loosening the bolts while the Arm #2 is not bent may cause the belt come off and the Arm #2 falls down, and it is extremely hazardous.　Be sure to do the Removal steps 1 and 2 before loosening the bolts.

8. Remove the Joint #2 motor unit.



9. Remove the Joint #2 pulley 1 and the drive boss from the motor shaft of the Joint #2 motor unit.
   Remove two screws at the flat (D-cut) part of the motor shaft when viewing from above. (A in the figure)

   Pulley and the motor shaft (A)
   Hexagon socket set screws: 2-M5×12

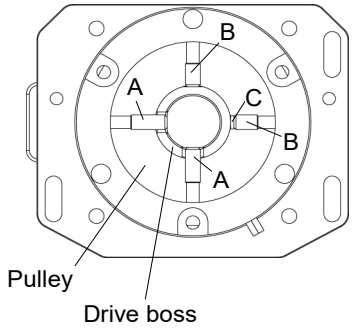


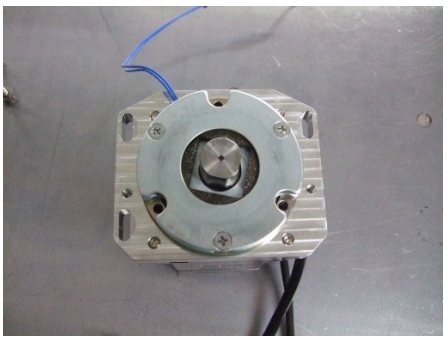
NOTE Do not remove the pulley and drive boss screws (B in the figure). There is a brass bushing on one of the set screws. If you removed the screws (B), be careful not to lose the brass bushing.

   A: Pulley and motor shaft screws
      (D-cut part of the motor shaft × 2)

   B: Pulley and drive boss screws
      Do not remove these screws.

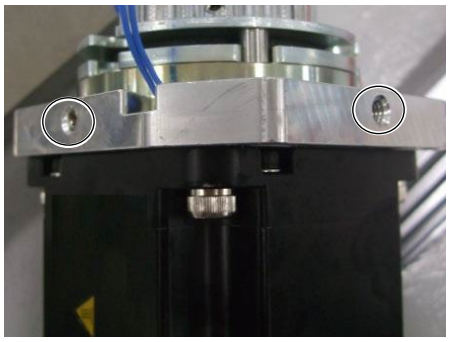
   C: Bushing





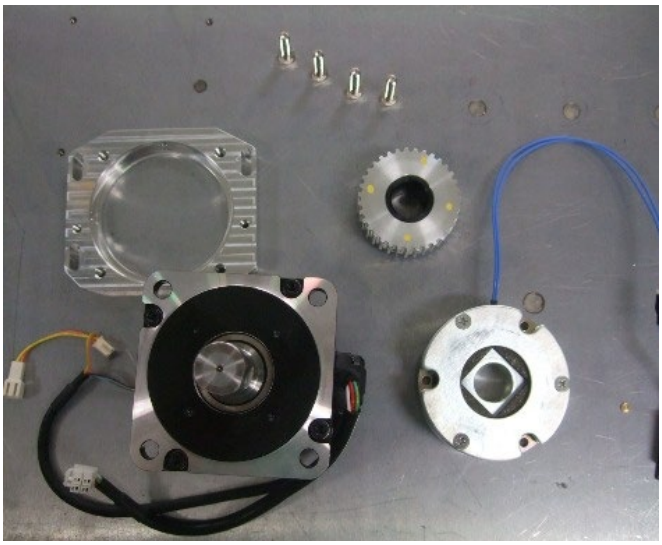
10. Remove the Joint #2 electromagnetic brake.

    Hexagon socket set screws: 2-M6×6 (with a brass bushing)



11. Remove the motor plate from the Joint #2 motor.

    Hexagon socket head cap bolts: 4-M6×20



Installation: Joint #2 Motor

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

1. Install the motor plate to the Joint #2 motor.

   Hexagon socket head cap bolts: 4-M6×20

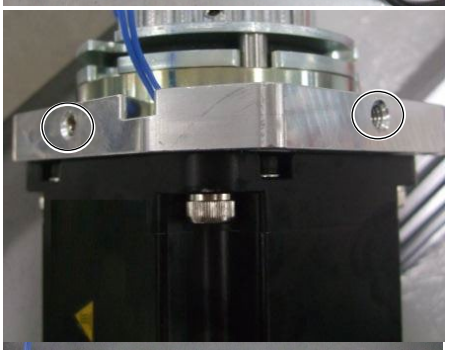
   Tightening torque: 13.0 ± 0.6 N·m

NOTE Be careful of the assembly direction of the motor plate. (See the photo.)

2. Mount the Joint #2 electromagnetic brake to the Joint #2 motor unit.

   Hexagon socket set screws: 2-M6×6 (with a brass bushing)

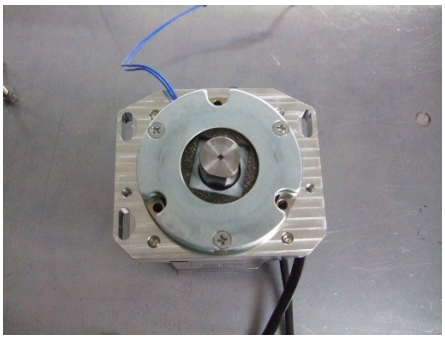
   Tightening torque: 6.0 ± 0.4 N·m



   Be careful of the assembly direction of the Joint #2 electromagnetic brake. (See the photo.)

   Fix the set screws while pressing the electromagnetic brake to the motor plate.
   The brass bushing is not necessary for the screw for the flat surface (D-cut). Set the bushing to the other screw and then fix the screw.

NOTE If the screw positions are incorrect or the bushing is not set, it may cause damage on the side of the brake and may result in the part being unable to be removed.



3. Mount the drive boss and the pulley 1 to the Joint #2 motor unit.

Insert the pulley 1 so that the set screw is aligned to the flat surface of the motor shaft.

Fix the pulley 1 and the motor shaft.
Leave 0.5 mm between the pulley 1 and the electromagnetic brake.
The countersunk screw of the electromagnetic brake is projecting.　Using the feeler gauge (0.5 mm), leave a space for the projection.

NOTE If there is no space for the projection, the parts may chafe while the motor is driving and it may result in breakage.

Hexagon socket set screws: 2-M5×12

Tightening torque: 3.9 ± 0.2 N·m

If the drive boss and the pulley 1 are removed:
Align the end faces of the drive boss and the pulley 1, and then fix them.

Hexagon socket set screws: 2-M5×8 (with a brass bushing)

Tightening torque: 3.9 ± 0.2 N·m

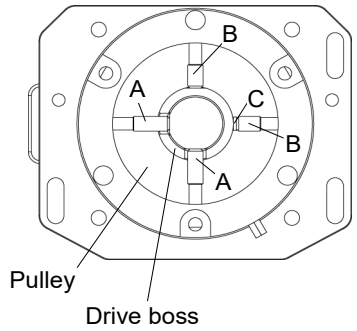
NOTE If the screw positions are incorrect or the bushing is not set, it may cause damage on the side of the part and may result in the part being unable to be removed.

Set the set screws to the positions indicated in the right figure.

A: Pulley and motor shaft screws
(D-cut part of the motor shaft × 2)

B: Pulley and drive boss screws
Do not remove these screws.

C: Bushing



4. Put the Joint #2 motor unit in the Arm #1.

5. Set the timing belt around the pulley 1 and the pulley 2 and fix it temporarily.
Check that the teeth of the timing belt engage with these of the pulley.
As a rough guide of temporary fixing, check that the motor unit can be moved by hand, and it does not tilt when being pulled.　If the belt is too loose or too tight, it will not have proper tension.

Hexagon socket set screws: 3-M5×25 (with a plain washer)

6. Apply tension to the Joint #2 timing belt and fix Joint #2 motor unit.

Joint #2 timing belt tension: 58 to 95 N

Belt tension meter setting values

Weight: 4.0 g/mm width × m span, Width: 14 mm,
Span: 146 mm

Hexagon socket set screws: 3-M5×25 (with a plain washer)

Tightening torque: 8.0 ± 0.4 N·m

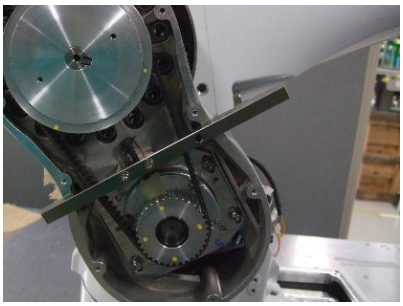
NOTE Regarding belt tension:

- Jumping (position gap) may occur if the value is below the lower limit.
- Vibration (abnormal noise) or reduction in life of the parts may occur if the value exceeds the upper limit.
- When you replace with a new belt, belt extends and the belt tension may decrease in the initial stage. Make sure to operate the robot two to three days and check the belt tension again.

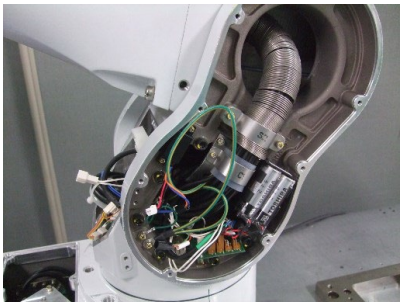
When using the belt tension tensile jig (maintenance part):

Fix the belt tension tensile jig (for J1, J2, and J3) with the screws (2-M4×35) and push the rubber against the pulley.

Tension is applied by pushing the set screw (M6×25) with the rubber.



7. Install the brake power supply.



Cross recessed head screws with captive washer: 2-M3×6

Tightening torque: 0.45 ± 0.1 N·m

8. Connect the following connectors.

Connectors: X121, X021, BT2, BR021

9. Mount the Arm #1 cover and the Arm #1 side cover.
   For details, refer to *C12 Maintenance: 3. Covers*.

10. Perform calibration.
    For details, refer to *C12 Maintenance: 16. Calibration*.

6.2 Joint #2- Replacing the Reduction Gear Unit

	Name		Qty.	Note
Maintenance Parts	Reduction gear unit (Joint #2)		1	1674606
	O-ring (Joint #2)	Arm #1	1	1670635
		Arm #2	1	1656140
	Belt tensile jig*		1	1674582
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts For M5 hexagon socket set screws
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolts
		width across flats: 5 mm	1	For M6 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Belt tension meter (0.5 mm)		2	For adjusting the pulley position
	Belt tension meter		1	Refer: Unitta U-505
	Cloth (cushioning)		1	For pressing arms

* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

When removing the Joint #2 timing belt, tilt the Arm #2 and press it against the Arm #1.
Reference: *C12 Maintenance: 6.1 Joint #2 - Replacing the Motor,* Removal step (2)

When pressing the arm, put a piece of cloth or a similar material between the arms to avoid contacting each other. This protects the arm surfaces from scratching and paint peeling off.

Removal: Joint #2 Reduction gear unit

1. Remove the Joint #2 timing belt.

   For details, refer to *C12 Maintenance 6.3 Joint #2 - Replacing the Timing Belt*, Removal steps (1) to (3).

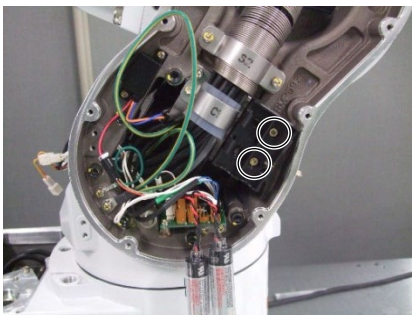
2. Remove the following parts.

   Battery
   Battery board
   Battery connector

   For details, refer to *C12 Maintenance 11.2 Replacing the Battery Board*, Removal steps (3) to (6).

3. Remove the battery box.

   Countersunk screws: 2-M3×8



4. Arm #1 side arm fixing bolts.

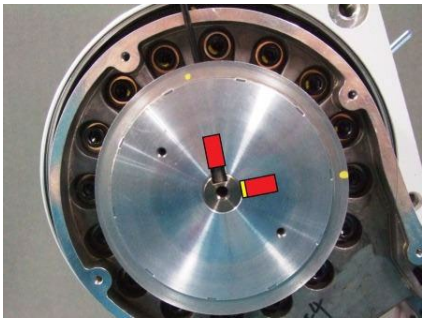
   Hexagon socket head cap bolts: 8-M6×25 (with a plain washer)

5. Remove the Joint #2 pulley 2 from the Joint #2 shaft.

   Hexagon socket set screws: 2-M5×10

   There is a brass bushing on one of the set screws.
   Be careful not to lose it.

   Remove the key from the shaft. The key will be used again.
   Be careful not to lose it.



6. Pull out the grease tube on the Arm #1 side from the fitting.

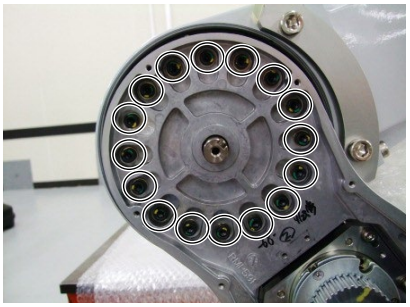
   The grease tube connects between the base and the Arm #1.

7. Remove the Arm #2.

   Hexagon socket head cap bolts (with a plain washer):
   16-M6×35

   Remove a wave washer on the Arm #1 side.
   The wave washer will be used again. Be careful not to lose it.

   Wipe grease on the part while removing it.



CAUTION	■ By removing the bolts, the Arm #1, #2, #3, #4, #5, and #6(end effector) can be separated. There is a possibility of hands and fingers being caught and/or damage or malfunction to the Manipulator. Be very careful when removing the arm. Have at least two workers so that one can support the Manipulator while the other worker is removing the bolts. ■ The Arms are connected by the internal cables. When replacing the parts, place the removed arm while not applying load on the cables. It may result in cable disconnection.

8. Remove the wave generator from the reduction gear unit.

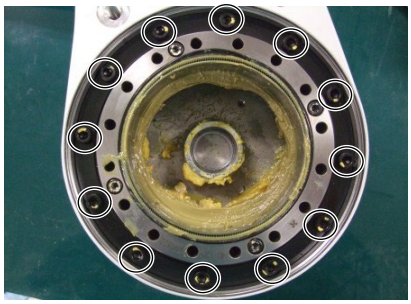
   If the wave generator unit does not come off easily, set the pulley 2 as shown in the photo to the shaft and pull out the parts.

   Wipe grease on the part while removing it.

9. Remove the reduction gear unit from the Arm #2.

   Hexagon socket head cap bolts (with plain washer):
   12-M6×45

   Wipe grease on the part while removing it.



10. Remove the O-ring from the groove on the Arm #2.

    Wipe grease on the part while removing it.

Installation: Joint #2 Reduction gear unit

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

1. Apply a thin coat of grease (SK-1A) to the O-ring.
   Fit the O-ring to the groove on the Arm #2.

   Do not allow the O-ring to come out of the groove.

   If the O-ring is swollen, damaged, or deteriorated, replace it with a new one.

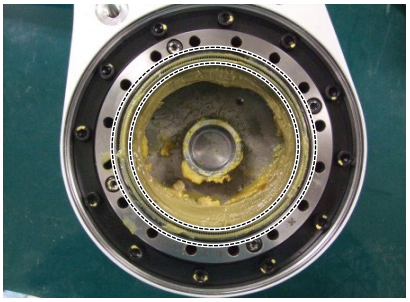
2. Install the reduction gear unit to the Arm #2.

   Hexagon socket head cap bolts: 12-M6×45
   Tightening torque: 18.0 ± 0.9 N·m

   Installation face of the Arm #2 reduction gear unit has clearance holes.
   Install the reduction gear unit to match the screws and the clearance holes.

3. Grease the inner side of the flexspline.

   Grease: SK-1A
   Grease amount: 102g



4. Insert the wave generator to the reduction gear unit and fix it.

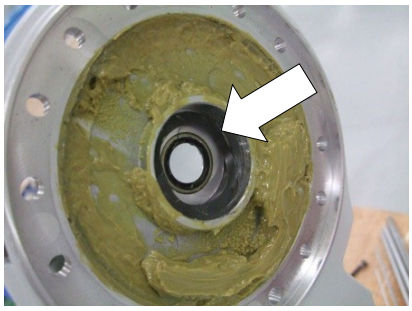
5. Apply a thin coat of grease (SK-1A) to the O-ring.
Fit the O-ring to the groove on the reduction gear unit.

Do not allow the O-ring to come out of the groove.

If the O-ring is swollen, damaged, or deteriorated, replace it with a new one.

6. Temporarily fix the Arm #1 side arm to the Arm #1.
At this time, set the wave washer to the Arm #1.

Hexagon socket head cap bolts: 8-M6×2 5(with a plain washer)

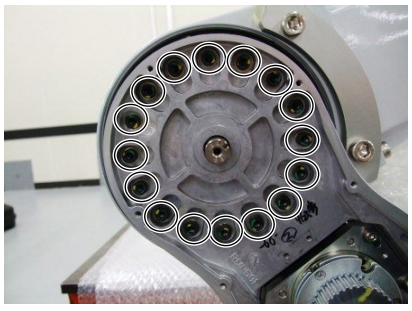


CAUTION	■ There is a possibility of hands and fingers being caught and/or damage or malfunction to the Manipulator. Be very careful when installing the arm. Have at least two workers so that one can support the Manipulator while the other worker is removing the bolts.

7. Fix the Arm #2.

Hexagon socket head cap bolts: 16-M6×35 (with a plain washer)
Tightening torque: 18.0 ± 0.9 N·m

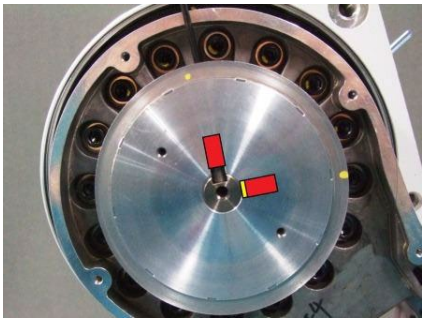
After fixing the Arm, check that there is no backlash or misalignment on the reduction gear unit by moving the Arm by hand.



8. After fixing the Arm #2, fix the Arm #1 side arm.

Hexagon socket head cap bolts: 8-M6×25 (with a plain washer)
Tightening torque: 18.0 ± 0.9 N·m

9. Install the Joint #2 pulley 2 to the Joint #2 shaft.



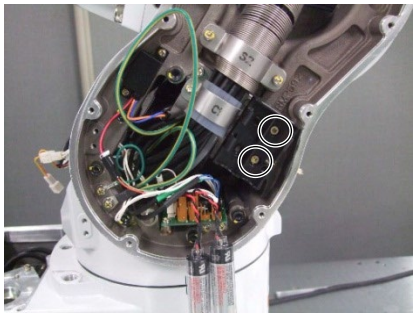
Hexagon socket head cap bolts: 2-M5×10
(with a brass washer)

Tightening torque: 3.9 ± 0.2 N·m

Set the key to the shaft and insert the pulley 2 while aligning to the key groove. The brass bushing is not necessary for the screw for the flat surface. Set the bushing to the other screw and then fix the screw.

NOTE ☞ If the screw positions are incorrect or the bushing is not set, it may cause damage on the side of the brake and may result in the part being unable to be removed.

10. Install the battery box.



Countersunk screws: 2-M3×8
Tightening torque: 0.45 ± 0.1 N·m

11. Install the following parts.
Battery
Battery board
Battery connector

For details, refer to *C12 Maintenance 11.2 Replacing the Battery Board*, Installation steps (2) to (5).

12. Install the Joint #2 timing belt.

For details, refer to *C12 Maintenance 6.3 Joint #2 – Replacing the Timing Belt*, Installation steps (1) to (2).

6.3 Joint #2 - Replacing the Timing Belt

	Name	Qty.	Note
Maintenance Parts	Timing belt (Joint #2) 540 mm	1	1655927
	Belt tensile jig *	1	1674582
Tools	Hexagonal wrench (width across flats: 4 mm)	1	For M5 hexagon socket head cap bolt
	Cross-point screwdriver	1	For cross recessed head screws
	Torque wrench	1	For tightening torque control
	Cloth (cushioning)	1	For pressing arms
	Belt tension meter	1	Refer: Unitta U-505

* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

When removing the Joint #2 motor, tilt the Arm #2 and press it against the Arm #1.
Reference: *C12 Maintenance: 6.1 Joint #2 - Replacing the Motor,* Removal step (2)

When pressing the arm, put a piece of cloth or a similar material between the arms to avoid contacting each other. This protects the arm surfaces from scratching and paint peeling off.

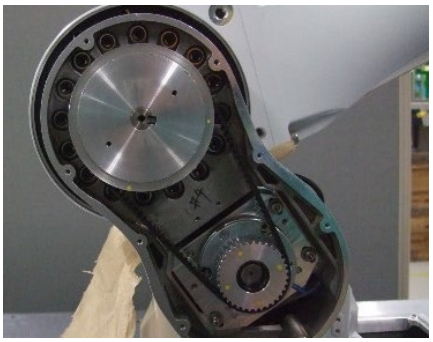
Removal: Joint #2 Timing belt

1. Follow Removal steps (1) through (4) of *C12 Maintenance: 6.1 Joint #2 – Replacing the Motor.*

2. Loosen the Joint #2 motor unit set screws.

   Hexagon socket head cap bolts: 3-M5×25
   (with a plain washer)

3. Remove the Joint #2 timing belt.



Installation: Joint #2 Timing belt

1. Pass the Joint #2 timing belt around the pulley 1 and the pulley 2 of the Joint #2.
   Pass the timing belt to the pulley 2 first, then, place it to the pulley 1.

2. Secure the Joint #2 motor unit.
   For details, refer to *C12 Maintenance: 6.1 Joint #2 – Replacing the Motor*,
   Installation steps (5) to (6) and (10) to (11).

6.4 Joint #2 - Replacing the Electromagnetic Brake

	Name		Qty.	Note
Maintenance Parts	Electromagnetic brake (Joints #1, #2)		1	2172926
	Belt tensile jig*		1	1674582
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M5 hexagon socket set screw
		width across flats: 3 mm	1	For M6 hexagon socket set screw
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolt
		width across flats: 5 mm	1	For M6 hexagon socket head cap bolt
	Cross-point screwdriver		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Feeler gauge (0.5 mm)		2	For adjusting the pulley position
	Belt tension meter		1	Refer: Unitta U-505
	Cloth (cushioning)		1	For pressing arms

* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

When removing the Joint #2 motor, tilt the Arm #2 and press it against the Arm #1.

Reference: *C12 Maintenance: 6.1 Joint #2 - Replacing the Motor,* Removal step (2)

When pressing the arm, put a piece of cloth or a similar material between the arms to avoid contacting each other. This protects the arm surfaces from scratching and paint peeling off.

Removal: Joint #2 Electromagnetic brake

1. Remove the Joint #2 electromagnetic brake.
   For details, refer to *C12 Maintenance: 6.1 Joint #2 – Replacing the Motor*, Removal steps (1) through (11).

Installation: Joint #2 Electromagnetic brake

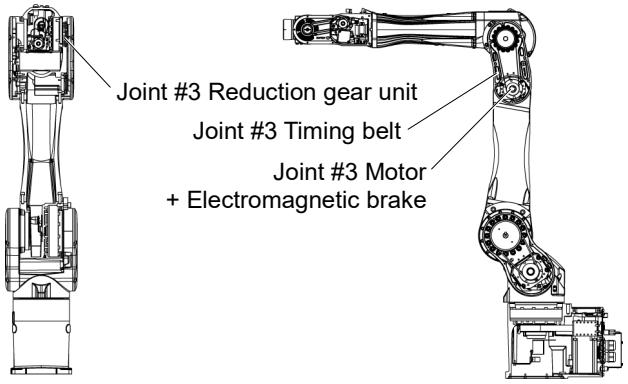
1. Mount the Joint #2 electromagnetic brake to the Joint #2 motor unit.
   For details, refer to *C12 Maintenance: 6.1 Joint #2 – Replacing the Motor*, Installation steps (2) through (11).

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 during replacement. The shock may shorten the life of the motors and encoder and/or damage them. ■ Never disassemble the motor and the encoder. Disassembled motor and encoder will cause a positional gap and cannot be used again.

After parts have been replaced (motors, reduction gear units, electromagnetic brakes, timing belts, etc.), the Manipulator cannot perform positioning properly because a gap exists between the origin stored in each motor encoder and its corresponding origin stored in the Controller.
Therefore, it is necessary to match these origins after replacing the parts.
The process of aligning the two origins is called “Calibration”.
Refer to *C12 Maintenance 16. Calibration* and perform the calibration after the parts replacement.



7.1 Joint #3 - Replacing the Motor

	Name		Qty.	Note
Maintenance Parts	AC servo motor 400 W		1	2168684
	Belt tensile jig*		1	1674582
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M5 hexagon socket set screws
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Feeler gauge (0.5 mm)		2	For pulley position adjustment
	Belt tension meter		1	Refer: Unitta U-505
	Cloth (cushioning)		1	For pressing arms

* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

When removing the Joint #3 motor, tilt the Arm #2 and press it against the Arm #2.
Reference: *C12 Maintenance: 7.1 Joint #3 - Replacing the Motor,* Removal step (2)

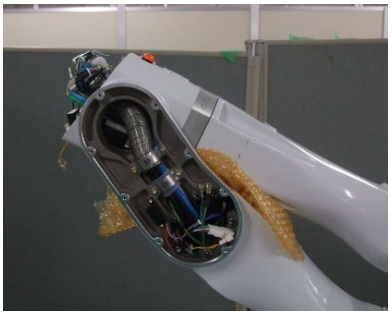
When pressing the arm, put a piece of cloth or a similar material between the arms to avoid contacting each other. This protects the arm surfaces from scratching and paint peeling off.

Removal: Joint #3 Motor

CAUTION	■ This procedure has possibility of hands and fingers being caught and/or damage or malfunction to the Manipulator. Be very careful when conducting maintenance. ■ Do not loosen the bolts while the Arm #3 is not tilted. It may cause the belt come off and the Arm #3 falls down, and it is extremely hazardous. Be sure to do the Removal steps 1 and 2 before removing the motor.

1. Turn ON the Controller power.
2. Release the Joint #3 brake. Tilt the Arm #3 and push it against the Arm #2.

   The Arm #3 falls by its weight when the Joint #3 motor unit is removed. Therefore, release the brake and tilt the Arm #3 in advance.



EPSON RC+

Command:

```
>brake off, 3
```

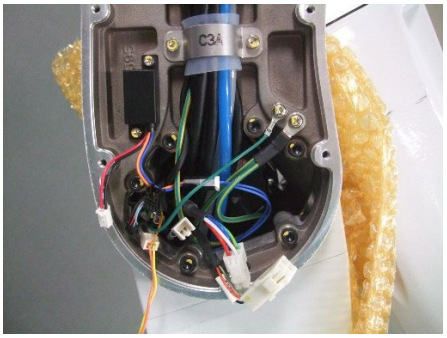
CAUTION	■ There is a possibility of hands and fingers being caught and/or damage or malfunction to the Manipulator. Be very careful when moving the Manipulator. Put a cloth between the Arm #2 and Arm #3 so that the arms do not touch each other.

3. Turn OFF the Controller power.
4. Remove the Arm #2 side cover.
   For details, refer to *C12 Maintenance: 3. Covers*.
5. Disconnect the following connectors.

   Connector: X131, X031, BT3, BR031

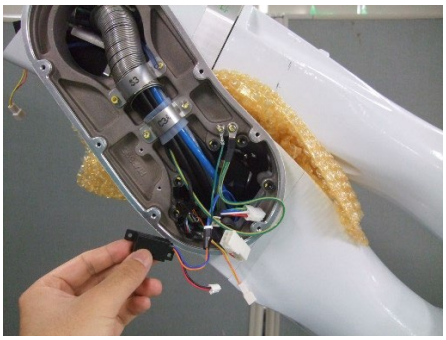
   (Hold the clip to remove.)

NOTE Be careful not to drop the removed connectors inside the Arm.



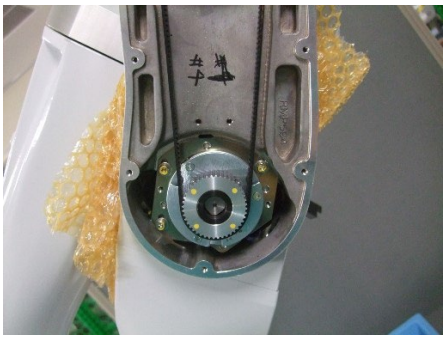
6. Remove the brake power supply.

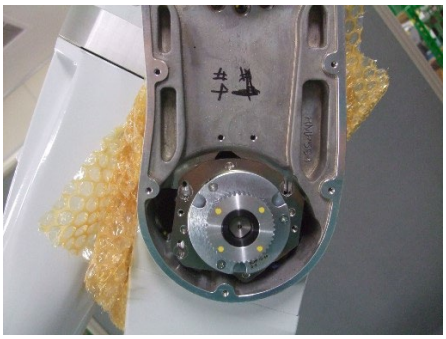
   Cross recessed head screws with captive washer: 2-M3×6



7. Loosen the bolts securing the Joint #3 motor unit and remove the belt.

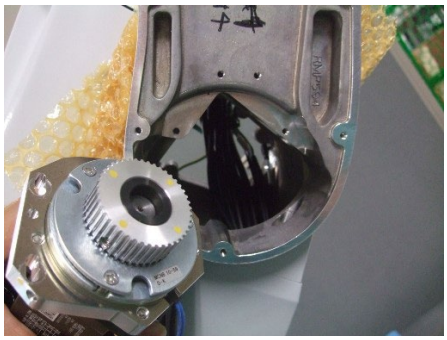
   Hexagon socket head cap bolts: 3-M4×20
   (with a plain washer)



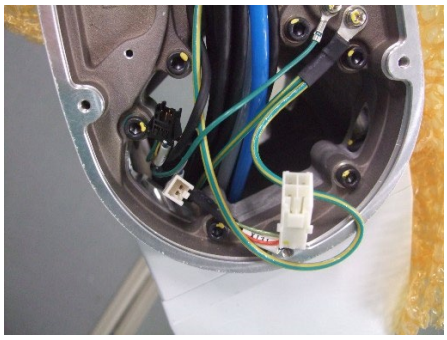


WARNING	■ Loosening the bolts while the Arm #3 is not bent may cause the belt come off and the Arm #3 falls down, and it is extremely hazardous. Be sure to do the Removal steps 1 and 2 before loosening the bolts.

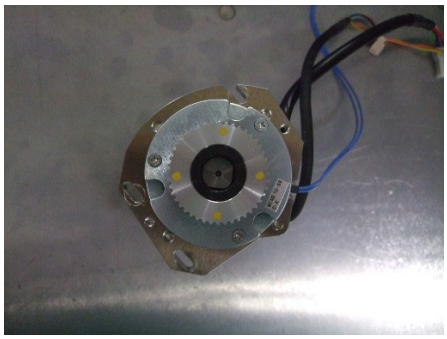
8. Remove the Joint #3 motor unit.



NOTE Be careful not to drop the removed connectors inside the Arm.



9. Remove the Joint #3 pulley 1 and the drive boss from the motor shaft of the Joint #3 motor unit.
Remove two screws at the flat (D-cut) part of the motor shaft when viewing from above. (A in the figure)



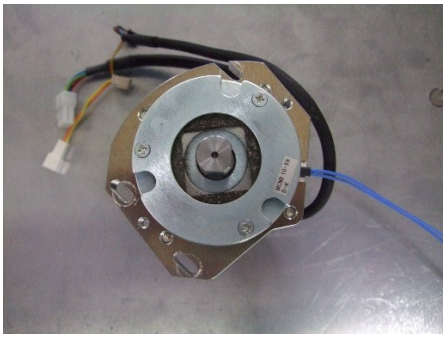
Pulley and motor shaft screws (A)
Hexagon socket set screws: 2-M5×12

NOTE Do not remove the pulley and drive boss screws (B in the figure.
There is a brass bushing on one of the set screws.
If you removed the screws (B), be careful not to lose the brass bushing.

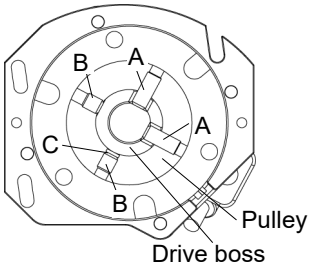
Pulley and drive boss screws (B)
Hexagon socket set screws: 2-M5×6
(with a brass bushing)

A: Pulley and motor shaft screws
(D-cut part of the motor shaft × 2)

B: Pulley and drive boss screws
Do not remove these screws.



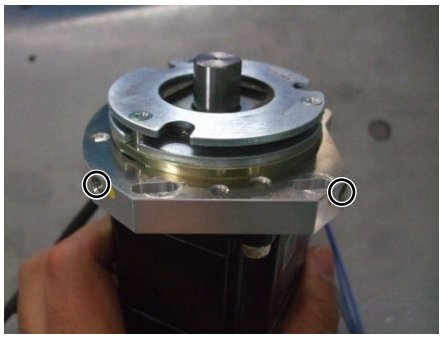
C: Bushing



10. Remove the Joint #3 electromagnetic brake.

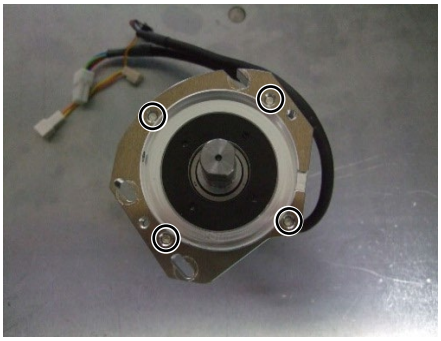
    Hexagon socket set screws: 2-M5×10 (with a brass bushing)

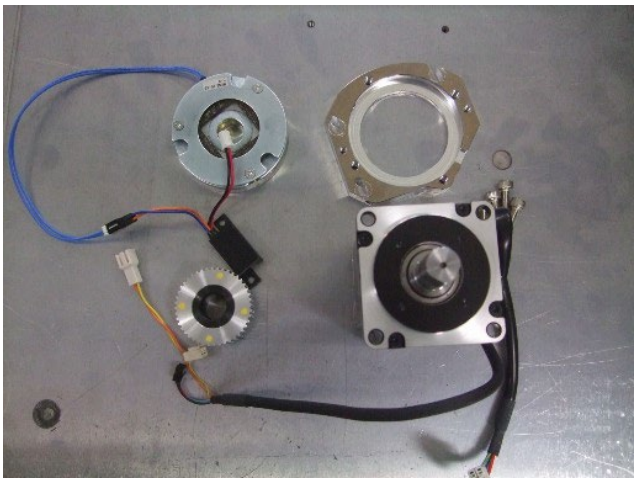
    The screws have a brass bushing.
    Be careful not to lose them.



11. Remove the motor plate from the Joint #3 motor.

    Hexagon socket head cap bolts: 4-M5×15





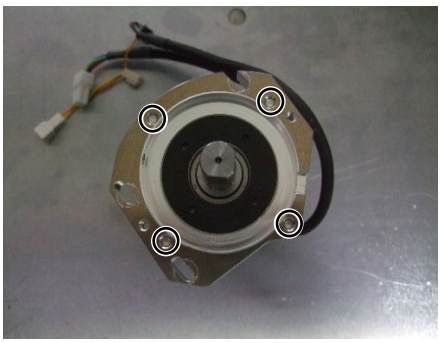
Installation: Joint #3 Motor

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

1. Install the motor plate to the Joint #3 motor.

   Hexagon socket head cap bolts: 4-M5×15

   Tightening torque: 8.0 ± 0.4 N·m

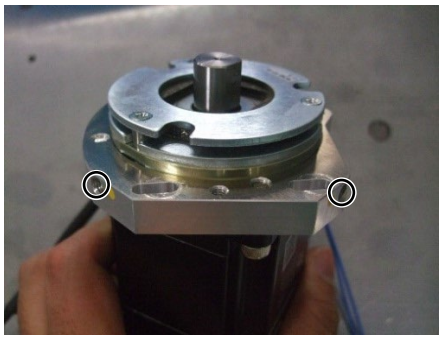


NOTE Be careful of the assembly direction of the motor plate. (See the figure.)

2. Mount the Joint #3 electromagnetic brake to the Joint #3 motor unit.

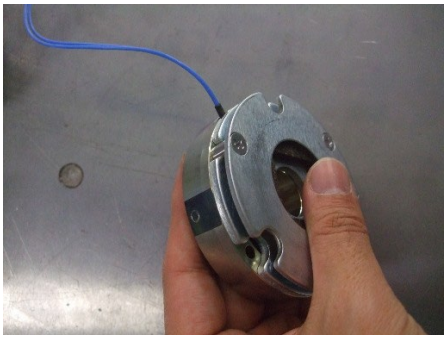
   Hexagon socket set screws: 2-M5×10 (with a brass bushing)

   Tightening torque: 3.9 ± 0.2 N·m

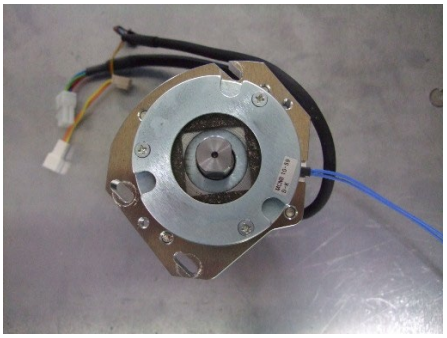


NOTE Be careful of the assembly direction of the Joint #3 electromagnetic brake. (See the photo.)

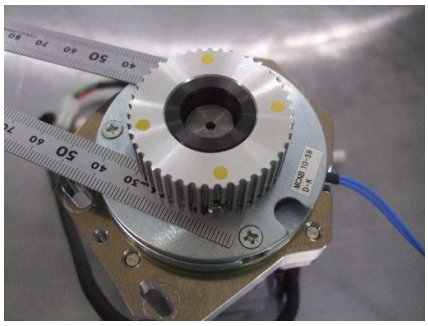
Fix the set screws while pressing the electromagnetic brake to the motor plate.
The brass bushing is not necessary for the screw for the flat surface (D-cut). Set the bushing to the other screw and then fix the screw.



NOTE If the screw positions are incorrect or the bushing is not set, it may cause damage on the side of the brake and may result in the part being unable to be removed.



3. Mount the drive boss and the pulley 1 to the Joint #3 motor unit.



Insert the pulley 1 so that the set screw is aligned to the flat surface of the motor shaft.

Fix the pulley 1 and the motor shaft.
Leave 0.5 mm between the pulley 1 and the electromagnetic brake.
The countersunk screw of the electromagnetic brake is projecting. Using the feeler gauge (0.5 mm), leave a space for the projection.

NOTE ☞ If there is no space for the projection, the parts may chafe while the motor is driving and it may result in breakage.

Hexagon socket set screws: 2-M5×12

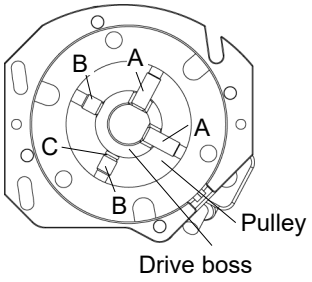
Tightening torque: 3.9 ± 0.2 N·m

If the drive boss and the pulley 1 are removed:
Align the end faces of the drive boss and the pulley 1, and then fix them.

Hexagon socket set screw: 2-M5×6 (with a brass bushing)

Tightening torque: 3.9 ± 0.2 N·m

Set the set screws to the positions indicated in the right figure.



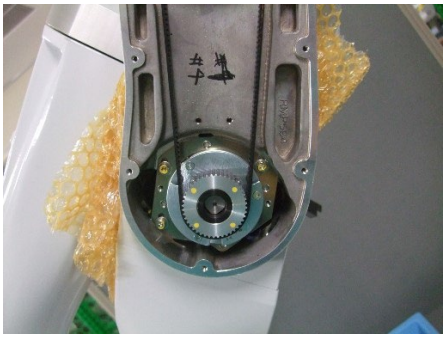
A: Pulley and motor shaft screws
(D-cut part of the motor shaft × 2)

B: Pulley and drive boss screws
Do not remove these screws.

C: Bushing

NOTE ☞ If the screw positions are incorrect or the bushing is not set, it may cause damage on the side of the part and may result in the part being unable to be removed.

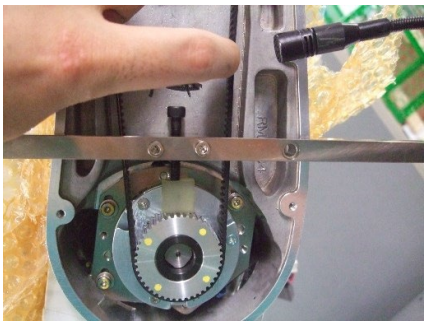
4. Put the Joint #3 motor unit in the Arm #2.



5. Set the timing belt around the pulley 1 and the pulley 2 and fix it temporarily.
Check that the teeth of the timing belt engage with these of the pulley.
As a rough guide of temporary fixing, check that the motor unit can be moved by hand, and it does not tilt when being pulled. If the belt is too loose or too tight, it will not have proper tension.

Hexagon socket set screws: 3-M4×20 (with a plain washer)

6. Apply tension to the Joint #3 timing belt and fix the Joint #3 motor unit.



Joint #3 timing belt tension: 25 to 85 N

Belt tension meter setting value

Weight: 2.5 g/mm width × m span, Width: 10 mm,
Span: 168 mm

Hexagon socket set screw: 3-M4×20 (with a plain washer)

Tightening torque: 4.0 ± 0.2 N·m

NOTE

Regarding belt tension:

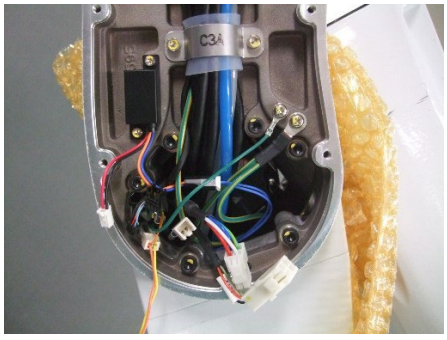
- Jumping (position gap) may occur if the value is below the lower limit
- Vibration (abnormal noise) or reduction of life of the parts may occur if the value exceeds the upper limit.
- When you replace with a new belt, belt may stretch and the belt tension will decrease in the initial stage of operation. Make sure to operate the robot two to three days and check the belt tension again.

When using the belt tension tensile jig (maintenance part):

Fix the belt tension tensile jig (for J1, J2, J3) with the screws (2-M4×35) and push the rubber against the pulley.

Tension is applied by pushing the set screw (M6×25) with the rubber.

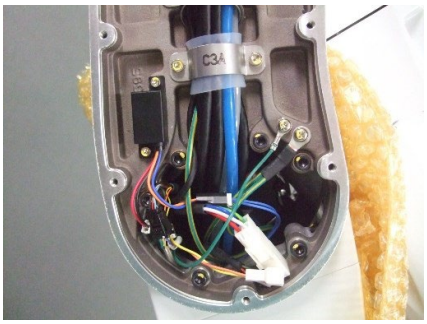
7. Install the brake power supply.



Cross recessed head screw with captive washer: 2-M3×6

Tightening torque: 0.45 ± 0.1 N·m

8. Connect the following connectors.



Connector: X131, X031, BT3, BR031

9. Install the Arm #2 side cover.
For details, refer to *C12 Maintenance: 3. Covers.*

10. Perform the calibration.
For details, refer to *C12 Maintenance: 16. Calibration.*

7.2 Joint #3 - Replacing the Reduction Gear Unit

	Name		Qty.	Note
Maintenance Parts	Reduction gear unit (Joint #3)		1	1674608
	O-ring (Joint #3)	Arm #2 side	1	1263977
		Arm #3 side	1	1510528
	Belt tensile jig*		1	1674582
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts For M5 hexagon socket set screws
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolts
		width across flats: 5 mm	1	For M6 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Feeler gauge (0.5 mm)		2	For adjusting the pulley position
	Belt tension meter		1	Refer: Unitta U-505
	Cloth (cushioning)		1	For pressing arms

* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

When removing the Joint #3 timing belt, tilt the Arm #2 and press it against the Arm #2.
Reference: *C12 Maintenance: 7.1 Joint #3 - Replacing the Motor,* Removal step (2)

When pressing the arm, put a piece of cloth or a similar material between the arms to avoid contacting each other. This protects the arm surfaces from scratching and paint peeling off.

Removal: Joint #3 Reduction gear unit

1. Remove the Joint #3 timing belt.

   For details, refer to *C12 Maintenance 7.3 Joint #3 - Replacing the Timing Belt*, Removal steps (1) to (3).

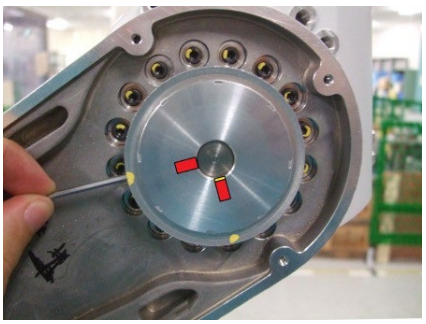
2. Remove the Arm #2 side arm fixing bolts.

   Hexagon socket head cap bolts: 6-M5×20 (with a plain washer)

3. Remove the Joint #3 pulley 2 from the Joint #3 shaft.

   Hexagon socket set screws: 2-M5×12

   There is a brass bushing on one of the set screws.
   Be careful not to lose it.



4. Remove the Arm #3.

   Hexagon socket head cap bolts: 16-M4×25 (with a plain washer)

   Remove a wave washer on the Arm #1 side.
   The wave washer will be used again. Be careful not to lose it.

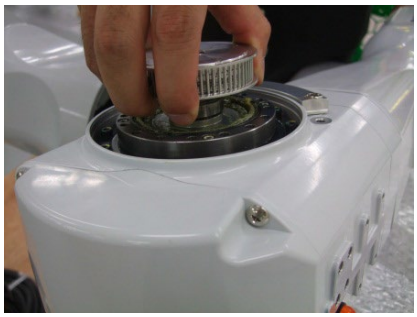
   Wipe grease on the parts while removing them.

⚠ CAUTION	■ By removing the bolts, the Arm #2 side arm, the Arm #3, #4, #5, and #6 (end effector) can be separated. There is a possibility of hands and fingers being caught and/or damage or malfunction to the Manipulator. Be very careful when removing the arm. Have at least two workers so that one can support the Manipulator while the other worker is removing the bolts. ■ The Arms are connected by the internal cables. When replacing the parts, place the removed arm while not applying load on the cables. It may result in cable disconnection.

5. Remove the wave generator from the reduction gear unit.

   If the wave generator unit does not come off easily, set the pulley 2 as shown in the photo to the shaft and pull out the parts.

   Wipe grease on the wave generator while removing it.



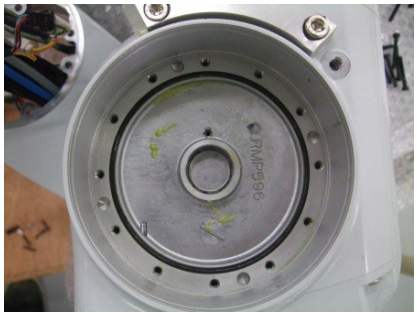
6. Remove the reduction gear unit from the Arm #3.

   Hexagon socket head cap bolts: 12-M4×30

   Wipe grease on the reduction gear unit while removing it.

7. Remove the O-ring from the groove on the Arm #3.

   Wipe grease on the O-ring while removing it.



Installation: Joint #3 Reduction gear unit

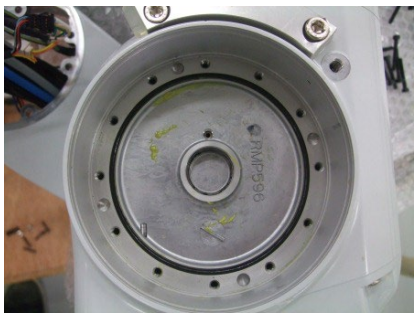
NOTE

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

1. Apply a thin coat of grease (SK-1A) to the O-ring.
   Fit the O-ring into the groove on the Arm #3.

   Do not allow the O-ring to come out of the groove.

   If the O-ring is swollen, damaged, or deteriorated, replace it with a new one.



2. Install the reduction gear unit to the Arm #3.

   Hexagon socket head cap bolts: 12-M4×30

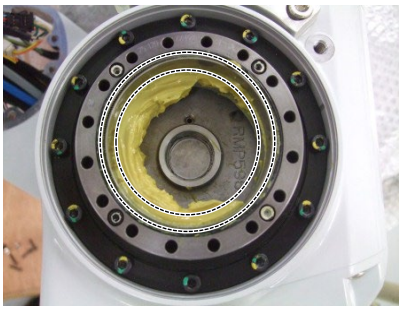
   Tightening torque: 5.5 ± 0.2 N·m

   Installation face of the Arm #3 reduction gear unit has clearance holes.
   Install the reduction gear unit to match the screws and the clearance holes.

3. Grease the inner side of the flexspline.

   Grease: SK-1A

   Grease amount: 26 g

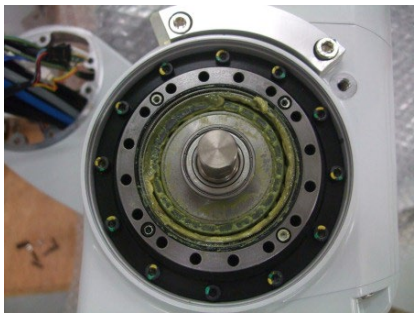


4. Insert the wave generator to the reduction gear unit and fix it.

5. Apply a thin coat of grease (SK-1A) to the O-ring.
   Fit the O-ring into the groove on the reduction gear unit.

   Do not allow the O-ring to come out of the groove.

   If the O-ring is swollen, damaged, or deteriorated, replace it with a new one.



6. Temporarily fix the Arm #1 side arm to the Arm #2.
   At this time, set the wave washer to the Arm #2.

   Hexagon socket head cap bolts: 6-M5×20 (with a plain washer)

CAUTION	■ There is a possibility of hands and fingers being caught and/or damage or malfunction to the Manipulator. Be very careful when installing the arm. Have at least two workers so that one can support the Manipulator while the other worker is removing the bolts.

7. Fix the Arm #3.

   Hexagon socket head cap bolts: 16-M4×25 (with a plain washer)

   Tightening torque: 5.5 ± 0.2 N·m

   After fixing the Arm, check that there is no backlash or misalignment on the reduction gear unit by moving the Arm by hand.

8. After fixing the Arm #3, fix the Arm #2 side arm.

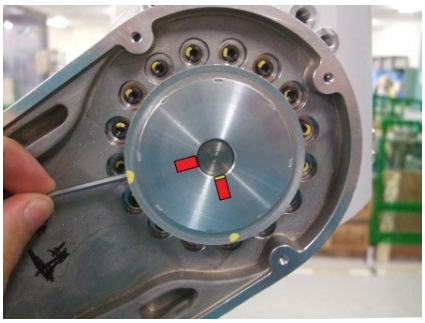
   Hexagon socket head cap bolts: 6-M5×20 (with a plain washer)

   Tightening torque: 10.0 ± 0.5 N·m

9. Install the Joint #3 pulley 2 to the Joint #3 shaft.

   Hexagon socket head cap bolts (with 1 brass bushing): 2-M5×12

   Tightening torque: 3.9 ± 0.2 N·m



NOTE ☞ Insert the pulley 2 so that one of the set screws is at the flat face of the shaft. The brass bushing is not necessary for the screw for the flat surface. Set the bushing to the other screw and then fix the screw.

If the screw positions are incorrect or the bushing is not set, it may cause damage on the side of the brake and may result in the part being unable to be removed.

10. Install the Joint #3 timing belt.

    For details, refer to *C12 Maintenance 7.3 Joint #2 – Replacing the Timing Belt*, Installation steps (1) to (2).

7.3 Joint #3 - Replacing the Timing Belt

	Name	Qty.	Note
Maintenance Parts	Timing belt (Joint #3) 501 mm	1	1655919
	Belt tensile jig*	1	1674582
Tools	Hexagonal wrench (width across flats: 3 mm)	1	For M4 hexagon socket head cap bolt
	Cross-point screwdriver (#2)	1	For cross recessed head screws
	Torque wrench	1	For tightening torque control
	Cloth (cushioning)	1	For pressing arms
	Belt tension meter	1	Refer: Unitta U-505

* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

When removing the Joint #3 motor, tilt the Arm #2 and press it against the Arm #2.
Reference: *C12 Maintenance: 7.1 Joint #3 - Replacing the Motor,* Removal step (2)

When pressing the arm, put a piece of cloth or a similar material between the arms to avoid contacting each other. This protects the arm surfaces from scratching and paint peeling off.

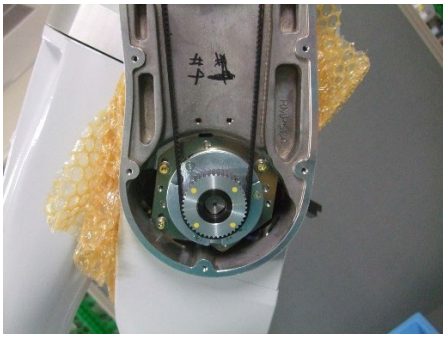
Removal: Joint #3 Timing belt

1. Follow Removal steps (1) through (4) of *C12 Maintenance: 7.1 Joint #3 – Replacing the Motor*.

2. Loosen the Joint #3 motor unit set screw.

   Hexagon socket head cap bolts: 3-M4×20
   (with a plain washer)

3. Remove the Joint #3 timing belt.



Installation: Joint #3 Timing belt

1. Pass the Joint #3 timing belt around the pulley 1 and the pulley 2 of the Joint #3.
   Pass the timing belt to the pulley 2 first, then, place the timing belt to the pulley 1.

2. Secure the Joint #2 motor unit.
   For details, refer to *C12 Maintenance: 7.1 Joint #3 – Replacing the Motor*, Installation steps (5) to (6) and (9) to (10).

7.4 Joint #3 - Replacing the Electromagnetic Brake

	Name		Qty.	Note
Maintenance Parts	Electromagnetic brake (Joint #3)		1	2172927
	Belt tensile jig*		1	1674582
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M5 hexagon socket set screw
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolt
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolt
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Feeler gauge (0.5 mm)		2	For adjusting the pulley position
	Belt tension meter		1	Refer: Unitta U-505
	Cloth (cushioning)		1	For pressing arms

* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

When removing the Joint #3 motor, tilt the Arm #2 and press it against the Arm #2.
Reference: *C12 Maintenance: 7.1 Joint #3 - Replacing the Motor,* Removal step (2)

When pressing the arm, put a piece of cloth or a similar material between the arms to avoid contacting each other. This protects the arm surfaces from scratching and paint peeling off.

Removal: Joint #3 Electromagnetic brake

1. Remove the Joint #3 electromagnetic brake.
   For details, refer to *C12 Maintenance: 7.1 Joint #3 – Replacing the Motor*, Removal steps (1) through (10).

Installation: Joint #3 Electromagnetic brake

1. Mount the Joint #3 electromagnetic brake to the Joint #3 motor unit.
   For details, refer to *C12 Maintenance: 7.1 Joint #3 – Replacing the Motor*, Installation steps (2) through (10).

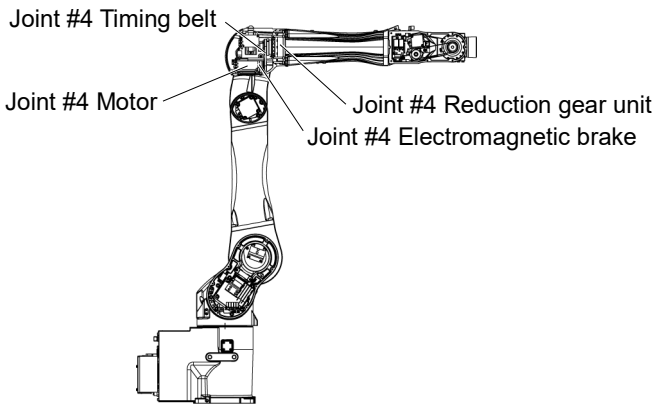
8. Joint #4

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 during replacement. The shock may shorten the life of the motors and encoder and/or damage them. ■ Never disassemble the motor and the encoder. Disassembled motor and encoder will cause a positional gap and cannot be used again.

After parts have been replaced (motors, reduction gear units, timing belts, etc.), the Manipulator cannot perform positioning properly because a gap exists between the origin stored in each motor encoder and its corresponding origin stored in the Controller.

Therefore, it is necessary to match these origins after replacing the parts.
The process of aligning the two origins is called “Calibration”.
Refer to *C12 Maintenance: 16. Calibration* and perform the calibration after the parts replacement.



8.1 Joint #4 - Replacing the Motor

	Name		Qty.	Note
Maintenance Parts	AC servo motor 150 W		1	2206705 (common to Joints #4, #5, #6)
	Belt tensile jig*		1	1674582
Tools	Hexagonal wrench	width across flats: 2 mm	1	For M4 hexagon socket set screws
		width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Feeler gauge (0.5 mm)		2	For pulley position adjustment
	Belt tension meter		1	Refer: Unitta U-505

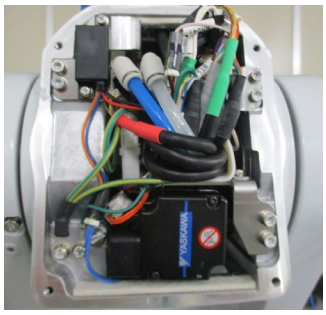
* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

NOTE ☞ The motors are common for Joints #4, #5, and #6.
The Joints #5 and #6 motors have an identification label for preventing misconnection of the connectors. The label is not necessary for the Joint #4 motor. (There is no connector identification label for the Joint #4.)

Removal: Joint #4 Motor

1. Turn OFF the Controller power.



2. Remove the following covers.
   Arm #3 cover
   Arm #3 maintenance cover
   Arm #2 side cover
   For details, refer to *C12 Maintenance: 3. Covers.*

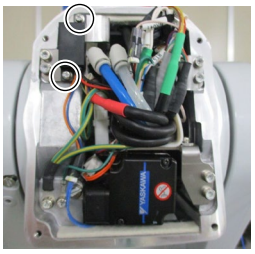
3. Pull out the cables from the Arm #3 and disconnect the following connectors.

   Connector: X141, X041, BT4, BR041

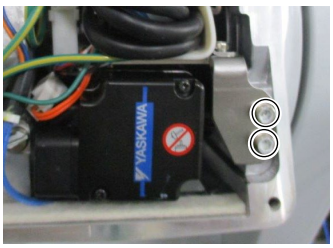
   (Hold the clip to remove.)

4. Remove the brake power supply.

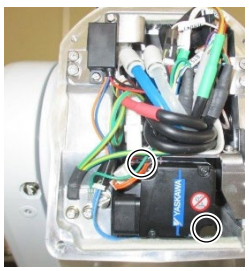
   Cross recessed head screws with captive washer: 2-M3×6



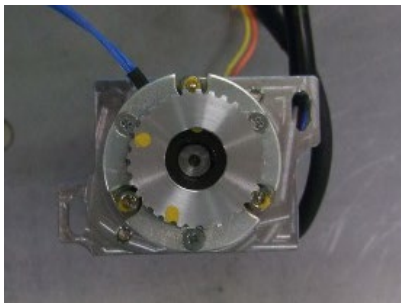
5. Remove the cable bracket.
   Hexagon socket head cap bolts: 2-M4×10



6. Remove the Joint #4 motor unit from the Arm #3.
   Hexagon socket head cap bolts: 2-M4×15
   (with a small plain washer)



7. Remove the Joint #4 pulley 1 and the drive boss from the motor shaft of the Joint #4 motor unit.



Pulley 1 and drive boss screws
Hexagon socket set screws: 2-M4×4 (with a brass bushing)

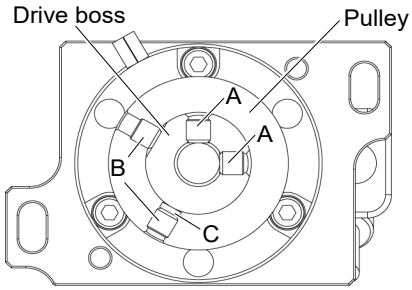
Drive boss and motor shaft screws
Hexagon socket set screws: 2-M4×4

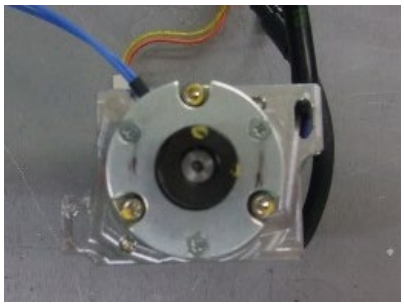
There is a brass bushing on one of the set screws fixing the drive boss and the pulley.　Be careful not to lose it.

A: Pulley and motor shaft screws

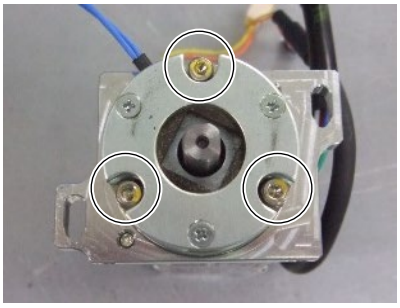
B: Pulley and drive boss screws

C: Bushing





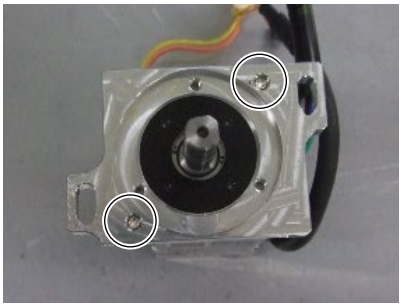
8. Remove the Joint #4 electromagnetic brake.

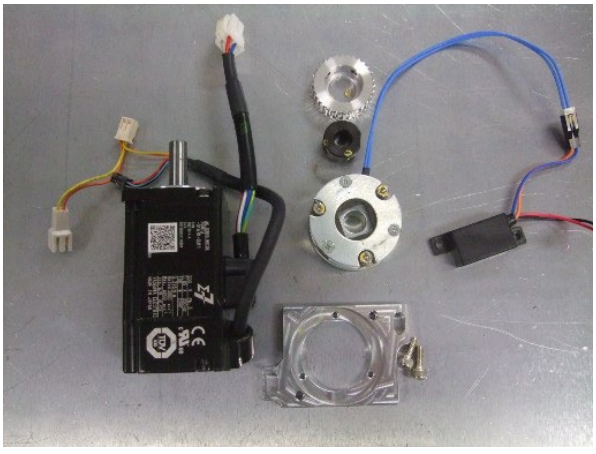


Hexagon socket set screws: 3-M3×15 (with a spacer)

Be careful not to lose the spacers.

9. Remove the motor plate from the Joint #4 motor.
Hexagon socket head cap bolts: 2-M4×10





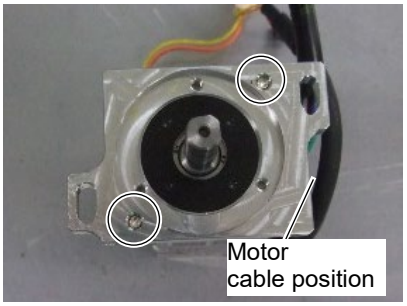
Installation: Joint #4 Motor

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

1. Install the motor plate to the Joint #4 motor.

   Hexagon socket head cap bolts: 2-M4×10

   Tightening torque: 4.0 ± 0.2 N·m

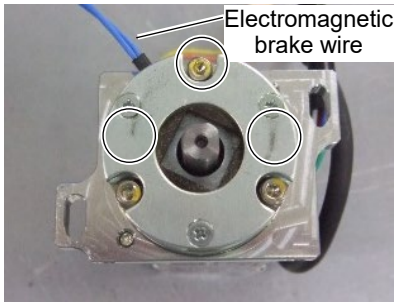


NOTE Be careful of the assembly direction of the motor plate. (See the photo.)

2. Mount the Joint #4 electromagnetic brake to the Joint #4 motor unit. Set the spacers between the hexagon socket set screws and the Joint #4 electromagnetic brake.

   Hexagon socket set screws: 3-M3×15 (with a spacer)

   Tightening torque: 2.0 ± 0.1 N·m



NOTE Be careful of the direction of the Joint #4 electromagnetic brake wire. (See the photo.)

3. Mount the drive boss and the pulley 1 to the Joint #4 motor unit.

   Fix the drive boss and the motor shaft.
   There is an uneven part for the feeler gauge (0.5 mm) on the boss.
   Use the uneven part to leave 0.5 mm space.

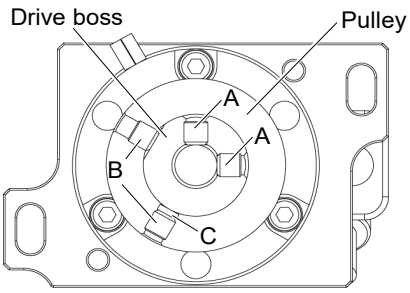
NOTE If there is no space, the parts may chafe while the motor is driving and it may result in breakage while the motor is moving.

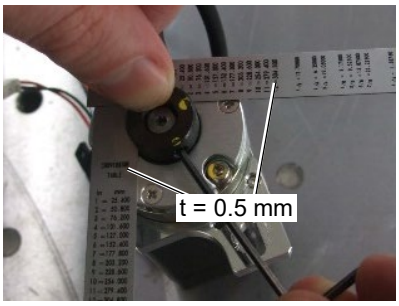
   Set the set screws to the positions indicated in the figure.

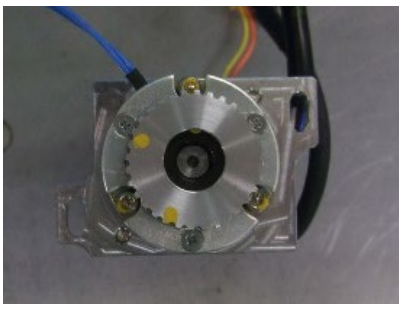
   A: Pulley and motor shaft screws

   B: Pulley and drive boss screws

   C: Bushing







NOTE If the screw positions are incorrect or the bushing is not set, it may cause damage on the side of the part and may result in the part being unable to be removed.

Drive boss and the motor shaft:

Hexagon socket set screws: 2-M4×4
Tightening torque: 2.5 ± 0.2 N·m

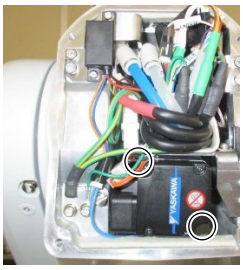
Align the screws to the two flat faces of the motor shaft and fix them.

Drive boss and the pulley 1:

Hexagon socket set screws: 2-M4×4 (with a brass bushing)
Tightening torque: 2.5 ± 0.2 N·m

Fix the set screws while pressing the pulley 1 to the drive boss.
The brass bushing is not necessary for the screw for the flat surface (D-cut). Set the bushing to the other screw and then fix the screw.

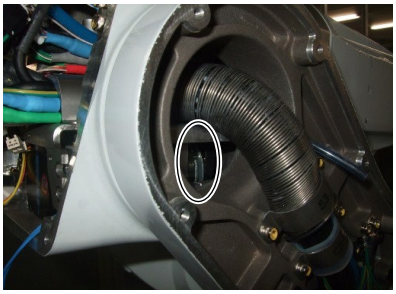
4. Put the Joint #4 motor unit inside the Arm #4.



5. Pass the timing belt around the pulley 1 and pulley 2 and temporarily fix it.

   Hexagon socket head cap bolts: 2-M4×15 (with a washer)

   Check that the teeth of the timing belt engage with these of the pulley.



   As a rough guide of temporary fixing, check that the motor unit can be moved by hand, and it does not tilt when being pulled. If the belt is too loose or too tight, it will not have proper tension.

6. Apply tension to the Joint #4 timing belt and fix the Joint #4 motor unit.

   Joint #4 timing belt tension: 15 to30 N

   Belt tension meter setting value

   Weight: 2.5 g/mm width × m span, Width: 6 mm, Span: 61 mm

   Hexagon socket head cap bolt: 2-M4×15 (with a plain washer)

   Tightening torque: 4.0 ± 0.2 N·m

   Regarding belt tension:

NOTE

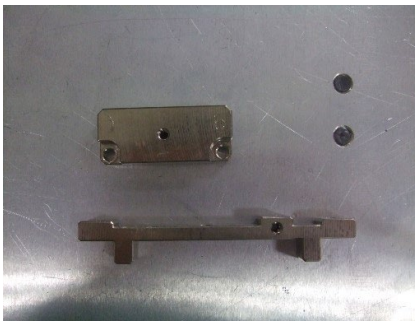
- Jumping (position gap) may occur if the value is below the lower limit.
- Vibration (abnormal noise) or reduction in life of the parts may occur if the value exceeds the upper limit.
- When you replace with a new belt, belt extends and the belt tension may decrease in the initial stage. Make sure to operate the robot two to three days and check the belt tension again.

When using the belt tension tensile jig (maintenance part):

Fix the belt tension tensile jig (for J4) to the Joint #4 motor plate.

Hexagon socket head cap bolt: 2-M4×15

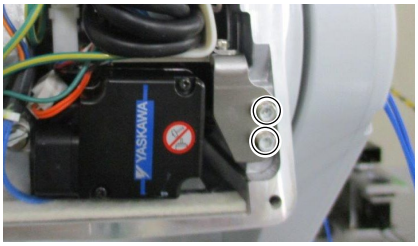
Push the belt tension tensile jig (for J4, J5, and J6) against the Arm #3 as shown in the photo. Insert the screw to the through hole at the center and fix it lightly to the hole for the belt tension tensile jig.



Hexagon socket head cap bolt: M4×15

Tension is applied as the Joint #4 motor unit is stretched by tightening the screw.

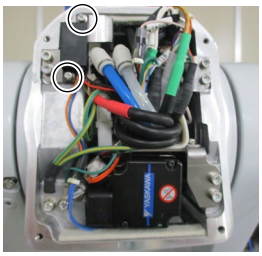
7. Install the plate for fixing the cables.
   Hexagon socket head cap bolts: 2-M4×10



8. Install the brake power supply to the plate.
   Install the brake power supply so that the cable is facing downward.

   Cross recessed head screw with captive washer: 2-M3×6

   Tightening torque: 0.45 ± 0.1 N·m



9. Connect the following connectors.

   Connectors: X141, X041, BT4, BR041

10. Install the following cover.
    Arm #3 cover
    Arm #3 maintenance cover
    Arm #2 side cover
    For details, refer to *C12 Maintenance: 3. Covers*.

11. Calibrate the Joint #4.
    For details, refer to *C12 Maintenance: 16. Calibration*.

8.2 Joint #4 - Replacing the Reduction Gear Unit

	Name		Qty.	Note
Maintenance Parts	Reduction gear unit (Joint #4)		1	1821978
	Belt tensile jig*		1	1674582
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolts
		width across flats: 5 mm	1	For M6 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Belt tension meter		1	Refer: Unitta U-505

* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

Removal: Joint #4 Reduction gear unit

1. Turn OFF the Controller power.
2. Remove the Arm #4 side cover and Arm #3 cover.

   For details, refer to *C12 Maintenance: 3. Covers*.

3. Remove the Joints #5 and #6 motors.

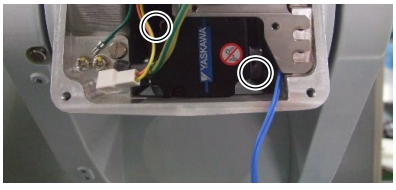
   For details, refer to the Removal steps in *C12 Maintenance: 9.1 Joint #5 - Replacing the Motor* and *C12 Maintenance: 10.1 Joint #6 - Replacing the Motor*.

4. Remove the cables passing through the Arm #4 as shown in the photo.

   For details, refer to the Removal steps in *C12 Maintenance: 4.1 Cable Unit*.

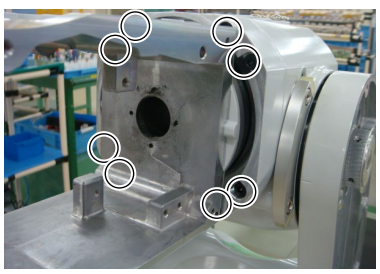
5. Loosen the fixing bolts of the Joint #4 motor plate and remove the belt. (Do not remove the Joint #4 motor.)

   Hexagon socket head cap bolts: 2-M4×15
   (with a small plain washer)



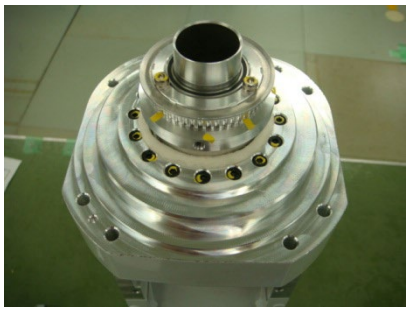
6. Remove the bolts fixing the J4 flange, and remove the Arm #4 from the Arm #3.
   To remove all bolts, change the position of the Joint #4 by rotating it.

   Hexagon socket head cap bolts: 8-M5×30



7. Remove the bolts fixing the J4 flange and the Joint #4 reduction gear unit.

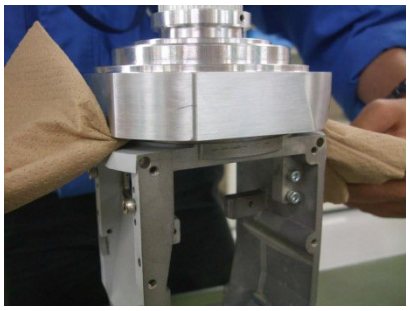
   Hexagon socket head cap bolts: 16-M3×20



8. Remove the wave generator of the Joint #4 reduction gear unit together with the J4 flange.

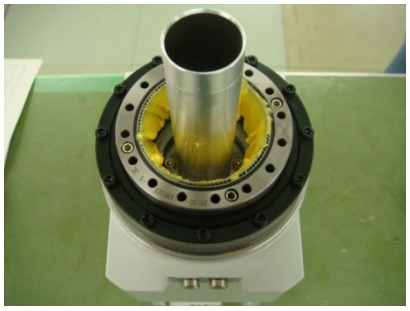
   If the wave generator does not come off easily, insert a tool in a gap between the J4 flange and the Arm and remove the wave generator little by little.

   Be careful not to damage the parts.



9. Remove the Joint #4 reduction gear unit.

   Hexagon socket head cap bolts: 12-M3×28

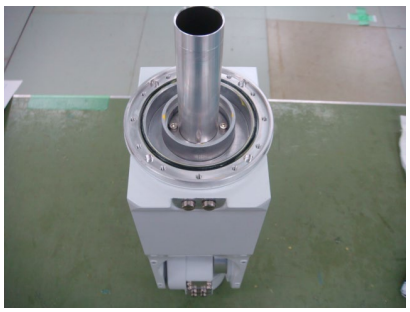


10. Remove the J4 sleeve holder.
    Then, remove the J4 sleeve.

    Hexagon socket head cap bolts: 4-M3×6

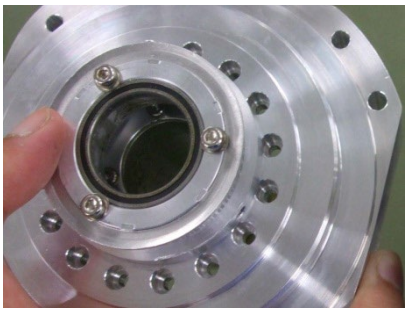
    The J4 sleeve is attached by gasket and may not be removed easily. If the part cannot be removed, pull the sleeve while rotating it.

    Handle the sleeve with care since it is thin and easy to deform.



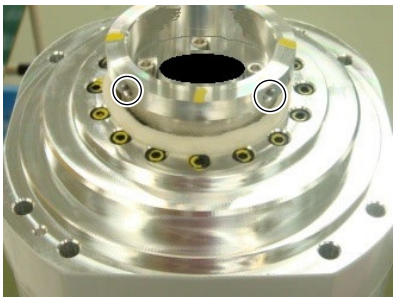
11. Remove the bolts of the bearing holder on the pulley.

    Hexagon socket head cap bolts: 3-M3×8 (with a plain washer)



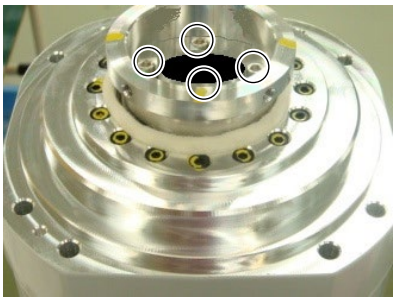
12. Remove the pulley from the pulley spacer.

    Hexagon socket set screws: 2-M4×4



13. Remove the pulley spacer from the wave generator.

    Hexagon socket head cap bolts: 4-M3×8



Installation: Joint #4 Reduction gear unit

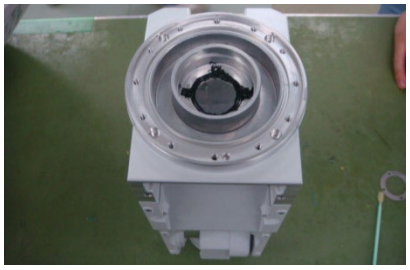
NOTE ☞ When tightening hexagon socket head cap bolts, refer to the *2.4 Tightening Hexagon Socket Head Cap Bolts*.

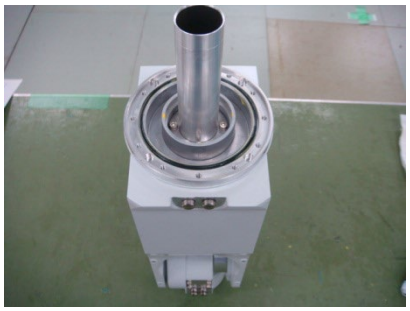
1. Apply grease to the mating surface of the sleeve and the fixing bolts. (for grease leakage prevention for the reduction gear unit)

   Fit the J4 sleeve and install the J4 sleeve holder.

   Hexagon socket head cap bolts: 4-M3×6

   Tightening torque: 2.0 ± 0.1 N·m

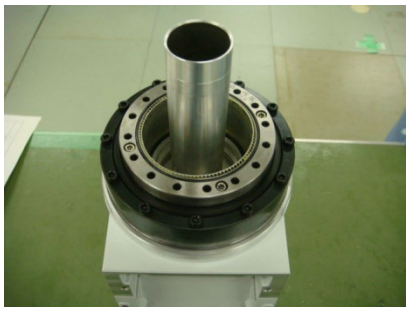




2. Install the O-ring to the O-ring groove.
   Install the Joint #4 reduction gear unit.

   Hexagon socket head cap bolts: 12-M3×28

   Tightening torque: 2.4 ± 0.1 N·m

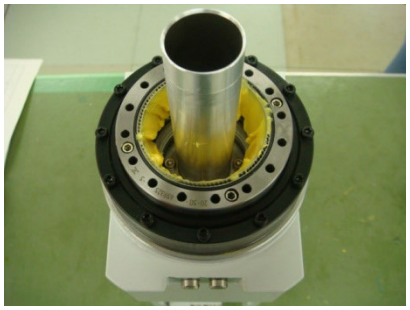


3. Apply grease to the Joint #4 reduction gear unit.

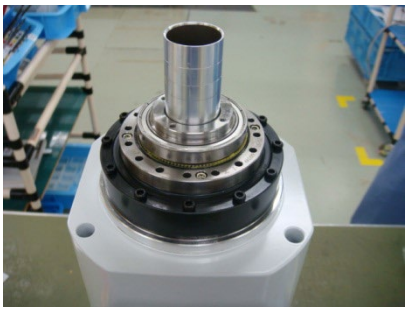
   Grease: SK-1A

   Grease amount: 20 g

   Apply 10g of grease to the wave generator.
   Apply the remaining 10 g to the inner side of the flexspline as shown in the photo.



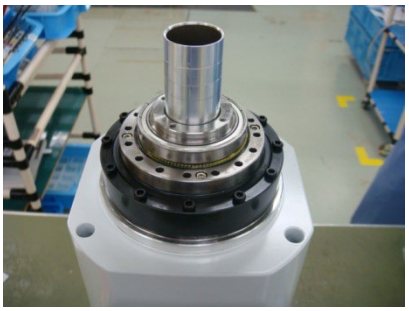
4. Install the wave generator of the Joint #4 reduction gear unit.

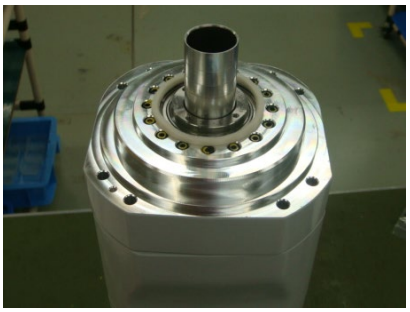


5. Set the O-ring attached to the reduction gear unit to the O-ring groove on the Joint #4 reduction gear unit.
   Then, install the J4 flange.

   Hexagon socket head cap bolts: 16-M3×20

   Tightening torque: 2.4 ± 0.1 N·m

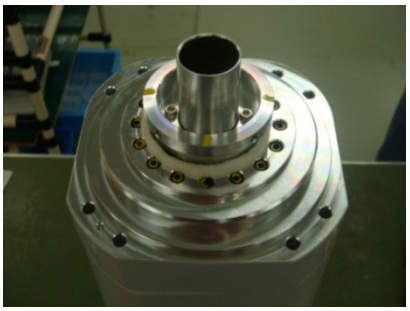




6. Fix the pulley spacer to the wave generator of the Joint #4 reduction gear unit.

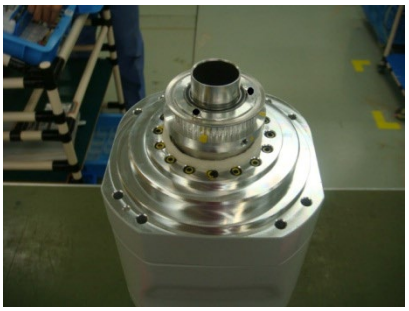
   Hexagon socket head cap bolts: 4-M3×8

   Tightening torque: 2.0 ± 0.1 N·m



7. Fix the J4 pulley to the J4 pulley spacer.

   Hexagon socket set screws: 2-M4×4



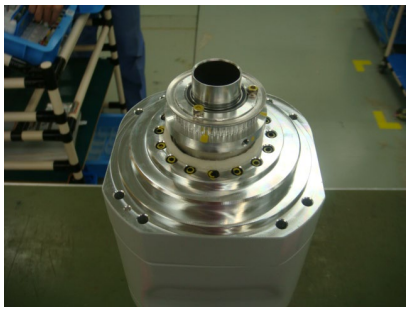
8. Apply adhesive to the following parts of the J4 pulley.
   Bearing mating part
   Inner ring (J4 sleeve)
   Outer ring (J4 pulley)

   Adhesive: Loctite 641

   Install the J4 pulley bearing, and tighten the bearing bolt.

   Hexagon socket head cap bolts: 3-M3×8 (with a plain washer)

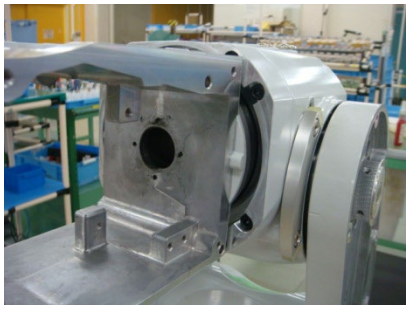
   Tightening torque: 2.0 ± 0.1 N·m



9. Install the Arm #4 to the Arm #3.
   To fix all bolts, change the position of the Joint #4 by rotating it.

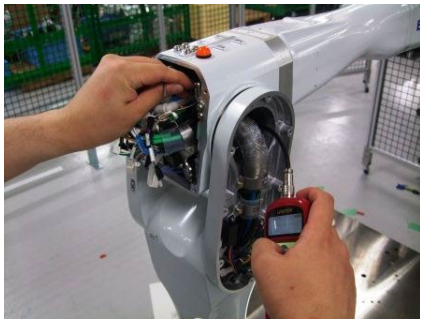
   Hexagon socket head cap bolts: 8-M5×30

   Tightening torque: 10.0 ± 0.5 N·m



10. Install the Joint #4 timing belt with a proper tension.

    For details, refer to *C12 Maintenance: 8.1 Joint #4 – Replacing the Motor*, Installation steps (5) and (6).



11. Pass the cables to the Arm #4.

    For details, refer to Installation steps in *C12 Maintenance: 4.1 Cable Unit*.

12. Install the Joints #5 and #6 motors.

    For details, refer to Installation steps of *C12 Maintenance: 9.1 Joint #5 – Replacing the Motor* and *C12 Maintenance: 10.1 Joint #6 – Replacing the Motor*.

13. Install the removed covers.

    For details, refer to *C12 Maintenance: 3. Covers*.

14. Perform the calibration.

    For details, refer to *C12 Maintenance: 16. Calibration*.

8.3 Joint #4 - Replacing the Timing Belt

	Name		Qty.	Note
Maintenance Parts	Timing belt (Joint #4)		1	1655931
	Belt tensile jig		1	1674582
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolt
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolt
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Belt tension meter		1	Refer: Unitta U-505
	Nippers		1	For cutting the wire tie
	Masking tape		1	For protecting the connector clips
	Wire tie (AB100 or equivalent)		As needed	For passing the cables
	Braid tube (600 mm or longer)		1	For passing the cables

* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

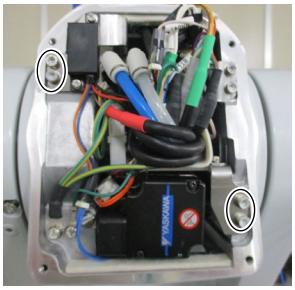
The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

Removal: Joint #4 Timing belt

1. Remove the Joint #4 motor unit.
   For details, refer to *C12 Maintenance: 8.1 Joint #4 – Replacing the Motor*, Installation steps (1) through (6).

2. Remove the connectors inside the Arm #3 and the air tube (transparent).
   Connectors:
   X71, X72, X041,
   BR041, BR051, PS,
   BT4, BT51, X141, X151, X161

3. Remove the cable bracket inside the Arm #3.
   Hexagon socket head cap bolts: 4-M4×10



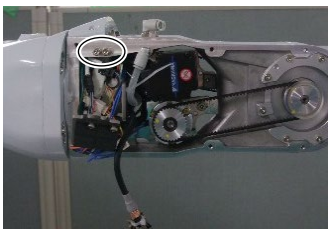
4. Remove the Arm #3 cable bracket and cable protection sheet.
   Hexagon socket head cap bolts: 2-M3×6

   The Arm #3 cable bracket and cable protection sheet will be used again.　Be careful not to lose them.

5. Remove the Arm #4 side cover.
   For details, refer to *C12 Maintenance: 3 Covers.*

6. Remove the cable protection plate attached to the Arm #4.

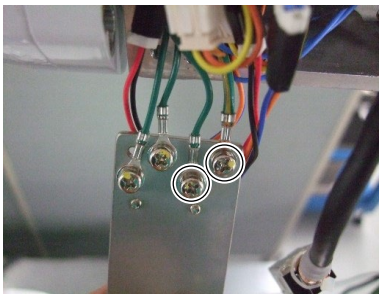
   Hexagon socket head cap bolts: 2-M4×10



7. Remove the green/yellow ground wire and the green ground wire connected to X052 and X062 from the cable protection plate.

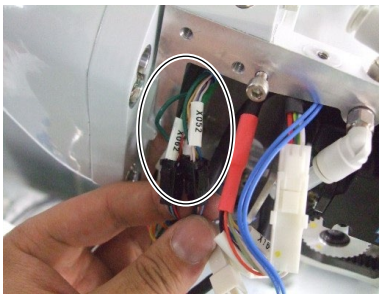
   Cross recessed head screws with captive washer: 2-M4×8

   Positions of the ground wire terminals may differ from the photo. Check which connector the terminal is connected to.



8. Remove the following connectors.

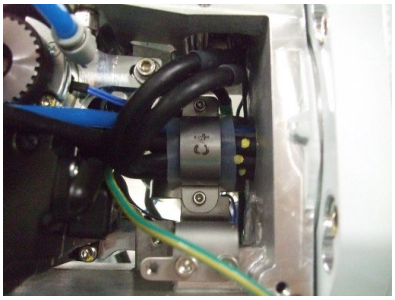
   Connector: X052, X062



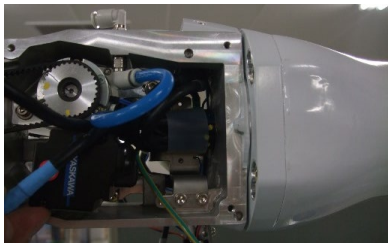
9. Remove the Arm #4 cable bracket and the cable protection sheet.

   Hexagon socket head cap bolts: 2-M3×6

   The Arm #4 cable bracket and cable protection sheet will be used again.　Be careful not to lose them.



10. Remove the air tube (blue) from the fitting.

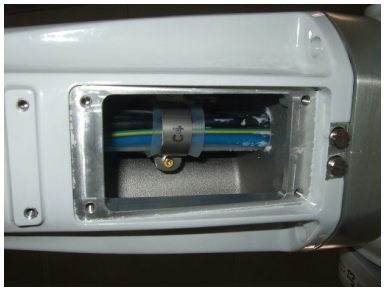


11. Remove the Arm #4 maintenance cover.
    For details, refer to *C12 Maintenance: 3 Covers*.

12. Remove the Arm #4 cable bracket and the cable protection sheet.

    Hexagon socket head cap bolts: 2-M3×6

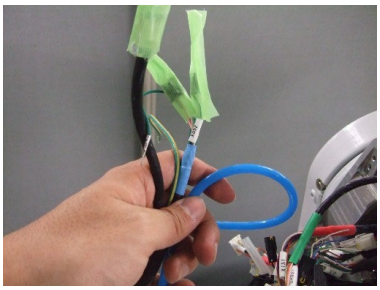
    The Arm #4 cable bracket and cable protection sheet will be used again.　Be careful not to lose them.



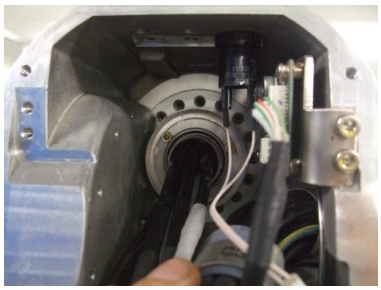
13. Pull the following parts from the Arm #4 to the Arm #3.
    LAN cable
    X052 and X062 cables
    Ground wire
    Air tube (blue)

    Protect the connectors with masking tapes.

    - To protect the connector's clips
    - To avoid adherence of cable grease



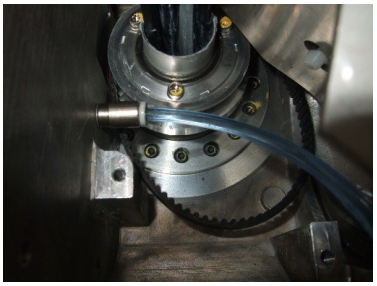
14. Remove the Joint #4 timing belt.



Installation: Joint #4 Timing belt

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

1. Pass the Joint #4 timing belt around the Joint #4 pulley 2



2. Install the Joint #4 motor unit.
   For details, refer to *C12 Maintenance: 8.1 Joint #4 – Replacing the Motor*, Installation steps (4) through (6).
3. Pass the following parts from the Arm #3 to the Arm #4.
   X052 and X062 cables
   LAN cable
   Ground wire
   Air tube (blue)

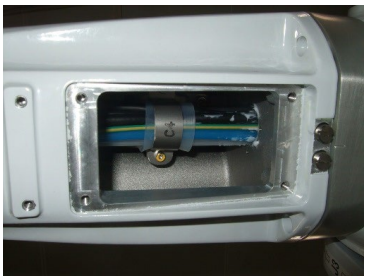
   How to pass the cables:
   First pass the braid tube from the Arm #4 side to the Arm #3 side. Insert the connectors through the braid tube, as shown in the photo, and fix the tube with the wire tie so that connectors are not to be pulled out. Then, pull the braid tube from the Arm #4 side while pushing the cables from the Arm #3 side to pass the cables through. (See the photo.)

NOTE Pulling the cables forcibly may cause falling off or breakage of the connectors and disconnection of the cables.
If it is difficult to pass the cables, pass the cables one by one in the following order.
X052 and X062 cables LAN cable Ground wire Air tube (blue)

4. Wrap the cables inside the Arm #4 extension part with a cable protection sheet and install the Arm #4 cable bracket.

   Hexagon socket head cap bolts: 2-M3×6

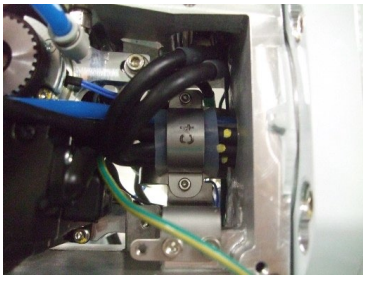
   Tightening torque: 2.0 ± 0.1 N·m



5. Wrap the cables inside the Arm #4 with a cable protection sheet and install the Arm #4 cable bracket.
   Install the Arm #4 cable bracket on the cable protection tube.

   Hexagon socket head cap bolts: 2-M3×6

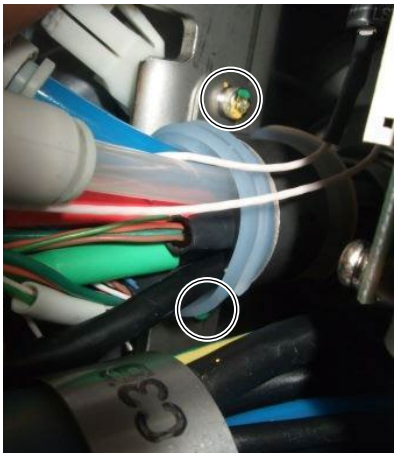
   Tightening torque: 2.0 ± 0.1 N·m



6. Wrap the cables inside the Arm #3 with a cable protection sheet and install the Arm #3 cable bracket.

   Hexagon socket head cap bolts: 2-M3×6

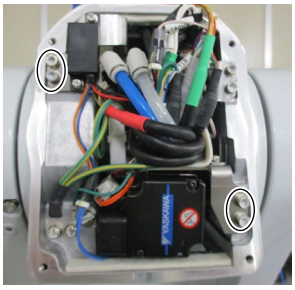
   Tightening torque: 2.0 ± 0.1 N·m



7. Install the cable bracket inside the Arm #3.

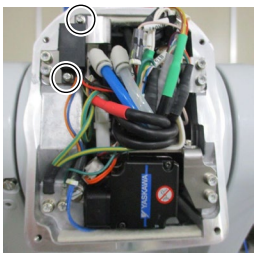
   Hexagon socket head cap bolts: 4-M4×10

   Tightening torque: 4.0 ± 0.2 N·m

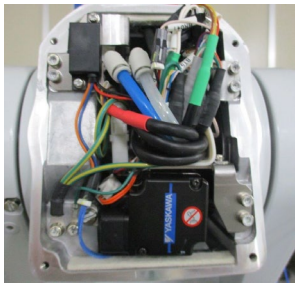


8. Install the brake power supply to the plate.
   Install the brake power supply so that the cable is facing downward.

   Cross recessed head screws with captive washer: 2-M3×6
   Tightening torque: 0.45 ± 0.1 N·m



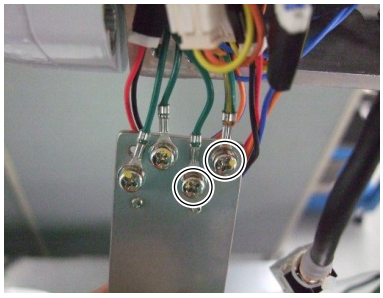
9. Connect the connectors inside the Arm #3 and the air tube (transparent).
   Connector:
   X71, X72, X041,
   BR041, BR051, PS,
   BT4, BT51, X141, X151, X161



10. Connect the ground wire terminals inside the Arm #4 to the Arm #4 cable protection bracket.

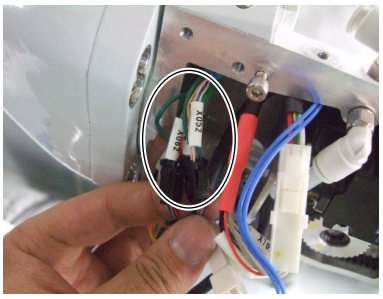
    Cross recessed head screws with captive washer: 2-M4×8

    Tightening torque: 0.45 ± 0.1 N·m



11. Connect the connectors inside the Arm #4.

    Connector:
    X052, X062

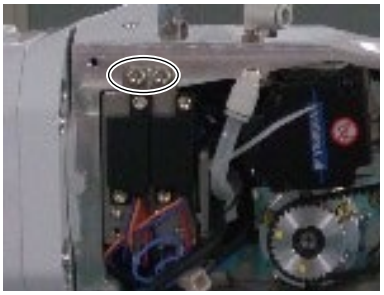


12. Fix the cable protection bracket to the Arm #4.

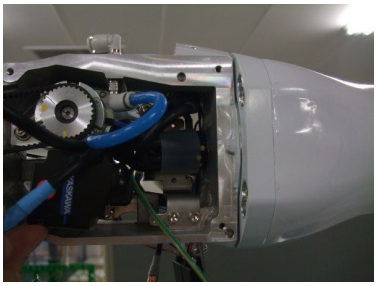
    Hexagon socket head cap bolts: 2-M4×10

    Tightening torque: 4.0 ± 0.2 N·m

NOTE Be careful not to get the cables caught.
It may cause cable breakage.



13. Install the air tube (blue) to the fitting.



14. Install the following covers.

    Arm #3 cover
    Arm #3 maintenance cover
    Arm #4 side cover
    Arm #4 maintenance cover

    For details, refer to *C12 Maintenance: 3. Covers*.

8.4 Joint #4 - Replacing the Electromagnetic Brake

	Name		Qty.	Note
Maintenance Parts	Electromagnetic brake		1	2172928 (common for Joints #4, #5, #6)
	Belt tensile jig		1	1674582
Tools	Hexagonal wrench	width across flats: 2 mm	1	For M4 hexagon socket set screws
		width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Feeler gauge (0.5 mm)		1	For adjusting the drive boss position
	Belt tension meter		1	Refer: Unitta U-505

* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

NOTE ☞ The electromagnetic brakes are common for Joints #4, #5, and #6.
The Joints #5 and #6 electromagnetic brakes have an identification label for preventing misconnection of the connectors. The label is not necessary for the Joint #4 electromagnetic brake.
(There is no connector identification label for the Joint #4.)

Removal: Joint #4 Electromagnetic brake

1. Remove the Joint #4 electromagnetic brake.
   For details, refer to *C12 Maintenance: 8.1 Joint #4 – Replacing the Motor*, Removal steps (1) through (8).

Installation: Joint #4 Electromagnetic brake

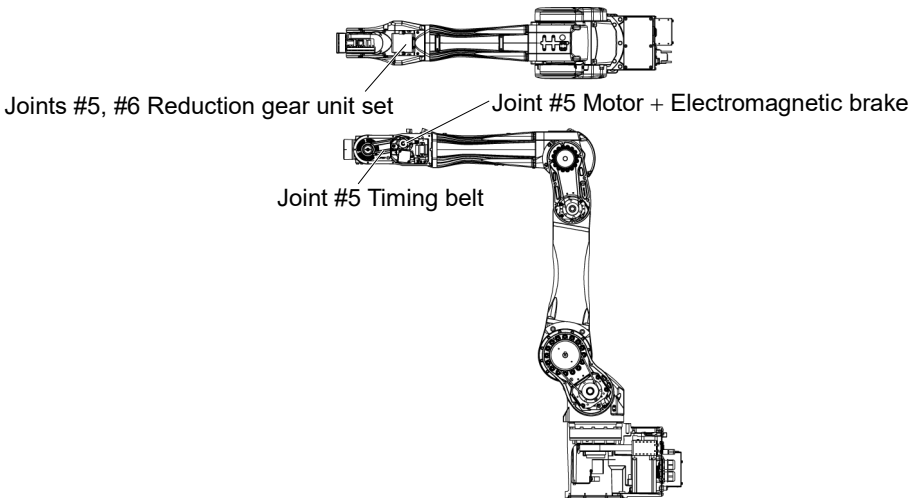
1. Mount the Joint #4 electromagnetic brake to the Joint #4 motor unit.
   For details, refer to *C12 M*aintenance: *8.1 Joint #4 – Replacing the Motor*, Installation steps (2) through (11).

9. Joint #5

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 during replacement. The shock may shorten the life of the motors and encoder and/or damage them. ■ Never disassemble the motor and the encoder. Disassembled motor and encoder will cause a positional gap and cannot be used again.

After parts have been replaced (motors, reduction gear units, electromagnetic brakes, timing belts, etc.), the Manipulator cannot perform positioning properly because a gap exists between the origin stored in each motor encoder and its corresponding origin stored in the Controller.
Therefore, it is necessary to match these origins after replacing the parts.
The process of aligning the two origins is called “Calibration”.
Refer to C12 *Maintenance: 16. Calibration* and perform the calibration after the parts replacement.



9.1 Joint #5 - Replacing the Motor

	Name		Qty.	Note
Maintenance Parts	AC servo motor 150 W		1	2206705 (Common for Joints #4, #5, #6)
	Belt tensile jig *		1	1674582
Tools	Hexagonal wrench	width across flats: 2 mm	1	For M4 hexagon socket set screws
		width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Spanner (width across flats: 8 mm)		1	For air tube fitting
	Feeler gauge (0.5 mm)		2	For adjusting the drive boss position
	Belt tension meter		1	Refer: Unitta U-505

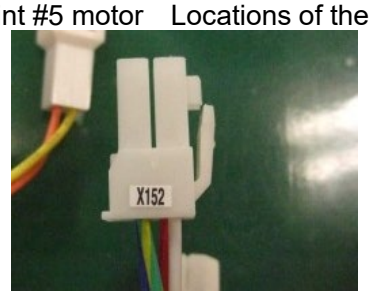
* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

Attaching the labels

The motors are common for Joints #4, #5, and #6.
In order to prevent misconnection of the connectors, attach the label for the motor as shown in the photos.

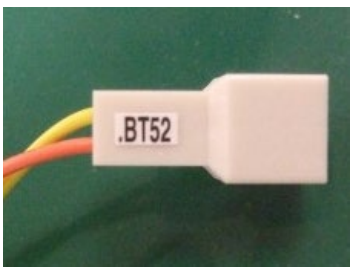
Joint #5 motor Locations of the connector labels



X152

X052

BT52

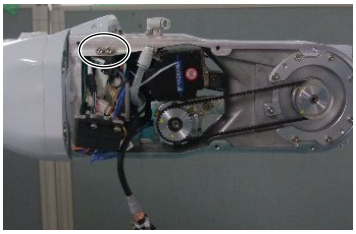


_BT52

Removal: Joint #5 Motor

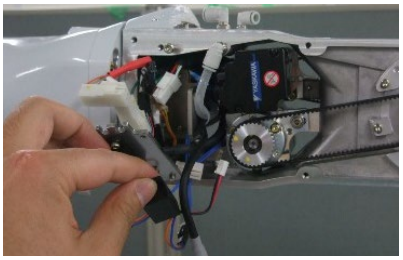
1. Turn OFF the Controller power.
2. Remove the Arm #4 side cover.
   For details, refer to C12 *Maintenance: 3. Covers*.
3. Loosen the screws fixing the cable protection bracket on the Arm #4 and pull out the cables.

   Hexagon socket head cap bolts: 2-M4×10



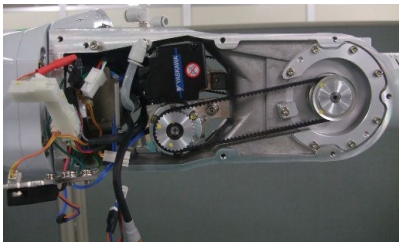
4. Remove the brake power supply for the brake connected to the connector (BR052) from the plate.

   Cross recessed head screw with captive washer: 2-M3×6

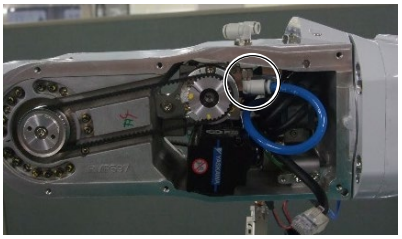


5. Disconnect the following connectors.

   Connector: X052, X152, BT52, BR052

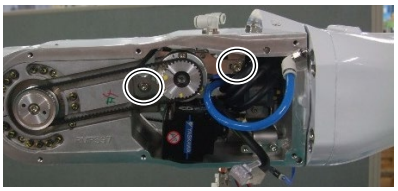


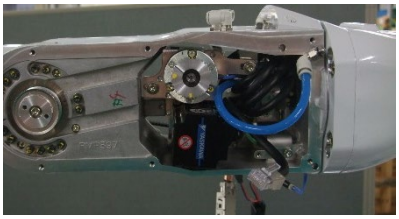
6. Remove the air tube fitting located in the front of the Joint #5 motor unit.



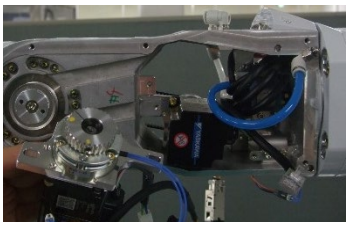
7. Loosen the screws fixing the Joint #5 motor unit and remove the belt.

   Hexagon socket head cap bolts: 2-M4×15 (with a plain washer)



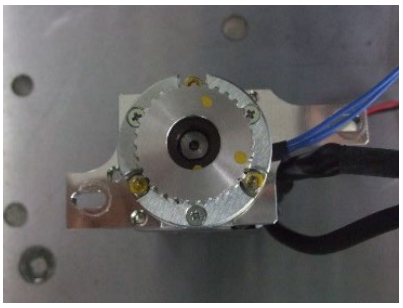


8. Remove the Joint #5 motor unit.



Hexagon socket head cap bolts:
2-M4×15 (with a plain washer)

9. Remove the Joint #5 pulley 1 and the drive boss from the motor shaft of the Joint #5 motor unit.



Pulley 1 and drive boss screws
Hexagon socket set screws: 2-M4×4 (with a brass bushing)

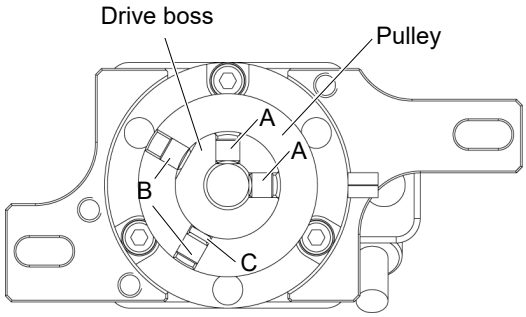
Drive boss and motor shaft screws
Hexagon socket set screws: 2-M4×4

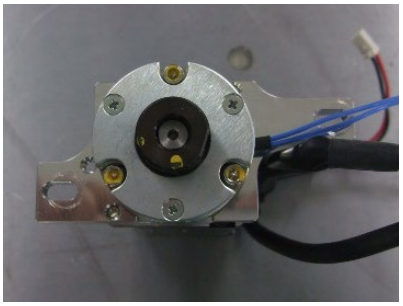
There is a brass bushing on one of the set screws fixing the drive boss and the pulley.　Be careful not to lose it.

A: Pulley and motor shaft screws

B: Pulley and drive boss screws

C: Bushing

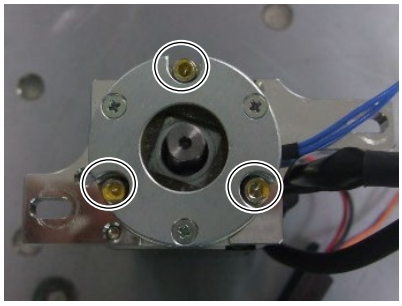




10. Remove the Joint #5 electromagnetic brake.

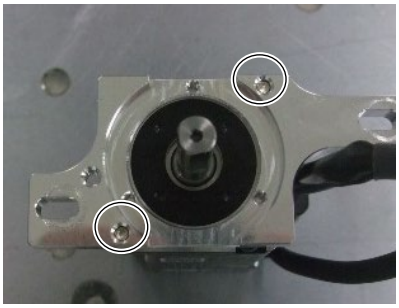
    Hexagon socket head cap bolts: 3-M3×15 (with a spacer)

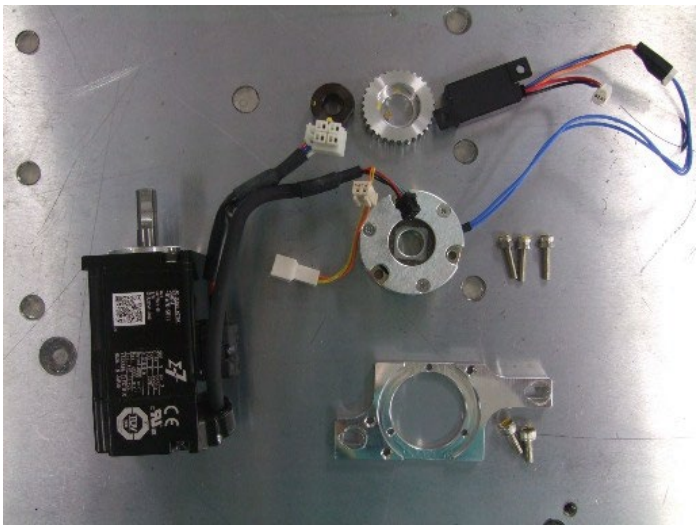
    Be careful not to lose the spacers.



11. Remove the motor plate from the Joint #5 motor.

    Hexagon socket head cap bolts: 2-M4×10





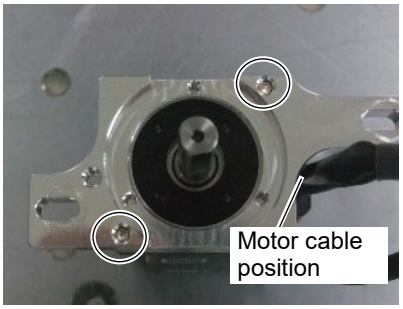
Installation: Joint #5 Motor

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

1. Install the motor plate to the Joint #5 motor.

   Hexagon socket head cap bolts: 2-M4×10

   Tightening torque: 4.0 ± 0.2 N·m

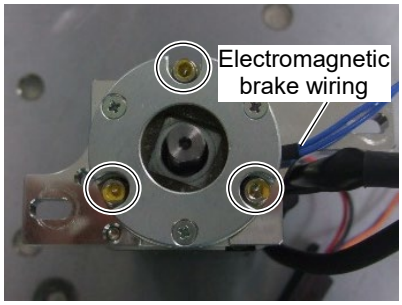


NOTE Be careful of the assembly direction of the motor plate. (See the photo.)

2. Mount the Joint #5 electromagnetic brake to the Joint #5 motor unit. Insert the spacers between the hexagon socket set screws and the Joint #5 electromagnetic brake.

   Hexagon socket set screws: 3-M2.5×10 (with a spacer)

   Tightening torque: 2.0 ± 0.1 N·m



NOTE Be careful of the assembly direction of the Joint #5 electromagnetic brake wiring. (See the photo.)

3. Mount the drive boss and the pulley 1 to the Joint #5 motor unit.

   Fix the drive boss and the motor shaft.
   There is an uneven part for the feeler gauge (0.5 mm) on the boss.
   Use the uneven part to leave 0.5 mm space.

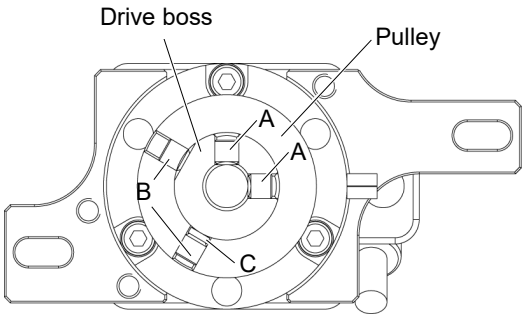
NOTE If there is no space, the parts may chafe while the motor is driving and it may result in breakage while the motor is moving.

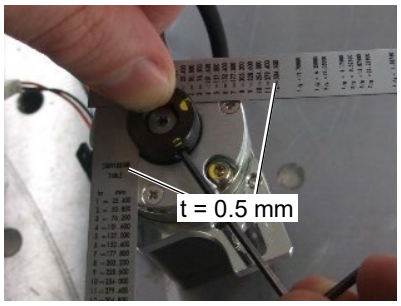
Set the set screws to the positions indicated in the figure.

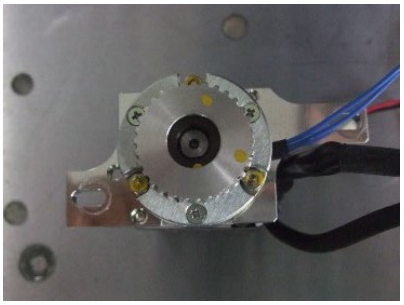
A: Pulley and motor shaft screws

B: Pulley and drive boss screws

C: Bushing







NOTE If the screw positions are incorrect or the bushing is not set, it may cause damage on the side of the part and may result in the part being unable to be removed.

Drive boss and the motor shaft:

Hexagon socket set screws: 2-M4×4

Tightening torque: 2.5 ± 0.2 N·m

Align the screws to the two flat faces of the motor shaft and fix them.

Drive boss and the pulley 1:

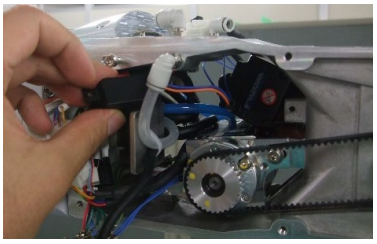
Hexagon socket set screws: 2-M4×4 (with a brass bushing)

Tightening torque: 2.5 ± 0.2 N·m

Fix the set screws while pressing the pulley 1 to the drive boss.

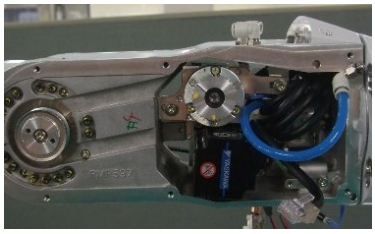
The brass bushing is not necessary for the screw for the flat surface (D-cut). Set the bushing to the other screw and then fix the screw.

4. Put the Joint #5 motor unit inside the Arm #4.



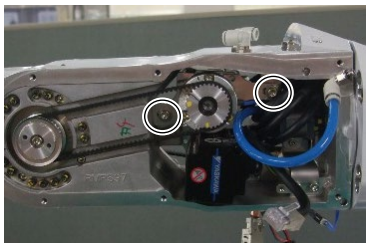
Pass the cables of the Joint #5 motor unit to the Joint #6 motor unit side so that the cables can be stored in the storage space.
(See the photo)

5. Pass the timing belt around the pulley 1 and pulley 2 and fix it temporarily.
Make sure that the teeth of the timing belt engage with these of the pulley.



As a rough guide of temporary fixing, check that the motor unit can be moved by hand, and it does not tilt when being pulled. If the belt is too loose or too tight, it will not have proper tension

6. Apply tension to the Joint #5 timing belt and fix the Joint #5 motor unit.



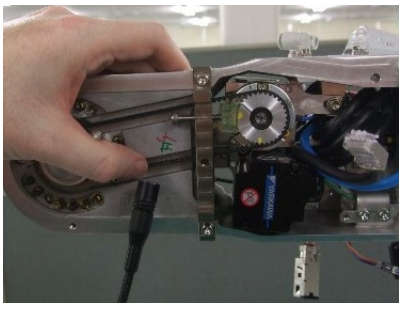
Joint #5 Timing belt tension: 15 to 30 N

Bet tension meter setting value

Weight: 2.5 g/mm width × m span, Width: 6 mm, Span: 117 mm

Hexagon socket head cap bolts: 2-M4×15 (with a plain washer)

Tightening torque: 4.0 ± 0.2 N·m



Regarding belt tension:

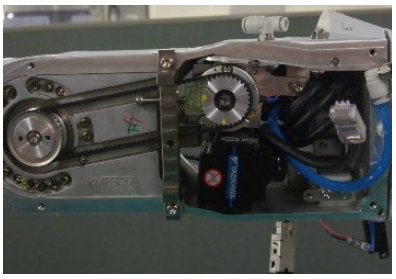
NOTE

- Jumping (position gap) may occur if the value is below the lower limit.
- Vibration (abnormal noise) or reduction in life of the parts may occur if the value exceeds the upper limit.
- When you replace with a new belt, belt extends and the belt tension may decrease in the initial stage. Make sure to operate the robot two to three days and check the belt tension again.

When using the belt tension tensile jig (maintenance part):

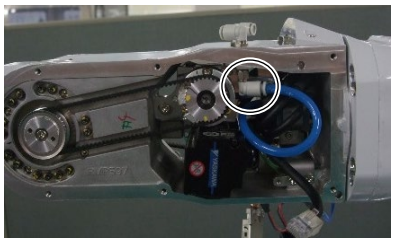
Fix the belt tension tensile jig (for J4, J5, and J6) with the screws (2-M4×15) and push the rubber against the pulley.

Tension is applied as the set screw (M6×15) is pushed by the rubber.



7. Install the air tube fitting in the front of the Joint #5 motor unit.

   After tightening by hand, tighten one sixth to quarter of a turn.



NOTE Tightening of the fitting:

Fitting is too tight:
It may cause air leakage due to screw breakage or gasket deformation.

Fitting is too loose:
It may cause loose screws and air leakage.

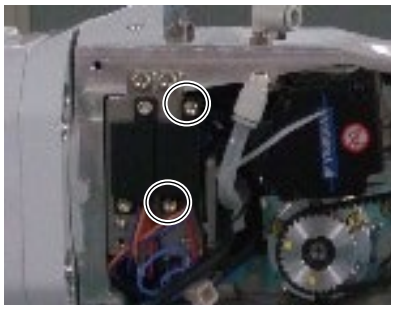
8. Connect the following connectors.

   Connectors: X052, X152, BT52, BR052

9. Install the power supply of the brake to the plate.

   Cross recessed head screw with captive washer: 2-M3×6

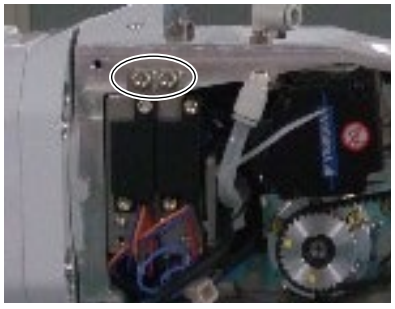
   Tightening torque: 0.45 ± 0.1 N·m



10. Fix the cable protection bracket to the Arm #4.

    Hexagon socket head cap bolts: 2-M4×10

    Tightening torque: 4.0 ± 0.2 N·m



NOTE Be careful not to get the cables caught. It may result in cable breakage.

11. Install the Arm #4 side cover.
    For details, refer to *C12 Maintenance: 3. Covers*.

12. Perform the calibration.
    For details, refer to *C12 Maintenance: 16. Calibration*.

9.2 Joint #5 - Replacing the Reduction Gear Unit (Replacing the Joint #5, #6 Reduction Gear Unit Set)

For replacement of the Joint #5 and Joint #6 reduction gear unit, replace the Joints #5, #6 reduction gear unit set. The Joints #5 and #6 reduction gear unit set is adjusted in advance.

	Name		Qty.	Note
Maintenance Parts	Joints #5, #6 Reduction gear unit set		1	1821979
	Belt tensile jig*		1	1674582
Tools	Hexagonal wrench	width across flats: 2 mm	1	For M4 hexagon socket set screws
		width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolts
		width across flats: 5 mm	1	For M6 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Spanner (width across flats: 8 mm)		1	For air fittings
	Feeler gauge (0.5 mm)		2	For drive boss position adjustment
	Belt tension meter		1	Refer: Unitta U-505

* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

Removal: Joints #5, #6 Reduction gear unit set

1. Turn OFF the Controller power.
2. Remove the Arm #4 side cover and Arm #3 cover.

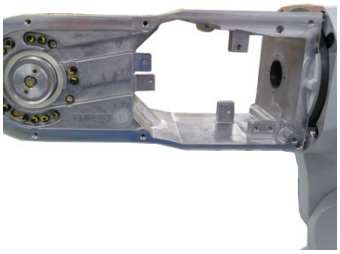
   For details, refer to *C12 Maintenance: 3. Covers*.

3. Remove the Joints #5 and #6 motors.

   For details, refer to the Removal steps in *C12 Maintenance: 9.1 Joint #5 - Replacing the Motor* and *C12 Maintenance: 10.1 Joint #6 - Replacing the Motor*.

4. Remove the cables passing through the Arm #4 as shown in the photo.

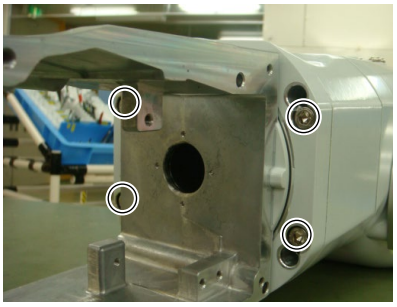
   For details, refer to the Removal steps in *C12 Maintenance: 4.1 Cable Unit*.



5. Remove the Joints #5, #6 reduction gear unit.

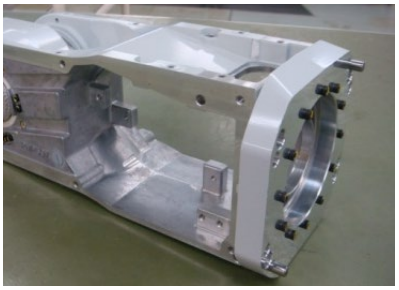
   Remove the bolts fixing the Arm #4 extension flange, and remove the Joints #5 and #6 reduction gear unit from the Arm #4 extension part.

   Hexagon socket head cap bolts: 4-M6×20



6. Remove the Arm #4 extension flange.

   Hexagon socket head cap bolts: 12-M3×18

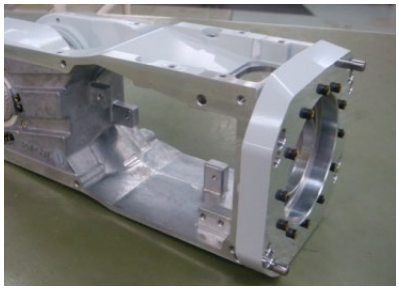


Installation: Joint #5, #6 Reduction gear unit set

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

1. Install the Arm #4 extension flange.

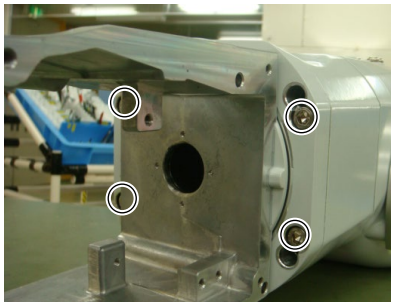
   Hexagon socket head cap bolts: 12-M3×18
   Tightening torque: 2.4 ± 0.1 N·m



2. Install the Joint #5 and #6 reduction gear unit.

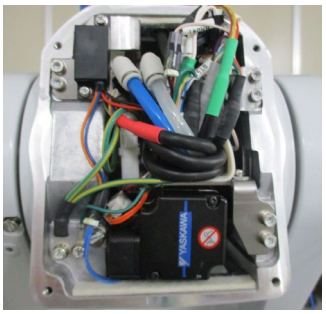
   Install the Arm #4 extension flange to the Arm #4 extension part.

   Hexagon socket head cap bolts: 4-M6×20
   Tightening torque: 13.0 ± 0.6 N·m



3. Pass the cables to the Arm #4.

   Connect all the connectors inside the Arm #3 and bind them together.

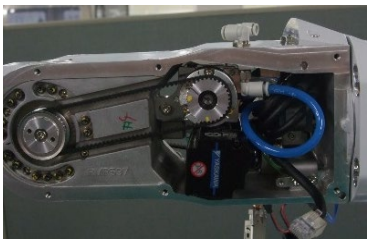


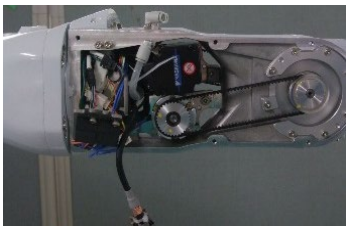
   Fix the cables inside the Arm #4, and connect the D-sub to the Arm #4.

   For details, refer to Installation steps in *C12 Maintenance: 4.1 Cable Unit*.

4. Install the Joint #5 and #6 motors.

   For details, refer to Installation steps in *C12 Maintenance: 9.1 Joint #5 – Replacing the Motor* and *C12 Maintenance: 10.1 Joint #6 – Replacing the Motor*.





5. Install the removed covers.

   For details, refer to *C12 Maintenance: 3. Covers*.

6. Perform the calibration.

   For details, refer to *C12 Maintenance: 16. Calibration*.

9.3 Joint #5 - Replacing the Timing Belt

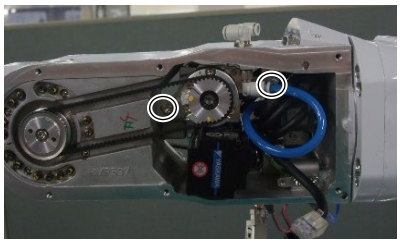
	Name		Qty.	Note
Maintenance Parts	Joint #5 timing belt	330 mm	1	1655932
	Belt tensile jig		1	1674582
Tools	Hexagonal wrench (width across flats: 3 mm)		1	For M4 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Belt tension meter		1	Refer: Unitta U-505

* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

Removal: Joint #5 Timing belt

1. Turn OFF the Controller power.
2. Remove the Arm #4 side cover.
   For details, refer to *C12 Maintenance: 3. Covers*.
3. Loosen the Joint #5 motor unit set screws.
   Hexagon socket head cap bolts: 2-M4×15 (with a plain washer)



4. Remove the Joint #5 timing belt.

Installation: Joint #5 Timing belt.

1. Pass the Joint #5 timing belt around the pulley 1 and the pulley 2 of the Joint #5.
2. Secure the Joint #5 motor unit.
   For details, refer to *C12 Maintenance: 9.1 Joint #5 – Replacing the Motor*, Installation steps (5) to (6) and (11) to (12).

9.4 Joint #5 - Replacing the Electromagnetic Brake

	Name		Qty.	Note
Maintenance Parts	Electromagnetic brake		1	2172928 (Common for Joints #4, #5, #6)
	Belt tensile jig		1	1674582
Tools	Hexagonal wrench	width across flats: 2 mm	1	For M4 hexagon socket set screws
		width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Spanner (width across flats: 8 mm)		1	For air tube fitting
	Feeler gauge (0.5 mm)		1	For adjusting the pulley position
	Belt tension meter		1	Refer: Unitta U-505

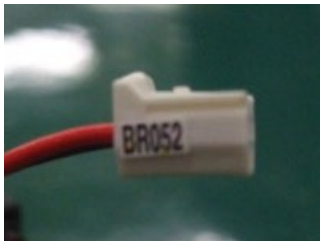
* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

Attaching the labels

The electromagnetic brakes are common for Joints #4, #5, and #6.
In order to prevent misconnection of the connectors, attach the label for the electromagnetic brakes as shown in the photos.

Joint #5 electromagnetic brakes Locations of the connector labels



BR052
Cable (red/black)

BR053
Cable (blue/blue)

BR053
Cable(blue/orange)

NOTE


BR053 is connected at the time of shipment. Before attaching the label, disconnect the connector.

One side of BR052 and BR053 have the same shape. Identify the connectors by color.

Removal: Joint #5 Electromagnetic brake

1. Remove the Joint #5 electromagnetic brake.

   For details, refer to *C12 Maintenance: 9.1 Joint #5 – Replacing the Motor*, Removal steps (1) through (10).

Installation: Joint #5 Electromagnetic brake

1. Mount the Joint #5 electromagnetic brake to the Joint #5 motor unit.

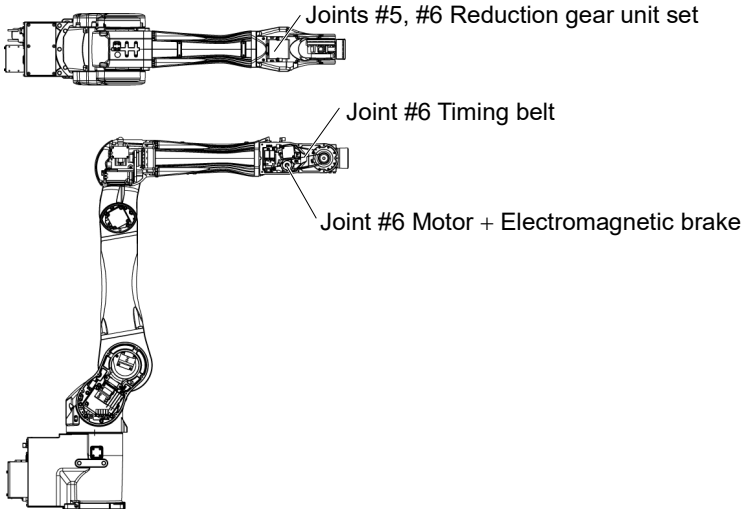
   For details, refer to *C12 Maintenance: 9.1 Joint #5 – Replacing the Motor*, Installation steps (2) through (12).

10. Joint #6

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 during replacement. The shock may shorten the life of the motors and encoder and/or damage them. ■ Never disassemble the motor and the encoder. Disassembled motor and encoder will cause a positional gap and cannot be used again.

After parts have been replaced (motors, reduction gear units, electromagnetic brakes, timing belts, etc.), the Manipulator cannot perform positioning properly because a gap exists between the origin stored in each motor encoder and its corresponding origin stored in the Controller.
Therefore, it is necessary to match these origins after replacing the parts.
The process of aligning the two origins is called “Calibration”.
Refer to *C12 Maintenance: 16. Calibration* and perform the calibration after the parts replacement.



10.1 Joint #6 - Replacing the Motor

	Name		Qty.	Note
Maintenance Parts	AC servo motor 150 W		1	2206705 (common to Joints #4, #5, #6)
	Belt tensile jig *		1	1674582
Tools	Hexagonal wrench	width across flats: 2 mm	1	For M4 hexagon socket set screws
		width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Feeler gauge		2	For adjusting the drive boss position
	Belt tension meter		1	Refer: Unitta U-505

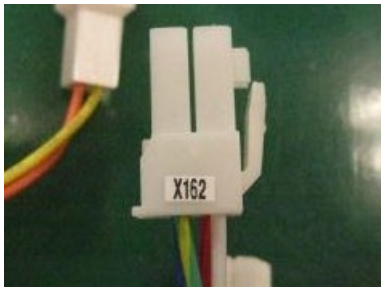
* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

Attaching the labels

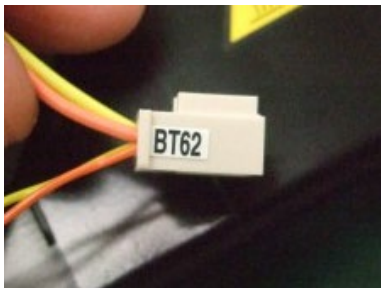
The motors are common to Joints #4, #5, and #6.
In order to prevent misconnection of the connectors, attach the label for the motor as shown in the photos.

Joint #6 motor Locations of the connector labels

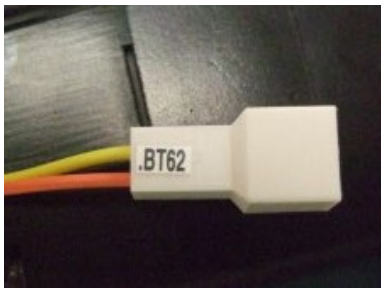


X162

X062



BT62

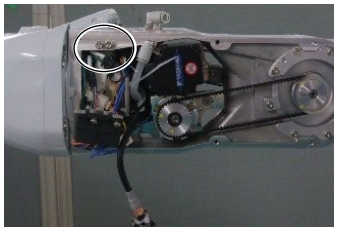


_BT62

Removal: Joint #6 Motor

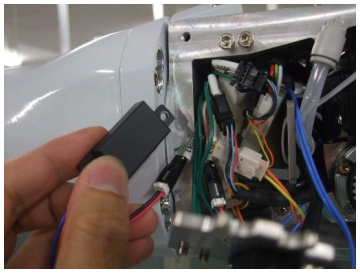
1. Turn OFF the Controller power.
2. Remove the Arm #4 side cover.
   For details, refer to *C12 Maintenance: 3. Covers*.
3. Loosen the screws fixing the cable protection plate on the Arm #4 and pull out the cables.

   Hexagon socket head cap bolts: 2-M4×10



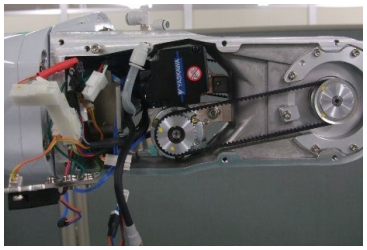
4. Remove the brake power supply for the brake connected to the connector (BR062) from the protection plate.

   Cross recessed head screw with captive washer: 2-M3×6



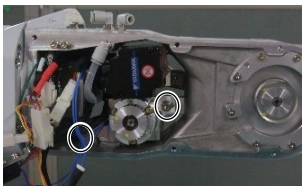
5. Pull out the cables from the Arm #4 and disconnect the following connectors.

   Connectors: X062, X162, BT62, BR062



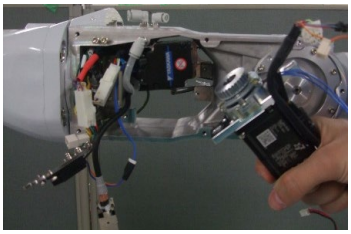
6. Loosen the bolts securing the Joint #6 motor unit and remove the belts.

   Hexagon socket head cap bolts: 2-M4×15 (with a plain washer)

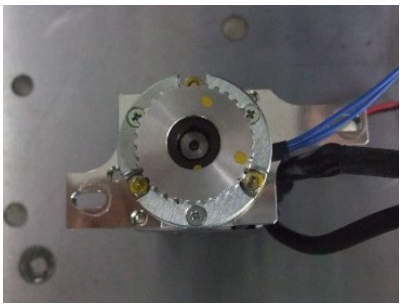


7. Remove the Joint #6 motor unit.

   Hexagon socket head cap bolts: 2-M4×15 (with a plain washer)



8. Remove the Joint #6 motor pulley 1 and the drive boss from the Joint #6 motor unit.



Pulley 1 and drive boss screws
Hexagon socket set bolts: 2-M4×4 (with a brass bushing)

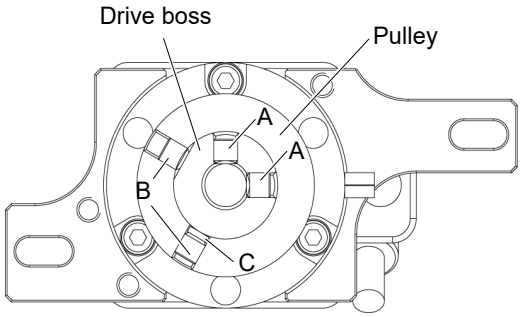
Drive boss and motor shaft screws
Hexagon socket set bolts: 2-M4×4

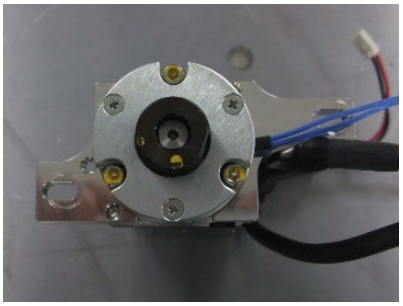
There is a brass bushing on one of the set screws fixing the drive boss and the pulley. Be careful not to lose it.

A: Pulley and motor shaft screws

B: Pulley and drive boss screws

C: Bushing

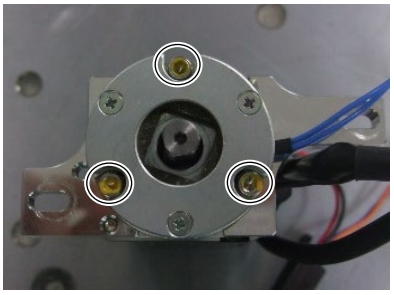




9. Remove the Joint #6 electromagnetic brake.

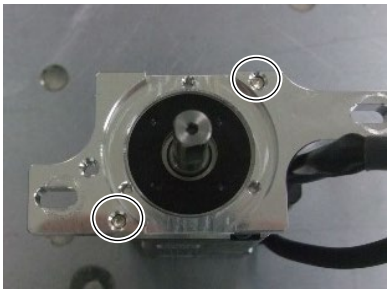
Hexagon socket set bolts: 3-M3×15 (with a spacer)

Be careful not to lose the spacers.



10. Remove the motor plate from the Joint #6 motor.

Hexagon socket head cap bolts: 2-M4×10



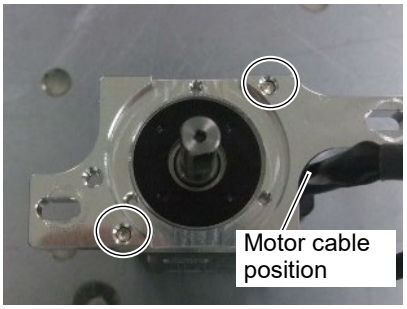
Installation: Joint #6 motor

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

1. Install the motor plate to the Joint #6 motor.

   Hexagon socket head cap bolts: 2-M4×10

   Tightening torque: 4.0 ± 0.2 N·m

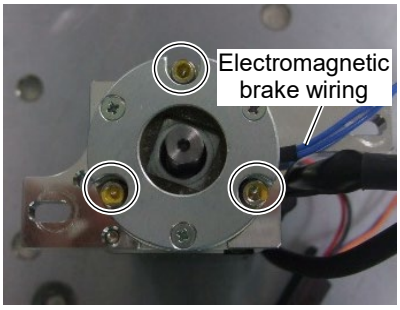


NOTE Be careful of the assembly direction of the motor plate. (See the photo.)

2. Mount the Joint #6 electromagnetic brake to the Joint #6 motor unit. Insert the spacers between the hexagon socket set screws and the Joint #6 electromagnetic brake.

   Hexagon socket set screws: 3-M3×15 (with a spacer)

   Tightening torque: 2.0 ± 0.1 N·m



NOTE Be careful of the assembly direction of the Joint #5 electromagnetic brake wiring. (See the photo.)

3. Mount the drive boss and the pulley 1 to the Joint #6 motor unit.

   Fix the drive boss and the motor shaft.
   There is an uneven part for the feeler gauge (0.5 mm) on the boss.
   Use the uneven part to leave 0.5 mm space.

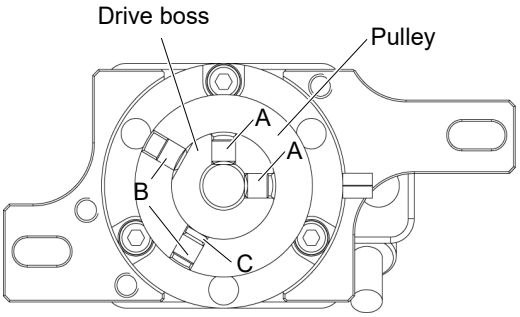
NOTE If there is no space, the parts may chafe while the motor is driving and it may result in breakage while the motor is moving.

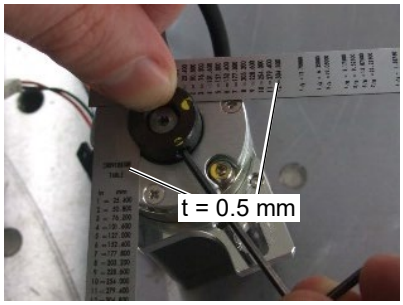
Set the set screws to the positions indicated in the figure.

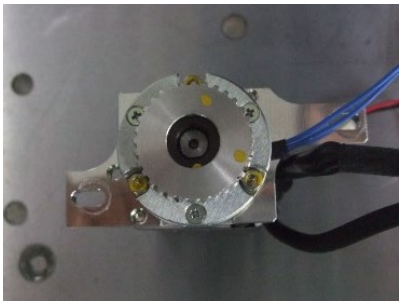
A: Pulley and motor shaft screws

B: Pulley and drive boss screws

C: Bushing







NOTE If the screw positions are incorrect or the bushing is not set, it may cause damage on the side of the part and may result in the part being unable to be removed.

Drive boss and the motor shaft:

Hexagon socket set screws: 2-M4×4

Tightening torque: 2.5 ± 0.2 N·m

Align the screws to the two flat faces of the motor shaft and fix them.

Drive boss and the pulley 1:

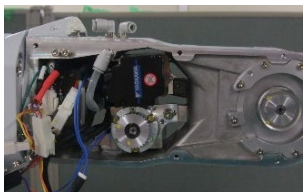
Hexagon socket set screws: 2-M4×4 (with a brass bushing)

Tightening torque: 2.5 ± 0.2 N·m

Fix the set screws while pressing the pulley 1 to the drive boss.

The brass bushing is not necessary for the screw for the flat surface (D-cut). Set the bushing to the other screw and then fix the screw.

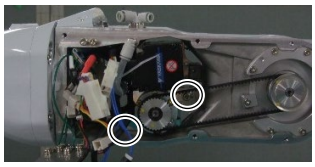
4. Put the Joint #6 motor unit inside the Arm #4.



5. Pass the timing belt around the pulley 1 and pulley 2 and fix it temporarily. Make sure that the teeth of the timing belt engage with these of the pulley.

As a rough guide of temporary fixing, check that the motor unit can be moved by hand, and it does not tilt when being pulled. If the belt is too loose or too tight, it will not have proper tension.

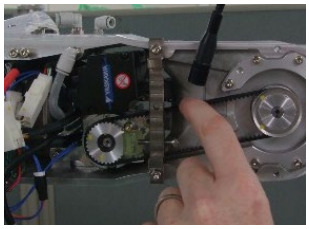
6. Apply tension to the Joint #6 timing belt and fix the Joint #6 motor unit.



Joint #6 timing belt tension: 15 to 30 N·m

Belt tension meter setting value

Weight: 2.5 g/mm width × m span, Width: 6 mm, Span: 122 mm



Hexagon socket head cap bolt: 2-M4×15 (with a plain washer)

Tightening torque: 4.0 ± 0.2 N·m

NOTE

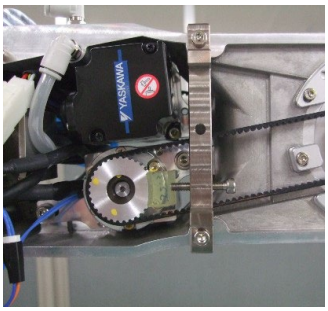
Regarding belt tension:

- Jumping (position gap) may occur if the value is below the lower limit.
- Vibration (abnormal noise) or reduction in life of the parts may occur if the value exceeds the upper limit
- When you replace with a new belt, belt may stretch and the belt tension will decrease in the initial stage of operation. Make sure to operate the robot two to three days and check the belt tension again.

When using the belt tension tensile jig (maintenance part):

Fix the belt tension tensile jig (for Joints #4, #5, and #6) with the screws (2-M4×15) and push the rubber against the pulley.

Tension is applied as the set screw (M6×15) is pushed by the rubber.



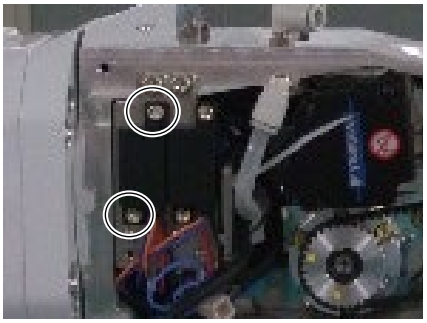
7. Connect the following connectors.

   Connectors: X062, X162, BT62, BR062

8. Install the brake power supply to the plate.

   Cross recessed head screw with captive washer: 2-M3×6

   Tightening torque: 0.45 ± 0.1 N·m

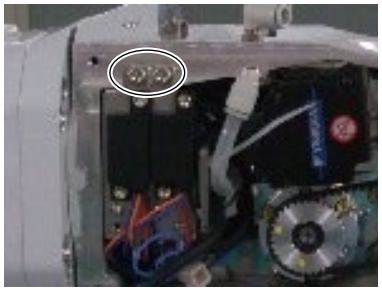


9. Fix the cable protection plate to the Arm #4.

   Hexagon socket head cap bolt: 2-M4×10

   Tightening torque: 4.0 ± 0.2 N·m

NOTE Be careful not to get the cables caught. It may result in cable breakage.



10. Install the Arm #4 side cover.
    For details, refer to *C12 Maintenance: 3. Covers*.

11. Perform the calibration.
    For details, refer to *C12 Maintenance: 16. Calibration*.

10.2 Joint #6 - Replacing the Reduction Gear Unit (Replacing the Joints #5, #6 Reduction Gear Unit Set)

For replacement of the Joint #5 and Joint #6 reduction gear unit, replace the Joints #5, #6 reduction gear unit set.

The Joints #5 and #6 reduction gear unit set is adjusted in advance.

	Name		Qty.	Note
Maintenance Parts	Joints #5, #6 Reduction gear unit set		1	1821979
	Belt tensile jig*		1	1674582
Tools	Hexagonal wrench	width across flats: 2 mm	1	For M4 hexagon socket set screws
		width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
		width across flats: 4 mm	1	For M5 hexagon socket head cap bolts
		width across flats: 5 mm	1	For M6 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Torque wrench		1	For tightening torque control
	Spanner (width across flats: 8 mm)		1	For air fittings
	Feeler gauge (0.5 mm)		2	For drive boss position adjustment
	Belt tension meter		1	Refer: Unitta U-505

For details of the replacement procedure, refer to *C12 Maintenance: 9.2 Joint #5 - Replacing the Reduction Gear Unit (Replacing the Joints #5, #6 Reduction Gear Unit)*.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

10.3 Joint #6 - Replacing the Timing Belt

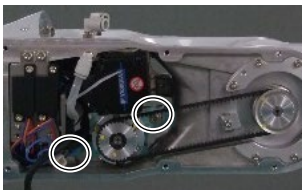
	Name		Qty.	Note
Maintenance Parts	Joint #6 timing belt	339 mm	1	1655933
	Belt tensile jig		1	1674582
Tools	Hexagonal wrench (width across flats: 3 mm)		1	For M4 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Belt tension meter		1	Refer: Unitta U-505

* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

Removal: Joint #6 Timing belt

1. Turn OFF the Controller power.
2. Remove the Arm #4 side cover.
   For details, refer to *C12 Maintenance: 3. Covers*.
3. Loosen the Joint #6 motor unit set screw.
   Hexagon socket head cap bolt: 2-M4×15 (with a plain washer)



4. Remove the Joint #6 timing belt.

Installation: Joint #6 Timing belt

1. Place the Joint #6 timing belt around the pulley 1 and 2 of the Joint #6.
2. Secure the Joint #6 motor unit.
   For details, refer to *C12 Maintenance: 10.1 Joint #6 – Replacing the Motor*, Installation steps (5) to (6) and (10) to (11).

10.4 Joint #6 - Replacing the Electromagnetic Brake

	Name		Qty.	Note
Maintenance Parts	Electromagnetic brake		1	2172928 (Common to Joints #4, #5, #6)
	Belt tensile jig		1	1674582
Tools	Hexagonal wrench	width across flats: 2 mm	1	For M4 hexagon socket set screws
		width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
	Cross-point screwdriver (#2)		1	For cross recessed head screws
	Feeler gauge (0.5 mm)		1	For adjusting the pulley position
	Belt tension meter		1	Refer: Unitta U-505

* The belt tensile jig is an assembly jig. Use the jig when adjusting belt tension.

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

Attaching the labels

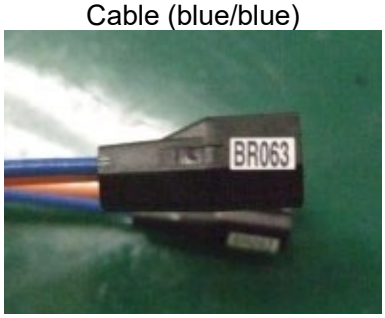
The electromagnetic brakes are common to Joints #4, #5, and #6.
In order to prevent misconnection of the connectors, attach the label for the electromagnetic brakes as shown in the photos.

Joint #6 electromagnetic brakes

BR062
Cable (red/black)

Locations of the connector labels

BR063
Cable (blue/blue)



BR063
Cable(blue/orange)

NOTE

BR063 is connected at the time of shipment. Before attaching the label, disconnect the connector.

One side of BR062 and BR063 have the same shape. Identify the connectors by color.

Removal: Joint #6 Electromagnetic brake

1. Remove the Joint #6 electromagnetic brake.

   For details, refer to *C12 Maintenance: 10.1 Joint #6 – Replacing the Motor*, Removal steps (1) through (9).

Installation: Joint #6 Electromagnetic brake

1. Mount the Joint #6 electromagnetic brake to the Joint #6 motor unit.

   For details, refer to *C12 Maintenance: 10.1 Joint #6 – Replacing the Motor*, Installation steps (2) through (11).

11. Replacing the Battery 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.

WARNING	■ Take meticulous care when handling the lithium battery. Improper handling of the lithium battery as mentioned below is extremely hazardous and may result in heat generation, leakage, explosion, or inflammation. It also may cause serious safety problems. <Improper Handling> Attempting to charge / Deforming by pressure Disassembling / Short-circuit (Polarity; Positive/Negative) Connecting batteries improperly / Heating (85 °C or more) Exposing to fire / Soldering the terminal of the lithium battery directly Forcing discharge ■ When disposing the battery, consult with the professional disposal services or comply with the local regulation. Make sure that the battery terminal is insulated, even for a used buttery. 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

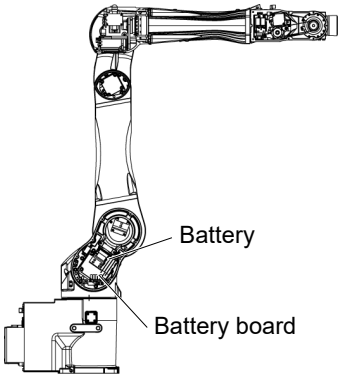
For the EPSON RC+ 7.0 the recommended replacement time for the battery can be checked in the [Maintenance] dialog box of the EPSON RC+ 7.0.
For details, refer to the following manual.
RC700 Series Maintenance Manual 6. Alarm

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.

Designated parts must be used for the lithium battery and battery board.

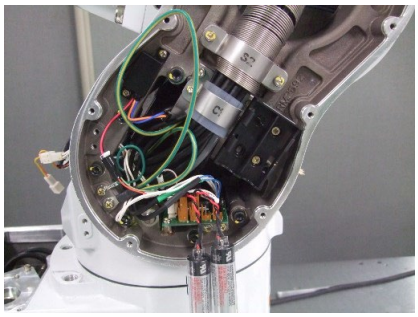
Be careful of the battery polarity to connect it correctly.



	Name	Qty.	Note
Maintenance Parts	Battery unit (Lithium battery)	1	2172925 (Two lithium batteries for replacement)
	Battery board	1	2173216
Tools	Cross-point screwdriver (#2)	1	For cross recessed head screws
	Hexagonal wrench (width across flats: 3 mm)	1	For M4 hexagon socket head cap bolts

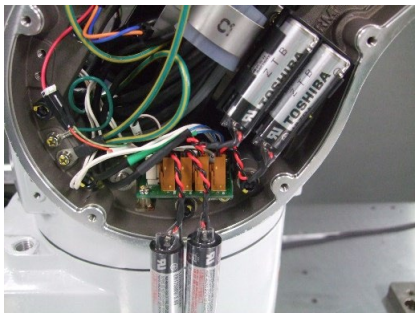
11.1 Replacing the Battery Unit (Lithium Battery)

1. Turn OFF the Controller power.
2. Remove the Arm #1 side cover.
   For details, refer to *C12 Maintenance: 3. Covers*.
3. Remove the battery from the battery box.

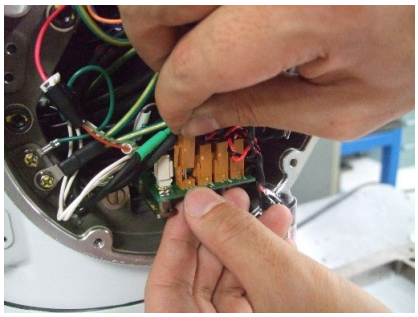


NOTE If you removed all the batteries before connecting the new ones, the calibration data will be deleted and you will need to perform calibration. Follow the steps below to remove the lithium batteries.

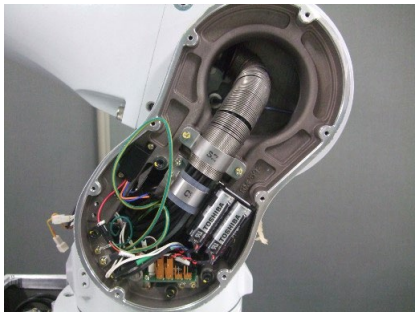
4. Connect the two new batteries to the connectors of the battery board which are not connected to anything.



5. Remove the old batteries.
   Hold the board by hand and pull the battery cable upward to remove the connector.



6. Install the battery to the battery box.



7. Install the Arm #1 side cover.
   For details, refer to *C12 Maintenance: 3. Covers*.

8. Turn ON the Controller power.

9. Check operation to see if the Manipulator's position and posture are out of position.
   Move the Manipulator to two or three points (poses) of the registered points.

10. If the Manipulator is out of position, calibrate all the joints and axes.
    For details, refer to *C12 Maintenance: 16. Calibration*.

11.2 Replacing the Battery Board

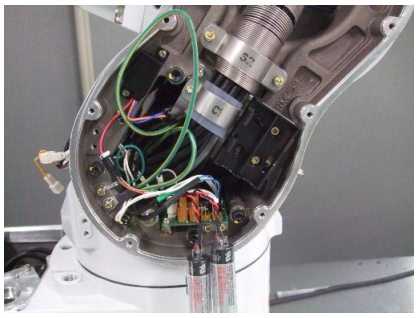
After parts have been replaced (motors, reduction gear units, brakes, timing belts, etc.), the Manipulator cannot perform positioning properly because a gap exists between the origin stored in each motor encoder and its corresponding origin stored in the Controller.
Therefore, it is necessary to match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

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

Refer to *C12 Maintenance: 16. Calibration* and perform the calibration after the parts replacement.

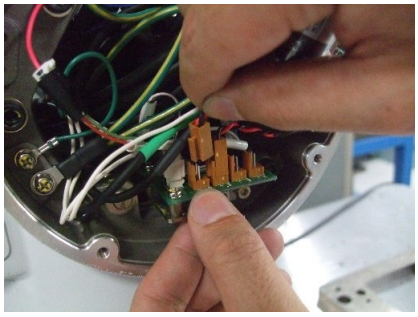
Removal: Battery board

1. Turn OFF the Controller power.
2. Remove the Arm #1 side cover.
   For details, refer to *C12 Maintenance: 3. Covers*.
3. Remove the battery from the battery box.



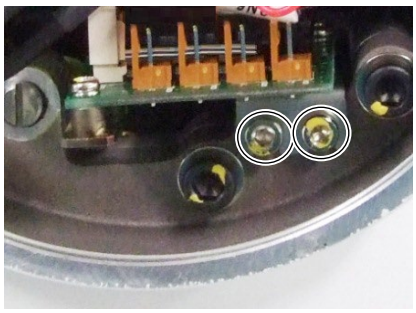
4. Remove the battery connectors.

NOTE ☞ Hold the board by hand and pull the battery cable upward to remove the connector.



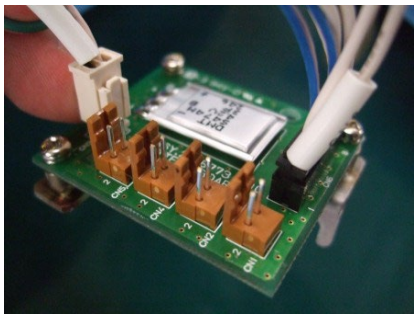
5. Remove the plate where the battery box is fixed to.

   Hexagon socket head cap bolts: 2-M4×10



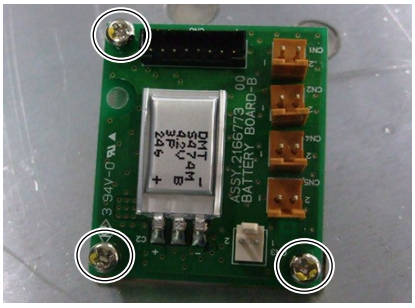
6. Remove the connectors.

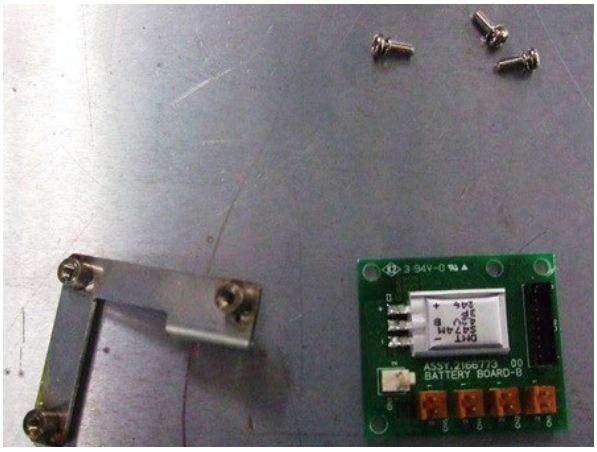
   Connectors: CN3, CN6



7. Remove the battery board fixed to the plate.

   Cross recessed head screws: 3-M3×6





Installation: Battery board

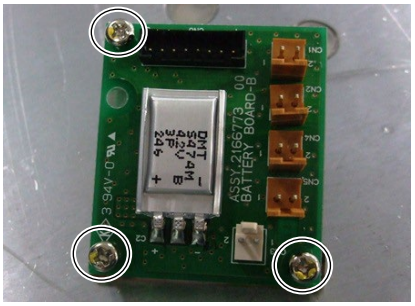
NOTE

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

1. Install the battery board to the plate.

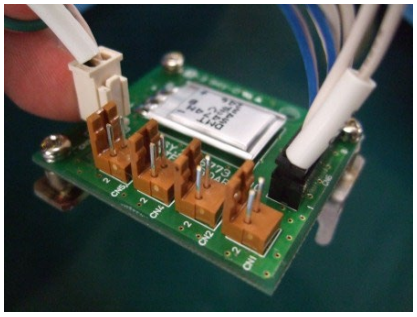
   Cross recessed head screws: 3-M3×6

   Tightening torque: 0.45 ± 0.1 N·m



2. Connect the connectors to the battery board.

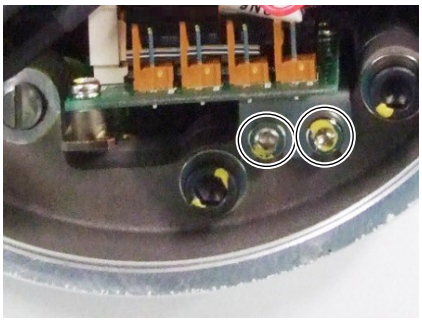
   Connector: CN3, CN6



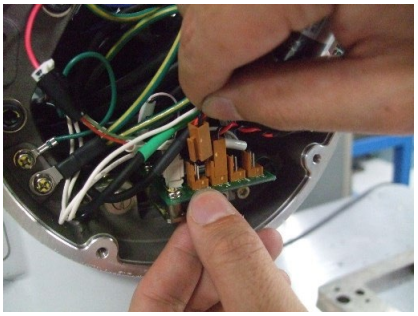
3. Install the plate where the battery board is installed to.

   Hexagon socket head cap bolts: 2-M4×10

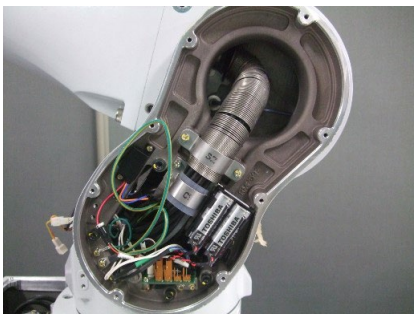
   Tightening torque: 4.0 ± 0.2 N·m



4. Connect the battery connectors.



5. Install the battery to the battery box.



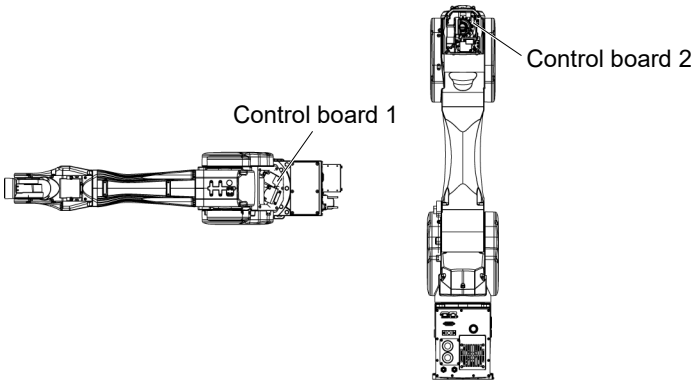
6. Install the Arm #1 side cover.
   For details, refer to *C12 Maintenance: 3. Covers.*

7. Perform the calibration.
   For details, refer to *C12 Maintenance: 16. Calibration*.

12. Replacing the Control Board

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.

Designated parts must be used for the control board.



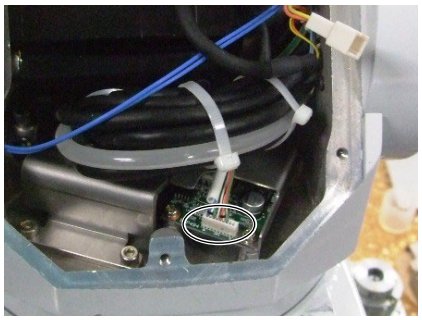
	Name	Qty.	Note
Maintenance Parts	Control board (1, 2)	1	2138032
Tools	Hexagonal wrench (width across flats: 3 mm)	1	For M4 hexagon socket head cap bolts
	Spanner (width across flats: 5.5 mm)	1	For spacers
	Cross-point screwdriver	1	For cross recessed head screws

12.1 Replacing the Control Board 1

Removal: Control board 1

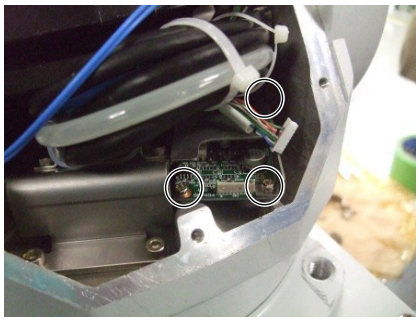
1. Turn OFF the Controller.
2. Remove the Arm #1 center cover.
   For details, refer to *C12 Maintenance: 3. Covers*.
3. Remove the connector connected to the control board 1.

   Connector: GS01



4. Remove the control board 1 fixed to the Arm #1.

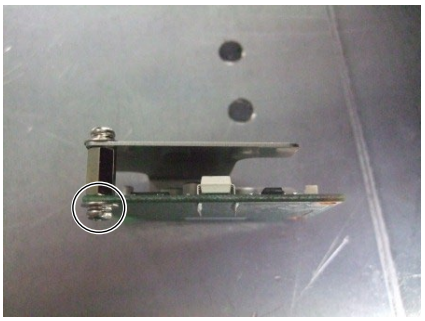
   Cross recessed head screws: 3-M3×8



NOTE Be careful not to drop the screws inside the Manipulator while removing them.

5. Remove the control board 1 protection plate.
   Cross recessed head screws with captive washer: M3×6

   It is not necessary to remove the spacer from the plate.

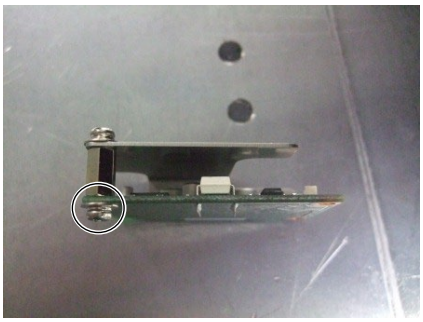


Installation: Control board 1

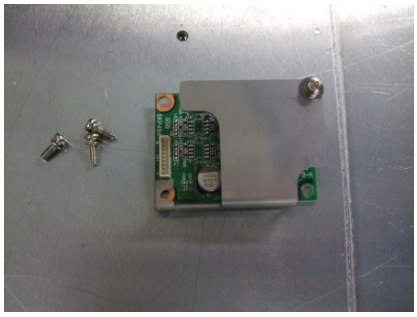
1. Install the control board 1 protection plate.

   Cross recessed head screws with captive washer: M3×6

   Tightening torque: 0.45 ± 0.1 N·m



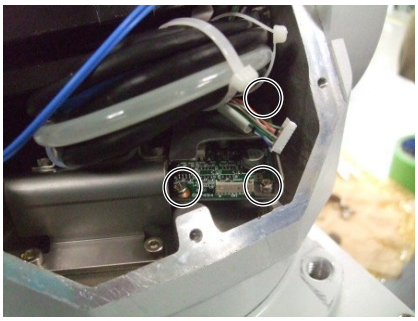
NOTE Be careful of the assembly direction of the protection plate. (See the photo)



2. Install the control board 1 to the Arm #1.

   Cross recessed head screws: 3-M3×8

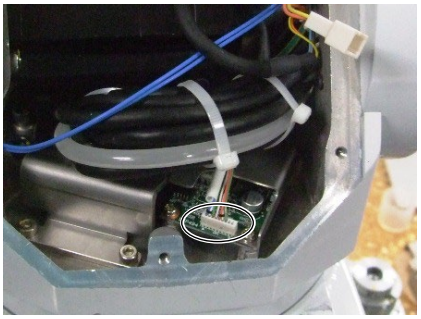
   Tightening torque: 0.45 ± 0.1 N·m



NOTE Be careful not to drop the screws inside the Manipulator while removing them.

3. Connect the connector to the control board 1.

   Connector: GS01



4. Install the Arm #1 center cover.
   For details, refer to *C12 Maintenance: 3. Covers*.

5. Check operation to see if the Manipulator's position and posture are out of position.
   Move the Manipulator to two or three points (poses) of the registered points.

6. If the Manipulator is out of position, calibrate all the joints and axes.
   For details, refer to *C12 Maintenance: 16. Calibration.*

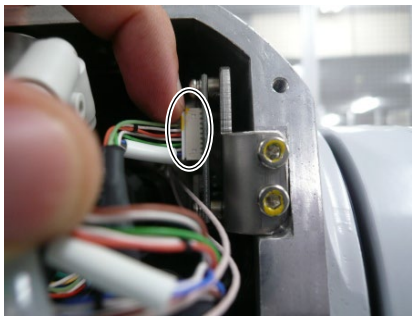
12.2 Replacing the Control Board 2

Removal: Control board 2

1. Turn OFF the Controller power.
2. Remove the Arm #3 cover.

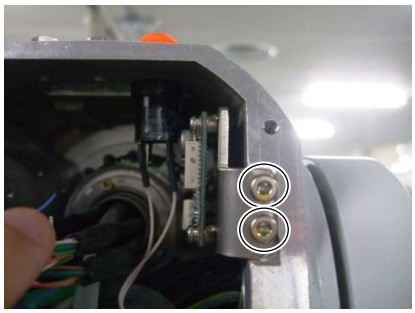
   For details, refer to *C12 Maintenance: 3. Covers*.
3. Remove the connector connected to the control board 2.

   Connector: GS02



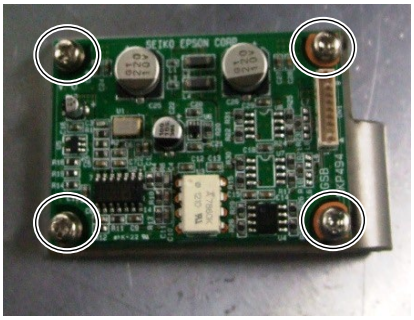
4. Remove the plate fixed to the Arm #3.

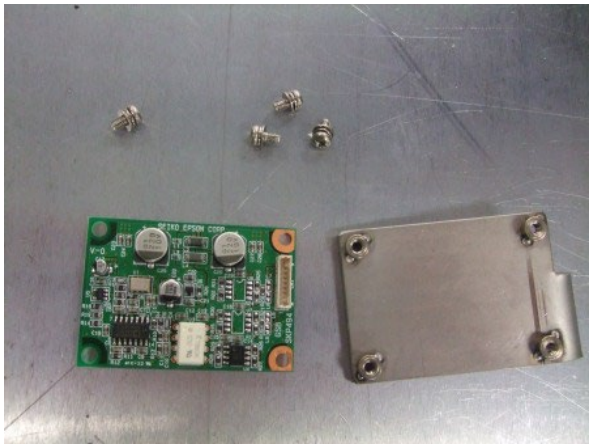
   Hexagon socket head cap bolts: 2-M4×10



5. Remove the control board 2 fixed to the plate.

   Cross recessed head screws: 4-M3×8





Installation: Control board 2

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

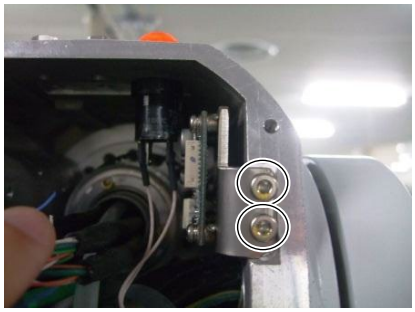
1. Install the control board 2 to the plate.

   Cross recessed head screws: 4-M3×8
   Tightening torque: 0.45 ± 0.1 N·m

NOTE Be careful of the assembly direction of the control board 2.
(See the photo.)

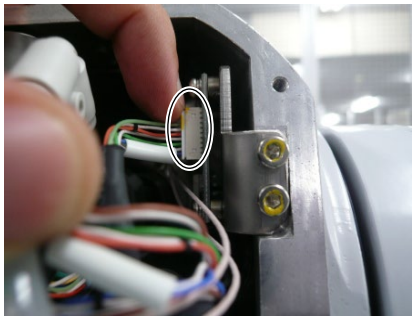
2. Install the plate with the control board 2 to the Arm #3.

   Hexagon socket head cap bolts: 2-M4×10
   Tightening torque: 4.0 ± 0.2 N·m



3. Connect the connector to the control board 2.

   Connector: GS02



4. Install the Arm #3 cover.

   For details, refer to *C12 Maintenance: 3. Covers*.

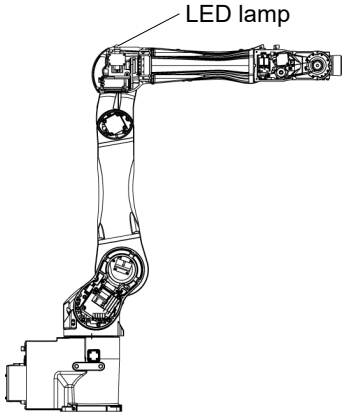
5. Turn ON the Controller power.

6. Check operation to see if the Manipulator's position and posture are out of position.
   Move the Manipulator to two or three points (poses) of the registered points.

7. If the Manipulator is out of position, calibrate all the joints and axes.
   For details, refer to *C12 Maintenance: 16. Calibration*.

13. Replacing the 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	Qty.	Note
Maintenance Part	LED lamp	1	1668127 (Standard, Clean-room models)
Tool	Cross-point screwdriver (#2)	1	For cross recessed head screws

Removal: LED lamp

1. Turn OFF the Controller power.

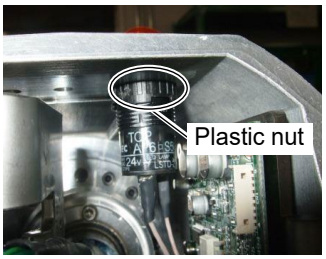
2. Remove the Arm #3 cover.
   For details, refer to *C12 Maintenance: 3. Covers*.

3. Remove the connector connected to the LED lamp.
   The connector for the LED lamp (LED) is under the Arm #3 cover.

   Connector: LED

4. Remove the LED lamp from the Arm #3.

   Turn the plastic nut securing the LED lamp in the Arm #3 counterclockwise.



Installation: LED lamp

1. Install the LED lamp to the Arm #3.
   Remove the plastic nut from the LED lamp.
   Pass the lamp from the inside of the Arm #3.
   Turn the nut clockwise and secure the lamp to the Arm #3.

2. Connect the following connector.

   Connector: LED

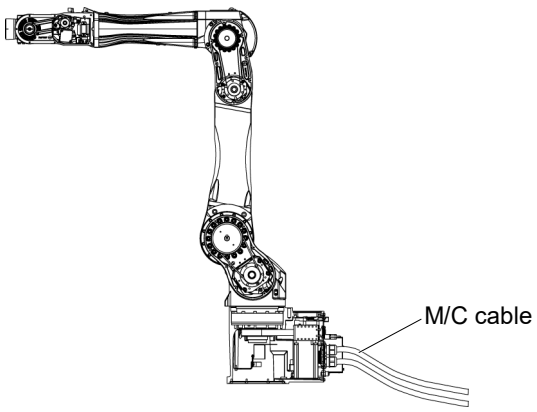
3. Install the Arm #3 cover.
   For details, refer to *C12 Maintenance: 3. Covers*.

14. Replacing the M/C Cable

Each motor is fed power by the battery for backup. Therefore, position data is held even after turning OFF the Controller. The position data will be lost when the cable connector connected to the battery is disconnected. And the EPSON RC+ will display the error message of encoder alarm occurrence when the Controller is turned ON.

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	■ When disconnecting the connectors during the replacement of the cable unit, be sure to reconnect the connectors to their proper positions. Improper connection of the connectors may result in improper function of the robot system. For details on the connections, please contact the supplier of your region. ■ When installing 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. These are extremely hazardous and may result in electric shock and/or improper function of the robot system. When routing the cables, check 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.) Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. These are extremely hazardous and may result in electric shock and/or improper function of the robot system.



	Name			Qty.	Note
Maintenance Parts	M/C cable	3 m	Straight	1	R12NZ900S1
			L-shaped	1	R12NZ900S5
		5 m	Straight	1	R12NZ900S2
			L-shaped	1	R12NZ900S6
		10 m	Straight	1	R12NZ900S3
			L-shaped	1	R12NZ900S7
		15 m	Straight	1	R12NZ900YC
			L-shaped	1	R12NZ900YB
		20 m	Straight	1	R12NZ900S4
			L-shaped	1	R12NZ900S8
	M/C cable (flexible)	3 m	Straight	1	R12NZ900S9
			L-shaped	1	R12NZ900SD
		5 m	Straight	1	R12NZ900SA
			L-shaped	1	R12NZ900SE
		10 m	Straight	1	R12NZ900SB
			L-shaped	1	R12NZ900SF
		15 m	Straight	1	R12NZ900YE
			L-shaped	1	R12NZ900YD
		20 m	Straight	1	R12NZ900SC
			L-shaped	1	R12NZ900SG
Tools	Hexagonal wrench (width across flats: 3 mm)			1	For M4 hexagon socket head cap bolts

Removal: M/C cable

1. Turn OFF the Controller power.

2. Disconnect the following connectors from the Controller.
   Power cable connector
   Signal cable connector

3. Remove the connector plate.
   For details, refer to *C12 Maintenance: 3. Covers*.

NOTE
Do not pull the connector plate forcibly.

Do not disconnect the M/C cable from the connector plate.

4. Remove the connectors.
   Connectors: X11, X12, X14, BR010, X010, X020, X040, LED, GS01

NOTE
Each connector is numbered and has a different shape.
Do not disconnect the battery connector (BT1*). Otherwise, calibration will be required.
For details, refer to *C12 Maintenance: 16. Calibration*.

5. Remove the connector sub plate.
   For details, refer to *C12 Maintenance: 3. Covers*.

Installation: M/C cable

1. Install the connector sub plate.
   For details, refer to *C12 Maintenance: 3. Covers*.

2. Connect the connectors of the new M/C cable to these of the cable unit.
   Connector: X11, X12, X14, BR010, X010, X020, X040, LED, GS01

3. Install the connector plate.
   For details, refer to *C12 Maintenance: 3. Covers*.

4. Connect the following connectors to the Controller.
   Power cable connector
   Signal cable connector

5. Turn ON the Controller power.

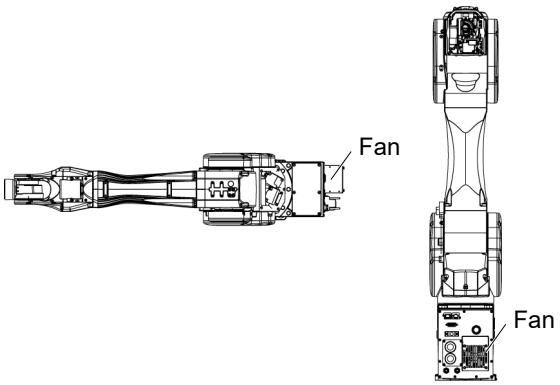
6. Check operation to see if the Manipulator's position and posture are out of position.
   Move the Manipulator to two or three points (poses) of the registered points.

7. If the battery connector (BT1*) was disconnected, calibrate the Joint #1.
   For details, refer to *C12 Maintenance: 16. Calibration*.

8. If the Manipulator is off position, calibrate all the joints and axes.
   For details, refer to *C12 Maintenance: 16. Calibration*.

15. Replacing the Fan

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.



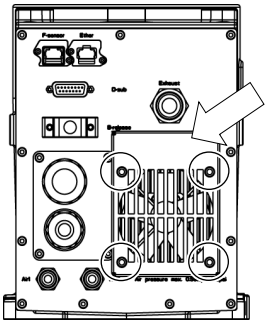
	Name	Qty.	Note
Maintenance Part	Fan	1	2177465
Tool	Cross-point screwdriver	1	For cross recessed head screws

(Figure: Cable backward model)

Removal: Fan

1. Remove the fan cover screws while supporting the cover.

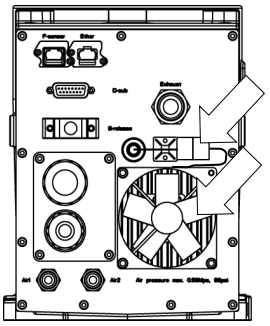
   Cross recessed head screws with washer: 4-M4×35



NOTE The cover falls when the screws are removed.
When removing the screws, be sure to support the cover.

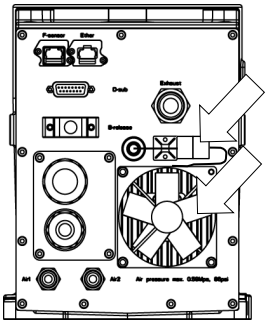
2. Remove the fan cover.

3. Remove the fan connectors.
4. Remove the fan.

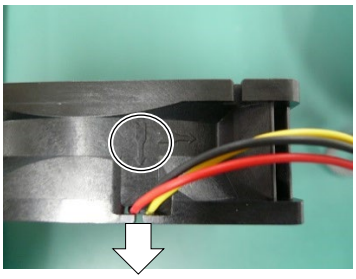


Installation: Fan

1. Install the fan.



NOTE Be careful of the installation direction of the fan.
The arrow on the fan (indicated with the arrow in the photo) should point the heat sink, and the cables should come to the upper side of the fan.

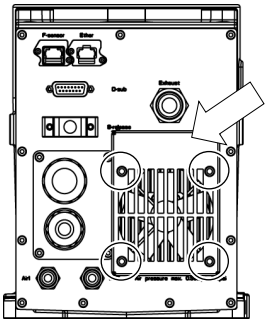


2. Connect the fan connectors.

3. Install the fan cover.

   Cross recessed head screws with washer: 4-M4×35

   Tightening torque: 0.9 ± 0.1 N·m



16. Calibration

16.1 Overview

After parts have been replaced (motors, reduction gear units, timing belts, etc.), the Manipulator cannot perform positioning properly because a gap exists between the origin stored in each motor encoder and its corresponding origin stored in the Controller.
Therefore, it is necessary to match these origins after replacing the parts.
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 the *Installation and Design Precautions* in the *Safety* chapter of the *EPSON RC+ User’s Guide*. ■ 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.

In EPSON RC+, a coordinate point including the arm pose is defined as “point” and its data is called “point data”.

There are two methods to move the Manipulator during calibration.
- Releasing the electromagnetic brake and moving the arms manually.
  For details, refer to the *C Series Manual C12 Manipulator 1.5 How to Move Arms with the Electromagnetic Brake*.
- Moving the Manipulator using Jog & Teach.

Moving the Manipulator while releasing the electromagnetic brake involves risk as described below.
It is recommended to move the Manipulator using Jog & Teach.

CAUTION	■ Normally, release the brake of joints one by one. Take extra care if you need to release the brakes of two or more joints simultaneously. Releasing the brakes of two or more joints simultaneously may cause hands and fingers to be caught and/or equipment damage to or malfunction of the Manipulator as the arms of the Manipulator may move in unexpected directions. ■ After releasing the brake, the arm may fall by its own weight or move to the unexpected direction. Make sure to prepare a countermeasure to prevent the arm from falling and check the operation environment is safe.

Also, pay attention to the following points at the encoder initialization.

CAUTION	■ The Joint #1 and Joint #4 have no mechanical stops and they may be rotated more than 360 degrees. If the encoder initialization is performed with improper posture, the Manipulator moves outside the operation range. If the Manipulator was moved outside the operation range, the internal wiring may be damaged by being twisted or pinched and it may result in Manipulator malfunction.

NOTE

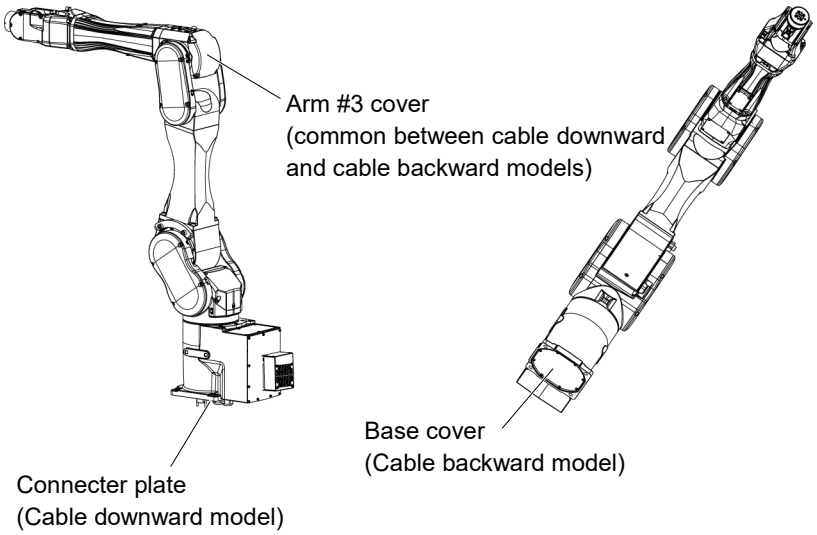
When the home positions of the Joints #1 and #4 are uncertain, check torsion of the internal cables. The home positions are where the Manipulator has the internal cables not twisted at the basic orientation described in *C Series Manual C12 Manipulator 3.7 Checking the Basic orientation*.

Torsion of the internal cables can be checked by removing the following covers.

Joint #1 : Base cover (Cable backward model)

: Connecter plate (Cable downward model)

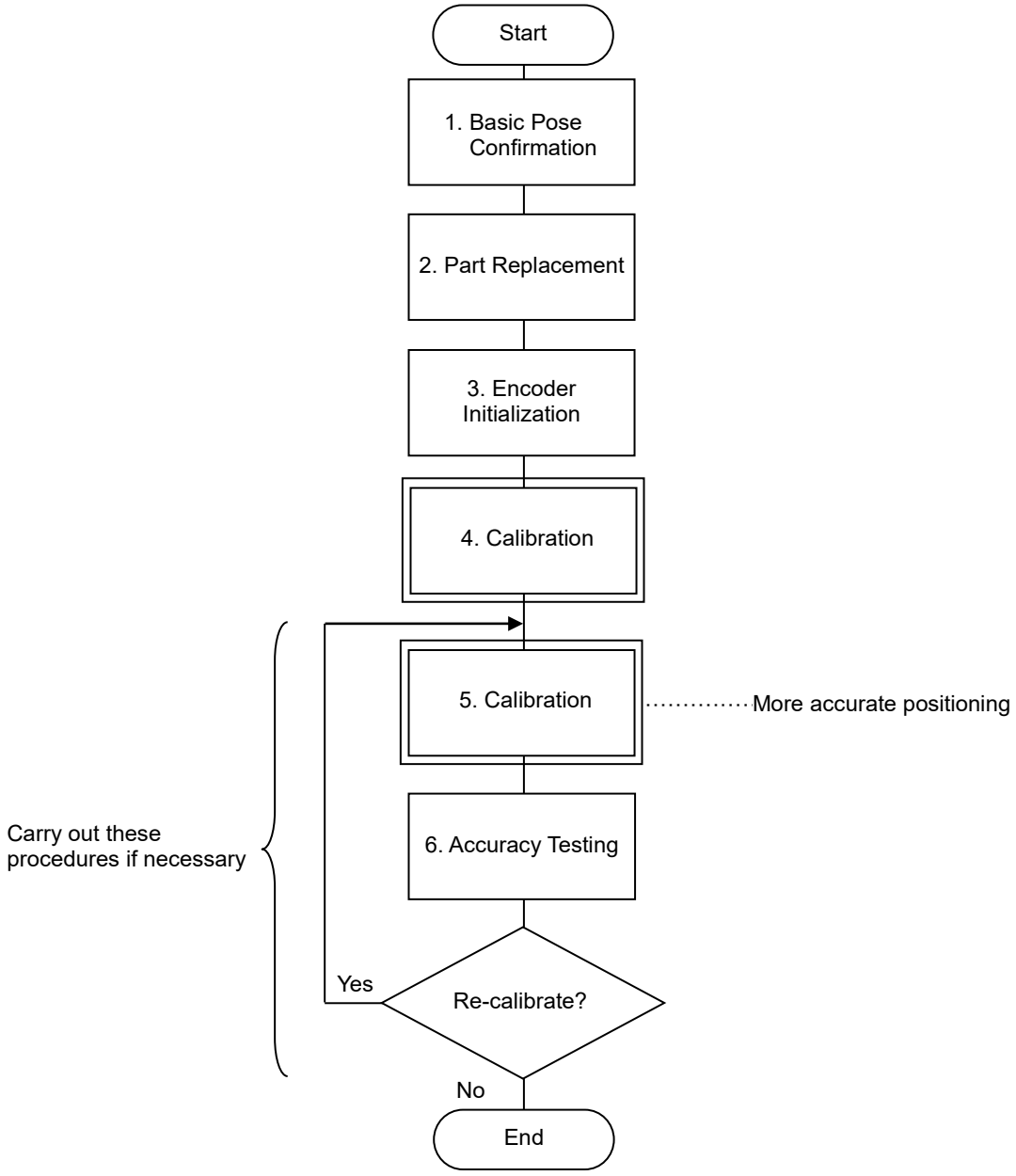
Joint #4 : Arm #3 cover (common between cable downward and cable backward models)



For details on Jog & Teach, refer to the following manual.
EPSON RC+ User's Guide
5.12.1 Robot Manager Command Tools: Robot Manager: Jog and Teach Page.

NOTE
- For details about the basic orientation, refer to *C Series Manual C12 Manipulator 3.7 Checking the Basic orientation.*
- Whenever possible, calibrate one joint at a time. (Also, replace parts of one joint at a time whenever possible.) If you calibrate the origins for multiple joints simultaneously, it will be more difficult to verify their origins and obtain the origin correct positions.
  However, joint #5 cannot be calibrated alone due to the structure of the Manipulator. Make sure you calibrate joint #5 and #6 at the same time.

Calibration Flowchart



16.2 Calibration Procedure

Command Input

Command execution is required in some calibration procedures.
Select the EPSON RC+ menu-[Tools]-[Command Window].

This step is omitted in the calibration procedures.

Jog Motion

Setting of the jog motion is required in some calibration procedures.
Select EPSON RC+ menu-[Tools]-[Robot Manager] and select the [Jog & Teach] page.

The panel, window, and page above are indicated as [Jog & Teach] in the calibration procedures.

Follow steps 1 to 6 to calibrate the Manipulator.

1. Basic Pose Confirmation

   Pose data (Point data) prior to the part replacement (motors, reduction gear unit, or belt) is necessary for the calibration.

   Verify the recorded pulse values of the basic pose obtained in the *C Series Manual C12 Manipulator 3.7 Checking the Basic orientation*.

2. Part Replacement

   Replace parts as instructed in this manual.
   Be careful not to injure yourself or damage parts during part replacement.

3. Encoder Initialization

   Turn ON the Controller while all joints are in the motion range.

   The error message “Encoder alarm has occurred. Check robot battery. EPSON RC+ must be restarted.” will be displayed.

   Initialize the encoder at the current position and reset the error.

   Initialize the encoder using one of the following procedures.

   Execute the following command at the [Monitor Window].

   EPSON RC+

   `>Encreset` [The joint number (1 to 6) of the encoder to be reset]

   Select EPSON RC+ menu-[Tools]-[Controller], then click <Reset Controller>.

After resetting the error, the motor encoder of the joint whose parts have been replaced will be initialized.
Set the jog mode to “Joint” in [Jog & Teach] and operate the Manipulator in jog motion to match the home position marks (0 pulse position) of the joint accurately.

When the joint cannot move to the home position, operate the Manipulator to match the tram mark placed in *C Series Manual C12 Manipulator 3.7 Checking the Basic Orientation* as accurate as possible.

Initialize the encoder when the joint matches the home position or the tram mark.

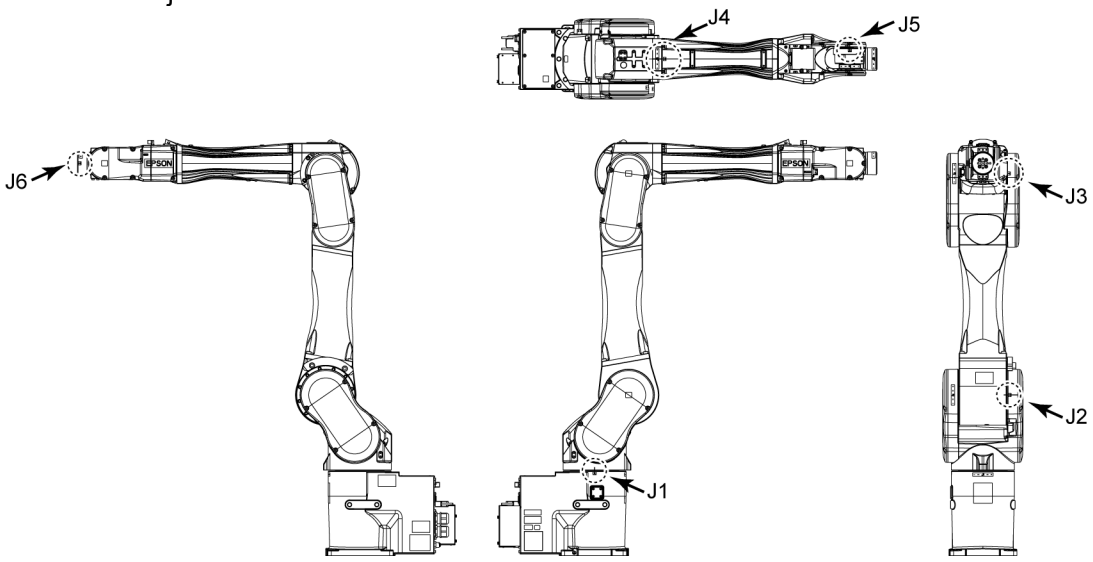
For the encoder initialization, refer to the procedure indicated above.

NOTE

When the origin of the Joint #5 is calibrated, the Joint #6 will be out of position. (Due to the structure of the Manipulator, any offset in the position of the Joint #5 affects the Joint #6.)
Calibrate the origin of the Joint #6 together when calibrating the Joint #5.

4. Calibration

Calibration marks of each joint



4-1 Move the arm you want to calibrate to the position of the calibration mark.

EPSON RC+

Select menu-[Tool]-[Robot Manager]-[Jog & Teach] panel to move the Manipulator.

If an error occurs after replacing the motor and you cannot use the [Jog & Teach] panel or “Brake OFF, *” does not work (* is an axis number to calibrate.), go through the steps (4) and (5) now.

Then, [Jog & Teach] panel and “Brake OFF, *” will be available. Move the arm you want to calibrate to the position of the calibration mark.

4-2 Reset the encoder.

EPSON RC+

Execute one of the following commands to reset the encoder of the joint you want to calibrate from the menu-[Tool]-[Command Window].

Joint #1 `>Encreset 1`
Joint #2 `>Encreset 2`
Joint #3 `>Encreset 3`
Joint #4 `>Encreset 4`
Joint #5 `>Encreset 5, 6`
Joint #6 `>Encreset 6`

4-3 Reboot the Controller.

EPSON RC+

Click EPSON RC+ menu-[Tool]-[Controller]-<Reset Controller>.

4-4 Input the command in the Command window and execute it.

EPSON RC+

Execute one of the following commands to reset the encoder of the joint you want to calibrate from the menu-[Tool]-[Command Window].

```
>calpls 0,0,0,0,0,0
```
* Manipulator does not move.

4-5 Perform the calibration.

EPSON RC+

Execute one of the following commands to reset the encoder of the joint you want to calibrate from the menu-[Tool]-[Command Window].

Joint #1 `>calib 1`
Joint #2 `>calib 2`
Joint #3 `>calib 3`
Joint #4 `>calib 4`
Joint #5 `>calib 5,6`
Joint #6 `>calib 6`

Move the arm to several points to check if the arm moves to the original positions properly.

Teach points if fine adjustment is necessary.

5. Calibration (More accurate positioning)

EPSON RC+

Move the Manipulator to the selected point data by jogging in [Jog & Teach].

Move the joint* which is not calibrated to the specified point by motion command.

*When the Joint #5 is being calibrated, move the Joints #1 - #4 to the home positions.

For example, when the selected point data is “P1”, execute “Motor On” in [Control Panel] and execute “Go P1” in [Jog & Teach].

Position the calibrating joint* to the selected point data position accurately by jog command.

* When the Joint #5 is being calibrated, move the Joint #5 and #6 to the home positions.

Select the “Joint” jog mode from [Jog & Teach] to operate in the jog motion.

Enter the command below in the command window and execute it.

Execute the command below in the menu -[Tools]-[Command Window].

```
>calpls ppls(P1,1), ppls(P1,2), ppls(P1,3), ppls(P1,4),
ppls(P1,5), ppls(P1,6)
```

*The Manipulator will not move.

Perform the calibration. Input one of the following commands according to the joint being calibrated.

Joint #1 : `>calib 1`
Joint #2 : `>calib 2`
Joint #3 : `>calib 3`
Joint #4 : `>calib 4`
Joint #5 : `>calib 5,6`
Joint #6 : `>calib 6`

6. Accuracy Testing

Move the Manipulator to a different pose (point) to verify whether it moves back to the original position. If accuracy is inadequate, it is necessary to re-calibrate the origin using a different pose (point). You must set the pose (point) again if the Manipulator does not move back to the original position after re-calibration.

17. C12 Maintenance Parts List

Name		Code	Note		Reference	Overhaul *1
AC servo motor	Joint #1 unit	2172922	1000 W, unit		5.1.1, 5.2.1	✓
	Joint #2	2168683	750 W, single item		6.1	✓
	Joint #3	2168684	400 W, single item		7.1	✓
	Joints #4, 5, 6	2206705	150 W, single item		8.1, 9.1, 10.1	✓
Reduction gear unit *2	Joint #1	1674604	Unit		5.1.2, 5.2.2	✓
	Joint #2	1674606			6.2	✓
	Joint #3	1674608			7.2	✓
	Joint #4	1821978			8.2	✓
	Joints #5, 6	1821979			9.2, 10.2	✓
Electromagnetic brake	Joints #1, 2	2172926	A set of brake and power supply		5.1.4, 5.2.4, 6.4	✓
	Joint #3	2172927			7,4	✓
	Joints #4, 5, 6	2172928			8.4, 9.4, 10.4	✓
J1 brake positioning jig		1675081	Assembly tool		5.1.4, 5.2.4	
Timing belt	Joint #1	1655930	Width 20 mm	595 mm	5.1.3, 5.2.3	✓
	Joint #2	1655927	Width 14 mm	540 mm	6.3	✓
	Joint #3	1655919	Width 10 mm	501 mm	7.3	✓
	Joint #4	1655931	Width 6 mm	243 mm	8.3	✓
	Joint #5	1655932		330 mm	9.3	✓
	Joint #6	1655933		339 mm	10.3	✓
Belt tensile jig		1674582	Assembly tool		5, 6, 7, 8, 9, 10	
Battery unit		2172925	(2 lithium batteries for replacement)		11.1	
Battery board		2173216			11.2	
Grease *3	Joints #1, #2, #3, #4, #5 : SK-1A	—	For purchasing grease, liquid gasket, and adhesive, please contact the supplier of your region.		2.3, 5.1.2, 5.2.2, 7.2, 8.2, 9.2	
	Joint #6, Bevel gear : SK-2	—			2.3, 10.2	
	Cable : GPL-224	—			4	
Adhesive	LOCTITE641	—			8.2, 9.2	
Grease-up kit		1674592	Set of grease gun, nipple, and extension tool		2.3	
Grease plug		1656158			2.3	
Control board 1, 2	Arms #1, #3	2138032			12	
O ring	Joint #2	1670635	Arm #1 side		6.2	
		1656140	Arm #2 side			
	Joint #3	1263977	Arm #2 side		7.2	
		1510528	Arm #3 side			
	Joint #4	1263976	Arm #3 side		8.2	
		1520370	Arm #4 side			
	Grease inlet	1657289	Base, Arm #5		2.3, 11	
LED lamp		1668127			13	

Name				Code	Note	Reference
M/C cable		3 m	Straight	R12NZ900S1		14
			L-shaped	R12NZ900S5		
		5 m	Straight	R12NZ900S2		
			L-shaped	R12NZ900S6		
		10 m	Straight	R12NZ900S3		
			L-shaped	R12NZ900S7		
		15 m	Straight	R12NZ900YC		
			L-shaped	R12NZ900YB		
		20 m	Straight	R12NZ900S4		
			L-shaped	R12NZ900S8		
M/C cable (flexible)		3 m	Straight	R12NZ900S9		
			L-shaped	R12NZ900SD		
		5 m	Straight	R12NZ900SA		
			L-shaped	R12NZ900SE		
		10 m	Straight	R12NZ900SB		
			L-shaped	R12NZ900SF		
		15 m	Straight	R12NZ900YE		
			L-shaped	R12NZ900YD		
		20 m	Straight	R12NZ900SC		
			L-shaped	R12NZ900SG		
Cable unit				2172931		4
Wire tie		AB100		1675753	1 bag (100 pcs: white)	4
		AB150		1675754	1 bag (100 pcs: white)	
		AB350		1697428	1 bag (50 pcs: white)	5.1, 5.2
Felt sheet		For Arm #3		1673981	Square	8
		For Arm #3 maintenance cover		1673980	Square	8
		For Joint #4		1673979	Round	8
		For Joint #5		1673978	Round	9
Fan				2177465		15
Heat radiation sheet		For heat radiation block		1694609		5.1, 5.2
		For Motor		1655043	Joint #1, 2 common	5.1, 5.2, 6.2
Cover	Arm #1	Center cover		1675435	Metal cover Common to Standard/ Clean-room models	3
		Side cover		1674537	Standard model Plastic cover	3
	Arm #2	Side cover (left)		1655114		
		Side cover (right)		1674542		
	Arm #3	Cover		1674543		
	Arm #4	Side cover (left)		1822063		
		Side cover (right)		1822064		
	Arm #1	Side cover		1674548	Clean-room model Plating cover	3
	Arm #2	Side cover (left)		1655127		
		Side cover (right)		1674550		
	Arm #3	Cover		1674551		
	Arm #4	Side cover (left)		1822065		
		Side cover (right)		1822066		
Gasket	Base	Gasket For Heat sink		1694610	Clean-room model	3

*1 Overhaul

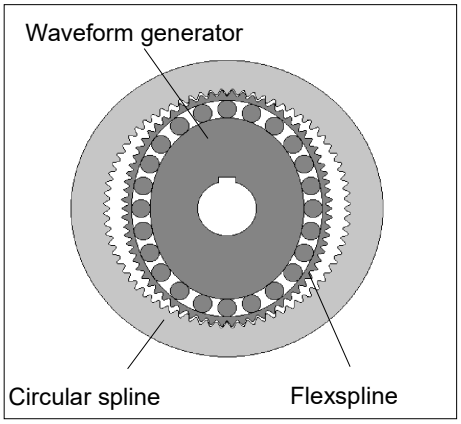
As a rough indication, perform the overhaul (parts replacement) before reaching 20,000 operation hours of the Manipulator. The operation hours can be checked in [Controller Status Viewer] dialog - [Motor On Hours]. For details, refer to *C12 Maintenance 2.2 Overhaul*.

*2 Reduction Gear Unit:

A reduction gear unit consists of the following three parts. When replacing the reduction gear unit, be sure to replace these parts all together as a set.

Waveform generator

The waveform generator consists of an ellipsoidal cam and ball bearings on outer circumference. The inner ring of the bearings is secured to the cam, while the outer ring is capable of flexible deformation through the ball bearings.



Flexspline

A thin, elastic, cup-shaped metal body with gear teeth around the outer circumference of the opening.

Circular spline

A rigid, ring-shaped body with gear teeth on the inner circumference. The circular spline has two more teeth than the flexspline does.

The splines are greased. Be sure to keep the grease from being attaching to the clothes.

*3 Regarding purchase of grease, liquid gasket and adhesive

Due to the chemicals regulations of individual countries (the UN GHS), we are requesting our customers to purchase grease and other materials required for maintenance from the manufacturers listed in the table below as of April 2015.

Regarding purchase of grease and other materials, please contact the following manufacturers. If there is anything unclear, please contact the supplier of your region.

Product name	Manufacturer	URL
Harmonic Grease SK-1A Harmonic Grease SK-2	Harmonic Drive Systems Inc.	https://www.harmonicdrive.net/
Krytox®GPL-224	Chemours	https://www.chemours.com/en/brands-and-products
1207B	ThreeBond Co.,Ltd	https://www.threebond.com
LOCTITE641	LOCTITE	https://loctite.com/

18. C12 Option Parts list

Name		Code	Note	Reference *
Brake release unit (with M/C short connector)		R12NZ900N4	For Europe	6.1
		R12NZ900N5	For U.S. & Japan	
MC short connector		R12NZ900N7	For brake release unit	
Camera plate unit		R12NZ9003F (Common to C3, C4, C8)	Old Code: R12B031922	6.2
Tool adapter (ISO flange)		R12NZ900LQ		6.3
Adjustable mechanical stop	J1	R12NZ900LR		6.4
	J2	R12NZ900LT		
	J3	R12NZ900LU		
Fittings for customer use	ø6 straight	R12NZ900LV		6.5
	ø6 elbow	R12NZ900LW		
Standard user connector kit	D-sub	R12NZ900LX		
Waterproof user connector kit	D-sub	R12NZ900LY		
	Ethernet	R12NZ900LZ		

* Refer to each manipulator's page of C series manual.