FOREWORD

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

WARRANTY

The Manipulator 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.

Product malfunctions resulting from normal handling or operation will be repaired free of charge during the normal warranty period. (Please contact the supplier of your region for warranty period information.)

However, customers will be charged for repairs in the following cases (even if they occur during the warranty period):

1. Damage or malfunction caused by improper use which is not described in the manual, or careless use.
2. Malfunctions caused by customers’ unauthorized disassembly.
3. Damage due to improper adjustments or unauthorized repair attempts.
4. Damage caused by natural disasters such as earthquake, flood, etc.

Warnings, Cautions, Usage:

1. If the Manipulator or associated equipment is used outside of the usage conditions and product specifications described in the manuals, this warranty is void.
2. If you do not follow the WARNINGS and CAUTIONS in this manual, we cannot be responsible for any malfunction or accident, even if the result is injury or death.
3. We cannot foresee all possible dangers and consequences. Therefore, this manual cannot warn the user of all possible hazards.
TRADEMARKS
Microsoft, Windows, and Windows logo are either registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries. Other brand and product names are trademarks or registered trademarks of the respective holders.

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 and Installation    Read this manual first
Regarding battery disposal

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.

The battery removal/replacement procedure is described in the following manuals:
Controller manual / Manipulator manual (Maintenance section)
Before Reading This Manual

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

Structure of Control System

The G3 series Manipulators can be used with the following combinations of Controllers and software.

The operating methods and descriptions are different depending on which software you are using. The following icons are put beside appropriate text as necessary. Use the descriptions that pertain to the software you are using.

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
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<td>Controller</td>
</tr>
<tr>
<td>RC700-A</td>
<td>Control Unit Drive Unit</td>
</tr>
</tbody>
</table>

The motions of the manipulators such as in emergency stops vary depending on the Controllers since they have different control methods. Details are described in the manual.

Turning ON/OFF Controller

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

Shape of Motors

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

Setting by Using Software

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

![EPSON RC+ icon]

Figures in this Manual

The figures of manipulators indicated in this manual are basically Standard-model Manipulator. Unless special instruction is provided, the specifications of Standard-model and Cleanroom-model are the same.
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Setup & Operation

This volume contains information for setup and operation of the G3 series Manipulators. Please read this volume thoroughly before setting up and operating the Manipulators.
1. Safety

Installation and transportation of robots and robotic equipment shall be performed by qualified personnel and should conform to all national and local codes. Please read this manual and other related manuals before installing the robot system or before connecting cables.

Keep this manual handy for easy access at all times.

1.1 Conventions

Important safety considerations are indicated throughout the manual by the following symbols. Be sure to read the descriptions shown with each symbol.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="WARNING" /></td>
<td>This symbol indicates that a danger of possible serious injury or death exists if the associated instructions are not followed properly.</td>
</tr>
<tr>
<td><img src="image" alt="WARNING" /></td>
<td>This symbol indicates that a danger of possible serious injury or death caused by electric shock exists if the associated instructions are not followed properly.</td>
</tr>
<tr>
<td><img src="image" alt="CAUTION" /></td>
<td>This symbol indicates that a danger of possible harm to people or physical damage to equipment and facilities exists if the associated instructions are not followed properly.</td>
</tr>
</tbody>
</table>
1.2 Design and Installation Safety

Only trained personnel should design and install the robot system. Trained personnel are defined as those who have taken robot system training and maintenance training classes held by the manufacturer, dealer, or local representative company, or those who understand the manuals thoroughly and have the same knowledge and skill level as those who have completed the training courses.

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.

The following items are safety precautions for design personnel:

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>■ Personnel who design and/or construct the robot system with this product must read the Safety chapter in the EPSON RC+ User’s Guide to understand the safety requirements before designing and/or constructing the robot system. Designing and/or constructing the robot system without understanding the safety requirements is extremely hazardous, may result in serious bodily injury and/or severe equipment damage to the robot system, and may cause serious safety problems.</td>
</tr>
<tr>
<td>■ The Manipulator and the Controller must be used within the environmental conditions described in their respective manuals. This product has been designed and manufactured strictly for use in a normal indoor environment. Using the product in an environment that exceeds the specified environmental conditions may not only shorten the life cycle of the product but may also cause serious safety problems.</td>
</tr>
<tr>
<td>■ The robot system must be used within the installation requirements described in the manuals. Using the robot system outside of the installation requirements may not only shorten the life cycle of the product but also cause serious safety problems.</td>
</tr>
</tbody>
</table>

Further precautions for installation are mentioned in the chapter Setup & Operation: 3. Environments and Installation. Please read this chapter carefully to understand safe installation procedures before installing the robots and robotic equipment.
1.2.1 Strength of the Ball Screw Spline

If a load exceeding the allowable value is applied to the ball screw spline, it may not work properly due to deformation or breakage of the shaft. If the ball screw spline is applied the load exceeding the allowable value, it is necessary to replace the ball screw spline unit. The allowable loads differ depending on distance where the load is applied to. For calculating the allowable load, see the calculation formula below.

[Allowable bending moment]

\[ G3: M = 13,000 \text{ Nmm} \]

Example: If 130 N load is applied at 100 mm from the end of the spline nut

[Moment]

\[ M = F \cdot L = 100 \times 130 = 13,000 \text{ Nmm} \]
### 1.3 Operation Safety

The following items are safety precautions for qualified Operator personnel:

| WARNING | Please carefully read the *Safety-related Requirements* in the *Safety* chapter of the *Safety and Installation* manual before operating the robot system. Operating the robot system without understanding the safety requirements is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system. |
| WARNING | Do not enter the operating area of the Manipulator while the power to the robot system is turned ON. Entering the operating area with the power ON is extremely hazardous and may cause serious safety problems as the Manipulator may move even if it seems to be stopped. |
| WARNING | 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. |
| WARNING | Immediately press the Emergency Stop switch whenever the Manipulator moves abnormally while the robot system is operated. |
| 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. |
| 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. |
| 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. |
Whenever possible, only one person should operate the robot system. If it is necessary to operate the robot system with more than one person, ensure that all people involved communicate with each other as to what they are doing and take all necessary safety precautions.

Joint #1, #2, and #4:
If the joints are operated repeatedly with the operating angle less than 5 degrees, they may get damaged early because the bearings are likely to cause oil film shortage in such situation. To prevent early breakdown, move the joints larger than 50 degrees for about five to ten times a day.

Joint #3:
If the up-and-down motion of the hand is less than 10 mm, move the joint a half of the maximum stroke for five to ten times a day.

Oscillation (resonance) may occur continuously in low speed Manipulator motion (Speed: approx. 5 to 20%) depending on combination of Arm orientation and end effector load. Oscillation arises from natural oscillation frequency of the Arm and can be controlled by following measures.

- Changing Manipulator speed
- Changing the teach points
- Changing the end effector load
1.4 Emergency Stop

Emergency stop motions of the Manipulators vary due to difference of control methods of the Controllers. See the section for your Controller model.

1.4.1 RC180

If the Manipulator moves abnormally during operation, immediately press the Emergency Stop switch. Stops the power supply to the motor, and the arm stops in the shortest distance with the dynamic brake and mechanical brake.

However, avoid pressing the Emergency Stop switch unnecessarily while the Manipulator is running normally. Otherwise, the Manipulator may hit the peripheral equipment since the operating trajectory while the robot system stops is different from that in normal operation. It may also result in short life of the reduction gear unit due to the shock or the electromagnetic brake due to the worn friction plate.

To place the system in emergency mode during normal operation, press the Emergency Stop switch when the Manipulator is not moving.

Refer to the Controller manual for instructions on how to wire the Emergency Stop switch circuit.

Do not press the Emergency Stop switch unnecessarily while the Manipulator is operating. Pressing the switch during the operation makes the brakes work. This will shorten the life of the brakes due to the worn friction plates.

Normal brake life cycle: About 2 years (when the brakes are used 100 times/day)

Do not turn OFF the Controller while the Manipulator is operating.

If you attempt to stop the Manipulator in emergency situations such as “Safeguard Open”, make sure to stop the Manipulator using the Emergency Stop switch of the Controller.

If the Manipulator is stopped by turning OFF the Controller while it is operating, following problems may occur.

- Reduction of the life and damage of the reduction gear unit
- Position gap at the joints

In addition, if the Controller was forced to be turned OFF by blackouts and the like while the Manipulator is operating, make sure to check the following points after power restoration.

- Whether or not the reduction gear is damaged
- Whether or not the joints are in their proper positions

If there is a position gap, perform calibration by referring to the Maintenance 14. Calibration in this manual.

Before using the Emergency Stop switch, be aware of the followings.

- The Emergency Stop (E-STOP) switch should be used to stop the Manipulator only in case of emergencies.
- To stop the Manipulator operating the program except in emergency, use Pause (halt) or STOP (program stop) commands. Pause and STOP commands do not turn OFF the motors. Therefore, the brake does not function.
- For the Safeguard system, do not use the circuit for E-STOP.
For details of the Safeguard system, refer to the following manuals.

EPSON RC+ User’s Guide  2. Safety - Installation and Design Precautions
- Safeguard System
Safety and Installation  2.6 Connection to EMERGENCY Connector

To check brake problems, refer to the following manuals.

Manipulator Manual  Maintenance
2.1.2  Inspection Point - Inspection While the Power is ON
(Manipulator is operating)

Safety and Installation
RC180: 5.1.1 Manipulator
- Inspection While the Power is ON (Manipulator is operating)

Free running distance in emergency
The operating Manipulator cannot stop immediately after the Emergency Stop switch is pressed.
The free running time/angle/distance of the Manipulator are shown below. However, remember that the values vary depending on following conditions.

- Weight of the end effector
- Weight of work piece
- Operating pose
- Weight
- Speed
- Accel
- etc.

Conditions for Measurement

<table>
<thead>
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</tr>
</thead>
<tbody>
<tr>
<td>Accel Setting</td>
<td>100</td>
</tr>
<tr>
<td>Speed Setting</td>
<td>100</td>
</tr>
<tr>
<td>Load [kg]</td>
<td>3</td>
</tr>
<tr>
<td>Weight Setting</td>
<td>3</td>
</tr>
</tbody>
</table>

Free running time

<table>
<thead>
<tr>
<th>Free running time</th>
<th>RC180</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joint #1 + Joint #2 [s]</td>
<td>0.5</td>
</tr>
<tr>
<td>Joint #3 [s]</td>
<td>0.5</td>
</tr>
<tr>
<td>Weight Setting</td>
<td>3</td>
</tr>
</tbody>
</table>

Free running angle

<table>
<thead>
<tr>
<th>Free running angle</th>
<th>RC180</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joint #1 [deg]</td>
<td>35</td>
</tr>
<tr>
<td>Joint #2 [deg]</td>
<td>50</td>
</tr>
<tr>
<td>Joint #1 + Joint #2 [deg]</td>
<td>85</td>
</tr>
<tr>
<td>Weight Setting</td>
<td>3</td>
</tr>
</tbody>
</table>

Free running distance

<table>
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<th>Free running distance</th>
<th>RC180</th>
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</thead>
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<td>Joint #3 G3-*<strong>1</strong> [mm]</td>
<td>95</td>
</tr>
<tr>
<td>Weight Setting</td>
<td>3</td>
</tr>
</tbody>
</table>
1.4.2 RC700-A

If the Manipulator moves abnormally during operation, immediately press the Emergency Stop switch. Pressing the Emergency Stop switch immediately changes the manipulator to deceleration motion and stops it at the maximum deceleration speed.

However, avoid pressing the Emergency Stop switch unnecessarily while the Manipulator is running normally. Pressing the Emergency Stop switch locks the brake and it may cause wear on the friction plate of the brake, resulting in the short life of the brake.

Normal brake life cycle: About 2 years (when the brakes are used 100 times/day)

To place the system in emergency mode during normal operation, press the Emergency Stop switch when the Manipulator is not moving.

Refer to the Controller manual for instructions on how to wire the Emergency Stop switch circuit.

Do not turn OFF the Controller while the Manipulator is operating.

If you attempt to stop the Manipulator in emergency situations such as “Safeguard Open”, make sure to stop the Manipulator using the Emergency Stop switch of the Controller.

If the Manipulator is stopped by turning OFF the Controller while it is operating, following problems may occur.

- Reduction of the life and damage of the reduction gear unit
- Position gap at the joints

In addition, if the Controller was forced to be turned OFF by blackouts and the like while the Manipulator is operating, make sure to check the following points after power restoration.

- Whether or not the reduction gear is damaged
- Whether or not the joints are in their proper positions

If there is a position gap, perform calibration by referring to the Maintenance 14. Calibration in this manual.

Before using the Emergency Stop switch, be aware of the followings.

- The Emergency Stop (E-STOP) switch should be used to stop the Manipulator only in case of emergencies.
- To stop the Manipulator operating the program except in emergency, use Pause (halt) or STOP (program stop) commands
  
  Pause and STOP commands do not turn OFF the motors. Therefore, the brake does not function.
- For the Safeguard system, do not use the circuit for E-STOP.

For details of the Safeguard system, refer to the following manuals.

  - Safeguard System
- Safety and Installation 2.6 Connection to EMERGENCY Connector
To check brake problems, refer to the following manuals.
Manipulator Manual  Maintenance
2.1.2  Inspection Point - Inspection While the Power is ON
(Manipulator is operating)
Safety and Installation
5.1.1 Manipulator
- Inspection While the Power is ON (Manipulator is operating)

Free running distance in emergency
The operating Manipulator cannot stop immediately after the Emergency Stop switch is pressed.
The free running time/angle/distance of the Manipulator are shown below. However, remember that the values vary depending on following conditions.
- Weight of the end effector
- Weight of work piece
- Operating pose
- Weight
- Speed
- Accel
- etc.

<table>
<thead>
<tr>
<th>Conditions for Measurement</th>
<th>Accel Setting</th>
<th>Speed Setting</th>
<th>Load [kg]</th>
<th>Weight Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start point of operation</td>
<td>100</td>
<td>100</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Target point</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stop point</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Controller</th>
<th>RC700-A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manipulator</td>
<td>G3-25***</td>
</tr>
<tr>
<td>Free running time</td>
<td>Joint #1 + Joint #2 [s]</td>
</tr>
<tr>
<td></td>
<td>Joint #3 [s]</td>
</tr>
<tr>
<td>Free running angle</td>
<td>Joint #1 [deg]</td>
</tr>
<tr>
<td></td>
<td>Joint #2 [deg]</td>
</tr>
<tr>
<td></td>
<td>Joint #1 + Joint #2 [deg]</td>
</tr>
<tr>
<td>Free running distance</td>
<td>Joint #3 G3-*<strong>1</strong> [mm]</td>
</tr>
</tbody>
</table>
1.5 Emergency Movement Without Drive Power

When the system is placed in emergency mode, push the arm or joint of the Manipulator by hand as shown below:

Arm #1 ............. Push the arm by hand.
Arm #2 ............. Push the arm by hand.
Joint #3 ............. The joint cannot be moved up/down by hand until the electromagnetic brake applied to the joint has been released. Move the joint up/down while pressing the brake release switch.
Joint #4 ............. Rotate the shaft by hand.

The brake release switch affects only Joint #3. When the brake release switch is pressed in emergency mode, the brake for Joint #3 is released.

Be careful of the shaft while the brake release switch is pressed because the shaft may be lowered by the weight of an end effector.
1.6 ACCELS Setting for CP Motions

To make the Manipulator move in CP motion, see the following and set ACCELS properly according to the tip load and the Z-axis height.

**NOTE**
Improper setting may cause following problems.
- Reduction of the life and damage of the ball screw spline

Set ACCELS as follows according to the Z-axis height.

ACCELS setting value by Z-axis position and tip load

<table>
<thead>
<tr>
<th>Z position (mm)</th>
<th>Tip load</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1kg or less</td>
</tr>
<tr>
<td>0 &gt; Z &gt;= -50</td>
<td>25000 or less</td>
</tr>
<tr>
<td>-50 &gt; Z &gt;= -100</td>
<td>24000 or less</td>
</tr>
<tr>
<td>-100 &gt; Z &gt;= -150</td>
<td>18000 or less</td>
</tr>
</tbody>
</table>

If the Manipulator is operated in CP motion with the wrong set values, make sure to check the following point.
- Whether the ball screw spline shaft is deformed or bent
1.7 Warning Labels

The Manipulator has the following warning labels.

The warning labels are attached around the locations where specific dangers exist. Be sure to comply with descriptions and warnings on the labels to operate and maintain the Manipulator safely. Do not tear, damage, or remove the warning labels. Use meticulous care when handling those parts or units to which the following warning labels are attached as well as the nearby areas.

<table>
<thead>
<tr>
<th>Location</th>
<th>Warning Label</th>
<th>NOTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td><img src="image1" alt="Warning Label" /></td>
<td>Before loosening the base mounting screws, hold the arm and secure it tightly with a band to prevent hands or fingers from being caught in the Manipulator.</td>
</tr>
<tr>
<td>B</td>
<td><img src="image2" alt="Warning Label" /></td>
<td>Be careful to avoid collision.</td>
</tr>
<tr>
<td>C</td>
<td><img src="image3" alt="Warning Label" /></td>
<td>Hazardous voltage exists while the Manipulator is ON. To avoid electric shock, do not touch any internal electric parts.</td>
</tr>
<tr>
<td>D</td>
<td><img src="image4" alt="Warning Label" /></td>
<td>You can catch your hand or fingers between the shaft and cover when bringing your hand close to moving parts. * Manipulators with bellows do not have this label for no danger of your hand or fingers being caught.</td>
</tr>
<tr>
<td>E</td>
<td><img src="image5" alt="Warning Label" /></td>
<td>HOT Be careful not to burn yourself.</td>
</tr>
<tr>
<td>F</td>
<td><img src="image6" alt="Warning Label" /></td>
<td>Only authorized personnel should perform sling work and operate a crane and a forklift. When these operations are performed by unauthorized personnel, it is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system.</td>
</tr>
<tr>
<td>G</td>
<td><img src="image7" alt="Warning Label" /></td>
<td>Be careful of the hand falling or rotating while the brake release switch is being pressed.</td>
</tr>
</tbody>
</table>
## Setup & Operation 1. Safety

### Location Label

<table>
<thead>
<tr>
<th>Location</th>
<th>Label</th>
</tr>
</thead>
</table>
| H        | **MODEL**: G3·51S  
**SERIAL.NO.**: 00001  
**MANUFACTURED**: 10/2007  
**WEIGHT**: 14kg  
**MAX PAYLOAD**: 8kg  
**MOTOR POWER**: AX1S: 200W  
AXIS2: 150W  
AXIS3: 150W  
AXIS4: 150W  
**SEIKO EPSON CORPORATION**: 3 CHIKEI-KU, SUWA-SHI  
NAGANO-KEN, 352-8502 JAPAN |
| I        | Air pressure max. 0.59Mpa, 86psi |

**Common**

**Table Top Mounting**

**Multiple Mounting**
2. Specifications

2.1 Features of G3 series Manipulators

The G3 series Manipulators are high-performance manipulators pursuing high speed, high accuracy, space saving, and high cost-performance. The features of the G3 series Manipulators are as follows:

**Space productivity**

Top level of cycle time and positioning accuracy

*Minimized body*

10% downsize of overall height, compared to E2C

*Extended motion range*

The same size of motion range compared with the other brands’ one up robots

*Extended range in Z direction*

Obtain the stroke under the body

**Succeeded E2C series advantages**

*Compatibility with the E2C series Manipulators*

The installation procedure and mounting dimensions of end effector for the G3 series are compatible with those for E2C series

* Secure the compatible mounting position with optional parts

*Improved productivity*

Increase in number of user wires and pneumatic tubes
Enhanced speed of Joint #1, 2, 3, and 4
Improved cycle time
2.2 Model Number and Model Differences

G3-25 1 S □-R-UL

UL specification
- UL: UL compliant
- □: Non UL compliant

Type
- □: Standard
- R: Right-Curved
- L: Left-Curved

Mounting type
- □: Table Top Mounting
- M: Multiple Mounting

Environment
- S: Standard
- C: Cleanroom & ESD (Anti-Static)

Joint #3 stroke
- 1: 150 mm
- □: 120 mm (Cleanroom-model)

Arm length
- 25: 250 mm
- 30: 300 mm
- 35: 350 mm

Environment

Cleanroom-model

This model has additional features that reduce dust emitted by the Manipulator to enable use in clean room environments.

For details on the specifications, refer to Setup & Operation: 2.4 Specifications.
<table>
<thead>
<tr>
<th>Arm Length</th>
<th>Arm Type</th>
<th>Mounting Type</th>
<th>Environment</th>
<th>Joint #3 Stroke</th>
<th>Model Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>250 mm</td>
<td>Standard</td>
<td>Table Top Mounting</td>
<td>Standard</td>
<td>150</td>
<td>G3-251S</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cleanroom</td>
<td>120</td>
<td>G3-251C</td>
</tr>
<tr>
<td>300 mm</td>
<td>Standard</td>
<td>Table Top Mounting</td>
<td>Standard</td>
<td>150</td>
<td>G3-301S</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cleanroom</td>
<td>120</td>
<td>G3-301C</td>
</tr>
<tr>
<td></td>
<td>Multiple</td>
<td>Mounting</td>
<td>Standard</td>
<td>150</td>
<td>G3-301SM</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cleanroom</td>
<td>120</td>
<td>G3-301CM</td>
</tr>
<tr>
<td></td>
<td>Right-Curved</td>
<td>Table Top Mounting</td>
<td>Standard</td>
<td>150</td>
<td>G3-301S-R</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cleanroom</td>
<td>120</td>
<td>G3-301C-R</td>
</tr>
<tr>
<td></td>
<td>Left-Curved</td>
<td>Table Top Mounting</td>
<td>Standard</td>
<td>150</td>
<td>G3-301S-L</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cleanroom</td>
<td>120</td>
<td>G3-301C-L</td>
</tr>
<tr>
<td>350 mm</td>
<td>Standard</td>
<td>Table Top Mounting</td>
<td>Standard</td>
<td>150</td>
<td>G3-351S</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cleanroom</td>
<td>120</td>
<td>G3-351C</td>
</tr>
<tr>
<td></td>
<td>Multiple</td>
<td>Mounting</td>
<td>Standard</td>
<td>150</td>
<td>G3-351SM</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cleanroom</td>
<td>120</td>
<td>G3-351CM</td>
</tr>
<tr>
<td></td>
<td>Right-Curved</td>
<td>Table Top Mounting</td>
<td>Standard</td>
<td>150</td>
<td>G3-351S-R</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cleanroom</td>
<td>120</td>
<td>G3-351C-R</td>
</tr>
<tr>
<td></td>
<td>Multiple</td>
<td>Mounting</td>
<td>Standard</td>
<td>150</td>
<td>G3-351SM-R</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cleanroom</td>
<td>120</td>
<td>G3-351CM-R</td>
</tr>
<tr>
<td></td>
<td>Left-Curved</td>
<td>Table Top Mounting</td>
<td>Standard</td>
<td>150</td>
<td>G3-351S-L</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cleanroom</td>
<td>120</td>
<td>G3-351C-L</td>
</tr>
<tr>
<td></td>
<td>Multiple</td>
<td>Mounting</td>
<td>Standard</td>
<td>150</td>
<td>G3-351SM-L</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cleanroom</td>
<td>120</td>
<td>G3-351CM-L</td>
</tr>
</tbody>
</table>
2.3 Part Names and Outer Dimensions

2.3.1 Table Top Mounting

Standard-model G3-**1S

- The brake release switch affects only Joint #3. When the brake release switch is pressed in emergency mode, the brake for Joint #3 is released.

- While the LED lamp is on, the current is being applied to the manipulator. Performing any work with the power ON is extremely hazardous and it may result in electric shock and/or improper function of the robot system. Make sure to turn OFF the controller power before the maintenance work.
Setup & Operation  2. Specifications

(*) indicates the stroke margin by mechanical stop.

1 mm flat cut
Conical hole Ø3.90°

Max.Ø11 through hole
Shaft diameter Ø3.6
Mechanical stop diameter Ø2.3

Detail of “A”
(Calibration point position of Joints #3 and #4)

Reference through hole
(View from the bottom of the base)

<table>
<thead>
<tr>
<th>G3-251S</th>
<th>G3-301S</th>
<th>G3-351S</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>120</td>
<td>170</td>
</tr>
<tr>
<td>b</td>
<td>Max.545</td>
<td>Max.575</td>
</tr>
</tbody>
</table>
Cleanroom-model: G3-***C

The following figures show the additional parts and specifications for Cleanroom-model (Table Top mounting) when compared with the Standard-model in appearance.
Setup & Operation  2. Specifications

G3-251C  G3-301C  G3-351C

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>120</td>
<td>170</td>
</tr>
<tr>
<td>b</td>
<td>Max.546</td>
<td>Max.575</td>
</tr>
</tbody>
</table>

(*) indicates the stroke margin by mechanical stop.

1 mm flat cut
Conical hole Ø3.90°

Detail of “A”
(Calibration point position of Joints #3 and #4)
2.3.2 Multiple Mounting

Standard-model: G3-**1SM

- The brake release switch affects only Joint #3. When the brake release switch is pressed in emergency mode, the brake for Joint #3 is released.

- While the LED lamp is on, the current is being applied to the manipulator. Performing any work with the power ON is extremely hazardous and it may result in electric shock and/or improper function of the robot system. Make sure to turn OFF the controller power before the maintenance work.
Setup & Operation  2. Specifications

<table>
<thead>
<tr>
<th></th>
<th>G3-301SM</th>
<th>G3-351SM</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>170</td>
<td>220</td>
</tr>
<tr>
<td>b</td>
<td>Max.410</td>
<td>Max.450</td>
</tr>
</tbody>
</table>

(*) indicates the stroke margin by mechanical stop.

1 mm flat cut
Conical hole Ø3.90°

Max. ø11 through hole
Shaft diameter
Mechanical stop diameter

Detail of “A”
(Calendar point position of Joints #3 and #4)

Reference through hole
(View from the bottom of the base)
Cleanroom-model: G3-**1CM

The following figures show the additional parts and specifications for Cleanroom-model (Multiple Mounting) when compared with the Standard-model in appearance.
2. Specifications

<table>
<thead>
<tr>
<th></th>
<th>G3-301CM</th>
<th>G3-351CM</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>170</td>
<td>220</td>
</tr>
<tr>
<td>b</td>
<td>Max.410</td>
<td>Max.450</td>
</tr>
</tbody>
</table>

(*) indicates the stroke margin by mechanical stop.

1 mm flat cut
Conical hole Ø3,90°

Max. ø11 through hole
shaft diameter
mechanical stop diameter

Detail of “A”
(Calibration point position of Joints #3 and #4)

Reference through hole
(View from the bottom of the base)
## 2.4 Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>G3 series Manipulator</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Arm length</strong></td>
<td></td>
</tr>
<tr>
<td>Arm #1, #2</td>
<td>250 mm</td>
</tr>
<tr>
<td>Arm #1</td>
<td>300 mm</td>
</tr>
<tr>
<td>Arm #2</td>
<td>350 mm</td>
</tr>
<tr>
<td>Arm #1</td>
<td>120 mm</td>
</tr>
<tr>
<td>Arm #2</td>
<td>170 mm</td>
</tr>
<tr>
<td>Arm #3</td>
<td>220 mm</td>
</tr>
<tr>
<td><strong>Max. operating speed</strong></td>
<td></td>
</tr>
<tr>
<td>Joints #1, #2</td>
<td>3550 mm/s</td>
</tr>
<tr>
<td>Joint #3</td>
<td>3950 mm/s</td>
</tr>
<tr>
<td>Joint #4</td>
<td>4350 mm/s</td>
</tr>
<tr>
<td>Joint #1</td>
<td>1100 mm/s</td>
</tr>
<tr>
<td>Joint #3</td>
<td>3000 deg/s</td>
</tr>
<tr>
<td><strong>Repeatability</strong></td>
<td></td>
</tr>
<tr>
<td>Joints #1, #2</td>
<td>± 0.008 mm</td>
</tr>
<tr>
<td>Joint #3</td>
<td>± 0.01 mm</td>
</tr>
<tr>
<td>Joint #4</td>
<td>± 0.005 deg</td>
</tr>
<tr>
<td><strong>Payload (Load)</strong></td>
<td></td>
</tr>
<tr>
<td>Rated</td>
<td>1 kg</td>
</tr>
<tr>
<td>Max.</td>
<td>3 kg</td>
</tr>
<tr>
<td><strong>Joint #4 allowable moment of inertia</strong></td>
<td></td>
</tr>
<tr>
<td>Rated</td>
<td>0.005 kg·m²</td>
</tr>
<tr>
<td>Max.</td>
<td>0.05 kg·m²</td>
</tr>
<tr>
<td><strong>Resolution</strong></td>
<td></td>
</tr>
<tr>
<td>Joints #1</td>
<td>0.0000343323 deg/pulse</td>
</tr>
<tr>
<td>Joint #2</td>
<td>0.0000549316 deg/pulse</td>
</tr>
<tr>
<td>Joint #3</td>
<td>0.0000878906 mm/pulse</td>
</tr>
<tr>
<td>Joint #4</td>
<td>0.000240928 deg/pulse</td>
</tr>
<tr>
<td><strong>Hand</strong></td>
<td></td>
</tr>
<tr>
<td>Shaft diameter</td>
<td>Ø 16 mm</td>
</tr>
<tr>
<td>Through hole</td>
<td>Ø 11 mm</td>
</tr>
<tr>
<td><strong>Mounting hole</strong></td>
<td></td>
</tr>
<tr>
<td>Table top mounting</td>
<td>120 × 120 mm (4-M8)</td>
</tr>
<tr>
<td>Multiple mounting</td>
<td></td>
</tr>
<tr>
<td>Wall mounting</td>
<td>174 × 70 mm (4-M8)</td>
</tr>
<tr>
<td>Ceiling mounting</td>
<td>120 × 120 mm (4-M8)</td>
</tr>
<tr>
<td><strong>Weight (cables not included)</strong></td>
<td>14 kg : 31 lb.</td>
</tr>
<tr>
<td><strong>Driving method</strong></td>
<td></td>
</tr>
<tr>
<td>All joints</td>
<td>AC servo motor</td>
</tr>
<tr>
<td><strong>Motor rated capacity</strong></td>
<td></td>
</tr>
<tr>
<td>Joint #1</td>
<td>200 W</td>
</tr>
<tr>
<td>Joint #2</td>
<td>150 W</td>
</tr>
<tr>
<td>Joint #3</td>
<td>150 W</td>
</tr>
<tr>
<td>Joint #4</td>
<td>150 W</td>
</tr>
<tr>
<td><strong>Option</strong></td>
<td></td>
</tr>
<tr>
<td>Installation method</td>
<td>-</td>
</tr>
<tr>
<td>Installation environment</td>
<td>Cleanroom &amp; ESD *3</td>
</tr>
<tr>
<td><strong>Joint #3 down force</strong></td>
<td>150 N</td>
</tr>
<tr>
<td><strong>Installed wire for customer use</strong></td>
<td>15 (15 pin: D-sub) : 15 cores</td>
</tr>
<tr>
<td><strong>Installed pneumatic tube for customer use</strong></td>
<td>2 pneumatic tubes (ø6 mm) : 0.59 MPa (6 kgf/cm² : 86 psi)</td>
</tr>
<tr>
<td></td>
<td>1 pneumatic tubes (ø4 mm) : 0.59 MPa (6 kgf/cm² : 86 psi)</td>
</tr>
<tr>
<td><strong>Environmental requirements</strong></td>
<td></td>
</tr>
<tr>
<td>Ambient Temp.</td>
<td>5 to 40°C (with minimum temperature variation)</td>
</tr>
<tr>
<td>Ambient relative humidity</td>
<td>10 to 80% (no condensation)</td>
</tr>
<tr>
<td><strong>Noise level</strong></td>
<td>L\text{Aeq} = 70 dB (A) or under</td>
</tr>
<tr>
<td><strong>Applicable Controller</strong></td>
<td>RC180, RC700-A</td>
</tr>
<tr>
<td><strong>Assignable Value ( ) Default values</strong></td>
<td></td>
</tr>
<tr>
<td>SPEED</td>
<td>1 to (5) to 100</td>
</tr>
<tr>
<td>ACCEL *6</td>
<td>1 to (10) to 120</td>
</tr>
<tr>
<td>SPEEDS</td>
<td>1 to (50) to 2000</td>
</tr>
<tr>
<td>ACCELS</td>
<td>1 to (200) to 25000</td>
</tr>
<tr>
<td>FINE</td>
<td>0 to (10000) to 65535</td>
</tr>
<tr>
<td>WEIGHT</td>
<td>0,130 to (1,130) 3,130</td>
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<tr>
<td><strong>Safety standard</strong></td>
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<tr>
<td>CE Marking</td>
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<td>EMC Directive, Machinery Directive</td>
<td></td>
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<tr>
<td>KC Marking, KCs Marking</td>
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<tr>
<td>UL standards (In case of UL specification)</td>
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<tr>
<td>UL1740</td>
<td></td>
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<tr>
<td>ANSI/RIA R15.06</td>
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</tr>
<tr>
<td>NFPA 79</td>
<td></td>
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</tbody>
</table>
Max. motion range (deg) (mm) / Max. pulse range (pulse)

### Standard-model, Table Top Mounting

<table>
<thead>
<tr>
<th>Item</th>
<th>G3-251S</th>
<th>G3-301S-*</th>
<th>G3-351S-*</th>
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</thead>
<tbody>
<tr>
<td><strong>Max. motion range (deg), (mm)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Straight</td>
<td>Joint #1</td>
<td>± 140</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Joint #2</td>
<td></td>
<td>± 142</td>
</tr>
<tr>
<td>Curved</td>
<td>Joint #1</td>
<td>Right hand</td>
<td>− 125 to 150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Left hand</td>
<td>− 150 to 125</td>
</tr>
<tr>
<td></td>
<td>Joint #2</td>
<td>Right hand</td>
<td>− 135 to 150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Left hand</td>
<td>− 150 to 135</td>
</tr>
<tr>
<td>Common</td>
<td>Joint #3</td>
<td></td>
<td>150 mm</td>
</tr>
<tr>
<td></td>
<td>Joint #4</td>
<td></td>
<td>± 360</td>
</tr>
<tr>
<td><strong>Max. pulse range (pulse)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Straight</td>
<td>Joint #1</td>
<td>Right hand</td>
<td>− 1019449 to 6990507</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Left hand</td>
<td>− 1747627 to 6262329</td>
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<tr>
<td></td>
<td>Joint #2</td>
<td>Right hand</td>
<td>− 2457600 to 2730667</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Left hand</td>
<td>− 2730667 to 2457600</td>
</tr>
<tr>
<td>Common</td>
<td>Joint #3</td>
<td></td>
<td>−1706667 to 0</td>
</tr>
<tr>
<td></td>
<td>Joint #4</td>
<td></td>
<td>± 1494221</td>
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### Standard-model / Multiple Mounting

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</thead>
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<td></td>
</tr>
<tr>
<td>Straight</td>
<td>Joint #1</td>
<td>± 115</td>
</tr>
<tr>
<td></td>
<td>Joint #2</td>
<td>± 135</td>
</tr>
<tr>
<td>Curved</td>
<td>Joint #1</td>
<td>Right hand</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Left hand</td>
</tr>
<tr>
<td></td>
<td>Joint #2</td>
<td>Right hand</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Left hand</td>
</tr>
<tr>
<td>Common</td>
<td>Joint #3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Joint #4</td>
<td></td>
</tr>
<tr>
<td><strong>Max. pulse range (pulse)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Straight</td>
<td>Joint #1</td>
<td>− 728178 to 5971058</td>
</tr>
<tr>
<td></td>
<td>Joint #2</td>
<td>± 2457600</td>
</tr>
<tr>
<td>Curved</td>
<td>Joint #1</td>
<td>Right hand</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Left hand</td>
</tr>
<tr>
<td></td>
<td>Joint #2</td>
<td>Right hand</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Left hand</td>
</tr>
<tr>
<td>Common</td>
<td>Joint #3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Joint #4</td>
<td></td>
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</table>
Cleanroom-model, Table Top Mounting

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<th>G3-351C-*</th>
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<tr>
<td>(deg), (mm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Straight</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Joint #1</td>
<td>± 137</td>
<td>± 140</td>
<td>± 142</td>
</tr>
<tr>
<td>Joint #2</td>
<td>± 137</td>
<td>± 140</td>
<td>± 142</td>
</tr>
<tr>
<td>Curved</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joint #1 Right hand</td>
<td>-</td>
<td>– 125 to 150</td>
<td>– 110 to 165</td>
</tr>
<tr>
<td>Joint #1 Left hand</td>
<td>-</td>
<td>– 150 to 125</td>
<td>– 165 to 110</td>
</tr>
<tr>
<td>Joint #2 Right hand</td>
<td>-</td>
<td>– 135 to 145</td>
<td>– 120 to 160</td>
</tr>
<tr>
<td>Joint #2 Left hand</td>
<td>-</td>
<td>– 145 to 135</td>
<td>– 160 to 120</td>
</tr>
<tr>
<td>Common Joint #3</td>
<td>120 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joint #4</td>
<td>± 360</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Straight</td>
<td>± 2494009</td>
<td>± 2566827</td>
<td>± 2585032</td>
</tr>
<tr>
<td>Curved</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joint #1 Right hand</td>
<td>– 1019449 to 6990507</td>
<td>– 582543 to 7427414</td>
<td></td>
</tr>
<tr>
<td>Joint #1 Left hand</td>
<td>– 1747627 to 6262329</td>
<td>– 2184534 to 5825423</td>
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</tr>
<tr>
<td>Joint #2 Right hand</td>
<td>– 257600 to 2639645</td>
<td>– 2184534 to 2912712</td>
<td></td>
</tr>
<tr>
<td>Joint #2 Left hand</td>
<td>– 2639645 to 2457600</td>
<td>– 2912712 to 2184534</td>
<td></td>
</tr>
<tr>
<td>Common Joint #3</td>
<td>– 1365334 to 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joint #4</td>
<td>± 1494221</td>
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Cleanroom-model, Multiple Mounting

<table>
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<tr>
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<tbody>
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<td>Max. motion range</td>
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<td></td>
</tr>
<tr>
<td>(deg), (mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Straight</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joint #1</td>
<td>± 115</td>
<td>± 120</td>
</tr>
<tr>
<td>Joint #2</td>
<td>± 135</td>
<td>± 142</td>
</tr>
<tr>
<td>Curved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joint #1 Right hand</td>
<td>-</td>
<td>– 105 to 130</td>
</tr>
<tr>
<td>Joint #1 Left hand</td>
<td>-</td>
<td>– 130 to 105</td>
</tr>
<tr>
<td>Joint #2 Right hand</td>
<td>-</td>
<td>– 120 to 150</td>
</tr>
<tr>
<td>Joint #2 Left hand</td>
<td>-</td>
<td>– 150 to 120</td>
</tr>
<tr>
<td>Common Joint #3</td>
<td>120 mm</td>
<td></td>
</tr>
<tr>
<td>Joint #4</td>
<td>± 360</td>
<td></td>
</tr>
<tr>
<td>Straight</td>
<td>± 2457600</td>
<td>± 2585032</td>
</tr>
<tr>
<td>Curved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joint #1 Right hand</td>
<td>-</td>
<td>– 436907 to 6407965</td>
</tr>
<tr>
<td>Joint #1 Left hand</td>
<td>-</td>
<td>– 1165085 to 5679787</td>
</tr>
<tr>
<td>Joint #2 Right hand</td>
<td>-</td>
<td>– 2184534 to 2730667</td>
</tr>
<tr>
<td>Joint #2 Left hand</td>
<td>-</td>
<td>– 2730667 to 2187534</td>
</tr>
<tr>
<td>Common Joint #3</td>
<td>– 1365334 to 0</td>
<td></td>
</tr>
<tr>
<td>Joint #4</td>
<td>± 1494221</td>
<td></td>
</tr>
</tbody>
</table>
Setup & Operation  2. Specifications

*1: In the case of PTP command.
Maximum operating speed for CP command is 2000 mm/s on horizontal plane.

*2: In the case where the center of gravity is at the center of Joint #4.
If the center of gravity is not at the center of Joint #4, set the parameter using Inertia command.

*3: The exhaust system in the Cleanroom-model Manipulator draws air from the base interior and arm cover interior together.
A crack or other opening in the base unit can cause loss of negative air pressure in the outer part of the arm, which can cause increased dust emission.
Do not remove the maintenance cover on the front of the base.
Seal the exhaust port and the exhaust tube with vinyl tape so that the joint is airtight.
If the exhaust flow is not sufficient, dust particle emission may exceed the specified maximum level.
Cleanliness level : Class ISO 3 (ISO14644-1)
Exhaust System : Exhaust port diameter : Inner diameter: ø12 mm / Outer diameter: ø16 mm
Exhaust tube : Polyurethane tube
Outer diameter: ø12 mm (Inner diameter: ø8 mm) or
Inner diameter ø16mm or larger
Recommended exhaust flow rate : approx. 1000 cm³/s (Normal)
ESD specification uses resin materials with antistatic treatment. This model controls adhesion of dust due to electrification.

*4: Conditions of Manipulator during measurement as follows:
Operating conditions : Under rated load, 4-joints simultaneous motion, maximum speed, maximum acceleration/deceleration, and duty 50%.
Measurement point : Rear of the Manipulator, 1000 mm apart from the motion range, 50 mm above the base-installed surface.

*5: For delivery up until January 2017, there are systems in combination of G series and RC620.

*6: In general use, Accel setting 100 is the optimum setting that maintains the balance of acceleration and vibration when positioning. Although values larger than 100 can be set to Accel, it is recommended to minimize the use of large values to necessary motions since operating the manipulator continuously with the large Accel setting may shorten the product life remarkably.
2.5 How to Set the Model

The Manipulator model for your system has been set before shipment from the factory. It is normally not required to change the model when you receive your system.

**CAUTION**

- When you need to change the setting of the Manipulator model, be sure to set the Manipulator model properly. Improper setting of the Manipulator model may result in abnormal or no operation of the Manipulator and/or cause safety problems.

**NOTE**

If the custom specifications number (MT***) is described on MODEL of the signature label (S/N label), the Manipulator has custom specifications. (A label with only the custom specifications number may be attached depending on shipment time.)

The custom specifications may require a different configuration procedure; check the custom specifications number (MT***) and contact the supplier of your region when necessary.

The Manipulator model can be set from software.

Refer to the chapter *Robot Configuration* in the *EPSON RC+ User’s Guide*. 
3. Environments and Installation

3.1 Environmental Conditions

A suitable environment is necessary for the robot system to function properly and safely. Be sure to install the robot system in an environment that meets the following conditions:

<table>
<thead>
<tr>
<th>Item</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient temperature *</td>
<td>5 to 40°C (with minimum temperature variation)</td>
</tr>
<tr>
<td>Ambient relative humidity</td>
<td>10 to 80% (no condensation)</td>
</tr>
<tr>
<td>First transient burst noise</td>
<td>1 kV or less (Signal wire)</td>
</tr>
<tr>
<td>Electrostatic noise</td>
<td>4 kV or less</td>
</tr>
<tr>
<td>Environment</td>
<td>- Install indoors.</td>
</tr>
<tr>
<td></td>
<td>- Keep away from direct sunlight.</td>
</tr>
<tr>
<td></td>
<td>- Keep away from dust, oily smoke, salinity, metal powder or other contaminants.</td>
</tr>
<tr>
<td></td>
<td>- Keep away from flammable or corrosive solvents and gases.</td>
</tr>
<tr>
<td></td>
<td>- Keep away from water.</td>
</tr>
<tr>
<td></td>
<td>- Keep away from shocks or vibrations.</td>
</tr>
<tr>
<td></td>
<td>- Keep away from sources of electric noise.</td>
</tr>
</tbody>
</table>

* The ambient temperature conditions are for the Manipulators only. For the Controller the Manipulators are connected to, refer to the Controller manual.

Manipulators are not suitable for operation in harsh environments such as painting areas, etc. When using Manipulators in inadequate environments that do not meet the above conditions, please contact the supplier of your region.

Special Environmental Conditions

The surface of the Manipulator has general oil resistance. However, if your requirements specify that the Manipulator must withstand certain kinds of oil, please contact the supplier of your region. Rapid change in temperature and humidity can cause condensation inside the Manipulator.

If your requirements specify that the Manipulator handles food, please contact the supplier of your region to check whether the Manipulator will damage the food or not.

The Manipulator cannot be used in corrosive environments where acid or alkaline is used. In a salty environment where the rust is likely to gather, the Manipulator is susceptible to rust.

WARNING

- Use an earth leakage breaker on the AC power cable of the Controller to avoid electric shock and circuit breakdown caused by short circuit. Prepare the earth leakage breaker that pertains the Controller you are using. For details, refer to the Controller manual.

CAUTION

- When cleaning the Manipulator, do not rub it strongly with alcohol or benzene. It may lose luster on the coated face.
3.2 Base Table

A base table for anchoring the Manipulator is not supplied. Please make or obtain the base table for your Manipulator. The shape and size of the base table differs depending on the use of the robot system. For your reference, we list some Manipulator table requirements here.

The base table must not only be able to bear the weight of the Manipulator but also be able to withstand the dynamic movement of the Manipulator when it operates at maximum acceleration/deceleration. Ensure that there is enough strength on the base table by attaching reinforcing materials such as crossbeams.

The torque and reaction force produced by the movement of the Manipulator are as follows:

- Max. Reaction torque on the horizontal plate: 300 Nm
- Max. Horizontal reaction force: 2000 N
- Max. Vertical reaction force: 1000 N

The threaded holes required for mounting the Manipulator base are M8. Use mounting bolts with specifications conforming to ISO898-1 property class: 10.9 or 12.9. For dimensions, refer to Setup & Operation: 3.3 Mounting Dimensions.

The plate for the Manipulator mounting face should be 20 mm thick or more and made of steel to reduce vibration. The surface roughness of the steel plate should be 25 μm or less.

The table must be secured on the floor or wall to prevent it from moving.

The Manipulator must be installed horizontally.

When using a leveler to adjust the height of the base table, use a screw with M16 diameter or more.

If you are passing cables through the holes on the base table, see the figures below.

[unit: mm]
WARNING

■ To ensure safety, a safeguard must be installed for the robot system. For details on the safeguard, refer to the *EPSON RC+ User’s Guide*.

NOTE

Do not remove the M/C cables from the Manipulator.

For environmental conditions regarding space when placing the Controller on the base table, refer to the *Controller manual*. 

3.3 Mounting Dimensions

The maximum space described in figures shows that the radius of the end effector is 60 mm or less. If the radius of the end effector exceeds 60 mm, define the radius as the distance to the outer edge of maximum space.

If a camera or electromagnetic valve extends outside of the arm, set the maximum range including the space that they may reach.

Be sure to allow for the following extra spaces in addition to the space required for mounting the Manipulator, Controller, and peripheral equipment.

- Space for teaching
- Space for maintenance and inspection
  (Ensure a space to open the rear side cover and the maintenance cover for maintenance.)
- Space for cables

The minimum bend radius of the power cable is 90 mm. When installing the cable, be sure to maintain sufficient distance from obstacles. In addition, leave enough space for other cables so that they are not bent forcibly.

Ensure distance to the safeguard from the maximum motion range is more than 100 mm.
### 3.3.1 Table Top Mounting – Straight Arm

<table>
<thead>
<tr>
<th></th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>e</th>
<th>f</th>
<th>g</th>
<th>h</th>
<th>j</th>
<th>k</th>
<th>q</th>
<th>m</th>
<th>n</th>
<th>p</th>
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<tbody>
<tr>
<td><strong>G3-251S</strong></td>
<td>140°</td>
<td>2°</td>
<td>141°</td>
<td>2.3°</td>
<td>79.3</td>
<td>84.0</td>
<td>120</td>
<td>250</td>
<td>221.9</td>
<td>224.5</td>
<td>143.3°</td>
<td>150</td>
<td>9.6</td>
<td>6.7</td>
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<tr>
<td><strong>G3-251C</strong></td>
<td>137°</td>
<td>6.3°</td>
<td>92.0</td>
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<tr>
<td><strong>G3-301S</strong></td>
<td>142°</td>
<td>3.8°</td>
<td>96.2</td>
<td></td>
<td>104.8</td>
<td>107.1</td>
<td>170</td>
<td>300</td>
<td>260.2</td>
<td>263.9</td>
<td>145.8°</td>
<td>150</td>
<td>9.6</td>
<td>6.7</td>
</tr>
<tr>
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<td>4.8°</td>
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<td></td>
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<td>4.1</td>
<td>10.7</td>
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<td></td>
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</tr>
<tr>
<td><strong>G3-351S</strong></td>
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<td>142.3</td>
<td>146.6</td>
<td>220</td>
<td>350</td>
<td>298.5</td>
<td>303.3</td>
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<td>3.8°</td>
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<td></td>
<td></td>
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</tr>
</tbody>
</table>

- **g**: Length of Arm #1 (mm)
- **b**: Joint #1 angle to hit mechanical stop (degree)
- **h-g**: Length of Arm #2 (mm)
- **d**: Joint #2 angle to hit mechanical stop (degree)
- **m**: Stroke of Joint #3 (mm)
- **n**: Joint #3 range to hit lower mechanical stop (mm)
- **f**: Motion range
- **p**: Joint #3 range to hit upper mechanical stop (mm)
- **a**: Motion range of Joint #1 (degree)
- **j**: Range from center of axis to back end (mm)
- **c**: Motion range of Joint #2 (degree)
- **k**: Range from center of axis to back end after moved to mechanical stop (mm)
- **e**: Mechanical stop area
- **q**: Joint #2 motion range + angle to hit mechanical stop (degree)
### 3.3.2 Table Top Mounting – Left-Curved Arm

<table>
<thead>
<tr>
<th></th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>e</th>
<th>f</th>
<th>g</th>
<th>h</th>
<th>j</th>
<th>k</th>
<th>m</th>
<th>n</th>
<th>p</th>
<th>q</th>
</tr>
</thead>
<tbody>
<tr>
<td>G3-301S-L</td>
<td>150°</td>
<td>3°</td>
<td>125°</td>
<td>6°</td>
<td>150°</td>
<td>3.3°</td>
<td>8.3°</td>
<td>79.5</td>
<td>86.8</td>
<td>113.2</td>
<td>120.7</td>
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<td>300</td>
<td>277.2</td>
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- **n**: Length of Arm #1 (mm)
- **b, d**: Joint #1 angle to hit mechanical stop (degree)
- **p-n**: Length of Arm #2 (mm)
- **f, z**: Joint #2 angle to hit mechanical stop (degree)
- **u**: Stroke of Joint #3 (mm)
- **v**: Joint #3 range to hit lower mechanical stop (mm)
- **m, j**: Motion range
- **q, s**: Range from center of axis to back end (mm)
- **a, c**: Motion range of Joint #1 (degree)
- **q, s**: Range from center of axis to back end after moved to mechanical stop (mm)
- **e, g**: Motion range of Joint #2 (degree)
- **r, t**: Range from center of axis to back end after moved to mechanical stop (mm)
- **h, k**: Mechanical stop area
- **x, y**: Joint #2 motion range + angle to hit mechanical stop (degree)
### 3.3.3 Table Top Mounting – Right-Curved Arm

<table>
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<td>6.7</td>
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<td>167.8°</td>
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</table>

- **n**: Length of Arm #1 (mm)  
- **p, q**: Length of Arm #2 (mm)  
- **r, s**: Joint #1 angle to hit mechanical stop (degree)  
- **u**: Stroke of Joint #3 (mm)  
- **v**: Joint #3 range to hit lower mechanical stop (mm)  
- **m, j**: Motion range  
- **a, c**: Motion range of Joint #1 (degree)  
- **e, g**: Motion range of Joint #2 (degree)  
- **h, k**: Mechanical stop area  
- **x, y**: Range from center of axis to back end after moved to mechanical stop (mm)  
- **q, s**: Joint #2 angle to hit mechanical stop (degree)  
- **x, y**: Range from center of axis to back end (mm)  
- **x, y**: Range from center of axis to back end after moved to mechanical stop (mm)  
- **x, y**: Joint #2 motion range + angle to hit mechanical stop (degree)
### 3.3.4 Multiple Mounting – Straight Arm

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<td>4.1</td>
<td>10.7</td>
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</tbody>
</table>

- **g**: Length of Arm #1 (mm)  
- **h-g**: Length of Arm #2 (mm)  
- **m**: Stroke of Joint #3 (mm)  
- **n**: Joint #3 range to hit lower mechanical stop (mm)  
- **f**: Motion range  
- **p**: Joint #3 range to hit upper mechanical stop (mm)  
- **a**: Motion range of Joint #1 (degree)  
- **j**: Range from center of axis to back end (mm)  
- **c**: Motion range of Joint #2 (degree)  
- **k**: Range from center of axis to back end after moved to mechanical stop (mm)  
- **e**: Mechanical stop area  
- **q**: Joint #2 motion range + angle to hit mechanical stop (degree)
3.3.5 Multiple Mounting – Left-Curved Arm

<table>
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<th>s</th>
<th>t</th>
<th>x</th>
<th>y</th>
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<table>
<thead>
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<td>G3-351CM-L</td>
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<td>4.1</td>
<td>10.7</td>
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</table>

- **n**: Length of Arm #1 (mm)
- **p**: Length of Arm #2 (mm)
- **q**: Stroke of Joint #3 (mm)
- **r**: Joint #1 angle to hit mechanical stop (degree)
- **s**: Joint #2 angle to hit mechanical stop (degree)
- **t**: Joint #3 range to hit lower mechanical stop (mm)
- **u**: Motion range
- **v**: Motion range of Joint #3 (mm)
- **w**: Joint #3 range to hit upper mechanical stop (mm)
- **a, c**: Motion range of Joint #1 (degree)
- **e, g**: Motion range of Joint #2 (degree)
- **h, k**: Mechanical stop area
- **x, y**: Range from center of axis to back end after moved to mechanical stop (mm)
- **m**: Range from center of axis to back end (mm)
### 3.3.6 Multiple Mounting – Right-Curved Arm

![Diagram of G3-351SM-R joint configuration]

<table>
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<th>h</th>
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<td>103.3</td>
<td>107.5</td>
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<td>G3-351CM-R</td>
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<td>4.1</td>
<td>10.7</td>
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</table>

- **n**: Length of Arm #1 (mm)  
- **p-n**: Length of Arm #2 (mm)  
- **u**: Stroke of Joint #3 (mm)  
- **m, j**: Motion range  
- **a, c**: Motion range of Joint #1 (degree)  
- **e, g**: Motion range of Joint #2 (degree)  
- **h, k**: Mechanical stop area  
- **b, d**: Joint #1 angle to hit mechanical stop (degree)  
- **f, z**: Joint #2 angle to hit mechanical stop (degree)  
- **v**: Joint #3 range to hit lower mechanical stop (mm)  
- **w**: Joint #3 range to hit upper mechanical stop (mm)  
- **q, s**: Range from center of axis to back end (mm)  
- **r, t**: Range from center of axis to back end after moved to mechanical stop (mm)  
- **x, y**: Joint #2 motion range + angle to hit mechanical stop (degree)
3.4 Unpacking and Transportation

THE INSTALLATION SHALL BE PREFORMED BY QUALIFIED INSTALLATION PERSONNEL AND SHOULD CONFORM TO ALL NATIONAL AND LOCAL CODES.

**WARNING**
- Only authorized personnel should perform sling work and operate a crane and a forklift. When these operations are performed by unauthorized personnel, it is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system.

**CAUTION**
- Using a cart or similar equipment, transport the Manipulator in the same manner as it was delivered.
- After removing the bolts securing the Manipulator to the delivery equipment, the Manipulator can fall. Be careful not to get hands or fingers caught.
- The arm is secured with a wire tie. Leave the wire tie secured until you finish the installation so as not to get hands or fingers caught.
- To carry the Manipulator, have two or more people to work on it and secure the Manipulator to the delivery equipment or hold the areas indicated in gray in the figure (bottom of Arm #1 and bottom of the base) by hand. When holding the bottom of the base by hand, be very careful not to get your hands or fingers caught.

Table Top Mounting
- G3-251*: approx. 14 kg; 31 lb.
- G3-301*: approx. 14 kg; 31 lb.

Multiple Mounting
- G3-301*M: approx. 14 kg; 31 lb.
- G3-351*M: approx. 14 kg; 31 lb.

- Stabilize the Manipulator with your hands when hoisting it.
- When transporting the Manipulator for a long distance, secure it to the delivery equipment directly so that the Manipulator never falls. If necessary, pack the Manipulator in the same style as it was delivered.
3.5 Installation Procedure

- The robot system must be installed to avoid interference with buildings, structures, utilities, other machines and equipment that may create a trapping hazard or pinch points.
- Oscillation (resonance) may occur during operation depending on rigidity of the installation table. If the oscillation occurs, improve rigidity of the table or change the speed or acceleration and deceleration settings.

The following sections describe the installation of the Standard Manipulator.

3.5.1 Table Top Mounting
3.5.2 Multiple Mounting
For Cleanroom-model manipulator, refer to this section;
3.5.3 Cleanroom-model

3.5.1 Table Top Mounting

- Install the Table Top Mounting Manipulator with two or more people. The Manipulator weights are as follows. Be careful not to get hands, fingers, or feet caught and/or have equipment damaged by a fall of the Manipulator.
  - G3-251*: approx. 14 kg: 31 lb.
  - G3-301*: approx. 14 kg: 31 lb.
  - G3-351*: approx. 14 kg: 31 lb.

Standard-model

1) Secure the base to the base table with four bolts.

NOTE
Use bolts with specifications conforming to ISO898-1 Property Class: 10.9 or 12.9.

Tightening torque:
32.0 N·m (326 kgf·cm)
(2) Using nippers, cut off the wire tie binding the shaft and arm retaining bracket on the base.

(3) Remove the bolts securing the wire ties removed in step (2).

(4) Remove the fixing jig for transport.

3.5.2 Multiple Mounting

**WARNING**

- Install the Multiple Mounting Manipulator with two or more people. The Manipulator weights are as follows. Be careful not to get hands, fingers, or feet caught and/or have equipment damaged by a fall of the Manipulator.
  
  G3-351*M : approx. 14 kg: 31 lb.

- When installing the Manipulator to the wall, support the Manipulator, and then secure the anchor bolts. Removing the support without securing the anchor bolts properly is extremely hazardous and may result in fall of the Manipulator.

**NOTE**

Design and make the base table for anchoring the Multiple Mounting Manipulators so that it does not touch any cable connected to the base connector plate and duct.

The recommended installation patterns are as follows:
Standard-model

1. Unpack the manipulator with retaining the arm posture.

2. Secure the base to the wall with four bolts. Use bolts with specifications conforming to ISO898-1 Property Class: 10.9 or 12.9. Tightening torque: 32.0 N·m (326 kgf·cm)

3. Remove the fixing jig for transport.

3.5.3 Cleanroom-model

1. Unpack it outside of the clean room.

2. Secure the Manipulator to delivery equipment such as a pallet with bolts so that the Manipulator does not fall.

3. Wipe off the dust on the Manipulator with a little alcohol or distilled water on a lint-free cloth.

4. Carry the Manipulator in the clean room.

5. Refer to the installation procedure of each Manipulator model and install the Manipulator.

6. Connect an exhaust tube to the exhaust port.

**CAUTION**

- When operating the Manipulator under special environmental conditions (adverse conditions with dust and oily smoke), do not place the controller in the same condition since the controller does not comply with IP54 / IP65. Doing so may cause equipment damage to and/or malfunction of the controller.
### 3.6 Connecting the Cables

#### 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.
- Be sure to connect the cables properly. Do not allow unnecessary strain on the cables. (Do not put heavy objects on the cables. Do not bend or pull the cables forcibly.) The unnecessary strain on the cables may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system.
- Grounding the manipulator is done by connecting with the controller. Ensure that the controller is grounded and the cables are correctly connected. If the ground wire is improperly connected to ground, it may result in the fire or electric shock.

#### CAUTION
- When connecting the Manipulator to the Controller, make sure that the serial numbers on each equipment match. Improper connection between the Manipulator and Controller may not only cause improper function of the robot system but also serious safety problems. The connection method varies with the Controller used. For details on the connection, refer to the Controller manual. If the G series Manipulator is connected to the Controller for the 6-axis robot, it may result in malfunction of the Manipulator.

When the Manipulator is a Cleanroom-model, be aware of the followings.
For the Manipulator of Cleanroom-model, use it with an exhaust system.
For details, refer to Setup & Operation: 2.4 Specifications.

#### CAUTION
- When operating the Manipulator under special environmental conditions (adverse conditions with dust and oily smoke), do not place the controller in the same condition since the controller does not comply with IP54 / IP65. Doing so may cause equipment damage to and/or malfunction of the controller.

**Cable Connections**

Connect the power connector and signal connector of the M/C cables to the Controller.
3.7 User Wires and Pneumatic Tubes

**CAUTION**

- Only authorized or certified personnel should be allowed to perform wiring. Wiring by unauthorized or uncertified personnel may result in bodily injury and/or malfunction of the robot system.

User electrical wires and pneumatic tubes are contained in the cable unit.

**Electrical Wires**

<table>
<thead>
<tr>
<th>Rated Voltage</th>
<th>Allowable Current</th>
<th>Wires</th>
<th>Nominal Sectional Area</th>
<th>Note</th>
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</thead>
<tbody>
<tr>
<td>AC/DC30 V</td>
<td>1 A</td>
<td>15</td>
<td>0.211 mm²</td>
<td>Twist pair</td>
</tr>
</tbody>
</table>

**Pneumatic Tubes**

<table>
<thead>
<tr>
<th>Max. Usable Pneumatic Pressure</th>
<th>Pneumatic Tubes</th>
<th>Outer Diameter × Inner Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.59 MPa (6 kgf/cm² : 86 psi)</td>
<td>2</td>
<td>ø6 mm × ø4 mm</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>ø4 mm × ø2.5 mm</td>
</tr>
</tbody>
</table>

Fittings for ø6 mm and ø4 mm (outer diameter) pneumatic tubes are supplied on both ends of the pneumatic tubes.

* Color differs depending on the shipment time

**Common Parts**

- Brake release switch
- 15-pin D-sub connector
- Fitting (black or blue)* for ø4 mm pneumatic tube
- Fitting (black or blue)* for ø6 mm pneumatic tube
- Fitting (white) for ø6 mm pneumatic tube

* Color differs depending on the shipment time
Table Top Mounting

- Fitting (white) for Ø6 mm pneumatic tube
- Fitting (black or blue)* for Ø6 mm pneumatic tube
- User connector (15-pin D-sub connector)

Multiple Mounting

- Fitting (white) for Ø6 mm pneumatic tube
- Fitting (black or blue)* for Ø6 mm pneumatic tube
- Fitting (black or blue)* for Ø4 mm pneumatic tube
- User connector (15-pin D-sub connector)
3.8 Relocation and Storage

3.8.1 Precautions for Relocation and Storage

Observe the following when relocating, storing, and transporting the Manipulators.

THE INSTALLATION SHALL BE PERFORMED BY QUALIFIED INSTALLATION PERSONNEL AND SHOULD CONFORM TO ALL NATIONAL AND LOCAL CODES.

**WARNING**
- Only authorized personnel should perform sling work and operate a crane and a forklift. When these operations are performed by unauthorized personnel, it is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system.

**CAUTION**
- Before relocating the Manipulator, fold the arm and secure it tightly with a wire tie to prevent hands or fingers from being caught in the Manipulator.
- When removing the anchor bolts, support the Manipulator to prevent falling. Removing the anchor bolts without support may result in a fall of the Manipulator, and then get hands, fingers, or feet caught.
- To carry the Manipulator, have two or more people to work on it and secure the Manipulator to the delivery equipment or hold the bottom of Arm #1, the bottom of the main cable fitting, and the bottom of the base by hand. When holding the bottom of the base by hand, be very careful not to get hands or fingers caught.
- Stabilize the Manipulator with your hands when hoisting it. Unstable hoisting is extremely hazardous and may result in fall of the Manipulator.

When transporting the Manipulator for a long distance, secure it to the delivery equipment so that the Manipulator cannot fall. If necessary, pack the Manipulator in the same way as it was delivered.

When the Manipulator is used for a robot system again after long-term storage, perform a test run to verify that it works properly, and then operate it thoroughly.

Transport and store the Manipulator in the range of −25°C to +55°C. Humidity within 10% to 90% is recommended.

When condensation occurs on the Manipulator during transport or storage, turn ON the power only after the condensation dries.

Do not shock or shake the Manipulator during transport.
3.8.2 Table Top Mounting

- Install or relocate the Table Top Mounting Manipulator with two or more people. The Manipulator weights are as follows. Be careful not to get hands, fingers, or feet caught and/or have equipment damaged by a fall of the Manipulator.
  - G3-251*: approx. 14 kg; 31 lb.
  - G3-301*: approx. 14 kg; 31 lb.
  - G3-351*: approx. 14 kg; 31 lb.

1. Turn OFF the power on all devices and unplug the cables.
2. Remove the mechanical stops if using them to limit the motion range of Joints #1 and #2. For details on the motion range, refer to Setup & Operation: 5.2 Motion Range Setting by Mechanical Stops.
3. Cover the arm with a sheet so that the arm will not be damaged.
   - Tie the lower end of the shaft and arm, and the base and arm together with the wire tie.
   - Be careful not to tie them too tight. Otherwise, the shaft may bend.

Example of Arm Retaining Posture

4. Hold the bottom of Arm #1 by hand to unscrew the anchor bolts.
   - Then, remove the Manipulator from the base table.
3.8.3 Multiple Mounting

WARNING

- Install or relocate the Multiple Mounting Manipulator with two or more people. The Manipulator weights are as follows. Be careful not to get hands, fingers, or feet caught and/or have equipment damaged by a fall of the Manipulator.
- When removing the Manipulator from the wall, support the Manipulator, and then remove the anchor bolts. Removing the anchor bolts without supporting is extremely hazardous and may result in fall of the Manipulator.

NOTE

(1) Turn OFF the power on all devices and unplug the cables. Remove the mechanical stops if using them to limit the motion range of Joints #1 and #2. For details on the motion range, refer to Setup & Operation: 5.2 Motion Range Setting by Mechanical Stops.

(2) Cover the arm with a sheet so that the arm will not be damaged. Refer to the figure below and bind the shaft and arm retaining bracket on the base.

(3) Hold the bottom of Arm #1 by hand to unscrew the anchor bolts. Then, remove the Manipulator from the wall.
4. Setting of End Effectors

4.1 Attaching an End Effector

Users are responsible for making their own end effector(s). Before attaching an end effector, observe these guidelines.

- If you use an end effector equipped with a gripper or chuck, connect wires and/or pneumatic tubes properly so that the gripper does not release the work piece when the power to the robot system is turned OFF. Improper connection of the wires and/or pneumatic tubes may damage the robot system and/or work piece as the work piece is released when the Emergency Stop switch is pressed. I/O outputs are configured at the factory so that they are automatically shut off (0) by power disconnection, the Emergency Stop switch, or the safety features of the robot system.

Shaft
- Attach an end effector to the lower end of the shaft.
  - For the shaft dimensions, and the overall dimensions of the Manipulator, refer to Setup & Operation: 2. Specifications.
  - Do not move the upper limit mechanical stop on the lower side of the shaft. Otherwise, when “Jump motion” is performed, the upper limit mechanical stop may hit the Manipulator, and the robot system may not function properly.
  - Use a split muff coupling with an M4 bolt or larger to attach the end effector to the shaft.

Brake release switch
- Joint #3 cannot be moved up/down by hand because the electromagnetic brake is applied to the joint while power to the robot system is turned OFF.

  This prevents the shaft from hitting peripheral equipment in the case that the shaft is lowered by the weight of the end effector when the power is disconnected during operation, or when the motor is turned OFF even though the power is turned ON.
  
  To move Joint #3 up/down while attaching an end effector, turn ON the Controller and press the brake release switch.

  This button switch is a momentary-type; the brake is released only while the button switch is being pressed.
  
  - Be careful of the shaft while the brake release switch is being pressed because the shaft may be lowered by the weight of the end effector.

Layouts
- When you operate the manipulator with an end effector, the end effector may interfere with the Manipulator because of the outer diameter of the end effector, the size of the work piece, or the position of the arms. When designing your system layout, pay attention to the interference area of the end effector.
4.2 Attaching Cameras and Valves

Arm #2 has threaded holes as shown in the figure below. Use these holes for attaching cameras, valves, and other equipment.

[Unit: mm]
4.3 Weight and Inertia Settings

To ensure optimum Manipulator performance, it is important to make sure that the load (weight of the end effector and work piece) and moment of inertia of the load are within the maximum rating for the Manipulator, and that Joint #4 does not become eccentric. If the load or moment of inertia exceeds the rating or if the load becomes eccentric, follow the steps below, “4.3.1 Weight Setting” and “4.3.2 Inertia Setting” to set parameters.

Setting parameters makes the PTP motion of the Manipulator optimal, reduces vibration to shorten the operating time, and improves the capacity for larger loads. In addition, it reduces persistent vibration produced when the moment of inertia of the end effector and work piece is larger than the default setting.

4.3.1 Weight Setting

- The total weight of the end effector and the work piece must not exceed 3 kg.
- The G3 series Manipulators are not designed to work with loads exceeding 3 kg. Always set the Weight parameters according to the load. Setting a value that is smaller than the actual load may cause errors, excessive shock, insufficient function of the Manipulator, and/or shorten the life cycle of parts/mechanisms.

The acceptable weight capacity (end effector and work piece) in G3 series is 1 kg at the default rating and 3 kg at the maximum. When the load (weight of the end effector and work piece) exceeds the rating, change the setting of Weight parameter.

After the setting is changed, the maximum acceleration/deceleration speed of the robot system at PTP motion corresponding to the “Weight Parameter” is set automatically.

Load on the Shaft

The load (weight of the end effector and work piece) on the shaft can be set by Weight parameter.

Enter a value into the [Load inertia:] text box on the [Inertia] panel ([Tools] - [Robot Manager]). (You may also execute the Inertia command from the [Command Window].)

Load on the Arm

When you attach a camera or other devices to the arm, calculate the weight as the equivalent of the shaft. Then, add this to the load and enter the total weight to the Weight parameter.

Equivalent Weight Formula

When you attach the equipment near Arm #2: \[ W_M = M \left( \frac{L_1}{L_1+L_2} \right)^2 \]

When you attach the equipment to the end of Arm #2: \[ W_M = M \left( \frac{L_M}{L_2} \right)^2 \]

- \( W_M \): equivalent weight
- \( M \): weight of camera etc.
- \( L_1 \): length of Arm #1
- \( L_2 \): length of Arm #2
- \( L_M \): distance from rotation center of Joint #2 to center of gravity of camera etc.
<Example> A “1 kg” camera is attached to the end of the G3 series arm (180 mm away from the rotation center of Joint #2) with a load weight of “1 kg”.

\[ M = 1 \]
\[ L_2 = 130 \]
\[ L_{M} = 180 \]

\[ W_M = 1 \times 180^2 / 130^2 = 1.917 \Rightarrow 2 \text{ (round up)} \]
\[ W + W_M = 1 + 2 = 3 \]

Enter “3” for the Weight Parameter.

Automatic speed setting by Weight

* The percentage in the graph is based on the speed at rated weight (1 kg) as 100%.

Automatic acceleration/deceleration setting by Weight

* The percentage in the graph is based on the acceleration / deceleration at rated weight (1 kg) as 100%.
4.3.2 Inertia Setting

Moment of Inertia and the Inertia Setting

The moment of inertia is defined as “the ratio of the torque applied to a rigid body and its resistance to motion”. This value is typically referred to as “the moment of inertia”, “inertia”, or “GD²”. When the Manipulator operates with additional objects (such as an end effector) attached to the shaft, the moment of inertia of load must be considered.

**CAUTION**

- The moment of inertia of the load (weight of the end effector and work piece) must be 0.05 kg·m² or less. The G3 series Manipulators are not designed to work with a moment of inertia exceeding 0.05 kg·m².
- Always set the moment of inertia parameter to the correct moment of inertia. Setting a value that is smaller than the actual moment of inertia may cause errors, excessive shock, insufficient function of the Manipulator, and/or shorten the life cycle of parts/mechanisms.

The acceptable moment of inertia of load for a G3 series Manipulator is 0.005 kg·m² at the default rating and 0.05 kg·m² at the maximum. When the moment of inertia of the load exceeds the rating, change the setting of the moment of inertia parameter of the Inertia command. After the setting is changed, the maximum acceleration/deceleration speed of Joint #4 at PTP motion corresponding to the “moment of inertia” value is set automatically.

**Moment of inertia of load on the shaft**

The moment of inertia of load (weight of the end effector and work piece) on the shaft can be set by the “moment of inertia” parameter of the Inertia command.

Enter a value into the [Load inertia:] text box on the [Inertia] panel ([Tools]-[Robot Manager]). (You may also execute the Inertia command from the [Command Window].)
CAUTION

The eccentric quantity of load (weight of the end effector and work piece) must be 150 mm or less. The G3 series Manipulators are not designed to work with eccentric quantity exceeding 150 mm.

Always set the eccentric quantity parameter according to the eccentric quantity. Setting a value that is smaller than the actual eccentric quantity may cause errors, excessive shock, insufficient function of the Manipulator, and/or shorten the life cycle of parts/mechanisms.

The acceptable eccentric quantity of load in G3 series is 0 mm at the default rating and 150 mm at the maximum. When the eccentric quantity of load exceeds the rating, change the setting of eccentric quantity parameter of Inertia command. After the setting is changed, the maximum acceleration/deceleration speed of the Manipulator at PTP motion corresponding to the “eccentric quantity” is set automatically.

Eccentric quantity of load on the shaft

The eccentric quantity of load (weight of the end effector and work piece) on the shaft can be set by “eccentric quantity” parameter of Inertia command.

Enter a value into the [Eccentricity:] text box on the [Inertia] panel ([Tools] - [Robot Manager]). (You may also execute the Inertia command from the [Command Window].)
Automatic acceleration/deceleration setting by Inertia (eccentric quantity)

* The percentage in the graph is based on the acceleration / deceleration at rated eccentricity (0 mm) as 100%.

Calculating the Moment of Inertia
Refer to the following examples of formulas to calculate the moment of inertia of load (end effector with work piece).

The moment of inertia of the entire load is calculated by the sum of each part (a), (b), and (c).

The methods for calculating the moment of inertia for (a), (b), and (c) are shown below. Calculate the total moment of inertia using the basic formulas.
(a) Moment of inertia of a rectangular parallelepiped

\[ I = m \left( \frac{b^2 + h^2}{12} + m \times L^2 \right) \]

(b) Moment of inertia of a cylinder

\[ I = m \left( \frac{r^2}{2} + m \times L^2 \right) \]

(c) Moment of inertia of a sphere

\[ I = m \left( \frac{2}{5} r^2 + m \times L^2 \right) \]
4.4 Precautions for Auto Acceleration/Deceleration of Joint #3

When you move the Manipulator in horizontal PTP motion with Joint #3 (Z) at a high position, the motion time will be faster.

When Joint #3 gets below a certain point, then auto acceleration/deceleration is used to reduce acceleration/deceleration. (Refer to the figure below.) The higher the position of the shaft is, the faster the motion acceleration/deceleration is. However, it takes more time to move Joint #3 up and down. Adjust the position of Joint #3 for the Manipulator motion after considering the relation between the current position and the destination position.

The upper limit of Joint #3 during horizontal motion using Jump command can be set by the LimZ command.

**Automatic acceleration/deceleration vs. Joint #3 position**

- Figures on the graph (%) are the proportion to the acceleration/deceleration speed at the shaft upper limit position.

- G3-25***
- G3-30***
- G3-35***

**NOTE** When moving the Manipulator horizontally while the shaft is being lowered, it may cause over-shoot at the time of final positioning.
5. Motion Range

- When setting up the motion range for safety, both the pulse range and mechanical stops must always be set at the same time.

The motion range is preset at the factory as explained in Setup & Operation: 5.4 Standard Motion Range. That is the maximum motion range of the Manipulator.

There are three methods for setting the motion range described as follows:

1. Setting by pulse range (for all joints)
2. Setting by mechanical stops (for Joints #1 to #3)
3. Setting the Cartesian (rectangular) range in the X, Y coordinate system of the Manipulator (for Joints #1 and #2)

When the motion range is changed due to layout efficiency or safety, follow the descriptions in 5.1 to 5.3 to set the range.

5.1 Motion Range Setting by Pulse Range (for All Joints)

Pulses are the basic unit of Manipulator motion. The motion range of the Manipulator is controlled by the pulse range between the pulse lower limit and upper limit of each joint. Pulse values are read from the encoder output of the servo motor.

For the maximum pulse range, refer to the following sections.

The pulse range must be set inside of the mechanical stop range.

5.1.1 Max. Pulse Range of Joint #1
5.1.2 Max. Pulse Range of Joint #2
5.1.3 Max. Pulse Range of Joint #3
5.1.4 Max. Pulse Range of Joint #4.

Once the Manipulator receives an operating command, it checks whether the target position specified by the command is within the pulse range before operating. If the target position is out of the set pulse range, an error occurs and the Manipulator does not move.

The pulse range can be set on the [Range] panel shown by selecting [Tools]-[Robot Manager]. (You may also execute the Range command from the [Command Window].)
5.1.1 Max. Pulse Range of Joint #1

The 0 (zero) pulse position of Joint #1 is the position where Arm #1 faces toward the positive (+) direction on the X-coordinate axis. When the 0 pulse is a starting point, the counterclockwise pulse value is defined as the positive (+) and the clockwise pulse value is defined as the negative (−).

### Table Top Mounting

<table>
<thead>
<tr>
<th>Arm</th>
<th>Standard</th>
<th>-R</th>
<th>-L</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>25 25°</td>
<td>−125 to 150</td>
<td>−150 to 125</td>
</tr>
<tr>
<td>A</td>
<td>30 ±140°</td>
<td>−110 to 165</td>
<td>−165 to 110</td>
</tr>
<tr>
<td>A</td>
<td>35 35°</td>
<td>−1019449 to 6990507</td>
<td>−1747627 to 6262329</td>
</tr>
<tr>
<td>B</td>
<td>25 −1456356 to 6699236</td>
<td>−582542 to 7427413</td>
<td>−2184533 to 5825422</td>
</tr>
</tbody>
</table>

### Multiple Mounting

<table>
<thead>
<tr>
<th>Arm</th>
<th>Standard</th>
<th>-R</th>
<th>-L</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>30 ±115°</td>
<td>−105 to 130</td>
<td>−130 to 105</td>
</tr>
<tr>
<td>A</td>
<td>35 ±120°</td>
<td>−728178 to 5971058</td>
<td>−436907 to 6407965</td>
</tr>
<tr>
<td>B</td>
<td>30 −873813 to 6116693</td>
<td>−873813 to 6116693</td>
<td>−873813 to 6116693</td>
</tr>
<tr>
<td>B</td>
<td>35 −873813 to 6116693</td>
<td>−873813 to 6116693</td>
<td>−873813 to 6116693</td>
</tr>
</tbody>
</table>
5.1.2 Max. Pulse Range of Joint #2

The 0 (zero) pulse position of Joint #2 is the position where Arm #2 is in-line with Arm #1. With the 0 pulse as a starting point, the counterclockwise pulse value is defined as the positive (+) and the clockwise pulse value is defined as the negative (−).

Table Top Mounting (S: Standard-model, C: Cleanroom-model)

<table>
<thead>
<tr>
<th>Arm</th>
<th>Standard</th>
<th>-R</th>
<th>-L</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. Motion Range (deg)</td>
<td>±141</td>
<td>–135 to 150</td>
<td>–150 to 135</td>
</tr>
<tr>
<td>25</td>
<td>±137</td>
<td>–135 to 145</td>
<td>–145 to 135</td>
</tr>
<tr>
<td>30</td>
<td>±142</td>
<td>–120 to 165</td>
<td>–165 to 120</td>
</tr>
<tr>
<td>35</td>
<td>±142</td>
<td>–120 to 160</td>
<td>–160 to 120</td>
</tr>
</tbody>
</table>

| B   |          |          |          |
| Max. Pulse Range (pulse) | –2566827 to 2566827 | –2576000 to 2576000 | –2576000 to 2576000 |
| 25  | –2594009 to 2594009 | –2639645 to 2639645 | –2639645 to 2639645 |
| 30  | –2585031 to 2585031 | –2730667 to 2730667 | –2730667 to 2730667 |
| 35  | –2585031 to 2585031 | –2912711 to 2912711 | –2912711 to 2912711 |

Table Top Mounting (S: Standard-model, C: Cleanroom-model)

<table>
<thead>
<tr>
<th>Arm</th>
<th>Standard</th>
<th>-R</th>
<th>-L</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. Motion Range (deg)</td>
<td>±135</td>
<td>–120 to 160</td>
<td>–160 to 120</td>
</tr>
<tr>
<td>30</td>
<td>±142</td>
<td>–120 to 150</td>
<td>–150 to 120</td>
</tr>
<tr>
<td>35</td>
<td>±142</td>
<td>–120 to 150</td>
<td>–150 to 120</td>
</tr>
</tbody>
</table>

| B   |          |          |          |
| Max. Pulse Range (pulse) | –2576000 to 2576000 | –2730667 to 2730667 | –2730667 to 2730667 |
| 30  | –2585031 to 2585031 | –2912711 to 2912711 | –2912711 to 2912711 |
| 35  | –2585031 to 2585031 | –2730667 to 2730667 | –2730667 to 2730667 |
5.1.3 Max. Pulse Range of Joint #3

The 0 (zero) pulse position of Joint #3 is the position where the shaft is at its upper limit. The pulse value is always negative because Joint #3 always moves lower than the 0 pulse position.

<table>
<thead>
<tr>
<th>Model</th>
<th>Joint #3 Stroke</th>
<th>Lower Limit Pulse</th>
</tr>
</thead>
<tbody>
<tr>
<td>G3-*<em>1S</em></td>
<td>150 mm</td>
<td>−1706667</td>
</tr>
<tr>
<td>G3-*<em>1C</em> (Cleanroom-model)</td>
<td>120 mm</td>
<td>−1365334</td>
</tr>
</tbody>
</table>

For the Cleanroom-model (G3-**1C*), the motion range set with the Joint #3 mechanical stop cannot be changed.

5.1.4 Max. Pulse Range of Joint #4

The 0 (zero) pulse position of Joint #4 is the position where the flat near the end of the shaft faces toward the end of Arm #2. With the 0 pulse as a starting point, the counterclockwise pulse value is defined as the positive (+) and the clockwise pulse value is defined as the negative (−).
5.2 Motion Range Setting by Mechanical Stops

Mechanical stops physically limit the absolute area that the Manipulator can move.

Both Joints #1 and #2 have threaded holes in the positions corresponding to the angle for the mechanical stop settings. Install the bolts in the holes corresponding to the angle that you want to set.

Joints #3 can be set to any length less than the maximum stroke.

**Table Top Mounting**

![Diagram of Table Top Mounting]

*The different mechanical stop positions from Table Top mounting are indicated for Multiple mounting.

**5.2.1 Setting the Mechanical Stops of Joints #1 and #2**

Both Joints #1 and #2 have threaded holes in the positions corresponding to the angle for the mechanical stop settings. Install the bolts in the holes corresponding to the angle that you want to set.

Install the bolts for the mechanical stop of Joint #1 (adjustable) to the following position.

- **Table Top mounting**: Arm bottom side
- **Multiple mounting**: Arm top side
Joint #1 Mechanical Stops

Views from the bottom of Arm #1

<table>
<thead>
<tr>
<th>Model</th>
<th>Arm</th>
<th>a</th>
<th>b</th>
<th>c</th>
</tr>
</thead>
<tbody>
<tr>
<td>G3-**1S/C</td>
<td>250</td>
<td>±140°</td>
<td>-110°</td>
<td>+110°</td>
</tr>
<tr>
<td></td>
<td>300</td>
<td>±140°</td>
<td>-110°</td>
<td>+110°</td>
</tr>
<tr>
<td></td>
<td>350</td>
<td>±140°</td>
<td>-110°</td>
<td>+110°</td>
</tr>
<tr>
<td>G3-**1S/C-R</td>
<td>300</td>
<td>-125° to 150°</td>
<td>-105°</td>
<td>+130°</td>
</tr>
<tr>
<td></td>
<td>350</td>
<td>-110° to 165°</td>
<td>-90°</td>
<td>+145°</td>
</tr>
<tr>
<td>G3-**1S/C-L</td>
<td>300</td>
<td>-150° to 125°</td>
<td>-130°</td>
<td>+105°</td>
</tr>
<tr>
<td></td>
<td>350</td>
<td>-165° to 110°</td>
<td>-145°</td>
<td>+90°</td>
</tr>
<tr>
<td>G3-**1SM/CM</td>
<td>300</td>
<td>±115°</td>
<td>-100°</td>
<td>+100°</td>
</tr>
<tr>
<td></td>
<td>350</td>
<td>±120°</td>
<td>-105°</td>
<td>+105°</td>
</tr>
<tr>
<td>G3-351SM/CM-R</td>
<td>350</td>
<td>-105° to 130°</td>
<td>-95°</td>
<td>+120°</td>
</tr>
<tr>
<td>G3-351SM/CM-L</td>
<td>350</td>
<td>-130° to 105°</td>
<td>-120°</td>
<td>+95°</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Setting Angle</th>
<th>Pulse Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>+90°</td>
<td>5242880</td>
</tr>
<tr>
<td>+95°</td>
<td>5388516</td>
</tr>
<tr>
<td>+100°</td>
<td>5534151</td>
</tr>
<tr>
<td>+105°</td>
<td>5679787</td>
</tr>
<tr>
<td>+110°</td>
<td>5825423</td>
</tr>
<tr>
<td>+115°</td>
<td>5971058</td>
</tr>
<tr>
<td>+120°</td>
<td>6116694</td>
</tr>
<tr>
<td>+125°</td>
<td>6262329</td>
</tr>
<tr>
<td>+130°</td>
<td>6407965</td>
</tr>
<tr>
<td>+140°</td>
<td>6699236</td>
</tr>
<tr>
<td>+145°</td>
<td>6844872</td>
</tr>
<tr>
<td>+150°</td>
<td>6990507</td>
</tr>
<tr>
<td>+165°</td>
<td>7427414</td>
</tr>
<tr>
<td>-90°</td>
<td>0</td>
</tr>
<tr>
<td>-95°</td>
<td>-145636</td>
</tr>
<tr>
<td>-100°</td>
<td>-291271</td>
</tr>
<tr>
<td>-105°</td>
<td>-436907</td>
</tr>
<tr>
<td>-110°</td>
<td>-582542</td>
</tr>
<tr>
<td>-120°</td>
<td>-728178</td>
</tr>
<tr>
<td>-125°</td>
<td>-1019449</td>
</tr>
<tr>
<td>-130°</td>
<td>-1456356</td>
</tr>
<tr>
<td>-140°</td>
<td>-1601991</td>
</tr>
<tr>
<td>-145°</td>
<td>-1747627</td>
</tr>
<tr>
<td>-150°</td>
<td>-2184533</td>
</tr>
</tbody>
</table>

(°: degree)
5. Motion Range

Joint #2 Mechanical Stops

Views from the top of Arm #1

<table>
<thead>
<tr>
<th>Model</th>
<th>Arm</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>G3-**1S/C</td>
<td>250</td>
<td>+141°</td>
<td>-141°</td>
<td>+120°</td>
<td>-120°</td>
</tr>
<tr>
<td></td>
<td>300</td>
<td>+142°</td>
<td>-142°</td>
<td>+120°</td>
<td>-120°</td>
</tr>
<tr>
<td></td>
<td>350</td>
<td>+142°</td>
<td>-142°</td>
<td>+120°</td>
<td>-120°</td>
</tr>
<tr>
<td>G3-**1S/C-R</td>
<td>300</td>
<td>+150°</td>
<td>-135°</td>
<td>+130°</td>
<td>-115°</td>
</tr>
<tr>
<td></td>
<td>350</td>
<td>+165°</td>
<td>-120°</td>
<td>+145°</td>
<td>-100°</td>
</tr>
<tr>
<td>G3-**1S/C-L</td>
<td>300</td>
<td>-100°</td>
<td>150°</td>
<td>+115°</td>
<td>-130°</td>
</tr>
<tr>
<td></td>
<td>350</td>
<td>-100°</td>
<td>165°</td>
<td>+100°</td>
<td>-145°</td>
</tr>
<tr>
<td>G3-**1SM/CM</td>
<td>300</td>
<td>+135°</td>
<td>-135°</td>
<td>+115°</td>
<td>-115°</td>
</tr>
<tr>
<td></td>
<td>350</td>
<td>+142°</td>
<td>-142°</td>
<td>+120°</td>
<td>-120°</td>
</tr>
<tr>
<td>G3-351SM/CM-R</td>
<td>350</td>
<td>+160°</td>
<td>-120°</td>
<td>+150°</td>
<td>-110°</td>
</tr>
<tr>
<td>G3-351SM/CM-L</td>
<td>350</td>
<td>+120°</td>
<td>-160°</td>
<td>+110°</td>
<td>-150°</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Setting Angle</th>
<th>Pulse Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>+100°</td>
<td>1820444</td>
</tr>
<tr>
<td>+110°</td>
<td>2002488</td>
</tr>
<tr>
<td>+115°</td>
<td>2093511</td>
</tr>
<tr>
<td>+120°</td>
<td>2184533</td>
</tr>
<tr>
<td>+130°</td>
<td>2366577</td>
</tr>
<tr>
<td>+135°</td>
<td>2457600</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Setting Angle</th>
<th>Pulse Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>+141°</td>
<td>2566826</td>
</tr>
<tr>
<td>+142°</td>
<td>2585031</td>
</tr>
<tr>
<td>+145°</td>
<td>2639644</td>
</tr>
<tr>
<td>+150°</td>
<td>2730666</td>
</tr>
<tr>
<td>+160°</td>
<td>2912711</td>
</tr>
<tr>
<td>+165°</td>
<td>3003733</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Setting Angle</th>
<th>Pulse Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>-100°</td>
<td>-1820444</td>
</tr>
<tr>
<td>-115°</td>
<td>-2002488</td>
</tr>
<tr>
<td>-120°</td>
<td>-2093511</td>
</tr>
<tr>
<td>-130°</td>
<td>-2184533</td>
</tr>
<tr>
<td>-135°</td>
<td>-2366577</td>
</tr>
<tr>
<td>-140°</td>
<td>-2457600</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Setting Angle</th>
<th>Pulse Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>-141°</td>
<td>-2566826</td>
</tr>
<tr>
<td>-142°</td>
<td>-2585031</td>
</tr>
<tr>
<td>-145°</td>
<td>-2639644</td>
</tr>
<tr>
<td>-150°</td>
<td>-2730666</td>
</tr>
<tr>
<td>-160°</td>
<td>-2912711</td>
</tr>
<tr>
<td>-165°</td>
<td>-3003733</td>
</tr>
</tbody>
</table>

NOTE

In case of Multiple Mounting, it is impossible to limit the operating range completely.
Because it may hit the wall within the setting range of mechanical stops.
(1) Turn OFF the Controller.

(2) Install a hexagon socket head cap bolt into the hole corresponding to the setting angle, and tighten it.

<table>
<thead>
<tr>
<th>Joint</th>
<th>Hexagon socket head cap bolt (fully threaded)</th>
<th>The number of bolts</th>
<th>Recommended tightening torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M8 × 10</td>
<td>1 bolt / one side</td>
<td>37.2 N⋅m (380 kgf⋅cm)</td>
</tr>
</tbody>
</table>

(3) Turn ON the Controller.

(4) Set the pulse range corresponding to the new positions of the mechanical stops.

Example: Using G3-251S*
- The angle of Joint #1 is set from −110 degrees to +110 degrees.
- The angle of Joint #2 is set from −120 degrees to +120 degrees.

Execute the following commands from the [Command Window].

```
>JRANGE 1, -582542, 5825423  'the pulse range of Joint #1
>JRANGE 2, -2184533, 2184533  'Sets the pulse range of Joint #2
>RANGE -582542, 5825423
, -2184533, 2184533, -1706667
, 0, 1494221, 1494221
```

(5) Move the arm by hand until it touches the mechanical stops, and make sure that the arm does not hit any peripheral equipment during operation.

(6) Operate the joint changed at low speeds until it reaches the positions of the minimum and maximum pulse range. Make sure that the arm does not hit the mechanical stops. (Check the position of the mechanical stop and the motion range you set.)

Example: Using G3-251S*
- The angle of Joint #1 is set from −110 degrees to +110 degrees.
- The angle of Joint #2 is set from −120 degrees to +120 degrees.

Execute the following commands from the [Command Window].

```
>MOTOR ON  'Turns ON the motor
>POWER LOW  'Enters low-power mode
>SPEED 5  'Sets at low speeds
>PULSE -582542, 0, 0, 0  'Moves to the min. pulse position of Joint #1
>PULSE 5825423, 0, 0, 0  'Moves to the max. pulse position of Joint #1
>PULSE 2621440, -2184533, 0, 0  'Moves to the min. pulse position of Joint #2
>PULSE 2621440, 2184533, 0, 0  'Moves to the max. pulse position of Joint #2
```

The Pulse command (Go Pulse command) moves all joints to the specified positions at the same time. Specify safe positions after considering motion of not only the joints whose pulse range have been changed, but also other joints.

In this example, Joint #1 is moved to the center of its motion range (pulse value: 2621440) when checking Joint #2.

If the arm is hitting the mechanical stops or if an error occurs after the arm hits the mechanical stops, either reset the pulse range to a narrower setting or extend the positions of the mechanical stops within the limit.
5.2.2 Setting the Mechanical Stop of Joint #3

This method applies only to the Standard-model Manipulator (G3-**1S**) / Multiple Mounting Manipulator (G3-**1SM). For the Cleanroom-model (G3-**1C**), the motion range set with the Joint #3 mechanical stop cannot be changed.

1. Turn ON the Controller and turn OFF the motors using the Motor OFF command.

2. Push up the shaft while pressing the brake release switch. Do not push the shaft up to its upper limit or it will be difficult for the arm top cover to be removed. Push the shaft up to a position where the Joint #3 mechanical stop can be changed.

3. Turn OFF the Controller.

4. Loosen the lower limit mechanical stop screw (M3×10).

5. The upper end of the shaft defines the maximum stroke. Move the lower limit mechanical stop down by the length you want to limit the stroke. For example, when the lower limit mechanical stop is set at “150 mm” stroke, the lower limit Z coordinate value is “−150”. To change the value to “−130”, move the lower limit mechanical stop down “20 mm”. Use calipers to measure the distance when adjusting the mechanical stop.

6. Firmly tighten the lower limit mechanical stop screw (M3×10) not to let it enter the shaft groove. Recommended tightening torque: 2.45 N⋅m (25 kgf⋅cm)

7. Turn ON the Controller.
(8) Move Joint #3 to its lower limit while pressing the brake release switch, and then check the lower limit position. Do not lower the mechanical stop too far. Otherwise, the joint may not reach a target position.

(9) Calculate the lower limit pulse value of the pulse range using the formula shown below and set the value.

The result of the calculation is always negative because the lower limit Z coordinate value is negative.

\[
\text{Lower limit of pulse (pulse)} = \frac{\text{lower limit Z coordinate value (mm)}}{\text{Resolution (mm/pulse)}}
\]

** For the Joint #3 resolution, refer to the section Setup & Operation 2.4 Specifications.

Execute the following command from the [Command Window]. Enter the calculated value in \(X\).

\[\text{JRANGE 3, X, 0} \quad \text{Sets the pulse range of Joint #3}\]

(10) Using the Pulse command (Go Pulse command), move Joint #3 to the lower limit position of the pulse range at low speed. If the mechanical stop range is less than the pulse range, Joint #3 will hit the mechanical stop and an error will occur. When the error occurs, either change the pulse range to a lower setting or extend the position of the mechanical stop within the limit.

If it is difficult to check whether Joint #3 hits a mechanical stop, turn OFF the Controller and lift the arm top cover to check the condition causing the problem from the side.

Execute the following commands from the [Command Window]. Enter the value calculated in Step (10) in \(X\).

\[\text{MOTOR ON} \quad \text{Turns ON the motor}\]
\[\text{SPEED 5} \quad \text{Sets low speed}\]
\[\text{PULSE 0, 0, X, 0} \quad \text{Moves to the lower limit-pulse position of Joint #3.}\]

(In this example, all pulses except those for Joint #3 are “0”. Substitute these “0s” with the other pulse values specifying a position where there is no interference even when lowering Joint #3.)
5.3 Setting the Cartesian (Rectangular) Range in the XY Coordinate System of the Manipulator

(Joints #1 and #2)

Use this method to set the upper and lower limits of the X and Y coordinates.
This setting is only enforced by software. Therefore, it does not change the physical range.
The maximum physical range is based on the position of the mechanical stops.

Set the XYLim setting on the [XYZ Limits] panel shown by selecting [Tools]-[Robot Manager].
(You may also execute the XYLim command from the [Command Window].)

5.4 Standard Motion Range

The following “motion range” diagrams show the standard (maximum) specification.
When each Joint motor is under servo control, the center of Joint #3’s (shaft’s) lowest point moves in the areas shown in the figure.
“Area limited by mechanical stop” is the area where the center of Joint #3’s lowest point can be moved when each joint motor is not under servo control.
“Mechanical stop” sets the limited motion range so that the center of Joint #3 cannot move beyond the area mechanically.
“Maximum space” is the area that contains the farthest reach of the arms. If the maximum radius of the end effector is over 60 mm, add the “Area limited by mechanical stop” and “radius of the end effector”. The total value is specified as the maximum area.
For the motion area figures, refer to Setup & Operation 3.3 Mounting Dimensions.
Maintenance

This volume contains maintenance procedures with safety precautions for G3 series Manipulators.
1. Safety Maintenance

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

Only authorized personnel who have taken safety training should be allowed to maintain the robot system. Safety training is the program for industrial robot operators that follows the laws and regulations of each nation. The personnel who have taken safety training acquire knowledge of industrial robots (operations, teaching, etc.), knowledge of inspections, and knowledge of related rules/regulations. The personnel who have completed the robot system-training and maintenance-training classes held by the manufacturer, dealer, or locally-incorporated company are allowed to maintain the robot system.

---

**WARNING**

- Do not remove any parts that are not covered in this manual. Follow the maintenance procedure strictly as described in this manual. Improper removal of parts or improper maintenance may not only cause improper function of the robot system but also serious safety problems.

- Keep away from the Manipulator while the power is ON if you have not taken the training courses. Do not enter the operating area while the power is ON. Entering the operating area with the power ON is extremely hazardous and may cause serious safety problems as the Manipulator may move even it seems to be stopped.

- When you check the operation of the Manipulator after replacing parts, be sure to check it while you are outside of the safeguarded area. Checking the operation of the Manipulator while you are inside of the safeguarded area may cause serious safety problems as the Manipulator may move unexpectedly.

- Before operating the robot system, make sure that both the Emergency Stop switches and safeguard switch function properly. Operating the robot system when the switches do not function properly is extremely hazardous and may result in serious bodily injury and/or serious damage to the robot system as the switches cannot fulfill their intended functions in an emergency.

---

**WARNING**

- To shut off power to the robot system, disconnect the power plug from the power source. Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source.

- Before performing any replacement procedure, turn OFF the Controller and related equipment, and then disconnect the power plug from the power source. Performing any replacement procedure with the power ON is extremely hazardous and may result in electric shock and/or malfunction of the robot system.
Be sure to connect the cables properly. Do not allow unnecessary strain on the cables. (Do not put heavy objects on the cables. Do not bend or pull the cables forcibly.) The unnecessary strain on the cables may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system.

2. General Maintenance

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

2.1 Maintenance Inspection

2.1.1 Schedule for Maintenance Inspection

Inspection points are divided into five stages: daily, monthly, quarterly, biannual, and annual. The inspection points are added every stage.

If the Manipulator is operated for 250 hours or longer per month, the inspection points must be added every 250 hours, 750 hours, 1500 hours, and 3000 hours operation.

<table>
<thead>
<tr>
<th>Inspection Point</th>
<th>Daily inspection</th>
<th>Monthly inspection</th>
<th>Quarterly inspection</th>
<th>Biannual inspection</th>
<th>Annual inspection</th>
<th>Overhaul (replacement)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 month (250 h)</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 months (500 h)</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 months (750 h)</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 months (1000 h)</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 months (1250 h)</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 months (1500 h)</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 months (1750 h)</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 months (2000 h)</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 months (2250 h)</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 months (2500 h)</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 months (2750 h)</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 months (3000 h)</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>13 months (3250 h)</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20000 h</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

h = hour
### 2.1.2 Inspection Point

#### Inspection While the Power is OFF (Manipulator is not operating)

<table>
<thead>
<tr>
<th>Inspection Point</th>
<th>Inspection Place</th>
<th>Daily</th>
<th>Monthly</th>
<th>Quarterly</th>
<th>Biannual</th>
<th>Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check looseness or backlash of bolts/screws.</td>
<td>End effector mounting bolts</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Manipulator mounting bolts</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Each arm locking bolts</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Bolts/screws around shaft</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Bolts/screws securing motors, reduction gear units, etc.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Check looseness of connectors. If the connectors are loosen, push it securely or tighten.</td>
<td>External connectors on Manipulator (on the connector plates etc.)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Manipulator cable unit</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Visually check for external defects. Clean up if necessary.</td>
<td>External appearance of Manipulator</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>External cables</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Check for bends or improper location. Repair or place it properly if necessary.</td>
<td>Safeguard etc.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Check tension of timing belts. Tighten it if necessary.</td>
<td>Inside of Arm #2</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Grease conditions</td>
<td>Refer to Maintenance: 2.3 Greasing.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Battery</td>
<td>Refer to Maintenance: 12 Lithium Battery.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

#### Inspection While the Power is ON (Manipulator is operating)

<table>
<thead>
<tr>
<th>Inspection Point</th>
<th>Inspection Place</th>
<th>Daily</th>
<th>Monthly</th>
<th>Quarterly</th>
<th>Biannual</th>
<th>Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check motion range</td>
<td>Each joint</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Move the cables back and forth lightly to check whether the cables are disconnected.</td>
<td>External cables (including cable unit of the Manipulator)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Push each arm in MOTOR ON status to check whether backlash exists.</td>
<td>Each arm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Check whether unusual sound or vibration occurs.</td>
<td>Whole</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Measure the accuracy repeatedly by a gauge.</td>
<td>Whole</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Turn ON and OFF the Brake Release switch and check the sound of the electromagnetic brake. If there is no sound, replace the brake.</td>
<td>Brake</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
2.2 Overhaul (Parts Replacement)

**CAUTION**

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 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.

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.

*Robot Controller RC700 / RC700-A Maintenance 6. Alarm*

For the EPSON RC+ 5.0 Ver. 5.4.7 or later (firmware Ver.1.16.4.x or 1.24.4.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+ 5.0.

For details, refer to the following manual.

*Robot Controller RC180 “Appendix. Alarm”*

**NOTE**

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].

2. Click the <View Controller Status> button to open the [Browse For Folder] dialog.
3. Select the folder where the information is stored.
4. Click <OK> to view the [Controller Status Viewer] dialog.
5. Select [Robot] from the tree menu on the left side (Dialog image: EPSON RC+ 7.0)

For the parts subject to overhaul, refer to Maintenance 15. Maintenance Parts List.
For details of replacement of each part, refer to the Maintenance section.
Please contact the supplier of your region for further information.
2. General Maintenance

2.3 Greasing

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

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

- 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.

<table>
<thead>
<tr>
<th>Greasing part</th>
<th>Greasing Interval</th>
<th>Grease</th>
<th>Refer to Maintenance:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joint #1, #2</td>
<td>Reduction gear units Overhaul timing</td>
<td>SK-1A</td>
<td>5.2 Replacing the Joint #1 Reduction Gear Unit</td>
</tr>
<tr>
<td>Joint #3</td>
<td>Ball screw spline unit At 100 km of operation (50 km for first greasing)</td>
<td>AFB</td>
<td>11.1 Greasing the Ball Screw Spline Unit</td>
</tr>
</tbody>
</table>

Joint #1, 2 reduction gear units
As a rough indication, perform greasing at the same timing as overhaul. However, it may vary depending on usage condition and degree of the load (such as when operated with the maximum motion speed and maximum acceleration / deceleration in continuous operation) applied on the Manipulator.

Joint #3 Ball screw spline unit
The recommended greasing interval is at 100 km of operation. However, greasing timing also can be checked from the grease condition. Perform greasing if the grease is discolored or becomes dry.

![Normal grease](image-normal.png) ![Discolored grease](image-discolored.png)

Perform greasing at 50 km of operation for the first time of greasing.
For the EPSON RC+ 7.0 Ver. 7.2.x or later (firmware Ver.7.2.x.x or later), the recommended replacement time for the grease on the ball screw spline unit can be checked in the [Maintenance] dialog box of the EPSON RC+ 7.0.
For details, refer to the following manual.
Robot Controller RC700 / RC700-A Maintenance 6. Alarm

For the EPSON RC+ 5.0 Ver. 5.4.7 or later (firmware Ver.1.16.4.x or 1.24.4.x or later), the recommended replacement time for the grease can be checked in the [Maintenance] dialog box of the EPSON RC+ 5.0.
For details, refer to the following manual.
Robot Controller RC180 “Appendix. Alarm”
2.4 Tightening Hexagon Socket Head Cap Bolts

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

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

<table>
<thead>
<tr>
<th>Bolt</th>
<th>Tightening Torque</th>
<th>Refer below for the set screw.</th>
</tr>
</thead>
<tbody>
<tr>
<td>M3</td>
<td>2.0 ± 0.1 N·m (21 ± 1 kgf·cm)</td>
<td></td>
</tr>
<tr>
<td>M4</td>
<td>4.0 ± 0.2 N·m (41 ± 2 kgf·cm)</td>
<td></td>
</tr>
<tr>
<td>M5</td>
<td>8.0 ± 0.4 N·m (82 ± 4 kgf·cm)</td>
<td></td>
</tr>
<tr>
<td>M6</td>
<td>13.0 ± 0.6 N·m (133 ± 6 kgf·cm)</td>
<td></td>
</tr>
<tr>
<td>M8</td>
<td>32.0 ± 1.6 N·m (326 ± 16 kgf·cm)</td>
<td></td>
</tr>
<tr>
<td>M10</td>
<td>58.0 ± 2.9 N·m (590 ± 30 kgf·cm)</td>
<td></td>
</tr>
<tr>
<td>M12</td>
<td>100.0 ± 5.0 N·m (1,020 ± 51 kgf·cm)</td>
<td></td>
</tr>
</tbody>
</table>

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

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

2.5 Matching Origins

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

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

Execute the following command from the [Command Window].

```bash
> PULSE
PULSE: [Joint #1 Pulse value] pls [Joint #2 Pulse value] pls [Joint #3 Pulse value] pls [Joint #4 Pulse value] pls
```
2.6 Layout of Maintenance Parts

2.6.1 Table Top Mounting

G3-**1S : Standard-model

G3-**1C : Cleanroom-model (with bellows)
2.6.2 Multiple Mounting

G3-**1SM : Standard-model

Ball screw
spline unit
Arm cover
Joint #4
motor
Z belt
U1 belt
U2 belt
Joint #2
reduction
gear
Joint #3
motor
Cable unit
Power cable
Signal cable
Lithium battery &
Battery board
Joint #3
motor
Brake release switch
LED lamp
Joint #1
motor
Joint #2
motor
Joint #1
reduction
gear
Joint #2
reduction
gear
Joint #3
brake
(Figure: G3-301SM)

G3-**1CM : Cleanroom-model (with bellows)

Bellows
Gasket
Joint #1
motor
Joint #2
motor
Joint #3
motor
Gasket
Bellows
Heat release sheet
(Figure: G3-301CM)
3. Covers

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

WARNING

■ Do not connect or disconnect the motor connectors while the power to the robot system is turned ON. Connecting or disconnecting the motor connectors with the power ON is extremely hazardous and may result in serious bodily injury as the Manipulator may move abnormally, and also may result in electric shock and/or malfunction of the robot system.

■ To shut off power to the robot system, disconnect the power plug from the power source. Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source.

■ Before performing any replacement procedure, turn OFF the Controller and related equipment, and then disconnect the power plug from the power source. Performing any replacement procedure with the power ON is extremely hazardous and may result in electric shock and/or malfunction of the robot system.

■ Be careful not to get any foreign substances in the Manipulator, connectors, and pins during maintenance. Turning ON the power to the robot system when any foreign substances exist in them is extremely hazardous and may result in electric shock and/or malfunction of the robot system.

<table>
<thead>
<tr>
<th>Name</th>
<th>Quantity</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance parts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Under cover gasket</td>
<td>1</td>
<td>R13B031226 Only for Cleanroom-model</td>
</tr>
<tr>
<td>Silicon adhesive (for the gasket on the Connector Plate)</td>
<td>1</td>
<td>R13B031227 Only for Cleanroom-model</td>
</tr>
</tbody>
</table>
| Hexagonal wrench (width across flats: 3 mm) | 1 | For M4 screw  
  Tightening Torque: 0.9 N-m (9.2 kgf-cm) |
| Torque wrench                 | 1        |                                           |
| Cross-point screwdriver       | 1        | For M4 truss screw  
  Tightening torque: 0.4 N-m (4.1 kgf-cm)  
  For bellows removal (Only for Cleanroom-model) |
| Wiping cloth                  | 1        | For wiping adhesive                       |
Table Top Mounting

Multiple Mounting
3.1 Arm Top Cover

- Do not remove the arm top cover forcibly. Removing the cover 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 mounting the cover, be careful not to allow the cables to interfere with the cover mounting and do not bend these cables forcibly to push them into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system.

When routing the cables, observe the cable locations after removing the cover. Be sure to place the cables back to their original locations.

### Arm Top Cover Removal

1. Turn ON the Controller.

2. Press and hold the brake release switch to let the shaft down. Be sure to keep enough space and prevent the end effector hitting any peripheral equipment.

   - The brake release switch affects only Joint #3. When the brake release switch is pressed, the brake for Joint #3 is released simultaneously.

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

3. Turn OFF the Controller.

4. Unscrew the arm top cover mounting bolts, and then lift the cover.

   - When bellows are installed to the manipulator, remove the upper bellows and then remove the arm top cover. For bellows removal, refer to Maintenance 10. Bellows.

   - Be careful for user wires and tubes when removing the cover.
Arm Top Cover
Installation

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

After mounting the arm top cover, make sure that the lower limit mechanical stop does not touch the cylindrical part of the arm top cover.

(2) When bellows are installed to the manipulator, install the arm top cover and then install the upper bellows.

For bellows installation, refer to Maintenance 10. Bellows.

3.2 Arm Bottom Cover

Unscrew the arm bottom cover mounting bolts, and then pull the cover downward and remove it.

The arm bottom cover may not be removed from the shaft because the end effector is installed.

If it is necessary to remove the cover completely (for replacement of the ball screw spline unit etc.), remove the end effector.

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

When bellows are installed to the manipulator, remove or pull down the lower bellows and then remove the arm bottom cover. For bellows removal, refer to Maintenance 10. Bellows.

A gasket is installed to G3-**1C* (Cleanroom-model).
3.3 Arm Cap

Unscrew the arm cap mounting bolts and remove the cover.
Arm cap is not installed to the Multiple Mounting Manipulators.

G3-**1 Table Top Mounting

3.4 Connector Plate

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

Unscrew the connector plate mounting bolts and remove the plate.
3.5 Connector Sub Plate

- Do not remove the connector sub plate forcibly. Removing the connector sub 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 sub plate, be careful not to allow the cables to interfere with the plate mounting and do not bend these cables forcibly to push them into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system.

When routing the cables, observe the cable locations after removing the connector sub plate. Be sure to place the cables back to their original locations.

Unscrew the connector sub plate mounting bolts and remove the plate.

- **G3-**1 Table Top Mounting

- **G3-**1M Multiple Mounting

3.6 User Plate

Unscrew the user plate mounting bolts and remove the plate.

- **G3-**1S Standard-model

- **G3-**1C Cleanroom-model

A gasket is installed to **G3-**1C* (Cleanroom-model).
3.7 Heatsink Plate

Unscrew the heatsink plate mounting bolts to remove the plate.

![Diagram of Heatsink Plate and Trusses]

*NOTE*
Be careful of the Heat release sheet at the side of the Motor, and be sure to keep it.

Be careful when you mount the Heatsink plate without the Heat release sheet, it may cause the malfunction or break by the heat from the Motor.

3.8 Base Bottom Cover

Unscrew the base bottom cover mounting bolts and remove the cover.

![Diagram of Base Bottom Cover and Trusses]

*NOTE*
A base bottom cover is not installed to G3-**1S* (Standard-model).
4. Cable

**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.

**CAUTION**

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

### 4.1 Replacing Cable Unit

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

If the error occurs, execute the calibration of all joints and axes. For details of the Calibration, refer to *Maintenance: 14. Calibration.*

<table>
<thead>
<tr>
<th>Name</th>
<th>Quantity</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maintenance parts</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cable unit</td>
<td>1</td>
<td>Each manipulator model</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(<em>Refer to Maintenance: 15. Maintenance parts</em>)</td>
</tr>
<tr>
<td>Battery Unit (Lithium battery)</td>
<td>1</td>
<td>2117879</td>
</tr>
<tr>
<td><strong>Tools</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hexagonal wrench</td>
<td>1</td>
<td>For M4 screw</td>
</tr>
<tr>
<td>width across flats: 3 mm</td>
<td>1</td>
<td>For M5 screw</td>
</tr>
<tr>
<td>width across flats: 4 mm</td>
<td>1</td>
<td>For D-sub connector removal</td>
</tr>
<tr>
<td>Spanner</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>width across flats: 5 mm</td>
<td>1</td>
<td>For D-sub connector removal</td>
</tr>
<tr>
<td>Nut screwdriver</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>width across flats: 5 mm</td>
<td>1</td>
<td>For D-sub connector removal</td>
</tr>
<tr>
<td>Torque wrench</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Nippers</td>
<td>1</td>
<td>For cutting wire tie</td>
</tr>
<tr>
<td><strong>Material</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wire tie</td>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>
Table Top mounting

Multiple Mounting

(Figure: G3-301S)

(Figure: G3-301SM)
CABLE UNIT REMOVAL

1. Turn ON the Controller and change the motor to OFF status (MOTOR OFF).
2. Press and hold the brake release switch to let the shaft down. Be sure to keep enough space and prevent the end effector hitting any peripheral equipment.
   - The brake release switch affects only Joint #3. When the brake release switch is pressed, the brake for Joint #3 is released simultaneously.
   - Be careful of the shaft while the brake release switch is being pushed because it may be lowered by the weight of an end effector.
3. Turn OFF the Controller and disconnect the power cable and signal cable connectors from the controller.
4. Remove the connector plate.
   - For details, refer to Maintenance: 3.4 Connector Plate.
5. Remove the connector sub plate.
   - For details, refer to Maintenance: 3.5 Connector Sub Plate.
6. Connect the spare battery to the spare battery connector (XB11) of Joint #1 signal cable.
   - Use the battery unit as the spare battery.
   - The position of Joint #1 motor is stored with the battery on Arm #2. Connect the spare battery otherwise the Joint #1 position data will be lost.
(7) Disconnect the air tubes, ground wire, D-sub cable, and seven connectors (X10, X20, X30, X111, X121, X131, XB10) connected to the connector plate and connector sub plate (inner side).

- Be sure to keep the connectors of the battery board connected at cables replacement. Otherwise, the motor will lose position data and the calibration must be executed again.
- Remember the cable layout so that the cables can be reconnected correctly after replacement.

(8) Cut off one wire tie binding Base side cables.

(9) Remove the arm top cover.
    For details, refer to Maintenance: 3.1 Arm Top Cover.

(10) Remove the Battery board.

(11) Loosen the mounting screws for the User plate and remove the plate from the Arm #2.

    At this point, the ground is removed with the plate.
(12) Disconnect 11 connectors on the Arm side.

Connectors X21, X22, X31, X32, X33, X41, X42, X61, X221, X231, X241

X61 is connected to the battery board.

Be sure to keep the connectors of the battery board connected at cables replacement. Otherwise, the Joint #2, #3, and #4 motors will lose position data and the calibration must be executed again.

(13) Disconnect the D-sub cable, air tubes, and connector of the brake release switch from the user plate.

NOTE

Mounting screws for the D-sub cable are very small. Be sure to keep the screws.

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

Be sure to observe the connection for connecting the disconnected parts after replacement.

(14) Remove the mounting screws for the cable unit and remove the unit from the Manipulator.

### Table Top Mounting

![Diagram of Table Top Mounting]

### Multiple Mounting

![Diagram of Multiple Mounting]
(1) Mount the cable unit to the Manipulator.

(2) Connect the following to inner connector plate and connector sub plate.
   - Air tube  //  Ground wire  //  D-sub cable
   - Joint #1 Signal cable connector and Power cable connector
     4 connectors (X20, X30, X121, X131)

(3) Connect Joint #1 Signal cable connector and XB10.

(4) Bundle the wire tie removed in Removal Step (8).

(5) Mount the user plate to the Arm #2.
    At this point, mount the ground together.

(6) Connect the connectors:
    - Connectors X21, X22, X31, X32, X33, X41, X61, X221, X231, X241

(7) Mount the battery board to the Arm #2.

(8) Remove the spare battery from XB11.

(9) Mount the connector plate to the base.
    For the details, refer to Maintenance: 3.4 Connector Plate.

(10) Mount the connector sub plate to the base.
     For details, refer to Maintenance: 3.5 Connector Sub Plate.

(11) Set and secure the Arm #2 cover without the cables being stuck.
     For details, refer to Maintenance: 3.1 Arm Top Cover.

(12) When the connector falls off from the battery board, execute the calibration of all axes.
     For details, refer to Maintenance: 14 Calibration.
4.2 Wiring Diagrams

4.2.1 Signal Cable

- Cable color:
  - Pink: P
  - Red: R
  - Violet: V
  - White: W
  - Yellow: Y

- Cable color:
  - Black: B
  - Brown: BR
  - Green: G
  - Blue: L
  - Orange: O

Mounting plate Detail Board Diagram
4.2.2 Power Cable

RC180

<table>
<thead>
<tr>
<th>Cable Color</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pink</td>
<td>P</td>
</tr>
<tr>
<td>Red</td>
<td>R</td>
</tr>
<tr>
<td>Violet</td>
<td>V</td>
</tr>
<tr>
<td>White</td>
<td>W</td>
</tr>
<tr>
<td>Yellow</td>
<td>Y</td>
</tr>
<tr>
<td>Black</td>
<td>B</td>
</tr>
<tr>
<td>Brown</td>
<td>BR</td>
</tr>
<tr>
<td>Green</td>
<td>G</td>
</tr>
<tr>
<td>Blue</td>
<td>L</td>
</tr>
<tr>
<td>Light green</td>
<td>LG</td>
</tr>
<tr>
<td>Orange</td>
<td>O</td>
</tr>
</tbody>
</table>
### 4.2.3 User Cable

<table>
<thead>
<tr>
<th>D-sub 15pin</th>
<th>Color</th>
<th>D-sub 15pin</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
<td></td>
<td>No.</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>L/(W)</td>
<td>1</td>
<td>L/(W)</td>
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<td>2</td>
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<td>(L)/W</td>
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<td>Y/(W)</td>
<td>3</td>
<td>Y/(W)</td>
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<td>4</td>
<td>(Y)/W</td>
<td>4</td>
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<td>G/(W)</td>
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<tr>
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<td>10</td>
<td>(V)/W</td>
</tr>
<tr>
<td>11</td>
<td>L/(BR)</td>
<td>11</td>
<td>L/(BR)</td>
</tr>
<tr>
<td>12</td>
<td>(L)/BR</td>
<td>12</td>
<td>(L)/BR</td>
</tr>
<tr>
<td>13</td>
<td>Y/(BR)</td>
<td>13</td>
<td>Y/(BR)</td>
</tr>
<tr>
<td>14</td>
<td>(Y)/BR</td>
<td>14</td>
<td>(Y)/BR</td>
</tr>
<tr>
<td>15</td>
<td>G/(BR)</td>
<td>15</td>
<td>G/(BR)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Cable color</th>
<th>Code</th>
<th>Cable color</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Black</td>
<td>R</td>
<td>Red</td>
</tr>
<tr>
<td>BR</td>
<td>Brown</td>
<td>V</td>
<td>Violet</td>
</tr>
<tr>
<td>G</td>
<td>Green</td>
<td>W</td>
<td>White</td>
</tr>
<tr>
<td>L</td>
<td>Blue</td>
<td>Y</td>
<td>Yellow</td>
</tr>
</tbody>
</table>

The following table shows the types of the use cable.

<table>
<thead>
<tr>
<th>Mounting type</th>
<th>Arm length</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>S, C</strong></td>
<td>250 mm</td>
<td>1514457</td>
</tr>
<tr>
<td>(Table Top Mounting)</td>
<td>300 mm</td>
<td>1514458</td>
</tr>
<tr>
<td></td>
<td>350 mm</td>
<td>1514459</td>
</tr>
<tr>
<td><strong>SM, CM</strong></td>
<td>300 mm</td>
<td>1514460</td>
</tr>
<tr>
<td>(Multiple Mounting)</td>
<td>350 mm</td>
<td>1514461</td>
</tr>
</tbody>
</table>
## 4.3 Replacing M/C Cable

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

If the connector connected to the battery was disconnected during cable replacement, execute calibration.


<table>
<thead>
<tr>
<th>Name</th>
<th>Quantity</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance parts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M/C Cable</td>
<td>1</td>
<td>Each manipulator model (Refer to <em>Maintenance: 15. Maintenance parts</em>)</td>
</tr>
<tr>
<td>Tools</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hexagonal wrench (width across flats: 3 mm)</td>
<td>1</td>
<td>For M4 screw</td>
</tr>
<tr>
<td>Torque wrench</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

### CAUTION

- If the connectors have been disconnected during the replacement of the cable unit, be sure to reconnect the connectors to their proper positions. Refer to the block diagrams. Improper connection of the connectors may result in improper function of the robot system.

For details on the connections, refer to *Maintenance: 4.2 Wiring Diagrams*.

- When mounting the cover, be careful not to allow the cables to interfere with the cover mounting and do not bend these cables forcibly to push them into the cover. Unnecessary strain on cables may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system.

When routing the cables, observe the cable locations after removing the cover. Be sure to place the cables back to their original locations.

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

(Figure: G3-301S)

Multiple Mounting

(Figure: G3-301SM)
**M/C Cable Removal**

1. Turn OFF the Controller.
2. Disconnect the power cable and signal cable connectors from the controller.
3. Remove the Connector Sub Plate.
   For details, refer to *Maintenance: 3.5 Connector Sub Plate*.

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

4. Disconnect the connectors.
   Connector: x10, x20, x30, x111, x121, x131

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

   **NOTE**
   Do not disconnect the battery connector (XB10). Otherwise, the calibration must be executed.

**M/C Cable Installation**

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

2. Mount the Connector Sub Plate.
   For details, refer to *Maintenance: 3.5 Connector Sub Plate*.

3. Connect the power cable and signal cable connectors to the controller.
4. Turn ON the Controller.
5. If the connector (XB10) falls off from the battery, execute the calibration for Joint #1.
   For details, refer to *Maintenance: 14 Calibration*. 
## 5. Joint #1

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

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

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

Refer to *Maintenance: 14. Calibration* to perform the calibration.
5.1 Replacing Joint #1 Motor

<table>
<thead>
<tr>
<th>Name</th>
<th>Quantity</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC Servo Motor (200 W)</td>
<td>1</td>
<td>1514451</td>
</tr>
<tr>
<td>Hexagonal wrench</td>
<td>width across flats: 2 mm</td>
<td>1                For M4 set screw</td>
</tr>
<tr>
<td></td>
<td>width across flats: 3 mm</td>
<td>1                For M4 screw</td>
</tr>
<tr>
<td></td>
<td>width across flats: 4 mm</td>
<td>1                For M5 screw</td>
</tr>
<tr>
<td></td>
<td>width across flats: 5 mm</td>
<td>1                For M6 screw</td>
</tr>
<tr>
<td>Torque wrench</td>
<td>1</td>
<td>For wiping grease</td>
</tr>
<tr>
<td>Wiping cloth</td>
<td>1</td>
<td>For wiping grease</td>
</tr>
<tr>
<td>Grease</td>
<td>Grease (SK-1A)</td>
<td>4 g</td>
</tr>
</tbody>
</table>

Joint #1 motor Removal

1. Remove the connector plate.
   For details, refer to Maintenance: 3.4 Connector Plate.

2. Remove the connector sub plate.
   For details, refer to Maintenance: 3.5 Connector Sub Plate.

3. Disconnect the following connectors.
   Connectors X111, X10 (Hold the clip to remove.)
   Connector XB10

4. Remove the heatsink plate.
   For details, refer to Maintenance: 3.7 Heatsink Plate.

5. Remove the heat release sheet from the Motor.

6. Unscrew and remove the bolts from Joint #1 flange mounting on the base.
   Mounting positions of the base and Joint #1 flange are determined by the positioning pin.
   Be sure to keep the positioning pin.
(7) Unscrew the bolts from Joint #1 Motor flange and remove the motor unit.

There is an oil seal (soft metal) in the assembly position of the motor flange and Joint #1 flange.
Be sure to keep the oil seal.

(8) Remove the waveform generator from the Joint #1 motor.

There is a brass bushing in one of the set screw holes. Be sure to keep the bushing.

(9) Remove the motor flange from the Joint #1 motor.
Joint #1 motor Installation

1. Mount the motor flange on the Joint #1 motor.

2. Apply grease (SK-1A) to the between the waveform generator and motor flange.
   Grease volume 4 g

3. Mount the waveform generator on the Joint #1 motor.
   Be sure to fit the end face of the waveform generator to the end face of the motor shaft. Tighten one of the set screws on the flat face of the motor shaft until the screw just touches the surface. Insert a bushing into the other set screw hole to prevent damage to the motor shaft. Then, tighten both set screws.

4. Mount the motor unit to the Joint #1 flange.
   Mount the oil seal (soft metal) hole to the mounting hole.
   The motor cable must face the connector plate side.
   If it is difficult to mount the motor, push it while moving Arm #1 slowly by hand.

5. Mount the Joint #1 flange to the base.
   Mounting positions of the Joint #1 flange and base are determined by the positioning pin.

6. Connect the connectors.
   Connectors: X110, X10, XB10

7. Mount the connector sub plate.
   For the details, refer to Maintenance: 3.5 Connector Sub Plate.

8. Mount the connector plate.
   For details, refer to Maintenance: 3.4 Connector Plate.

9. Mount the heatsink plate.
   For details, refer to Maintenance: 3.7 Heatsink Plate.

10. Perform the calibration of Joint #1.

CAUTION
See the figures above for the orientation of the waveform generator. Be sure to install the waveform generator properly. Improper installation of the waveform generator will result in improper function of the Manipulator.
5.2 Replacing Joint #1 Reduction Gear Unit

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

Waveform generator / Flexspline / Circular spline

For details of the reduction gear unit, refer to Maintenance: 14. Maintenance parts list.

<table>
<thead>
<tr>
<th>Maintenance Parts</th>
<th>Name</th>
<th>Quantity</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reduction Gear Unit</td>
<td>1</td>
<td>1649160</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tools</th>
<th>Name</th>
<th>Quantity</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hexagonal wrench</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>width across flats: 2 mm</td>
<td>1</td>
<td>For M4 set screw</td>
</tr>
<tr>
<td></td>
<td>width across flats: 2.5 mm</td>
<td>1</td>
<td>For M3 screw</td>
</tr>
<tr>
<td></td>
<td>width across flats: 3 mm</td>
<td>1</td>
<td>For M4 screw</td>
</tr>
<tr>
<td></td>
<td>width across flats: 5 mm</td>
<td>1</td>
<td>For M6 screw</td>
</tr>
<tr>
<td></td>
<td>Torque wrench</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>M4</td>
<td>1</td>
<td>Tightening torque: 6.0 N⋅m (61.2 kgf⋅cm)</td>
</tr>
<tr>
<td></td>
<td>M6</td>
<td>1</td>
<td>Tightening torque: 22.0 N⋅m (224.3 kgf⋅cm)</td>
</tr>
<tr>
<td></td>
<td>Nippers</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spatula</td>
<td>1</td>
<td>For apply grease</td>
</tr>
<tr>
<td></td>
<td>Wiping cloth</td>
<td>1</td>
<td>For wiping grease (Flange)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>For wiping grease (Bolt)</td>
</tr>
<tr>
<td></td>
<td>Screw (M4)</td>
<td>2</td>
<td>About 20 mm in length</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>For flexspline removal</td>
</tr>
<tr>
<td></td>
<td>Grease</td>
<td>16 g</td>
<td></td>
</tr>
</tbody>
</table>

Joint #1 reduction gear unit Removal

1. Remove the Joint #1 motor unit.
   Refer to the removal steps (1) to (7) in Maintenance: 5.1 Replacing Joint #1 Motor.

2. Remove the Reduction gear unit from the Joint #1 flange.
Joint #1 Reduction Gear Unit

Installation

(1) A new reduction gear unit contains the parts shown in the picture on the right when it is unpacked.

The gear grooves of the flexspline, circular spline, and the bearings of the waveform generator have been greased. Wipe off excess grease from the mounting surface.

Never adjust (loosen or tighten) the mounting bolts between the flexspline and cross roller bearing unit. If the mounting bolts are adjusted, the flexspline and cross roller bearing unit must be aligned by the maker of the reduction gear unit.

(2) Fit the O-rings into the grooves on both sides of the new circular spline.

Make sure that the rings do not come out of the grooves.

(3) Face the convex side of the circular spline down, and then fit it into the flexspline.

(4) Match the screw holes on the inner ring of the cross roller bearing unit and the through holes of the circular spline.
(5) Secure the reduction gear flange to the circular spline.

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

<table>
<thead>
<tr>
<th>Item</th>
<th>Bolt type</th>
<th>Number of bolts</th>
<th>Tightening torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joint #1 reduction gear unit</td>
<td>M3×15</td>
<td>16</td>
<td>3.0 N-m (30.6 kgf-cm)</td>
</tr>
</tbody>
</table>

NOTE
Be careful not to apply too much force since it may damage the parts.

(6) Apply grease (SK-1A) inside the flexspline.

Grease volume 12 g

(7) Execute the installation steps (2) to (10) in Maintenance: 5.1 Replacing Joint #1 Motor.
### 6. Joint #2

| WARNING | Do not connect or disconnect the motor connectors while the power to the robot system is turned ON. Connecting or disconnecting the motor connectors with the power ON is extremely hazardous and may result in serious bodily injury as the Manipulator may move abnormally, and also may result in electric shock and/or malfunction of the robot system.

To shut off power to the robot system, disconnect the power plug from the power source. Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source.

Before performing any replacement procedure, turn OFF the Controller and related equipment, and then disconnect the power plug from the power source. Performing any replacement procedure with the power ON is extremely hazardous and may result in electric shock and/or malfunction of the robot system. |

| CAUTION | Be careful not to apply excessive shock to the motor shaft when replacing the motors. The shock may shorten the life cycle of the motors and encoder and/or damage them.

Never disassemble the motor and encoder. A disassembled motor and encoder will cause a positional gap and cannot be used again. |

---

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

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

Refer to Maintenance: 14. Calibration to perform the calibration.
### 6.1 Replacing Joint #2 Motor

<table>
<thead>
<tr>
<th>Maintenance Parts</th>
<th>Name</th>
<th>Quantity</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parts</strong></td>
<td>AC Servo Motor (150W)</td>
<td>1</td>
<td>1514453</td>
</tr>
<tr>
<td><strong>Tools</strong></td>
<td>Hexagonal wrench</td>
<td>1</td>
<td>width across flats: 2 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>For M4 set screw</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>width across flats: 3 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>For M4 screw</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>width across flats: 4 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>For M5 screw</td>
</tr>
<tr>
<td></td>
<td>Torque wrench</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nippers</td>
<td>1</td>
<td>For cutting wire tie</td>
</tr>
<tr>
<td></td>
<td>Wiping cloth</td>
<td>1</td>
<td>For wiping grease</td>
</tr>
<tr>
<td><strong>Material</strong></td>
<td>Wire tie</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td><strong>Grease</strong></td>
<td>Grease (SK-2)</td>
<td>3 g</td>
<td></td>
</tr>
</tbody>
</table>

**Joint #2 motor Removal**

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

   The brake release switch affects only Joint #3. When the brake release switch is pressed, the brake for the Joint #3 is released simultaneously.

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

3. Turn OFF the Controller.
4. Remove the arm top cover.
   For details, refer to *Maintenance: 3.1 Arm Top Cover*.
5. Remove the battery board.
6. Remove the user plate.
7. Cut off the wire tie used for binding the cables connected to the user cable.
8. Cut off the wire tie used for binding the motor cables to the Joint #2 motor.
9. Disconnect the following connectors.
   Connectors X221, X21 (Hold the clip to remove.)
   Connector X62
10. Remove the Joint #2 motor unit from Arm #2.

   If the motor cannot be removed easily, pull it out while moving Arm #2 slowly by hand.

   Also, the motor flange touches the intermediate pulley and you cannot pull the motor straight upward. Therefore, tip the motor and pull it avoiding the intermediate pulley.
(11) Remove the waveform generator from the Joint #2 motor.

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

(12) Remove the motor flange from the Joint #2 motor.
Joint #2 motor Installation

1. Mount the motor flange on the Joint #2 motor.

2. Mount the waveform generator on the Joint #2 motor.
   - Be sure to fit the end face of the waveform generator to the end face of the motor shaft.
   - Tighten one of the set screws on the flat face of the motor shaft until the screw touches vertically the surface. Insert a bushing into the other set screw hole without damage to the motor shaft.
   - Then, tighten both set screws.

3. Apply grease (SK-2) to the between the waveform generator and motor flange.
   - Grease volume 3 g
   - See the figures above for the orientation of the waveform generator. Be sure to install the waveform generator properly. Improper installation of the waveform generator will result in improper function of the Manipulator.

4. Mount the Joint #2 motor unit on Arm #2.
   - The motor flange touches the intermediate pulley and you cannot insert the motor straight on the arm. Therefore, tip the motor and insert it avoiding the intermediate pulley.
   - Also, if it is difficult to insert the motor, push it while moving Arm #2 slowly by hand.

5. Re-bundle the cables in their original positions with a wire tie removed in the Removal procedure step (8).
   - Do not allow unnecessary strain on the cables.

6. Mount the user plate to Arm #2.

7. Mount the battery board to Arm #2.

8. Connect the connectors.
   - Connectors X221, X21

9. Connect the backup cable connector X62 to the battery board.
   - Band the cables with a wire tie to prevent the back up cable connectors to fall out by mistake.
(10) Re-bundle the cables in their original positions with a wire tie removed in the Removal procedure step (7).

Do not allow unnecessary strain on the cables.

(11) Mount the arm top cover.

For details, refer to *Maintenance: 3.1 Arm Top Cover*.

(12) Perform the calibration of Joint #2.

6.2 Replacing Joint #2 Reduction Gear Unit

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

Waveform generator / Flexspline / Circular spline

For details of the reduction gear unit, refer to Maintenance: 15. Maintenance parts list.

<table>
<thead>
<tr>
<th>Maintenance parts</th>
<th>Name</th>
<th>Quantity</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reduction Gear Unit</td>
<td>1</td>
<td>1661086</td>
</tr>
<tr>
<td></td>
<td>Hexagonal wrench</td>
<td>1</td>
<td>For M4 set screw</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>For M3 screw</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>width across flats: 2 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>width across flats: 2.5 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>width across flats: 3 mm</td>
</tr>
<tr>
<td></td>
<td>Torque wrench (M3)</td>
<td>1</td>
<td>Tightening torque: 3.0 N-m (30.6 kgf⋅cm)</td>
</tr>
<tr>
<td></td>
<td>Spatula</td>
<td>1</td>
<td>For apply grease</td>
</tr>
<tr>
<td></td>
<td>Wiping cloth</td>
<td>1</td>
<td>For wiping grease (Flange)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>For wiping grease (Bolt)</td>
</tr>
<tr>
<td></td>
<td>Screw (M3)</td>
<td>2</td>
<td>For flexspline removal</td>
</tr>
<tr>
<td>Material</td>
<td>Wire tie</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Grease</td>
<td>Grease (SK-2)</td>
<td>11 g</td>
<td></td>
</tr>
</tbody>
</table>

Joint #2 reduction gear unit Removal

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

   The brake release switch affects only Joints #3. When the brake release switch is pressed, the brake of the Joints #3 is released simultaneously.

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

3. Turn OFF the Controller.
4. Execute steps from (1) to (11) in Maintenance: 6.1 Replacing Joint #2 Motor and remove the waveform generator from the Joint #2 motor.
5. Remove the mounting screws for the Arm #2 and remove the reduction gear unit from the Arm #1.
Joint #2 reduction gear unit
Installation

(1) A new reduction gear unit contains the parts shown in the picture on the right when it is unpacked.

The gear grooves of the flexspline, circular spline, and the bearings of the waveform generator have been greased. Wipe off excess grease from the mounting surface.

---

**CAUTION**

Never adjust (loosen or tighten) the mounting bolts between the flexspline and cross roller bearing unit. If the mounting bolts are adjusted, the flexspline and cross roller bearing unit must be aligned by the maker of the reduction gear unit.

(2) Fit the O-rings into the grooves on both sides of the new circular spline.

Make sure that the rings do not come out of the grooves.

(3) Face the convex side of the circular spline down, and then fit it into the flexspline.

(4) Match the screw holes on the inner ring of the cross roller bearing unit and the through holes of the circular spline.
(5) Mount the circular spline to Arm #2.

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

<table>
<thead>
<tr>
<th>Item</th>
<th>Bolt type</th>
<th>Number of bolts</th>
<th>Tightening torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joint #2 reduction gear unit</td>
<td>M3×20</td>
<td>10</td>
<td>3.0 N·m (30.6 kgf·cm)</td>
</tr>
</tbody>
</table>

- Be careful not to apply too much force since it may damage the parts

(6) Apply grease (SK-2) inside the flexspline.

   Grease volume 8 g

(7) Install the O ring to the Arm #1.

(8) Install and secure the flexspline.

   Slide the Arm #2 to the right/left to adjust the holes position.

(9) Execute installation steps (2) to (12) in Maintenance: 6.1 Replacing Joint #2 Motor.
7. Joint #3

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

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

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

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

Refer to *Maintenance: 14. Calibration* to perform the calibration.
7.1 Replacing Joint #3 Motor

<table>
<thead>
<tr>
<th>Name</th>
<th>Quantity</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maintenance parts</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AC Servo Motor (150W)</td>
<td>1</td>
<td>1514453</td>
</tr>
<tr>
<td><strong>Tools</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hexagonal wrench width across flats: 2.5 mm</td>
<td>1</td>
<td>For M4 set screw</td>
</tr>
<tr>
<td>Hexagonal wrench width across flats: 3 mm</td>
<td>1</td>
<td>For M4 screw</td>
</tr>
<tr>
<td>Torque wrench</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Nippers</td>
<td>1</td>
<td>For cutting wire tie</td>
</tr>
<tr>
<td>Force gauge</td>
<td>1</td>
<td>Belt tension 74 N (7.5 ± 0.5 kgf)</td>
</tr>
<tr>
<td>Suitable cord (Length about 800 mm)</td>
<td>1</td>
<td>For belt tension</td>
</tr>
<tr>
<td><strong>Material</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wire tie</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

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

Note that the brake will not work during the replacement procedure.
Move the shaft down to its lower limit before starting the replacement procedure by following the removal steps from (1) to (3).

Joint #3 motor Removal

1. Turn ON the Controller.
2. Push down the shaft to its lower limit while pressing the brake release switch. Be sure to keep enough space and prevent the end effector hitting any peripheral equipment.
   The brake release switch affects only Joints #3. When the brake release switch is pressed, the brake for Joints #3 is released simultaneously.
   Be careful of the shaft while the brake release switch is being pressed because the shaft may be lowered by the weight of an end effector.
3. Turn OFF the Controller.
4. Remove the arm top cover and the arm bottom cover.
   For details, refer to Maintenance: 3. Covers.
5. Remove the battery board.
   Be careful not to pull the connector when removing the battery board.
6. Cut off the wire tie used for bundling the power cables and signal cables of motor.
7. Remove the user plate.
8. Cut off the wire tie used for bundling the motor cables with the Joint #3 motor.
9. Disconnect the following connectors.
   Connectors X231, X241, X31, X32, X41 (Hold the clip to remove.)
   Connector X63, X64 (Backup cable connector of Joint #3 and #4)
(10) Loosen bolts of the Joint #4 motor unit.

    Pull the Joint #4 motor unit upward to remove.

(11) Unscrew the bolts securing the Joint #3 motor unit.

(12) Unscrew the screws securing the ball screw spline unit on the upper part of Arm #2.

(13) Hold up the upper rotator part of ball screw spline unit and the Joint #3 motor unit together.

(14) Hold the Joint #3 motor up. Pass the Z belt through the upper rotator part of ball screw spline and remove the belt.

(15) Remove the Joint #3 motor from the Joint #3 motor unit.

(16) Remove the pulley and brake hub from the Joint #3 motor.

    There is a brass bushing in one of the set screw holes. Be sure to keep them.
Joint #3 motor installation

1. Mount the pulley and brake hub to the Joint #3 motor.
   Insert the brake hub until it touches the end face of the motor shaft and secure the hub.
   Be sure to fit the end face of the pulley to the brake hub.
   Tighten one of the set screws on the flat face of the motor shaft until the screw just touches the surface.

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

2. Mount the Z plate to the Joint #3 motor.
   Screw: 4-M4×10

3. Pass the Z belt of Joint #3 motor unit through the ball screw spline.
   Place the belt around the pulley.
   Make sure that the gear grooves of the belt are fit into those of the pulleys completely.

4. Move the Joint #3 motor unit and spline upper rotator part downwards together and put them on the Arm #2 upper side.
   Be sure to keep the belt on the pulley.

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

6. Place the U1 belt around the pulley.
   Place the Joint #4 motor unit on the Arm #2 upper side.
(7) Loosely secure the Joint #4 motor unit to Arm #2.

Check that the motor unit can be moved by hand, and it will not tilt when pulled.

If the unit is secured too loose or too tight, the belt will not have the proper tension.

(8) Secure the spline upper rotator part on the Arm #2 upper side with screws.

(9) Rotate and move up/down the ball screw spline shaft.

(10) Apply the proper tension to the U1 belt, and secure the Joint #4 motor unit.

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

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

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

(12) Connect the connectors.

Connectors: X231, X241, X31, X41

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

Do not allow unnecessary strain on the cables.

(14) Connect the backup connectors for Joint #3 and #4 (X63, X64) to the battery board.

Bundle the backup cable with wire tie to prevent the cable connector to fall off by mistake.

(15) Mount the user plate and ground wire to Arm #2.

(16) Mount the battery board to the Arm #2.

(17) Install the arm top cover and the arm bottom cover.

For details, refer to Maintenance: 3. Covers.

(18) Perform the calibration of Joint #3 and #4.

### 7.2 Replacing the Timing Belt

<table>
<thead>
<tr>
<th>Name</th>
<th>Quantity</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance parts</td>
<td>Z belt</td>
<td>width 9 mm</td>
</tr>
<tr>
<td>Tools</td>
<td>Hexagonal wrench</td>
<td>width across flats: 2.5 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>width across flats: 3 mm</td>
</tr>
<tr>
<td></td>
<td>Nippers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Force gauge</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Suitable cord (Length about 800 mm)</td>
<td>1</td>
</tr>
<tr>
<td>Material</td>
<td>Wire tie</td>
<td></td>
</tr>
</tbody>
</table>

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

Note that the brake will not work during the replacement procedure. Move the shaft down to its lower limit before the replacement procedure following the removal steps from (1) to (3).

#### Z belt Removal

1. Turn ON the Controller.
2. Push down the shaft to its lower limit while pressing the brake release switch. Be sure to keep enough space and prevent the end effector hitting any peripheral equipment.
   
   The brake release switch affects only Joint #3. When the brake release switch is pressed, the brake for Joint #3 is released simultaneously.
   
   Be careful of the shaft while the brake release switch is being pressed because the shaft may be lowered by the weight of an end effector.
3. Turn OFF the Controller.
4. Remove the arm top cover and the arm bottom cover.
   
   For details, refer to Maintenance: 3. Covers.
5. Remove motors of the Joint #3 and #4.
   
   For details, refer to steps from (1) to (17) in Maintenance: 7.1 Replacing Joint #3 Motor.
6. Remove the brake unit mounting plate from the motor blade.
7. Remove the Z belt.
Z belt Installation

1. Place a new Z belt around the brake unit, and then mount it to the motor plate.

2. Mount the Joint #3 motor unit.

3. Place the Z belt of Joint #3 motor unit around the ball screw spline unit and the pulley. Check the gear grooves of the belt are fit into those of the pulleys completely.

4. Put the Joint #3 motor unit and the spline upper rotator parts downwards and place them on the Arm #2 upper surface. Be sure to keep the belt on the pulley.

5. Secure the Joint #3 motor unit to Arm #2 so that the open side faces toward the end of the arm.

NOTE: Loosely secure the Joint #3 motor unit to Arm #2 so that the motor unit can be moved by hand, and it will not tilt when pulled. If the unit is secured too loose or too tight, the belt will not have the proper tension.
(6) Put the pulley to the U2 belt and place the Joint #4 motor unit on the Arm #2 surface. Make sure the motor cables face to the end of the arm.

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

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

(9) Apply the proper tension to the U1 belt, and then secure the Joint #4 motor unit.
To do so, pass a suitable cord or string around the Joint #4 motor unit near its mounting plate. Then, pull the cord using a force gauge or similar tool to apply the specified tension shown in the figure on the right.

(10) Apply the proper tension to the Z belt, and then secure the Joint #3 motor unit.
To do so, pass a suitable cord or string around the Joint #3 motor unit near its mounting plate. Then, pull the cord using a force gauge or similar tool to apply the specified tension shown in the figure on the right.

(11) Connect the connectors.
Connectors: X231, X241, X31, X32, X41
(12) Connect the backup connectors for Joint #3 and #4 (X63, X64) to the battery board. Bundle the backup cable with wire tie to prevent the cable connector to fall off by mistake.

(13) Re-bundle the cables in their original positions with a wire tie removed in step (5). Do not allow unnecessary strain on the cables.

(14) Install the arm top cover and the arm bottom cover. For details, refer to Maintenance: 3. Covers.

## 7.3 Replacing the Brake

<table>
<thead>
<tr>
<th>Maintenance parts</th>
<th>Name</th>
<th>Quantity</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electromagnetic brake</td>
<td>1</td>
<td>1497639</td>
<td></td>
</tr>
</tbody>
</table>

### Tools

<table>
<thead>
<tr>
<th>Name</th>
<th>Quantity</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hexagonal wrench</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>width across flats: 1.5 mm</td>
<td>1</td>
<td>For M3 set screw</td>
</tr>
<tr>
<td>width across flats: 2.5 mm</td>
<td>1</td>
<td>For M3 screw</td>
</tr>
<tr>
<td>width across flats: 3 mm</td>
<td>1</td>
<td>For M4 screw</td>
</tr>
<tr>
<td>width across flats: 4 mm</td>
<td>1</td>
<td>For M5 screw</td>
</tr>
<tr>
<td>Torque wrench</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Nippers</td>
<td>1</td>
<td>For cutting wire tie</td>
</tr>
<tr>
<td>Force gauge</td>
<td>1</td>
<td>Belt tension 74N</td>
</tr>
<tr>
<td>Suitable cord</td>
<td>1</td>
<td>(Length about 800 mm)</td>
</tr>
<tr>
<td>Wire tie</td>
<td>3</td>
<td>For belt tension</td>
</tr>
</tbody>
</table>

### Material

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

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

Move the shaft down to its lower limit before the replacement procedure following the removal steps from (1) to (3).

1. **Joint #3 brake Removal**
   - **(1)** Turn ON the Controller.
   - **(2)** Push down the shaft to its lower limit while pressing the brake release switch. Be sure to keep enough space and prevent the end effector hitting any peripheral equipment.
   - The brake release switch affects only Joint #3. When the brake release switch is pressed, the brake for Joint #3 is released simultaneously.
   - Be careful of the shaft while the brake release switch is being pressed because the shaft may be lowered by the weight of an end effector.
   - **(3)** Turn OFF the Controller.
   - **(4)** Remove the arm top cover and the arm bottom cover. For details, refer to Maintenance: 3. Covers.
   - **(5)** Remove the Joint #3 motor. For details, refer to Maintenance: 7.1 Replacing Joint #3 Motor - Joint #3 motor removal step (1) to (17).
   - **(6)** Remove the brake from the brake plate.
   - **(7)** Remove the brake hub from the Joint #3 motor.
Joint #3 brake installation

1. Mount the brake to the brake plate.

2. Mount the brake hub to the Joint #3 motor.

3. Mount the motor unit to the Z plate.
   - Align the position of the disk on the brake and the hub.
   - When the brake disk is not aligned, connect the connector X32. Press the brake release switch and release the brake to manually adjust the position.

4. Mount the Joint #3 motor unit to Arm #2 so that the open side faces toward the end of the arm.
   - For the brake hub mounting procedure, refer to the section 7.1 Replacing Joint #3 Motor - Joint #3 motor installation - Step (3) - (19).

5. Install the arm top cover and the arm bottom cover.
   - For details, refer to Maintenance: 3. Covers.

6. Perform the calibration of Joint #3.
## 8. Joint #4

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

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

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

The process of aligning the two origins is called “Calibration”. Refer to *Maintenance: 14. Calibration* to perform the calibration.

---

![Joint #4 Diagram](image)

**Joint #4 motor**

**U2 belt**

**U1 belt**

**Joint #4 brake**
8.1 Replacing Joint #4 Motor

<table>
<thead>
<tr>
<th>Name</th>
<th>Quantity</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maintenance parts</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AC Servo Motor (150 W)</td>
<td>1</td>
<td>1514453</td>
</tr>
<tr>
<td><strong>Tools</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hexagonal wrench width across flats: 2 mm</td>
<td>1</td>
<td>For M4 set screw</td>
</tr>
<tr>
<td>Hexagonal wrench width across flats: 3 mm</td>
<td>1</td>
<td>For M4 screw</td>
</tr>
<tr>
<td>Torque wrench</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Nippers</td>
<td>1</td>
<td>For cutting wire tie</td>
</tr>
<tr>
<td>Force gauge</td>
<td>1</td>
<td>Belt tension 74 N (7.5 ± 0.5 kgf)</td>
</tr>
<tr>
<td>Suitable cord (Length about 800 mm)</td>
<td>1</td>
<td>For belt tension</td>
</tr>
</tbody>
</table>

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

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

Move the shaft down to its lower limit before starting the replacement procedure by following the removal steps from (1) to (3).

Joint #4 motor Removal

1. Turn ON the Controller.

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

   The brake release switch affects only Joint #3. When the brake release switch is pressed, the brake for Joint #3 is released simultaneously.

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

3. Turn OFF the Controller.

4. Remove the arm top cover and the arm bottom cover.
   For details, refer to Maintenance: 3. Covers.

5. Remove the battery board from Arm #2.
   Be careful of the connector not to fall off when removing the battery board.
   If the connector falls off, the joints other than Joint #4 need the calibration.

6. Remove the user plate and ground wire secured on Arm #2.

7. Cut off a wire tie used for bundling the motor cables and signal cables.

8. Disconnect the following connectors.
   - Connectors X241, X41 (Hold the clip to remove.)
   - Connector X64 (for backup cable connector of Joint #4)
(9) Remove the Joint #4 motor unit from Arm #2.

Unscrew the bolts securing the Joint #4 motor unit to the Motor plate. Pull the motor unit upward to remove.

(10) Remove the pulley from the Joint #4 motor.

There is a brass bushing in one of the set screw holes. Be sure to keep them.

(11) Remove the motor plate from the Joint #4 motor.

Screw: 2-M4×8
Joint #4 motor Installation

1. Mount the motor plate to the Joint #4 motor.
   Screw: 2-M4×8

2. Secure the pulley to the new Joint #4 motor.
   Be sure to fit the end face of the pulley to the end face of
   the motor shaft.
   Tighten one of the set screws on the flat face of the motor
   shaft until the screw just touches the surface.
   Insert a bushing into the other set screw hole to prevent damage to the motor shaft.
   Then, tighten both set screws.

3. Place the pulley around the U2 belt and
   place the Joint #4 motor unit in the arm so
   that the motor cable faces toward the Arm #2 head.

4. Loosely secure the Joint #4 motor unit to
   Arm #2.
   Make sure the motor unit can be moved by
   hand, and it will not tilt when pulled. If
   the unit is secured too loose or too tight, the
   belt will not have the proper tension.
   Also, check the gear grooves of the belt are
   fit into those of the pulleys completely.

5. Apply the proper tension to the U1 belt and
   secure the Joint #4 motor unit.
   Pass a suitable cord or string around the
   Joint #4 motor unit near its mounting plate.
   Then, pull the cord using a force gauge or
   similar tool to apply the specified tension
   shown in the figure.

6. Connect the connectors.
   Connectors: X241, X41, X42
(7) Connect the backup cable of Joint #4: X64.
   Bundle the cables with the wire tie to prevent the backup connector from falling off by mistake.

(8) Mount the battery board to Arm #2.
   The screws on the rear side secure both the battery board and the user plate. Set these screws when mounting the user plate.

(9) Mount the user plate and ground wire to Arm #2.

(10) Re-bundle the cables in their original positions with a wire tie removed in step (6).
   Do not allow unnecessary strain on the cables.

(11) Install the arm top cover and the arm bottom cover.
   For details, refer to Maintenance: 3. Covers.

(12) Perform the calibration of Joint #4.
8.2 Replacing the Timing Belt

<table>
<thead>
<tr>
<th>Name</th>
<th>Quantity</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance parts</td>
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<td></td>
</tr>
<tr>
<td>U1 belt (width 10 mm)</td>
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<td></td>
</tr>
<tr>
<td>U2 belt (width 16 mm)</td>
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<tr>
<td>Tools</td>
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<td></td>
</tr>
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<td>Hexagonal wrench (width across flats: 3 mm)</td>
<td>1</td>
<td>For M4 screw</td>
</tr>
<tr>
<td>Spanner (width across flats: 7 mm)</td>
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<td></td>
</tr>
<tr>
<td>Torque wrench</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Force gauge</td>
<td>1</td>
<td>Belt tension 98N (10 kgf) / 74N (7.5kgf)</td>
</tr>
<tr>
<td>Nippers</td>
<td>1</td>
<td>For cutting wire tie</td>
</tr>
<tr>
<td>Suitable cord</td>
<td>1</td>
<td>For belt tension</td>
</tr>
</tbody>
</table>

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

Note that the brake will not work during the replacement procedure.
Move the shaft down to its lower limit before the replacement procedure following the removal steps from (1) to (3).

1. Turn ON the Controller.

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

   The brake release switch affects only Joint #3. When the brake release switch is pressed, the brake for Joint #3 is released simultaneously.

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

3. Turn OFF the Controller.

4. Remove the arm top cover and the arm bottom cover.
   For details, refer to Maintenance: 3. Covers.

5. Remove the battery board and mounting metal jig.

6. Remove the user plate and ground wire secured on Arm #2.

7. Cut off a wire tie bundling the motor cables and signal cables.

8. Disconnect the following connectors.
   Connectors X231, X241, X31, X32, X41 (Hold the clip to remove.)
   Connector X63, X64 (for backup cable connector of Joint #3 and 4)
(9) Loosen the bolts securing the Joint #4 motor unit and pull the motor unit upwards.

(10) Remove the screws securing the ball screw spline on the surface of Arm #2.

(11) Remove the screws on the Joint #3 motor unit.

(12) Hold the upper rotator part of ball screw spline and Joint #3 motor up together.

(13) Pass the belt through the upper rotator part of spline and hold the Joint #3 motor up and remove the belt.

(14) Remove the screws securing the Joint #4 intermediate shaft unit.

Pull the Joint #4 intermediate shaft unit upwards.

(15) Remove the U1 belt.

(16) Keep the spline upper rotator part up and remove the U1 belt.
**U2 belt Installation**

(1) Hold the spline upper rotator part and set the U1 belt around the U1 pulley.

**NOTE**

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

(2) Pass the Z belt through the ball screw spline of Joint #3 motor unit and set the belt around the pulley.

**NOTE**

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

(3) Place the Joint # motor unit and spline rotator part on the Arm #2 top surface.

Make sure the belt stays on the pulley.

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

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

(5) Place the U1 belt in Arm #2 around the small pulley and put it on the Arm #2 top surface.

At this point, keep the U2 belt on the large pulley of Joint #4 intermediate unit.

Make sure the gear grooves of the belt are fit into those of the pulleys completely.
(6) Loosely secure the Joint #4 intermediate unit with screws.

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

(7) Place the Joint #4 motor unit around the U1 belt. Put the Joint #4 motor unit on the Arm #2 top surface.

Put the Joint #4 motor cable toward the end of Arm #2.

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

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

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

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

(10) Apply the proper tension to the U2 belt, and then secure the Joint #4 intermediate shaft unit.

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

(11) Apply the proper tension to the U1 belt, and then secure the Joint #4 motor unit.

Pass a suitable cord or string around the Joint #4 motor unit near its mounting plate.

Then, pull the cord using a force gauge or similar tool to apply the specified tension shown in the figure on the right.
(12) Apply the proper tension to the Z belt, and then secure the Joint #3 motor unit.

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

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

(14) Connect the following connectors.
Connector X231, X241, X31, X32, and X41

(15) Connect the backup connectors of Joint #3 and #4 (X63, X64) to the battery board.
Bundle the cables with wire tie to prevent the backup cable connectors from falling off by mistake.

(16) Mount the battery board to Arm #2.

(17) Mount the user plate and ground wire to Arm #2.

(18) Install the arm top cover and the arm bottom cover.
For details, refer to Maintenance: 3. Covers.

(19) Perform the calibration of Joint #3.
U1 belt Removal

(1) Remove the Joint #4 motor with referring to the procedure of Joint #4 motor Removal (1) to (9).

(2) Remove the Joint #4 intermediate shaft unit.

(3) Remove the U1 belt.
U1 belt Installation

(1) Place the U2 belt in Arm #2 around the small pulley and put it on the Arm #2.

At this point, keep the U1 belt on the large pulley of Joint #4 intermediate unit.

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

(2) Loosely secure the Joint #4 intermediate unit.

Make sure the motor unit can be moved by hand, and it will not tilt when pulled.

If the unit is secured too loose or too tight, the belt will not have the proper tension.

(3) Place the pulley in the U1 belt and put the Joint #4 motor unit to Arm #2.

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

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

Make sure the motor unit can be moved by hand, and it will not tilt when pulled.

If the unit is secured too loose or too tight, the belt will not have the proper tension.

(5) Apply the proper tension to the U2 belt, and then secure the Joint #4 intermediate shaft unit.

Pass a suitable cord or string around the Joint #4 intermediate unit near its mounting plate.

Then, pull the cord using a force gauge or similar tool to apply the specified tension shown in the figure on the right.
(6) Apply the proper tension to the U1 belt, and then secure the Joint #4 intermediate shaft unit.

Pass a suitable cord or string around the Joint #4 motor unit near its mounting plate.

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

(7) Connect the connector.
   Connector: X241, X41

(8) Re-bundle the cables in their original positions with a wire tie removed in step (9).

(9) Connect the backup connectors of Joint #4, X64 to the battery board.

   Bundle the cables with wire tie to prevent the backup cable connectors from falling off by mistake.

(10) Mount the battery board to Arm #2.

(11) Mount the user plate and ground wire to Arm #2.

(12) Install the arm top cover and arm bottom cover.

   For details, refer to Maintenance: 3. Covers.

(13) Perform the calibration of Joint #4.

9. Replacing Arm #1

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

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

After parts have been replaced (motors, reduction gear units, brakes, timing belts, ball screw spline unit, etc.), the Manipulator cannot operate properly because a mismatch exists between the origin stored in each motor and its corresponding origin stored in the Controller. After replacing the parts, it is necessary to match these origins. The process of aligning the two origins is called “Calibration”. Refer to Maintenance: 14. Calibration to perform the calibration.
## Maintenance parts

### 9. Replacing Arm #1

<table>
<thead>
<tr>
<th>Name</th>
<th>Quantity</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Table Top Mounting</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard arm</td>
<td>250 mm</td>
<td>1 Arm #1_25ST</td>
</tr>
<tr>
<td></td>
<td>300 mm</td>
<td>1 Arm #1_30ST</td>
</tr>
<tr>
<td></td>
<td>350 mm</td>
<td>1 Arm #1_35ST</td>
</tr>
<tr>
<td>Curved arm</td>
<td>300 mm</td>
<td>1 Arm #1_30B</td>
</tr>
<tr>
<td></td>
<td>350 mm</td>
<td>1 Arm #1_35B</td>
</tr>
<tr>
<td><strong>Multiple Mounting</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard arm</td>
<td>300 mm</td>
<td>1 Arm #1_M_30ST</td>
</tr>
<tr>
<td></td>
<td>350 mm</td>
<td>1 Arm #1_M_35ST</td>
</tr>
<tr>
<td>Curved arm</td>
<td>350 mm</td>
<td>1 Arm #1_M_35B</td>
</tr>
<tr>
<td><strong>Tools</strong></td>
<td>Hexagonal wrench</td>
<td>1 For screw M3</td>
</tr>
<tr>
<td></td>
<td>Torque wrench</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Flathead screwdriver</td>
<td>1</td>
</tr>
</tbody>
</table>

When changes the arm length, it requires the other cable unit for the new arm length.

Right / Left-curved arm have the shared maintenance parts.

- **CAUTION**
  - Replacing Arm #1 should be done by two persons.
  - There are dangers of main parts to fall or get damage.
9. Replacing Arm #1

**Arm #1 Removal**

1. Remove the arm cap.
   For details, refer to *Maintenance: 3.3 Arm Cap.*

2. Remove the harmonic mounting screws on the Joint #2 side and remove the Arm #2 unit.
   
   This procedure should be done with an assistant. The assistant supports the Arm #2 unit.
   
   Do not allow unnecessary strain on the cables.
   
   For Multiple mounting, removal direction of Joint “1 and #2 is the same. In this procedure, remove the only screws on the left side of figure.

3. Remove the O ring on the part where Arm #2 was mounted.

4. Remove the Arm #1 covet and hose elbow.
   
   These parts are not attached for the Multiple mounting Manipulators.
(5) Remove the harmonic mounting screws on the Joint #1 side and remove the Arm #1 unit.

In case of Multiple mounting type, Arm #1 falls without mounting screws. Support Arm #1 when removing the screws. Remove the O ring which is attached to the Joint #1 mounting part.
Arm #1 Installation

(1) Prepare the spare Arm #1 and mount the mechanical stop.

<table>
<thead>
<tr>
<th>Side</th>
<th>Table Top</th>
<th>Multiple</th>
<th>Arm #2 side</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base side</td>
<td>M8×10</td>
<td>M8×10</td>
<td>M8×10</td>
</tr>
<tr>
<td>Table Top</td>
<td>1 unit</td>
<td>2 units</td>
<td>2 units</td>
</tr>
<tr>
<td>(Bottom surface, Center, 1 point)</td>
<td>(Top surface, Center, 2 points)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(2) Insert the base side of Arm #1 to the harmonic drive of the base.

In case of Multiple mounting type,

Insert the O ring into the chase in the Joint #1 mounting surface of Arm #1 before mounting the arm.

Apply a small amount of grease for the reduction gear to the O ring.

Fit with the space for the screws head of harmonic drive on Arm #1 side.

(3) Put washer on screws and mount the Arm #1 unit with specified torque.

M3 tightening torque: 3.0 N-m (30.6 kgf-cm)

Use 35 mm screws to all side and the middle one in each side is 20 mm.

Do not use the screws of different length. Otherwise, it causes a malfunction.

(4) There is an O ring groove in the Arm #2 mounting part on Arm #1 side. Insert an O ring in the groove.

Apply a small amount of grease on the O ring.

(5) Insert the Arm #2 side on Arm #1 to the harmonic drive of Arm #2.

Fit with the space for the screws head of harmonic drive on Arm #2 side.
(6) Put washer on screws and mount the Arm #1 unit with specified torque.
   M3 tightening torque: 3.0 N\(\cdot\)m (30.6 kgf\(\cdot\)cm)

Use 35 mm screws to all side and the middle one in each side is 20 mm.

Do not use screws of different length. It causes a malfunction.

(7) Mount the hose elbow and Arm #1 cover.

These parts are not attached to the Multiple mounting Manipulators.

(8) Put the \(\theta_2\) movement direction label to the end of Arm #1, in Arm #2 side.

---

### CAUTION

- After replacing the arm, do not fail to change the robot model in the software.
- If the model is different, it may cause a robot to malfunction. Also, the robot may collide with the mechanical stop and break it.
(9) Change the robot model.

(9)-1 From the Setup Menu, select Controller.

(9)-2 Click on the Robot folder in the tree on the left side to open the Robot Model page.

(9)-3 Select the model for your robot from the Model dropdown list. Only robot models that can be used with the amplifiers currently in the controller are listed. When using Dry Run, all robot models are shown in the list.

(9)-4 Click the **Apply** button to save settings.

(9)-5 Click on Robot Configuration in the tree to open the Robot Configuration page.

(9)-6 Type in a name for the new robot and enter the serial number from the robot's nameplate. Any serial number can be used, but it is recommended that you use the number that is stamped on the robot.

(9)-7 Click **Apply** to save settings.
(9)-1 From the Setup Menu, select System Configuration.

(9)-2 Click on Robots in the tree on the left.

(9)-3 Click Add and the next dialog will appear.

(9)-4 Type in a name for the new robot and enter the serial number from the robot’s nameplate. Any serial number can be used, but it is recommended that you use the number that is stamped on the robot.

(9)-5 Select a motion system to use from the [Motion System] dropdown list. If there are no other motion systems installed, then “Standard” will already be selected.

(9)-6 Select a Drive Unit for your robot from the [Drive Unit] dropdown list.

(9)-7 Select a robot type from the [Robot type] box.

(9)-8 Select a robot series from the [Series] dropdown list.

(9)-9 Select a robot model from the [Model] dropdown list. After you select a robot model, all robots available for the type of motor driver currently installed in the controller will be shown. If you use [Dry run], all robots selected in step 8 will be shown.

(9)-10 Click OK and the controller will be rebooted.
9.1 From the Setup Menu, select System Configuration.

9.2 Click [Controller]-[Robots] in the tree on the left.

9.3 Click <Add> and the following dialog box will appear.

9.4 Type in a name for the new manipulator and enter the serial number on the manipulator’s nameplate. Any serial number can be used, but it is recommended that you use the number that is stamped on the manipulator.

9.5 Select a motion system to use from the [Motion System] dropdown list. If there are no other motion systems installed, then “Standard” will already be selected.

9.6 Select a Drive Unit for your manipulator from the [Drive Unit] dropdown list.

9.7 Select a manipulator type from the [Robot type] box.

9.8 Select a manipulator series from the [Series] dropdown list.

9.9 Select a manipulator model from the [Model] dropdown list.

After you select a manipulator model, all manipulators available for the type of motor driver currently installed in the controller will be displayed. If you use [Dry run], all robots selected in step 9 will be shown.

9.10 Click <OK> and the controller will be rebooted.

(10) Perform the calibration of Joint #1, #2.

10. Bellows

The bellows are provided in a unit of one piece. The upper and lower bellows have the same shape.

A large amount of dust is emitted when replacing the bellows. Take the Manipulator to an outer room such as the room in front of the clean room’s entrance, or take the necessary countermeasures to prevent dust emission before removing the bellows.

<table>
<thead>
<tr>
<th>Maintenance parts</th>
<th>Name</th>
<th>Quantity</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bellows</td>
<td>120 mm</td>
<td>1</td>
<td>1513008</td>
</tr>
</tbody>
</table>

| Tools             | Cross-point screwdriver | 1 | For clamp band removal |

Bellows Removal

1. Remove the end effector.
2. Remove the wires and tubes from the end effector.
3. Turn ON the controller. Stop motor excitation. (MOTOR OFF)
4. Loosen the two clamp bands on each bellows.
5. Pull the bellows and clamp bands out of the shaft.
Bellows Installation

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

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

The brake release switch affects only Joint #3. When the brake release switch is pressed, the brake for Joint #3 is released simultaneously.

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

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

(3) Secure the cover side of the bellows.
The bellows has two joints:
The larger joint must be attached to the cover side.
The smaller joint must be attached to the end face side of the shaft.
Attach the mounting part of the bellows until the end touches the cylindrical part of the cover.
Then, secure them with clamp bands.

(4) Secure the end face side of the bellows to the shaft.
Cover the bearing case (black) on the end face of the shaft with the bellows mounting part.
Then, secure them with clamp bands.

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

(6) Turn OFF the Controller and peripheral equipment.

(7) Attach the end effector.

(8) Connect the wires and tubes to the end effector.
11. Ball Screw Spline 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.

**NOTE**

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

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

Refer to *Maintenance: 14. Calibration* to perform the calibration.

### 11.1 Greasing the Ball Screw Spline Unit

<table>
<thead>
<tr>
<th>Name</th>
<th>Quantity</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grease</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For Ball Screw Spline Unit (AFB grease)</td>
<td>Proper quantity</td>
<td>For wiping grease (Spline shaft)</td>
</tr>
<tr>
<td>Tools</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wiping cloth</td>
<td>1</td>
<td>For clamp band removal Only for Cleanroom-model and Protected-model</td>
</tr>
<tr>
<td>Cross-point screwdriver</td>
<td>1</td>
<td>For clamp band removal Only for Cleanroom-model and Protected-model</td>
</tr>
</tbody>
</table>

**NOTE**

The brake release switch affects only Joint #3. When the brake release switch is pressed, the brake for Joint #3 is released simultaneously.

Be careful of the shaft while the brake release switch is being pressed because the shaft may be lowered by the weight of the end effector.
11.1.1 Standard-model (S type)

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

(1) Turn ON the Controller. Stop motor excitation. (MOTOR OFF)

(2) Move the arm to a position where Joint #3 can be moved in full stroke.

(3) Move the shaft to its upper limit manually while pressing the brake release switch.

(4) Turn OFF the Controller.

(5) Wipe off the old grease from the upper part of the shaft, and then apply new grease to it.

When applying the new grease to the upper part of the shaft, directly fill the grooves on it by hand. Wipe off excess grease from the shaft.

(6) Turn ON the Controller.

(7) Move the shaft to its lower limit by hand while pressing the brake release switch.

(8) Wipe off the old grease from the lower part of the shaft, and then apply new grease to it.

When applying the new grease to the lower part of the shaft, directly fill the grooves on it by hand. Wipe off excess grease from the shaft.

(9) Move the shaft up and down several times while pressing the brake release switch to smooth out the grease on the shaft. Wipe off excess grease from the shaft.

When wiping off the excess grease from the upper part of shaft, turn OFF the Controller and remove the arm top cover. For details, refer to Maintenance: 3.1 Arm Top Cover.
11.1.2 Cleanroom-model (C with bellows)

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

**Upper Part of the Shaft**

(1) Turn ON the Controller. Stop motor excitation. (MOTOR OFF)

(2) Move the arm to a position where Joint #3 can be moved in full stroke.

(3) Move the shaft to its lower limit manually while pressing the brake release switch.

(4) Loosen the clamp band under the bellows, and then lift the bellows.

(5) Move the shaft to its upper limit manually while pressing the brake release switch.

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

   Directly fill the grooves on the shaft inside the bellows with grease by hand.
   Wipe off excess grease from the shaft.

**Lower Part of the Shaft**

(7) Loosen the clamp band on the bellows, and then move the bellows downward.

(8) Move the shaft to its lower limit manually while pressing the brake release switch.

(9) Wipe off the old grease from the lower part of the shaft, and then apply new grease to it.

   Directly fill the grooves on the shaft inside the bellows with grease by hand.
   Wipe off excess grease from the shaft.

(10) Move the shaft up and down several times while pressing the brake release switch to smooth out the grease on the shaft. Wipe off excess grease from the shaft.

(11) Secure the bellows.

   To attach the upper bellows, move the shaft to its lower limit.
   To attach the lower bellows, move the shaft to its upper limit.
   To move the shaft up/down, press and hold the brake release switch.

   Attach the mounting part of the bellows until it touches the cylindrical part of the cover. Then, secure them with clamp bands.
### 11.2 Replacing the Ball Screw Spline Unit

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

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

Move the shaft down to its lower limit before starting the replacement procedure by following the removal steps from (1) to (3).

<table>
<thead>
<tr>
<th></th>
<th>Name</th>
<th>Quantity</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance parts</td>
<td>Ball Screw Spline Unit</td>
<td>1</td>
<td>Each manipulator model (Refer to Maintenance: 15. Maintenance parts)</td>
</tr>
<tr>
<td>Grease</td>
<td>For Ball Screw Spline Unit (AFB grease)</td>
<td>Proper quantity</td>
<td></td>
</tr>
<tr>
<td>Tools</td>
<td>Hexagonal wrench</td>
<td>1</td>
<td>For M4 screw</td>
</tr>
<tr>
<td></td>
<td>(width across flats: 3 mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Torque wrench</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nippers</td>
<td>1</td>
<td>For cutting wire tie</td>
</tr>
<tr>
<td></td>
<td>Cross-point screwdriver</td>
<td>1</td>
<td>Only for Cleanroom-model</td>
</tr>
<tr>
<td></td>
<td>Force gauge</td>
<td>1</td>
<td>Belt tension 98 N (10 kgf) / 74 N (7.5 kgf)</td>
</tr>
<tr>
<td></td>
<td>Suitable cord (Length about 1000 mm)</td>
<td>1</td>
<td>For belt tension</td>
</tr>
<tr>
<td>Material</td>
<td>Wiping cloth</td>
<td>1</td>
<td>For wiping grease (Spline shaft)</td>
</tr>
<tr>
<td></td>
<td>Wire tie</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

#### Ball screw spline unit Removal

1. Turn ON the Controller.

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

   The brake release switch affects only Joint #3. When the brake release switch is pressed, the brake for Joint #3 is released simultaneously.

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

3. Turn OFF the Controller.

4. Detach the wires/tubes from the end effector, and remove the end effector.

5. This step is only for Cleanroom-model (C with bellows option).

   Remove the bellows. For details, refer to Maintenance: 10. Bellows.

6. Remove the arm top cover and arm bottom cover.

   For details, refer to Maintenance: 3. Covers.
(7) Remove the battery board from Arm #2.

(8) Remove the user plate and grounding wire from Arm #2.

(9) Disconnect the following connectors.
    Connectors X231, X31, X341, X41 (Hold the clip to remove.)
    Connector X32
    Connector X63, X64 (Backup cable connector for Joint #3, #4)

(10) Remove the motor unit by pulling it up.
    Remove the bolts securing the Joint #4 motor unit.

(11) Remove the screws securing the ball screw spline of Arm #3 surface.

(12) Remove the screws securing the Joint #3 motor unit.

(13) Hold the rotator part of ball screw spline and Joint #3 motor up together.

(14) Hold the Joint #3 motor up.
    Remove the belt by passing though the spline rotator part.
(15) Remove the screws securing the Joint #4 intermediate unit.
    
    Remove the unit by pulling it up.

(16) Remove the U2 belt.

(17) Hold the spline upper rotator part.
    
    Remove the U2 belt.

(18) Remove the mounting screws of the ball screw spline shaft on the lower part of Arm #2.

(19) Remove the ball screw spline unit by pulling it upward from Arm #2.
Ball screw spline unit Installation

(1) Pass the U2 belt through the ball screw spline unit and U3 pulley and insert the belt to Arm #2 from above.

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

Be careful not to put the timing belt between the nut and Arm #2.

(3) Mount the ball screw spline unit.
   For the procedure, refer to Maintenance: 8. Arm #4 – 8.2 Replacing the Timing Belt – U2 belt installation.

(4) Grease the shaft.
   For details, refer to Maintenance: 11.1. Greasing the Ball Screw Spline Unit.

(5) Install the arm top cover and arm bottom cover.
   For details, refer to Maintenance: 3. Covers.

(6) Turn OFF the Controller and peripheral equipment.

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

(8) This step is only for Cleanroom-model. Install the bellows.

(9) Perform the calibration of Joints #3 and #4.
## 12. Lithium Battery

**WARNING**

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

**WARNING**

- Use meticulous care when handling the lithium battery. Improper handling of the lithium battery as mentioned below is extremely hazardous, may result in heat generation, leakage, explosion, or inflammation, and may cause serious safety problems.

  <Improper Handling>
  - Battery Charge
  - Disassembly
  - Incorrect Installation
  - Exposing to Fire
  - Forced Discharge
  - Deformation by Pressure
  - Short-circuit (Polarity; Positive/Negative)
  - Heating (85°C or more)
  - Soldering the terminal of the lithium battery directly

- When disposing of the battery, consult with the professional disposal services or comply with the local regulation. Spent battery or not, make sure the battery terminal is insulated. If the terminal contacts with the other metals, it may short and result in heat generation, leakage, explosion, or inflammation.

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

The life span of the lithium battery varies depending on the energizing hours and installation environment of the Controller. It is about 3 years as a rough guide (when the Controller is connected to power for 8 hours a day). When the Controller is not connected to power, the battery consumption will significantly increase compared to when the Controller is energized. If warnings of voltage reduction occur, replace the lithium metal battery even if it has not reached the above product life.
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.
   Robot Controller RC700 / RC700-A Maintenance 6. Alarm

For the EPSON RC+ 5.0 Ver. 5.4.7 or later (firmware Ver.1.16.4.x or 1.24.4.x or later), the recommended replacement time for the battery can be checked in the [Maintenance] dialog box of the EPSON RC+ 5.0.
For details, refer to the following manual.
   Robot Controller RC180 “Appendix. 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: 15. Maintenance Parts List.)
Be careful of the battery polarity to connect it correctly.

<table>
<thead>
<tr>
<th>Maintenance parts</th>
<th>Name</th>
<th>Quantity</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery unit (Lithium battery)</td>
<td>1</td>
<td>2117879</td>
<td></td>
</tr>
<tr>
<td>Battery board</td>
<td>1</td>
<td>2120180</td>
<td></td>
</tr>
<tr>
<td>Tools</td>
<td>Nippers</td>
<td>1</td>
<td>For cutting wire tie</td>
</tr>
<tr>
<td></td>
<td>Hexagonal wrench (width across flats: 3 mm)</td>
<td>1</td>
<td>For M4 screw</td>
</tr>
<tr>
<td>Material</td>
<td>Wire tie</td>
<td>2</td>
<td>For fixing battery unit (battery)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>For fixing cable</td>
</tr>
</tbody>
</table>
### 12.1 Replacing the Battery Unit (Lithium Battery)

#### Battery unit (lithium battery) Removal

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

   - The brake release switch affects only Joint #3. When the brake release switch is pressed, the brake for Joint #3 is released simultaneously.
   - Be careful of the shaft while the brake release switch is being pressed because the shaft may be lowered by the weight of an end effector.
3. Remove the arm top cover.
   - For details, refer to *Maintenance: 3.1 Arm Top Cover*.
4. Connect the connector of the new lithium battery (battery unit) to the battery board.
   - Use the unused connector of the two connectors X60A, X60B on the upper part of the battery board.
   - Be sure to connect the connector of the new battery before disconnecting the old battery. If the current battery is disconnected before connecting the new one, the robot will lose the origin position data and the calibration must be executed again.
5. Cut off the wire tie banding the lithium battery and remove the lithium battery.
6. Cut off the wire tie banding the lithium battery, remove the battery.

#### Battery unit (lithium battery) Installation

1. Mount the new lithium battery to the battery board.
2. Fix the cable of lithium battery and connector cable connecting to battery board with wire tie. Refer to the *Removal step (4)*.
3. Mount the arm top cover.
   - For details, refer to *Maintenance: 3.1 Arm Top Cover*.
4. Turn ON the Controller.
5. Check if the Manipulator moves to points (poses) correctly.
   - To do so, select 2 points (poses) or more from the registered points (poses) and move the Manipulator to the points (poses).
6. If the Manipulator does not move to the points (poses) correctly, perform the calibration of all joints and axes.
12.2 Replacing the Battery Board

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

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

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

Refer to Maintenance: 14. Calibration to perform the calibration.

Battery board Removal

(1) Turn OFF the Controller.

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

The brake release switch affects only Joint #3. When the brake release switch is pressed, the brake for Joint #3 is released simultaneously.

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

(3) Remove the arm top cover.

For details, refer to Maintenance: 3.1 Arm Top Cover.

(4) Disconnect the wiring tie connecting the connector cable.

(5) Disconnect the connectors X61, X62, X63, and X64 from the battery board.

(6) Loosen the screws securing the battery board and remove the battery board.
(1) Mount the new battery board and secure it with screws.

(2) Connect the connectors.
   Connectors: X61, X62, X63, X64

(3) Fix the connector cable with wiring tie.
   Refer to Removal step (4).

(4) Mount the arm top cover.
   For details, refer to Maintenance: 3.1 Arm Top Cover.

(5) Turn ON the Controller.

(6) Perform the calibration of all joints.
13. 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.

<table>
<thead>
<tr>
<th>Maintenance parts</th>
<th>Name</th>
<th>Quantity</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LED Lamp</td>
<td>1</td>
<td>2077258</td>
</tr>
<tr>
<td>Tools</td>
<td>Cross-point screwdriver</td>
<td>1</td>
<td>For wire removal</td>
</tr>
<tr>
<td></td>
<td>Nippers</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Material</td>
<td>Wire tie</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

LED Lamp Removal

(1) Remove the arm top cover.
   For details, refer to Maintenance: 3.1 Arm Top Cover.

(2) Remove the user plate from the Arm #2 cover.

(3) Disconnect the X1 and X2 terminals from the LED.

(4) Turn the lens counterclockwise to remove it. Then, turn the lens holder counterclockwise to remove it.

(5) Remove the LED and ring from the user plate.

LED Lamp Installation

(1) Connect the X1 and X2 terminals to the LED.
   Each terminal must be connected to its terminal number on the LED.

(2) Put the user plate between the ring and lens holder, and then mount the LED on the arm top cover.

(3) Install the lens to the lens holder.

(4) Mount the user plate to Arm #2.

(5) Install the arm top cover.
   For details, refer to Maintenance: 3.1 Arm Top Cover.
### 14. Calibration

#### 14.1 About Calibration

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

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

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

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

---

**WARNING**

- To ensure safety, a safeguard must be installed for the robot system. For details on the safeguard, refer to EPSON RC+ User’s Guide: 2.4 Installation and Design Precautions.

- Before operating the robot system, make sure that no one is inside the safeguarded area. The robot system can be operated in the mode for teaching even when someone is inside the safeguarded area. The motion of the Manipulator is always in restricted (low speeds and low power) status to secure the safety of an operator. However, operating the robot system while someone is inside the safeguarded area is extremely hazardous and may result in serious safety problems in case that the Manipulator moves unexpectedly.

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#### Command Input

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

The information above is omitted in the calibration procedure.

#### Jog Motion

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

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

When the calibration procedure is different for each type of software, see your software type.
14.2 Calibration Procedure

EPSON RC+ has a wizard for calibration.

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

You can also calibrate with option TP1 in TEACH mode. For details, refer to RC180/RC90 option Teach pendant TP1 manual, Operation: 2.7 Calibrating Origin: E2 Series / G Series / RS series.

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

When coordinates for the Manipulator working point require calculation, it is important for Joint #2 to be calibrated accurately. Execute the procedure in “Calibration Using Right / Left Arm Orientations” to accurately calibrate Joint #2. For details, refer to Maintenance: 14.3 Accurate Calibration of Joint #2.

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

If Err9716 or 5016 (Power supply failure of the absolute encoder. Replace the battery. Check the robot internal wiring) occurs, apply the procedure of Maintenance: 14.4 Calibration Procedure without using Calibration Wizard - 3. Encoder Initialization and then, start the calibration wizard.
The reference point (a point to check the accuracy) needs to be specified for calibration.

(1) Start the calibration wizard.

i. Select EPSON RC+ menu-[Setup]-[Controller] to display the [Controller] dialog.

ii. Select [Robot]-[Calibration] to display [Robot Calibration].

iii. Select the joint and click the <Calibrate...> button.
i. Select EPSON RC+ menu-[Setup]-[System Configuration].

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

Only selected robot can be calibrated.

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

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

(3) Move the joint to calibrate manually to approximate 0 pulse position, as shown in the dialog. After moving the joint click the <Next> button.
0 pulse position of Joint #1: position aligned with X-axis in Robot coordinate system

0 pulse position of Joint #2: position where Arms #1 and #2 are in a straight line (Regardless of the Joint #1 direction.)

0 pulse position of Joint #3: upper limit position in motion range

The height of Joint #3 depends on manipulator model.

0 pulse position of Joint #4: position where the flat surface (or groove in the up/down mechanical stop) on the shaft faces toward the tip of Arm #2
(4) Click the <Yes> button to reset the encoder.

* This window will disappear when the Controller starts up.

(5) Reboot the Controller.

* This window will disappear when the Controller starts up.

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

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

* Before operating the robot, open the [Jog & Teach] tab and execute <Motor ON>.

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

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

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

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

* Position Joint #2 only and move Joint #3 to around 0 pulse.
(15) Click the <Next> button.

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

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

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

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

(18) Move the manipulator to other points and check if it can move without problems. Teach points where appropriate.
14.3 Accurate Calibration of Joint #2

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

NOTE

If the accuracy of Joint #2 is not obtained through the steps in the section Maintenance: 14.2 Calibration Procedure, follow the steps below “Calibration Using Right / Left Arm Orientations” to accurately calibrate Joint #2.

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

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

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

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

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

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

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

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

2. Open the Tools menu | Robot Manager | Control Panel and click the MOTOR ON.

3. Click the <Free All> button to free all joints from servo control. Now, you can move arms by hands.

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

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

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

6. Click the Lock All in the [Control Panel] to lock all joints under servo control.

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

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

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

8. The joints are slightly out of position.

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

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

9. Input the new Hofs value.

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

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

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

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

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

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

12. Move the manipulator to other point data and make sure it moves to the correct position.

    Teach some more points if required.

    * Delete the two points taught for the Joint #2 calibration.
14.4 Calibration Procedure without using Calibration Wizard

This section indicates the calibration without using the calibration wizard of EPSON RC+. For details of calibration using the calibration wizard, refer to 14.2 Calibration Procedure.

When coordinates for the Manipulator working point require calculation, it is important for Joint #2 to be calibrated accurately. Execute the procedure in “Calibration Using Right / Left Arm Orientations” to accurately calibrate Joint #2. For details, refer to Maintenance: 14.3 Accurate Calibration of Joint #2.

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

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

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

1. Basic Pose Confirmation

(1)-1 After the part replacement, perform the calibration using the point data currently registered.

Confirm the point data number (P*) to reconstruct the correct manipulator position.

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

2. Part Replacement

(2)-1 Replace parts as dictated by this manual.

* Be careful not to injure yourself or damage parts during part replacement.

3. Encoder Initialization

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

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

0 pulse position of Joint #1:
position aligned with X-axis in Robot coordinate system
0 pulse position of Joint #2:
position where Arms #1 and #2 are in a straight line
(Regardless of the Joint #1 direction.)

0 pulse position of Joint #3:
upper limit position in motion range

The height of Joint #3 depends on manipulator model.

0 pulse position of Joint #4:
position where the flat surface (or groove in the up/down mechanical stop) on the shaft faces toward the tip of Arm #2

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

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

> robot 1
(3)-4 Execute the absolute encoder initialization command.

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

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

(3)-5 Reboot the Controller.

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

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

4. Rough Calibration

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

>calpls 0,0,0,0

* Manipulator does not move.

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

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

5. Calibration (Accurate Positioning)

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

(5)-2 Click the <Free All> button to free all joints from servo control. Now, you can move arms by hands.

(5)-3 Move the Manipulator by hand to a rough position/posture of the calibration point data.
(5)-4 Create the data from the calibration point data.
   Enter and execute the following command in [Command Window].
   (In this example, P1 is used as the calibration point data.)
   ```
   > Calpls Ppls(P1,1), Ppls(P1,2), Ppls(P1,3),
   Ppls(P1,4)
   ```

(5)-5 Move the joint to the specified point using a motion command.
   For example, when the specified point data is “P1”,
   execute “Jump P1:Z(0)” from [Jog & Teach].
   * The joint NOT being calibrated moves to the original position.

(5)-6 Accurately align the joint* being calibrated to the specified point using jog commands.
   * You must move Joint #3 and #4 to the position when calibrating Joint #4.
   Select the jog mode [Joint] from [Jog & Teach] to execute the jog motion.

(5)-7 Execute the calibration.
   Enter and execute one of the following commands in [Command Window] according to the joint being calibrated.
   ```
   Joint #1: >Calib 1
   Joint #2: >Calib 2
   Joint #3: >Calib 3
   Joint #4: >Calib 3, 4
   ```

6. Accuracy Testing

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

### 15.1 Common Parts

<table>
<thead>
<tr>
<th>Part Name</th>
<th>Code</th>
<th>Old Code</th>
<th>Note</th>
<th>Ref. Maintena</th>
<th>Overhaul</th>
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</thead>
<tbody>
<tr>
<td>Cable Unit</td>
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</tr>
<tr>
<td>S</td>
<td>250 mm</td>
<td>1514457</td>
<td>R13B020023</td>
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<td>350 mm</td>
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<td>R13B020027</td>
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<td>M/C Cable</td>
<td>3 m</td>
<td>For RC180</td>
<td>R12NZ9002C</td>
<td>R12B020431</td>
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<td></td>
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<td>For RC700-A</td>
<td>R12NZ900KA</td>
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<td>For RC700-A,</td>
<td>R12NZ900KD</td>
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<td>R12NZ900KB</td>
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<td>L-shaped</td>
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<td>20 m</td>
<td>For RC700-A</td>
<td>R12NZ900XX</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Straight</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AC Servo Motor</td>
<td>Joint #1</td>
<td>1514451</td>
<td>R13B000614</td>
<td>200 W</td>
<td>5.1</td>
</tr>
<tr>
<td></td>
<td>Joint #2 / #3 / #4</td>
<td>1514453</td>
<td>R13B000615</td>
<td>150 W</td>
<td>6.1, 7.1, 8.1,</td>
</tr>
<tr>
<td>Reduction Gear Unit</td>
<td>Joint #1</td>
<td>1649160</td>
<td>R13B010016</td>
<td>5.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Joint #2</td>
<td>1661086</td>
<td>R13B010017</td>
<td>6.2</td>
<td></td>
</tr>
<tr>
<td>Electromagnetic Brake</td>
<td>Z axis</td>
<td>1497639</td>
<td>R13B030501</td>
<td>7.3</td>
<td></td>
</tr>
<tr>
<td>Timing Belt</td>
<td>Joint #3</td>
<td>1510625</td>
<td>R13B030213</td>
<td>Z</td>
<td>7.2</td>
</tr>
<tr>
<td></td>
<td>Joint #4</td>
<td>1510626</td>
<td>R13B030214</td>
<td>U1</td>
<td>8.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1510627</td>
<td>R13B030215</td>
<td>U2</td>
<td>8.2</td>
</tr>
<tr>
<td>O-ring</td>
<td>Joint #1</td>
<td>1653181</td>
<td>R13A0307002 00</td>
<td>5.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Joint #2</td>
<td>1653819</td>
<td>R13A0307001 00</td>
<td>6.2</td>
<td></td>
</tr>
</tbody>
</table>
### Maintenance Parts List

<table>
<thead>
<tr>
<th>Part Name</th>
<th>Code</th>
<th>Old Code</th>
<th>Note</th>
<th>Ref. Maintenance</th>
<th>Overhaul *1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joint #1</td>
<td>1213267</td>
<td>R13A0312007 00</td>
<td>O-ring20 For Multiple layout mounting only.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joint #2</td>
<td>1213266</td>
<td>R13A0312006 00</td>
<td>O-ring17</td>
<td>6.2</td>
<td></td>
</tr>
<tr>
<td>Brake Release Switch</td>
<td>2117817</td>
<td>R13Z7026401 00</td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Oil seal (soft metal)</td>
<td>1510206</td>
<td>R13B031233</td>
<td></td>
<td>5.1</td>
<td></td>
</tr>
<tr>
<td>Battery Board</td>
<td>2120180</td>
<td>R13B041202</td>
<td>With lithium battery Installed in Arm #2 ER17330V (TOSHIBA)</td>
<td>12.2</td>
<td></td>
</tr>
<tr>
<td>Battery Unit</td>
<td>2117879</td>
<td>R13ZA006003 00</td>
<td>Lithium battery for replacement ER17330V (TOSHIBA)</td>
<td>4.1, 12.1</td>
<td></td>
</tr>
<tr>
<td>LED Lamp</td>
<td>2077258</td>
<td>R13A0300002 00</td>
<td></td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Grease *2 For Ball Screw Spline : AFB</td>
<td>-</td>
<td>-</td>
<td>For purchasing the grease, please contact the supplier of your region.</td>
<td>2.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>-</td>
<td>For Reduction Gear Unit SK-1A SK-2</td>
<td></td>
<td>2.3</td>
</tr>
</tbody>
</table>

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

*2 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 supplier of your region.

<table>
<thead>
<tr>
<th>Product name</th>
<th>Manufacturer</th>
<th>URL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harmonic Grease SK-1A</td>
<td>Harmonic Drive Systems Inc.</td>
<td><a href="http://www.harmonicdrive.net/">http://www.harmonicdrive.net/</a></td>
</tr>
</tbody>
</table>
## 15.2 Parts by Environment Model

### 15.2.1 S: Standard-model

<table>
<thead>
<tr>
<th>Part Name</th>
<th>Code</th>
<th>Old Code</th>
<th>Note</th>
<th>Reference: Maintenance</th>
<th>Overhaul *1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ball Screw Spline 150 mm</td>
<td>1514454</td>
<td>R13B010220</td>
<td>11.1.1</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Arm Cover</td>
<td>1514465</td>
<td>R13B030421</td>
<td>White 3.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

For details, refer to Maintenance 2.2 Overhaul (Parts Replacement).

### 15.2.2 C: Cleanroom-model

<table>
<thead>
<tr>
<th>Part Name</th>
<th>Code</th>
<th>Old Code</th>
<th>Note</th>
<th>Reference: Maintenance</th>
<th>Overhaul *1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ball Screw Spline 120 mm</td>
<td>1514455</td>
<td>R13B010221</td>
<td>11.1.2</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Arm Cover</td>
<td>1514466</td>
<td>R13B030422</td>
<td>Plating 3.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bellows</td>
<td>1513008</td>
<td>R13B030704</td>
<td>*2 10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gasket Unit</td>
<td>1514467</td>
<td>R13B031234</td>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

For details, refer to Maintenance 2.2 Overhaul (Parts Replacement).

*2 Common with LS3 series.

The bellows are provided in a unit of one piece. The upper and lower bellows have the same shape.