EPSON

Robot System
Safety and Installation

Read this manual first

Rev.22 EM164B3207F

Robot Controller RC180
Programming Software EPSON RC+5.0

Manipulator G series
RS series
C3 series
S5 series

Robot System　Safety and Installation

(RC180 / EPSON RC+ 5.0)

Rev.22

FOREWORD

Thank you for purchasing our robot products.

This manual contains the information necessary for the correct use of the Operator Panel.

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 robot system and its optional parts are shipped to our customers only after being subjected to the strictest quality controls, tests, and inspections to certify its compliance with our high performance standards.

Product malfunctions resulting from normal handling or operation will be repaired free of charge during the normal warranty period. (Please ask your Regional Sales Office 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 robot system 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

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TRADEMARK NOTATION IN THIS MANUAL

Microsoft® Windows® XP Operating system

Microsoft® Windows® Vista Operating system

Microsoft® Windows® 7 Operating system

Microsoft® Windows® 8 Operating system

Throughout this manual, Windows XP, Windows Vista, Windows 7 and Windows 8 refer to above respective operating systems. In some cases, Windows refers generically to Windows XP, Windows Vista, Windows 7 and Windows 8.

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.

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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)

NOTE

Do not connect the followings to TP/OP port of RC180. Connecting to the followings may result in malfunction of the device since the pin assignments are different.

OPTIONAL DEVICE dummy plug
Operation Pendant OP500
Operator Pendant OP500RC
Jog Pad JP500
Teaching Pendant TP-3**

NOTE

For RC180, be sure to install the EPSON RC+5.0 to the development PC first, then connect the development PC and RC180 with the USB cable.
If RC180 and the development PC are connected without installing the EPSON RC+5.0 to the development PC, [Add New Hardware Wizard] appears. If this wizard appears, click the <Cancel> button.

NOTE

Concerning the security support for the network connection:
The network connecting function (Ethernet) on our products assumes the use in the local network such as the factory LAN network. Do not connect to the external network such as Internet.
In addition, please take security measure such as for the virus from the network connection by installing the antivirus software.

NOTE

Security support for the USB memory:
Make sure the USB memory is not infected with virus when connecting to the Controller.

NOTE

Every data of the Controller is stored to the Compact Flash inside the Controller. When you execute the commands listed below, data is written to the Compact Flash. Frequent data writing to the Compact Flash may shorten the Compact Flash life. It is recommended to use the following commands only when it is necessary.

- Renew the Point files
  (SavePoints)
- Change the Robot parameters
  (Base, Local, LocalClr, CalPls, Calib, Hofs, ArmSet, ArmClr, HomeSet, HomeClr, Hordr, MCOder, Weight, JRange, Range, XYLim, TLSet, TLClr, Arm, Tool, Inertia, EcpSet, EcpClr, Box, BoxClr, Plane, PlaneClr)

TABLE OF CONTENTS

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.

 WARNING	This symbol indicates that a danger of possible serious injury or death exists if the associated instructions are not followed properly.
 WARNING	This symbol indicates that a danger of possible harm to people caused by electric shock exists if the associated instructions are not followed properly.
 CAUTION	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.

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 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:

WARNING

- 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, and may result in serious bodily injury and/or severe equipment damage to the robot system.
- 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.
- 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.

Further precautions for installation are mentioned in the following manuals. Please read this chapter carefully to understand safe installation procedures before installing the robots and robotic equipment.

1.2.1 Relevant Manuals

Refer

This manual : 2. Installation
Manipulator manual : Setup & Operation 3. Environment and Installation
Controller manual : Setup & Operation 3. Installation

1.2.2 Designing a Safe Robot System

It is important to operate robots safely. It is also important for robot users to give careful consideration to the safety of the overall robot system design.

This section summarizes the minimum conditions that should be observed when using EPSON robots in your robot systems.

Please design and manufacture robot systems in accordance with the principles described in this and the following sections.

Environmental Conditions

Carefully observe the conditions for installing robots and robot systems that are listed in the “Environmental Conditions” tables included in the manuals for all equipment used in the system.

System Layout

When designing the layout for a robot system, carefully consider the possibility of error between robots and peripheral equipment. Emergency stops require particular attention, since a robot will stop after following a path that is different from its normal movement path. The layout design should provide enough margins for safety. Refer to the manuals for each manipulator, and ensure that the layout secures ample space for maintenance and inspection work.

When designing a robot system to restrict the area of motion of the robots, do so in accordance with the methods described in each manipulator manual. Utilize both software and mechanical stops as measures to restrict motion.
Install the emergency stop switch at a location near the operation unit for the robot system where the operator can easily press and hold it in an emergency.

Do not install the controller at a location where water or other liquids can leak inside the controller. In addition, never use liquids to clean the controller.

Disabling Power to the System using lock out / tag out

The power connection for the robot controller should be such that it can be locked and tagged in the off position to prevent anyone from turning on power while someone else is in the safeguarded area.
For further details, refer to the following section:

1.8 Lockout/Tagout

End Effector Design

Provide wiring and piping that will prevent the robot end effector from releasing the object held (the work piece) when the robot system power is shut off.

Design the robot end effector such that its weight and moment of inertia do not exceed the allowable limits. Use of values that exceed the allowable limits can subject the robot to excessive loads. This will not only shorten the service life of the robot but can lead to unexpectedly dangerous situations due to additional external forces applied to the end effector and the work piece.

Design the size of the end effector with care, since the robot body and robot end effector can interfere with each other.

Peripheral Equipment Design

When designing equipment that removes and supplies parts and materials to the robot system, ensure that the design provides the operator with sufficient safety. If there is a need to remove and supply materials without stopping the robot, install a shuttle device or take other measures to ensure that the operator does not need to enter a potentially dangerous zone.

Ensure that an interruption to the power supply (power shutoff) of peripheral equipment does not lead to a dangerous situation. Take measures that not only prevent a work piece held from being released as mentioned in “End effector Design” but that also ensure peripheral equipment other than the robots can stop safely. Verify equipment safety to ensure that, when the power shuts off, the area is safe.

Remote Control

To prevent operation by remote control from being dangerous, start signals from the remote controller are allowed only when the control device is set to REMOTE, TEACH mode is OFF, and the system is configured to accept remote signals. Also when remote is valid, motion command execution and I/O output are available only from remote. For the safety of the overall system, however, safety measures are needed to eliminate the risks associated with the start-up and shutdown of peripheral equipment by remote control.

Emergency Stop

Each robot system needs equipment that will allow the operator to immediately stop the system’s operation. Install an emergency stop device that utilizes emergency stop input from the controller and all other equipment.

During an emergency stop, the power that is supplied to the motor driving the robot is shut off, and the robot is stopped by dynamic braking.

The emergency stop circuit should also remove power from all external components that must be turned off during an emergency. Do not assume that the robot controller will turn off all outputs if configured to. For example, if an I/O card is faulty, the controller cannot turn off a component connected to an output. The emergency stop on the controller is hardwired to remove motor power from the robot, but not external power supplies.

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

1.5 Emergency Stop

Safeguard System

To ensure safety, a safeguard system should be installed for the robot system.

When installing the safeguard system, strictly observe the following points:

Refer to each robot manual, and install the safeguard system outside the maximum space. Carefully consider the size of the end effector and the work pieces to be held so that there will be no error between the moving parts and the safeguard system.

Manufacture the safeguard system to withstand calculated external forces (forces that will be added during operation and forces from the surrounding environment).

When designing the safeguard system, make sure that it is free of sharp corners and projections, and that the safeguard system itself is not a hazard.

Make sure that the safeguard system can only be removed by using a tool.

There are several types of safeguard devices, including safety doors, safety barriers, light curtains, safety gates, and safety floor mats. Install the interlocking function in the safeguard device. The safeguard interlock must be installed so that the safeguard interlock is forced to work in case of a device failure or other unexpected accident. For example, when using a door with a switch as the interlock, do not rely on the switch's own spring force to open the contact. The contact mechanism must open immediately in case of an accident.

Connect the interlock switch to the safeguard input of the drive unit's EMERGENCY connector. The safeguard input informs the robot controller that an operator may be inside the safeguard area. When the safeguard input is activated, the robot stops immediately and enters pause status, as well as either operation-prohibited status or restricted status (low power status).

Make sure not to enter the safeguarded area except through the point where the safeguard interlock is installed.

The safeguard interlock must be installed so that it can maintain a safe condition until the interlock is released on purpose once it initiates. The latch-release input is provided for the EMERGENCY connector on the Controller to release the latch condition of the safeguard interlock. The latch release switch of the safeguard interlock must be installed outside of the safeguarded area and wired to the latch-release input.

It is dangerous to allow someone else to release the safeguard interlock by mistake while the operator is working inside the safeguarded area. To protect the operator working inside the safeguarded area, take measures to lock out and tag out the latch-release switch.

Presence Sensing Device

The above mentioned safeguard interlock is a type of presence sensing device since it indicates the possibility of somebody being inside the safeguard system. When separately installing a presence sensing device, however, perform a satisfactory risk assessment and pay thorough attention to its dependability.

Here are precautions that should be noted:

- Design the system so that when the presence sensing device is not activated or a dangerous situation still exists that no personnel can go inside the safeguard area or place their hands inside it.
- Design the presence sensing device so that regardless of the situation the system operates safely.
- If the robot stops operating when the presence sensing device is activated, it is necessary to ensure that it does not start again until the detected object has been removed. Make sure that the robot cannot automatically restart.

Resetting the Safeguard

Ensure that the robot system can only be restarted through careful operation from outside the safeguarded system. The robot will never restart simply by resetting the safeguard interlock switch. Apply this concept to the interlock gates and presence sensing devices for the entire system.

Robot Operation Panel

When using the robot operation panel, it must be installed so as to operate the robot system from outside the safeguard.

1.3 Operation Safety

The following items are safety precautions for qualified Operator personnel:

 WARNING	■ Please carefully read the *Safety-related Requirements* in this 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. ■ 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. ■ 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 status (low speeds and low power) 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. ■ Immediately press the Emergency Stop switch whenever the Manipulator moves abnormally while the robot system is operated. Continuing the operating the robot system while the Manipulator moves abnormally is extremely hazardous and may result in serious bodily injury and/or severe equipment change to the robot system.

 WARNING	■ To shut off power to the robot system, pull out 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 pull out 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 insert or pull out the motor connectors while the power to the robot system is turned ON. Inserting or pulling out 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.

 CAUTION	■ 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. ■ Vertical 6-axis Robot: 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 30 degrees for about 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

1.3.1 Safety-related Requirements

Specific tolerances and operating conditions for safety are contained in the manuals for the robot, controller and other devices. Be sure to read those manuals as well.

For the installation and operation of the robot system, be sure to comply with the applicable local and national regulations.

Robot systems safety standards and other examples are given in this chapter. Therefore, to ensure that safety measures are complete, please refer to the other standards listed as well.

(Note: The following is only a partial list of the necessary safety standards.)

EN ISO 10218-1	Robots and robotic devices -- Safety requirements for industrial robots -- Part 1: Robots
EN ISO 10218-2	Robots and robotic devices -- Safety requirements for industrial robots -- Part 2: Robot systems and integration
ANSI/RIA R15.06	American National Standard for Industrial Robots and Robot Systems -- Safety Requirements
EN ISO 12100	Safety of machinery -- General principles for design -- Risk assessment and risk reduction
EN ISO 13849-1	Safety of machinery -- Safety-related parts of control systems -- Part 1: General principles for design
EN ISO 13850	Safety of machinery -- Emergency stop -- Principles for design
EN ISO 13855	Safety of machinery -- Positioning of safeguards with respect to the approach speeds of parts of the human body.
EN ISO 13857	Safety of machinery -- Safety distances to prevent hazard zones being reached by upper and lower limbs.
ISO 14120 EN 953	Safety of machinery -- Guards -- General requirements for the design and construction of fixed and movable guards
IEC 60204-1 EN 60204-1	Safety of machinery -- Electrical equipment of machines -- Part 1: General requirements
CISPR11 EN55011	Industrial, scientific and medical (ISM) radio-frequency equipment -- Electromagnetic disturbance characteristics -- Limits and methods of measurement
IEC 61000-6-2 EN 61000-6-2	Electromagnetic compatibility (EMC) -- Part 6-2: Generic standards -- Immunity for industrial environments

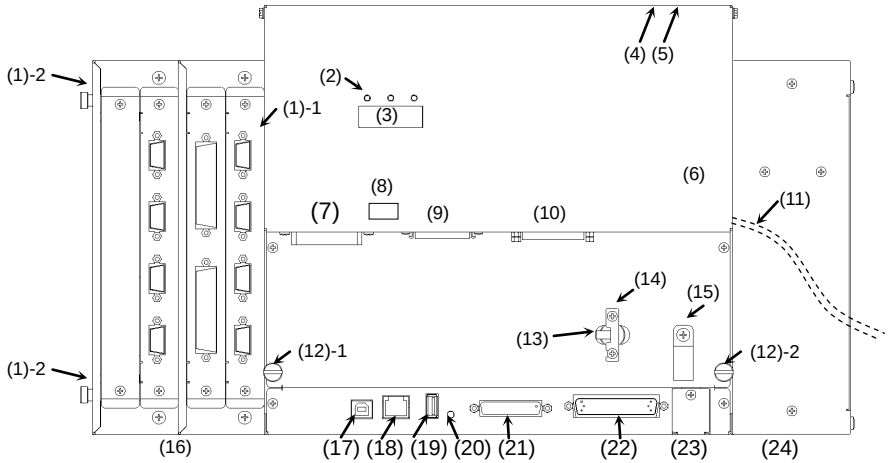
RC180 UL specification

Compatibility assessment of the UL-compliant model is performed according to the following standards.

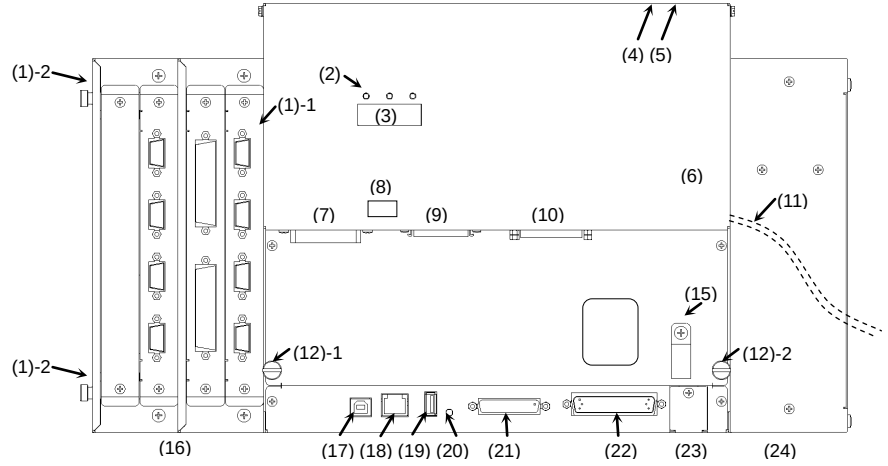
UL1740 (Third Edition, Dated December 7, 2007)
ANSI/RIA R15.06-1999
NFPA 79 (2007 Edition)
CSA/CAN Z434-03 (February 2003)

1.3.2 Part Names / Arm Motion

RC180



RC180-UL



(1) -1 Fan Filter (Without Option Unit)

(1) -2 Fan Filter (With Option Unit)

(2) LED

(3) Seven-segment LED

(4) Signature label (top panel)

(5) MT label (top panel)

(6) MT label (top panel)

(7) MT label (top panel)

(8) Connection Check label

(9) M/C SIGNAL connector

(10) EMERGENCY connector

(11) AC IN

(12) Thumb Head screw

(13) POWER switch

(14) Power Switch metal hasp

(15) Cable Clamp

(16) Option Unit

(17) Development PC connection port

(18) LAN (Ethernet communication) port

(19) Memory port

(20) Trigger Switch

(21) TP/OP port

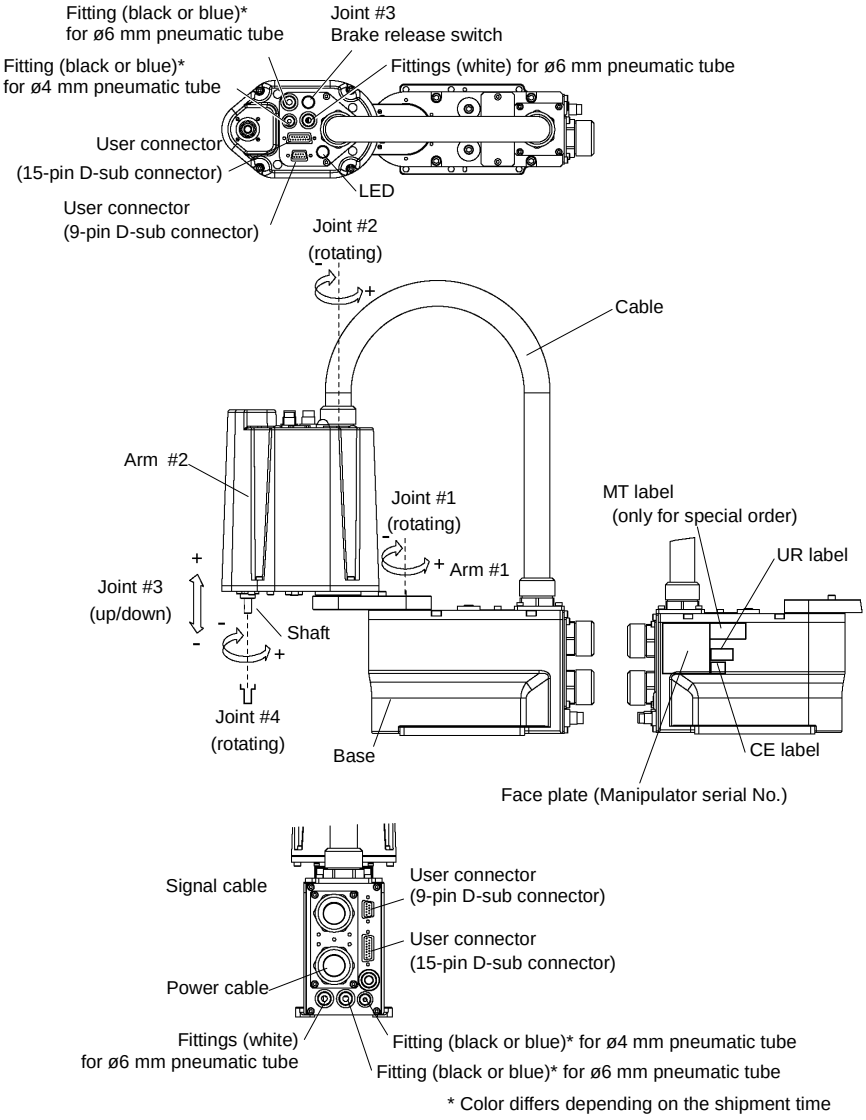
(22) I/O connector

(23) Battery

(24) ProSix Driver Unit

G1 series

The motion range of each arm is shown in the figure below. Take all necessary safety precautions.



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

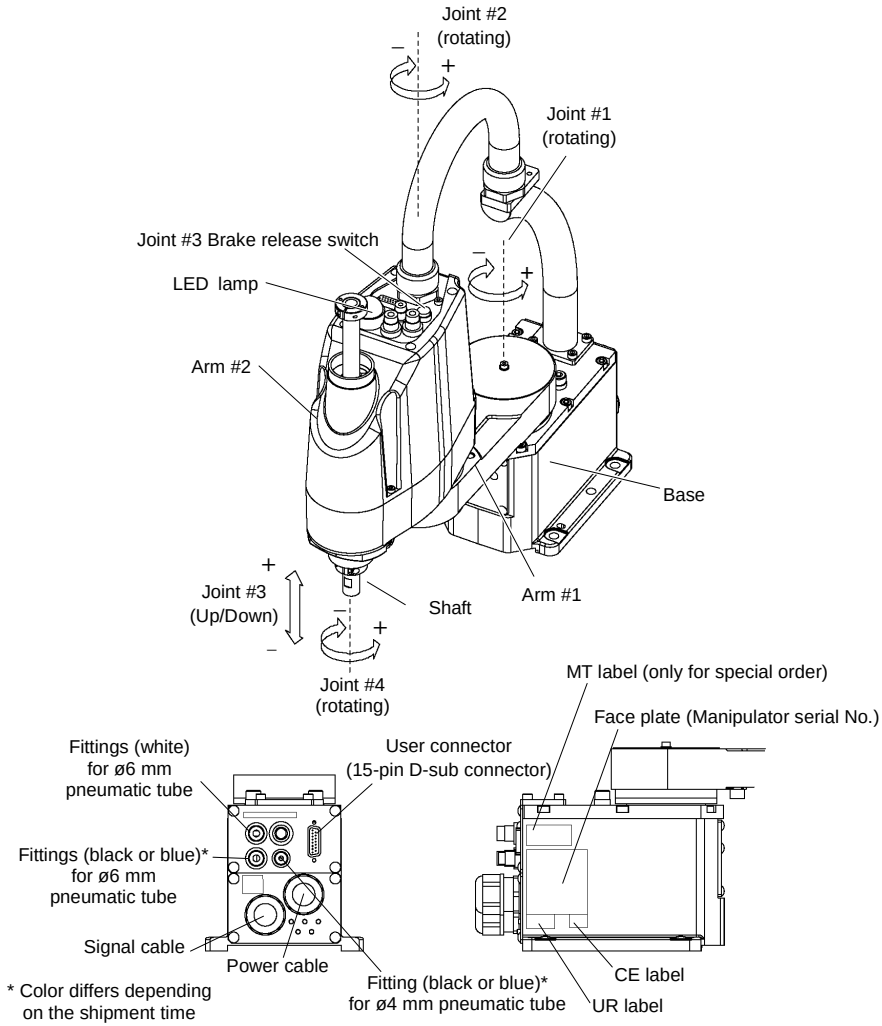
Arm #1	Push the arm by hand.
Arm #2	Push the arm by hand.
Joint #3	The joint cannot be moved up/down by hand until the electromagnetic brake applied to the joint has been released. Move the joint up/down while pressing the brake release switch.
Joint #4	Rotate the shaft by hand.

NOTE

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.

G3 series

The motion range of each arm is shown in the figure below. Take all necessary safety precautions.



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.

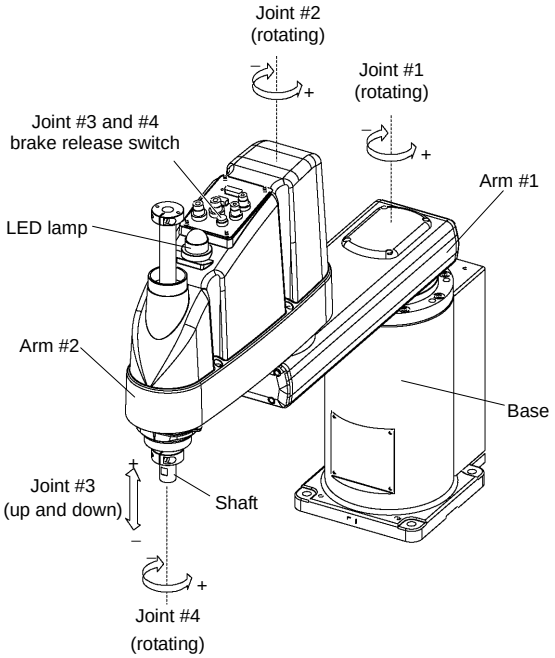
NOTE

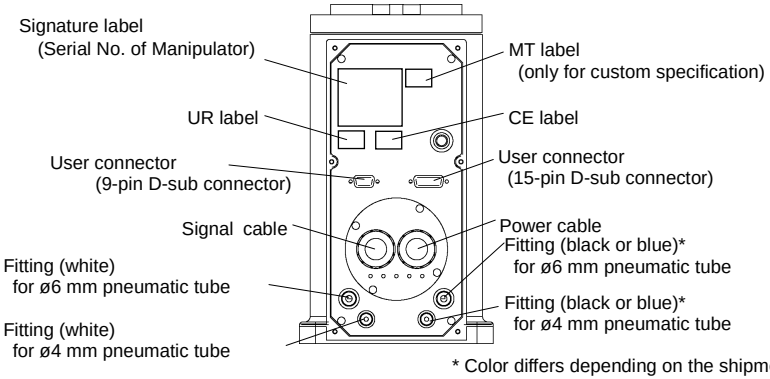
When the brake release switch is pressed in emergency mode, the brake for Joint #3 is released.

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.

G6 series

The motion range of each arm is shown in the figure below. Take all necessary safety precautions.





* Color differs depending on the shipment time

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	For G6-**1**, Rotate the shaft by hand. For G6-**3**, The shaft cannot be rotated by hand until the electromagnetic brake applied to the shaft has been released. Move the shaft while pressing the brake release switch.

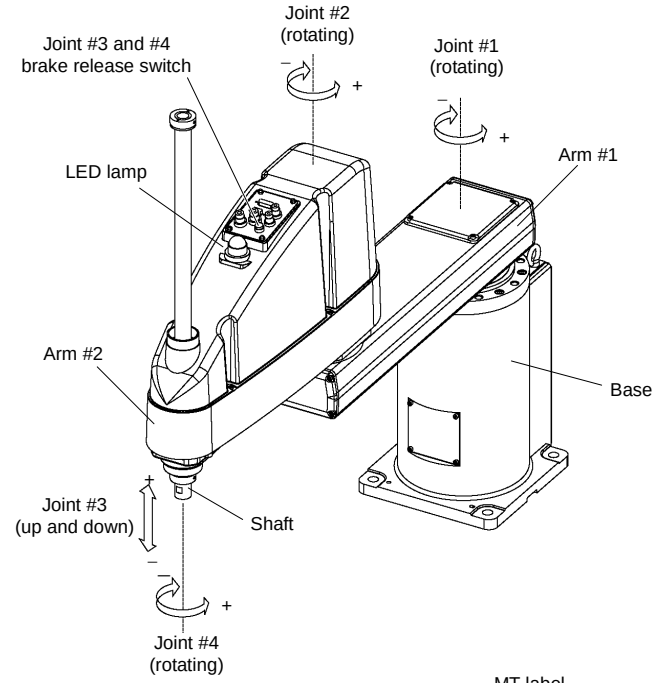
NOTE

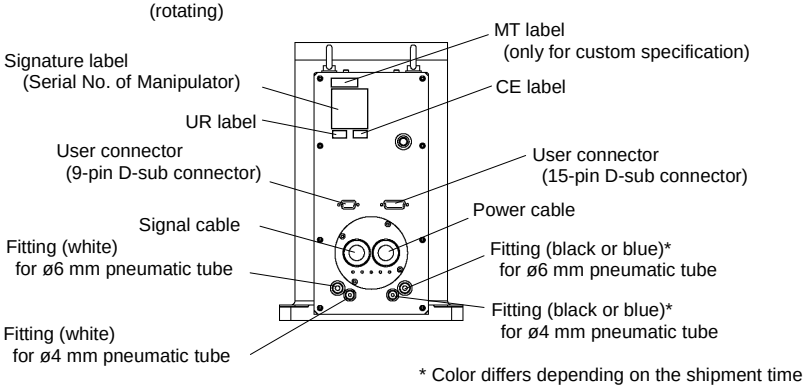
The brake release switch affects both Joints #3 and #4. When the brake release switch is pressed in emergency mode, the brakes for both Joints #3 and #4 are released simultaneously.
(For G6-**1**, Joint #4 has no brake on it.)

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

G10/G20 series

The motion range of each arm is shown in the figure below. Take all necessary safety precautions.





* Color differs depending on the shipment time

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	The shaft cannot be rotated by hand until the electromagnetic brake applied to the shaft has been released. Move the shaft while pressing the brake release switch.

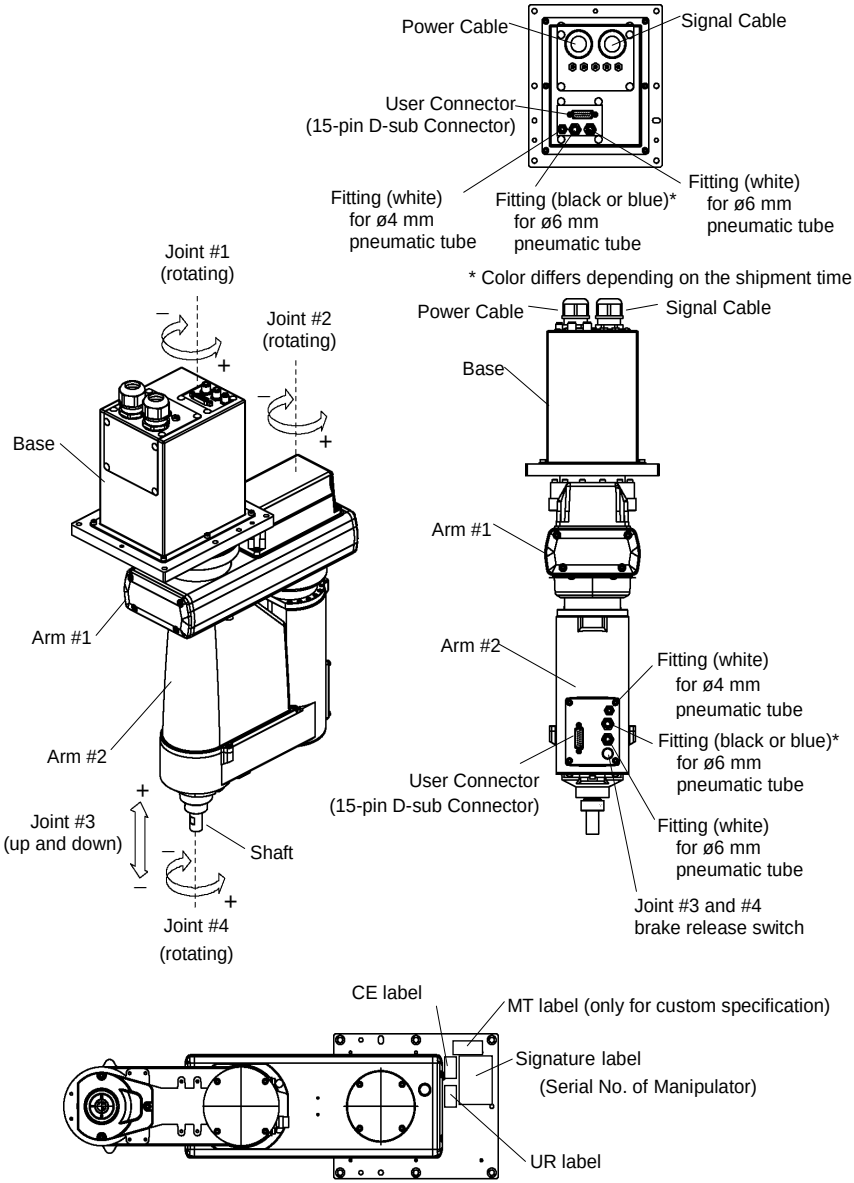
NOTE

The brake release switch affects both Joints #3 and #4. When the brake release switch is pressed in emergency mode, the brakes for both Joints #3 and #4 are released simultaneously.

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

RS3 series

The motion range of each arm is shown in the figure below. Take all necessary safety precautions.



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

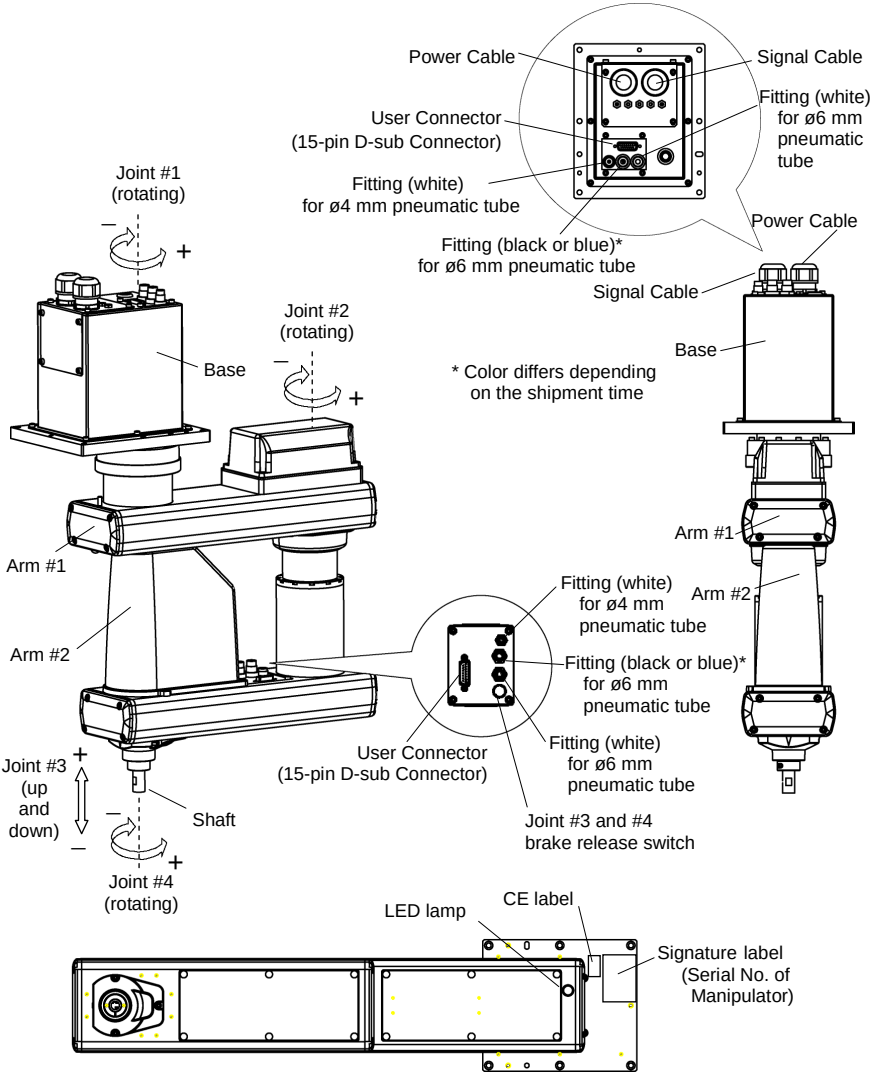
Arm #1	Push the arm by hand.
Arm #2	Push the arm by hand.
Joint #3	The joint cannot be moved up/down by hand until the electromagnetic brake applied to the joint has been released. Move the joint up/down while pressing the brake release switch.
Joint #4	Rotate the shaft by hand.

NOTE

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.

RS4 series

The motion range of each arm is shown in the figure below. Take all necessary safety precautions.



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

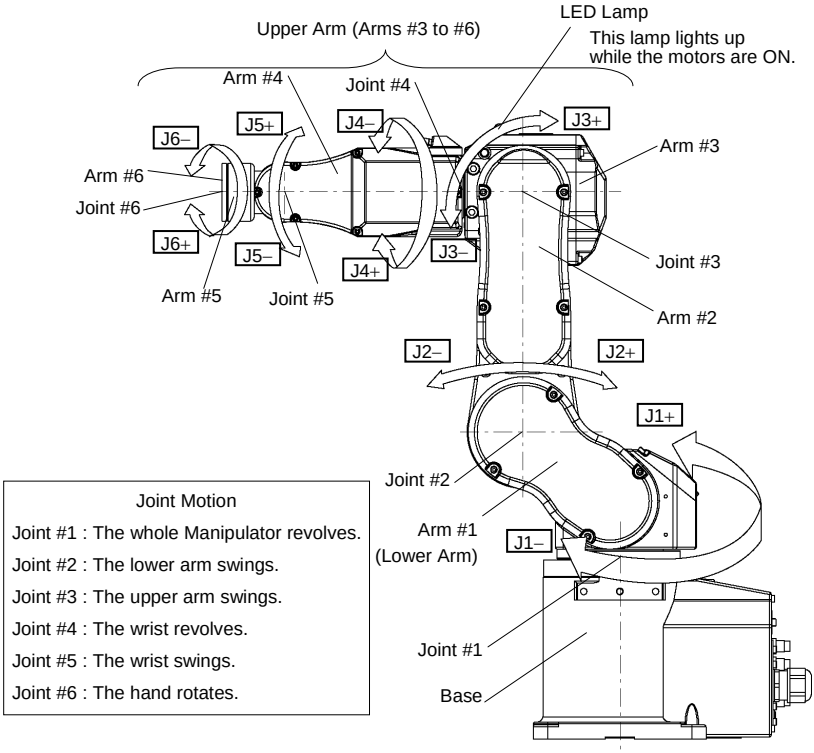
Arm #1	Push the arm by hand.
Arm #2	Push the arm by hand.
Joint #3	The joint cannot be moved up/down by hand until the electromagnetic brake applied to the joint has been released. Move the joint up/down while pressing the brake release switch.
Joint #4	Rotate the shaft by hand.

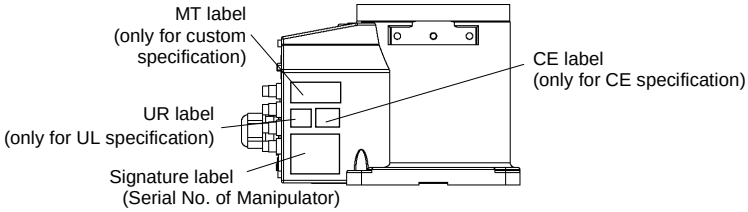
NOTE

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.

C3 series

The motion range of each arm is shown in the figure below. Take all necessary safety precautions.





Standard: Brakes on Joints #2, #3, #5

While the electromagnetic brake is ON (such as in emergency mode), you can move Arms #1, #4, #6 by pushing manually.

Option: Brakes on all joints

While the electromagnetic brake is ON (such as in emergency mode), you cannot move any arm by pushing manually.

There are two methods to release the electromagnetic brake.

Follow either method to release the electromagnetic brake and move the arms manually.

Moving the arm using the brake release unit

Follow the method when you just unpack the delivered boxes or when the Controller does not start up yet.
For details, refer to *C3 series Manipulator Manual, Setup & Operation 6. Option.*

Moving the arm using the software

Follow the method when you can use the software.
After releasing the Emergency Stop switch, execute the following command in [Command Window].

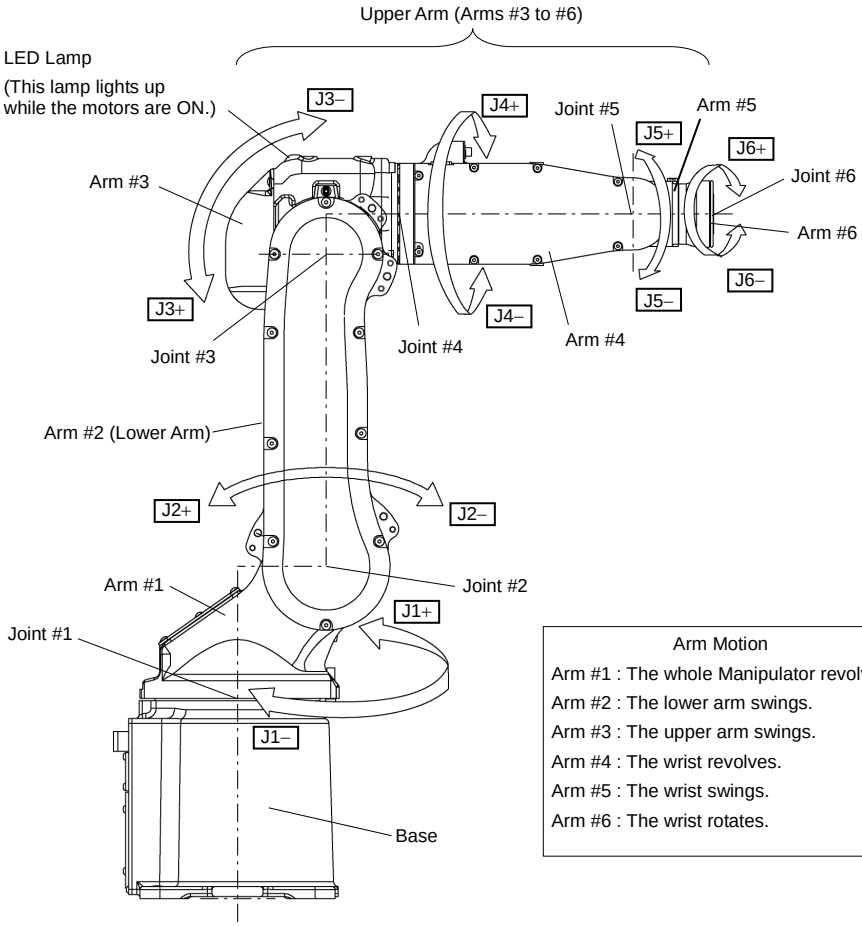
```
>Reset
>Brake Off,
```
[the number (from 1 to 6) corresponding to the arm whose brake will be turned off]

Execute the following command to turn on the brake again.

```
>Brake On,
```
[The number (from 1 to 6) corresponding to the arm whose brake will be turned on]

S5 series

The motion range of each arm is shown in the figure below. Take all necessary safety precautions.



While the electromagnetic brake is ON (such as in emergency mode), you cannot move any arm by pushing manually.

There are two methods to release the electromagnetic brake.

Follow either method to release the electromagnetic brake and move the arms manually.

Moving the arm using the brake release unit

Follow the method when you just unpack the delivered boxes or when the Controller does not start up yet.
For details, refer to *S5 series Manipulator Manual, Setup & Operation 1.5.1. Moving the Arm Using the Brake Release Unit.*

Moving the arm using the software

Follow the method when you can use the software.
After releasing the Emergency Stop switch, execute the following command in [Command Window].

```
>Reset
>Brake Off,
```
[the number (from 1 to 6) corresponding to the arm whose brake will be turned off]

Execute the following command to turn on the brake again.

```
>Brake On,
```
[The number (from 1 to 6) corresponding to the arm whose brake will be turned on]

1.3.3 Operation Modes

The operation mode is defined as the single control point for the controller, therefore you cannot use more than one operation mode at the same time.

There are three operation modes for the controller: AUTO, PROGRAM, and TEACH.

- AUTO operation mode allows you to execute programs in the controller when the safeguard is closed.
- PROGRAM operation mode allows you to execute and debug programs when the safeguard is closed.
- TEACH operation mode allows you to jog and teach the robot at slow speed while inside the safeguarded area.

1.4 Maintenance Safety

Please read this section, *Maintenance* of the Manipulator manual, *Maintenance* of the Controller manual, and other related manuals carefully to understand safe maintenance procedures before performing any maintenance.

Only authorized personnel who have taken the safety training should be allowed to maintain the robot system. The safety training is the program for the industrial robot operator that follows the laws and regulations of each nation.
The personnel who have taken the safety training acquire knowledge of industrial robots (operations, teaching, etc.), knowledge of inspections, and knowledge of related rules/regulations. Only personnel who have completed the robot system-training and maintenance-training classes held by the manufacturer, dealer, or locally-incorporated company should be 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, and the *Maintenance* of the Manipulator manual, and *Maintenance* of the Controller 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 though 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 switches 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	■ Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source. To shut off power to the robot system, pull out the power plug from the power source. Performing any work while connecting the AC power cable to a factory power source is extremely hazardous and may result in electric shock and/or malfunction of the robot system. ■ Before performing any replacement procedure, turn OFF the Controller and related equipment, and then pull out 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.

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

 CAUTION	■ Wear protective gear including a mask, protective goggles, and oil-resistant gloves during grease up. If grease gets into your eyes, mouth, or on your skin, follow the instructions below. If grease gets into your eyes : Flush them thoroughly with clean water, and then see a doctor immediately. If grease gets into your mouth: If swallowed, do not induce vomiting. See a doctor immediately. If grease just gets into your mouth, wash out your mouth with water thoroughly. If grease gets on your skin: Wash the area thoroughly with soap and water.

1.5 Emergency Stop

If the Manipulator moves abnormally during operation, immediately press the Emergency Stop switch. The motor power will be turned OFF, and the arm motion by inertia will be stopped with the electromagnetic brake and dynamic 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 robot 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 *Maintenance: Calibration* in the manipulator manual.
Manipulator manuals contain information on the Emergency Stop. Please also read the descriptions in the manuals and use the robot system properly.

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
G, LS, RS: *2.1.2 Inspection Point*
- Inspection While the Power is ON (Manipulator is operating)
C3, S5: *2.2.2 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)

1.5.1 Free Running Distance in Emergency

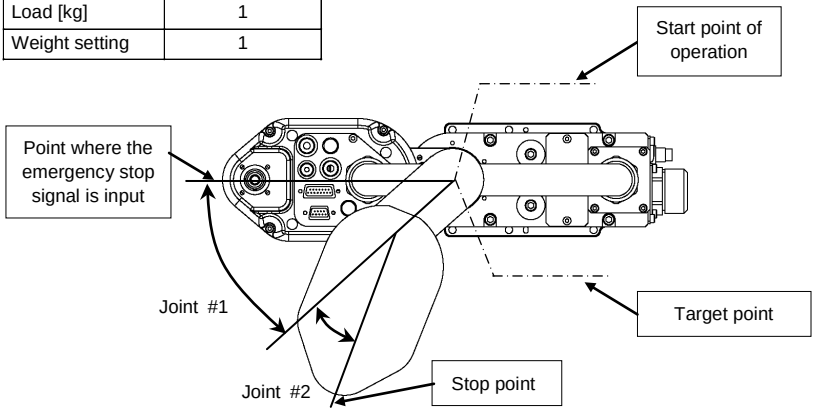
The Manipulator in operation cannot stop immediately after the Emergency Stop switch is pressed.
The free running time/angle/distance of the Manipulator are shown below.
However, remember that the values vary depending on following conditions.

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

G1

Conditions for measurement

Accel setting	100
Speed setting	100
Load [kg]	1
Weight setting	1

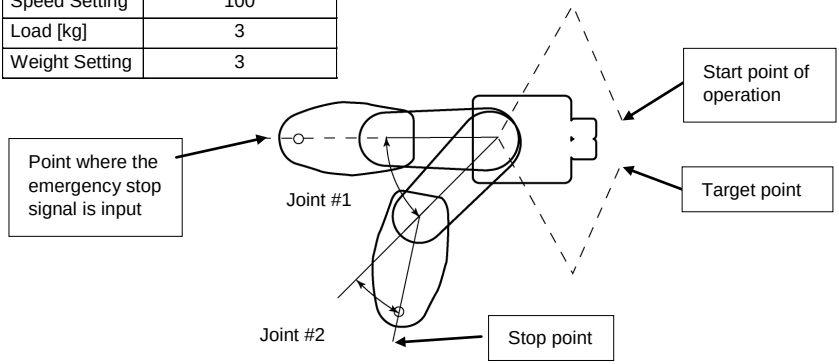


	Controller		RC180, RC620	
	Manipulator		G1-171*/ G1-171*Z	G1-221*/ G1-221*Z
Free running time	Joint #1 + Joint #2	[sec.]	0.4	
	Joint #3	[sec.]	0.3	
Free running angle	Joint #1	[deg.]	40	50
	Joint #2	[deg.]	40	45
	Joint #1 + Joint #2	[deg.]	80	95
Free running distance	Joint #3	[mm]	50	

G3

Conditions for Measurement

Accel Setting	100
Speed Setting	100
Load [kg]	3
Weight Setting	3

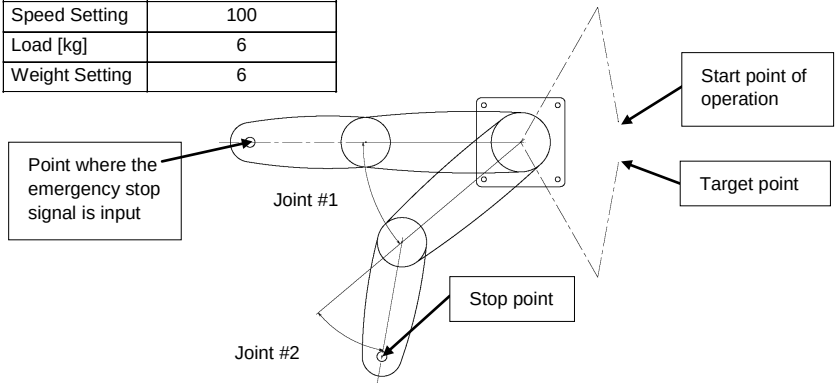


		Controller	RC180, RC620		
		Manipulator	G3-25***	G3-30***	G3-35***
Free running time	Joint #1 + Joint #2	[sec.]	0.5	0.5	0.5
	Joint #3	[sec.]	0.5	0.5	0.5
Free running angle	Joint #1	[deg.]	35	35	40
	Joint #2	[deg.]	50	50	50
	Joint #1 + Joint #2	[deg.]	85	85	90
Free running distance	Joint #3 G3-**1**	[mm]	95	95	95

G6

Conditions for Measurement

Accel Setting	100
Speed Setting	100
Load [kg]	6
Weight Setting	6

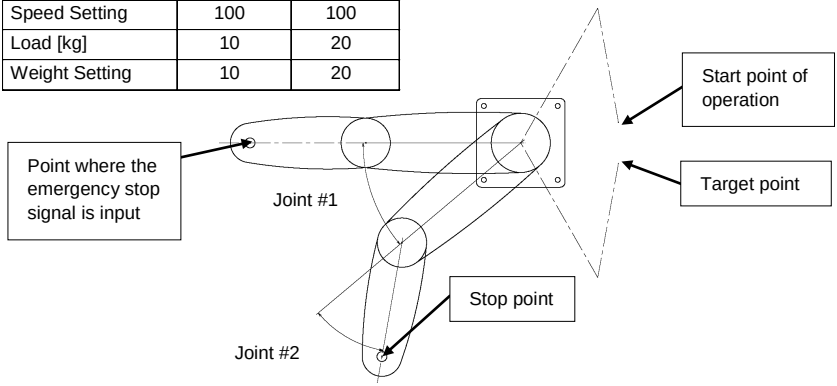


			Controller	RC180, RC620	
			Manipulator	G6-45***	G6-55***	G6-65***
Free running time	Joint #1 + Joint #2	[sec.]		0.6	0.7	0.8
	Joint #3	[sec.]		0.4	0.4	0.4
Free running angle	Joint #1	[deg.]		35	45	55
	Joint #2	[deg.]		60	60	65
	Joint #1 + Joint #2	[deg.]		100	110	120
Free running distance	Joint #3	G6-**1**	[mm]	40	40	40
		G6-**3**		80	80	80

G10/G20

Conditions for Measurement

	G10	G20
Accel Setting	100	100
Speed Setting	100	100
Load [kg]	10	20
Weight Setting	10	20

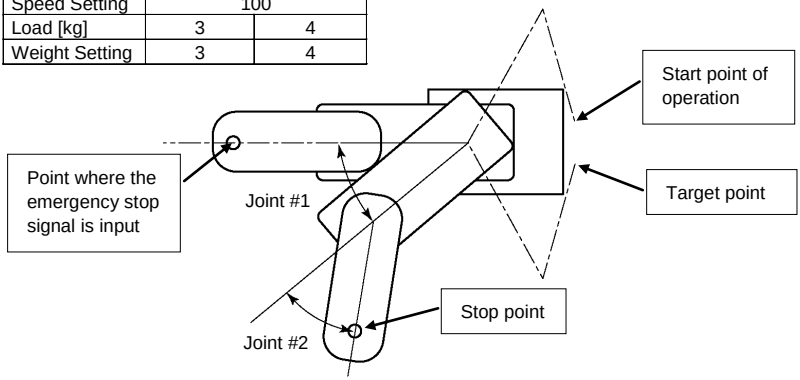


		Controller	RC180, RC620			
		Manipulator	G10-65***	G10-85***	G20-85***	G20-A0***
Free running time	Joint #1 + Joint #2	[sec.]	0.6	0.7	1.0	1.3
	Joint #3	[sec.]	0.6	0.5	0.5	0.8
Free running angle	Joint #1	[deg.]	80	70	80	110
	Joint #2	[deg.]	70	50	40	50
	Joint #1 + Joint #2	[deg.]	110	120	110	160
Free running distance	Joint #3 G10/G20-**1**	[mm]	90	80	70	90
	G10/G20-**4**		210	160	200	170

RS

Conditions for Measurement

	RS3-351*	RS4-551*
Accel Setting	100	
Speed Setting	100	
Load [kg]	3	4
Weight Setting	3	4



		Controller	RC180 / RC620	
		Manipulator	RS3-351*	RS4-551*
Free running time	Joint #1 + Joint #2	[sec.]	0.4	0.7
	Joint #3	[sec.]	0.2	0.4
Free running angle	Joint #1	[deg.]	50	30
	Joint #2	[deg.]	30	50
	Joint #1 + Joint #2	[deg.]	80	80
Free running distance	Joint #3	[mm]	55	75

S5

Conditions of Measurement

ACCEL Setting	100
SPEED Setting	100
Load [kg]	5
WEIGHT Setting	5

		RC180 / RC620	
		S5-A701**	S5-A901**
Free running time [second]	Arm #1	0.4	
	Arm #2	0.4	
	Arm #3	0.4	
	Arm #4	0.4	
	Arm #5	0.4	
	Arm #6	0.1	
Free running angle [degree]	Arm #1	80	70
	Arm #2	85	75
	Arm #3	75	90
	Arm #4	40	
	Arm #5	50	
	Arm #6	20	

C3

Conditions of Measurement

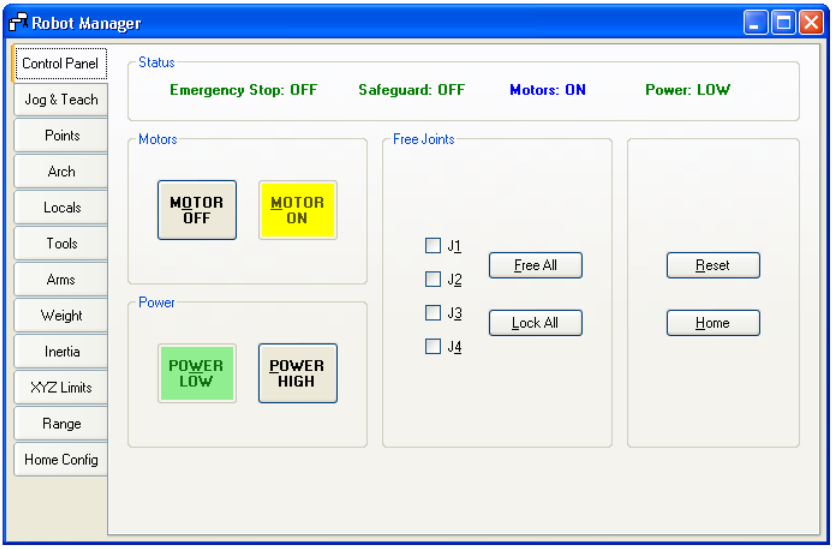
ACCEL Setting	100
SPEED Setting	100
Load [kg]	3
WEIGHT Setting	3

Robot controller		RC180 / RC620	
Brake		Standard J2, J3, J5 with brake	Option All joint with brake
Free running time [sec.]	Arm #1	0.4	
	Arm #2	0.4	
	Arm #3	0.4	
	Arm #4	0.5	0.3
	Arm #5	0.3	
	Arm #6	0.1	
Free running angle [deg.]	Arm #1	85	
	Arm #2	60	
	Arm #3	55	
	Arm #4	55	45
	Arm #5	45	
	Arm #6	10	

1.5.2 How to Reset the Emergency Mode

Select EPSON RC+ [Tools] – [Robot Manager] – [Control Panel] tab, and then click <Reset>.

The Control Panel page contains buttons for basic robot operations, such as turning motors on/off and homing the robot. It also shows status for Emergency Stop, Safeguard, Motors, and Power.



1.6 Labels

Labels are attached around the locations of the Controller and Manipulator where specific dangers exist.

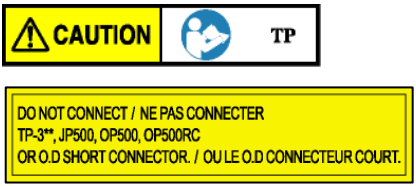
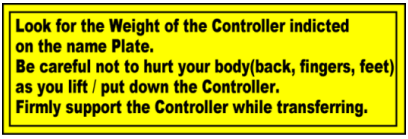
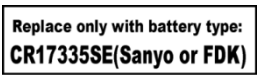
Be sure to comply with descriptions and warnings on the labels to operate and maintain the Robot system safely.

Do not tear, damage, or remove the labels. Use meticulous care when handling those parts or units to which the following labels are attached as well as the nearby areas.

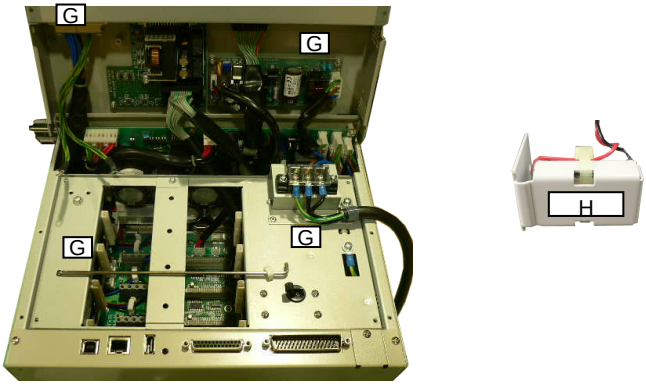
Label types differ according to the specifications.

1.6.1 Controller

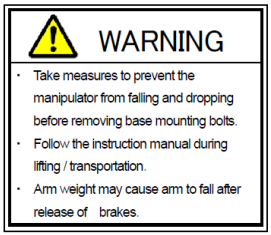
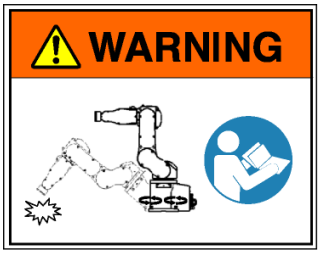
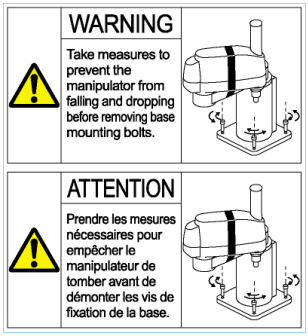
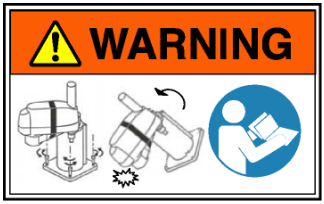
Location	Label	Note
A		Residual voltage exists. To avoid electric shock, do not open the cover while the Power is ON, or for 2 minutes after the Power is OFF.
		Residual voltage exists. To avoid electric shock, do not open the cover while the Power is ON, or for 300 seconds after the Power is OFF.
B	  	Disconnect and lockout main power before performing maintenance and repair.

Location	Label	Note
C		Do not connect the followings to TP/OP port of RC180. Connecting to the followings may result in malfunction of the device. OPTIONAL DEVICE dummy plug, OP500, OP500RC, JP500,and TP-3** Refer to 4.2 Connection and Display Language of Option TP1 and OP1
D		
E		
F		Weight of the unit is indicated on the Signature label Make sure to check the weight before units transfer or relocation and prevent throwing out your back at holding the unit. Also, make sure to keep your hands, fingers, and feet safe from being caught or serious injury.
G		Hazardous voltage exists while the Manipulator is ON. To avoid electric shock, do not touch any internal electric parts.
H		Make sure to use the designated lithium battery. Refer to Controller Manual *Maintenance 14. Maintenance parts list*

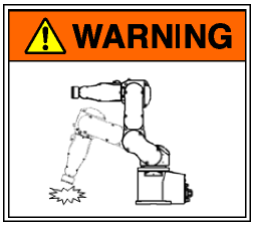

A
F
G
EPSON
RC180
A
D
E
B
C
A
G
A

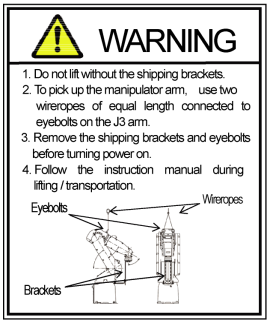
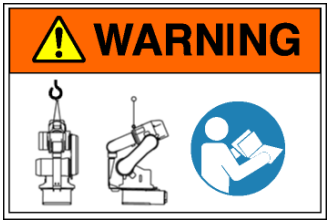
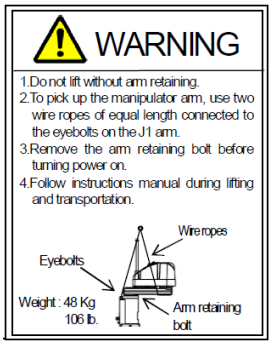
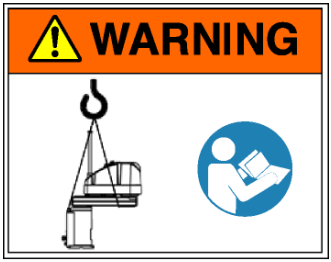

G
G
G
G
H

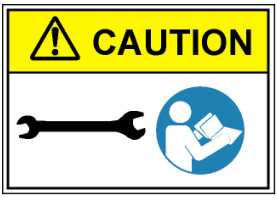
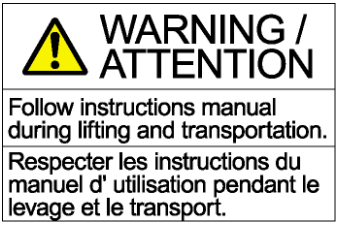
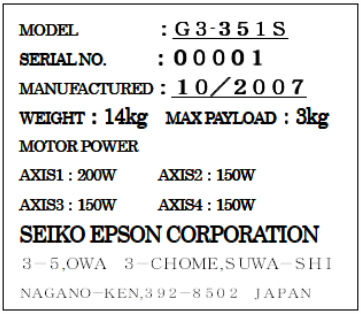
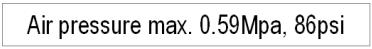
1.6.2 Manipulator

Location	Label	Note
A	   	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. Follow the directions in this manual for installation and transportation.

Location	Label	Note
B	   	Do not enter the operation area while the Manipulator is moving. The robot arm may collide against the operator. This is extremely hazardous and may result in serious safety problems.
C		Hazardous voltage exists while the Manipulator is ON. To avoid electric shock, do not touch any internal electric parts.

Location	Label	Note
D		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.
E	 	Be careful of the arm falling due to the arm's own weight while the brake release button is being pressed. * This label is attached to the option brake release box.
		Be careful of the shaft falling due to the hand's own weight while the brake release button is being pressed.

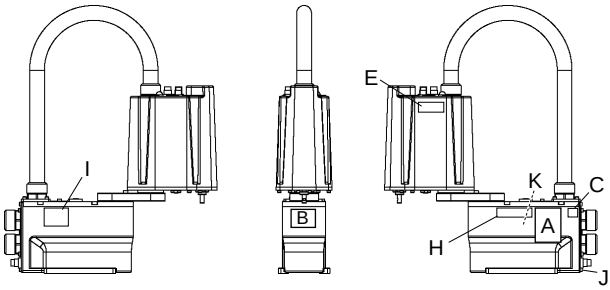
Location	Label	Note
F	   	Do not lift without the shipping bracket. To pick up the manipulator arm, use two wire ropes of equal length. Remove the shipping brackets and eyebolts before turning power on. Follow the directions in this manual for installation and transportation.

Location	Label	Note
G	 	Arm weight may cause arm to fall during disassembly operation. Follow the directions in this manual for disassembly operation.
H	 (Only UL model)	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.
I		
J		

Location	Label	Note
K	Replace only with battery type: Toshiba ER17330V/3.6V	Make sure to use the designated lithium battery. Refer to Manipulator Manual *Maintenance : Maintenance parts list*

Location of Labels

G1



G3

Common

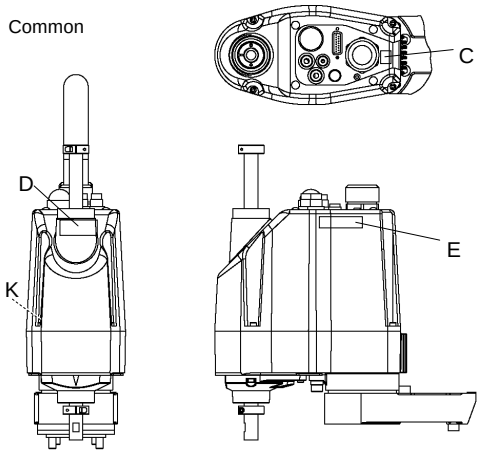
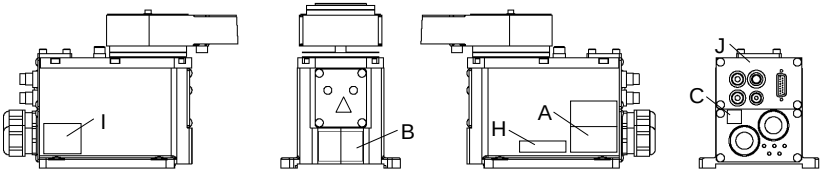
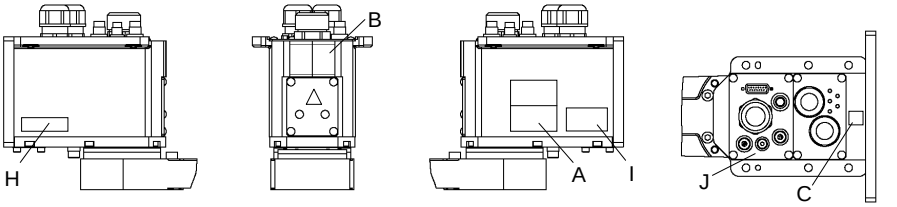


Table Top Mounting



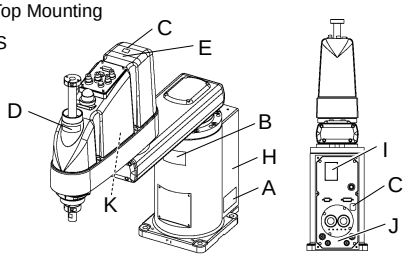
Multiple Mounting



G6

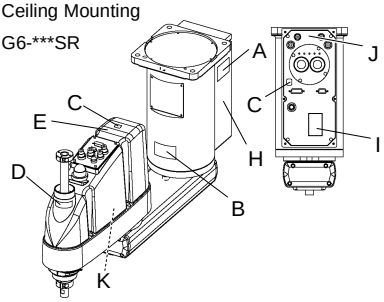
Table Top Mounting

G6-***S



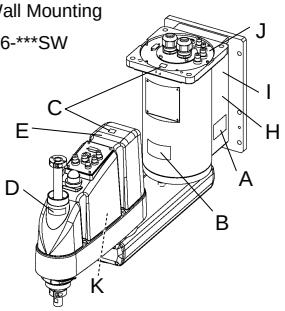
Ceiling Mounting

G6-***SR



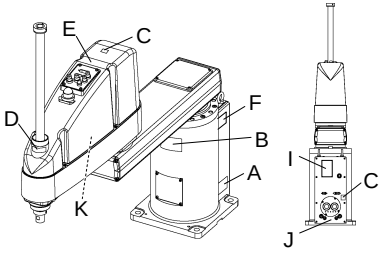
Wall Mounting

G6-***SW

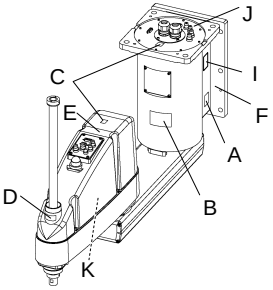


G10/G20

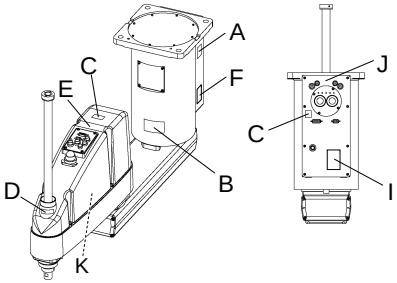
Table Top Mounting: G10/G20-****



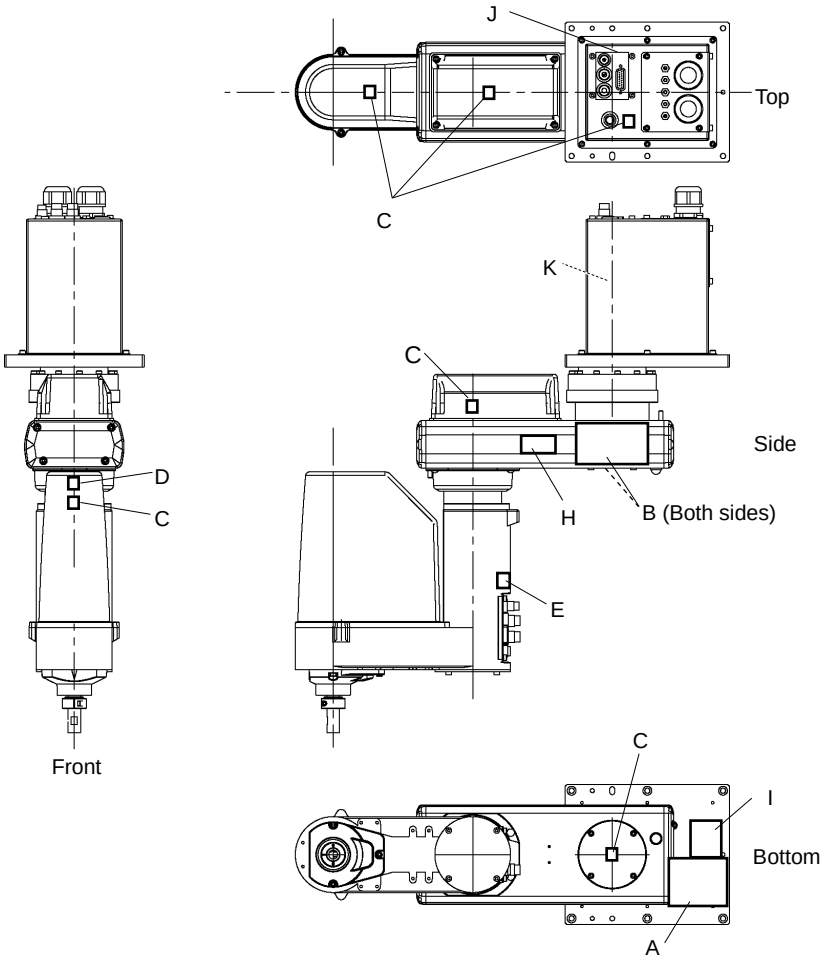
Wall Mounting: G10/G20-****W



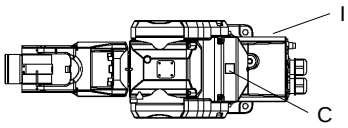
Ceiling Mounting: G10/G20-****R



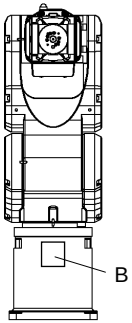
RS



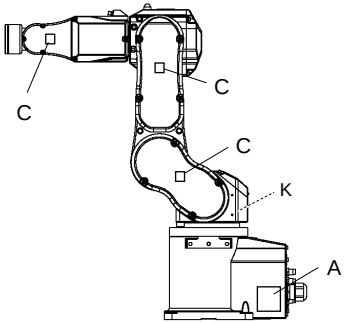
C3



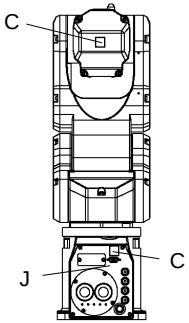
Top View



Front View

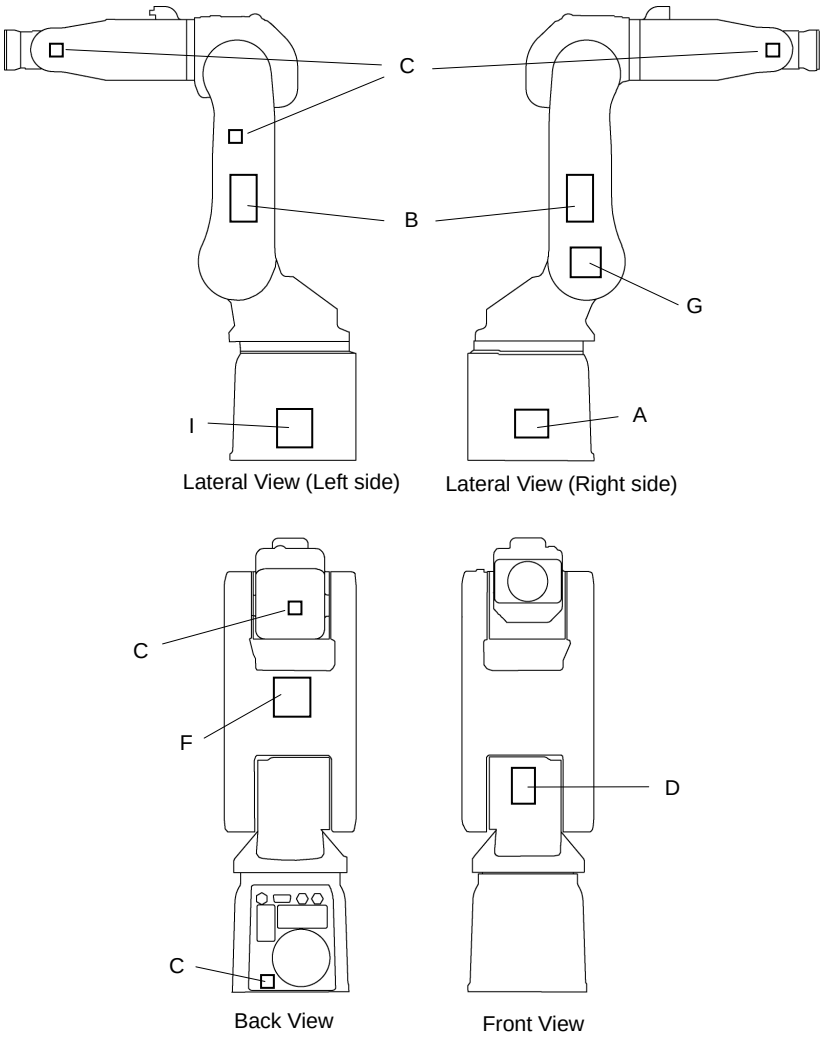


Lateral View



Back View

S5


C
B
G
I
A
Lateral View (Left side)
Lateral View (Right side)
C
F
C
D
Back View
Front View

1.7 Safety Features

The robot control system supports safety features described below. However, the user is recommended to strictly follow the proper usage of the robot system by thoroughly reading the attached manuals before using the system. Failure to read and understand the proper usage of the safety functions is highly dangerous.

Among the following safety features, the Emergency Stop Switch and Safety Door Input are particularly important. Make sure that these and other features function properly before operating the robot system.

For details, refer to the *2.5 Controller Installation - Safety Door Switch and Latch Release Switch*.

Emergency Stop Switch

The EMERGENCY connector on the Controller has expansion Emergency Stop input terminals used for connecting the Emergency Stop switches.
Pressing any Emergency Stop switch can shut off the motor power immediately and the robot system will enter the Emergency Stop condition.

Safety Door Input

In order to activate this feature, make sure that the Safety Door Input switch is connected to the EMERGENCY connector at the Controller.
When the safety door is opened, normally the Manipulator immediately stops the current operation, and the status of Manipulator power is operation-prohibited until the safety door is closed and the latched condition is released. In order to execute the Manipulator operation while the safety door is open, you must change the mode selector key switch on the Teach Pendant to the “Teach” mode. Manipulator operation is available only when the enable switch is on. In this case, the Manipulator is operated in low power status.

Low Power Mode

The motor power is reduced in this mode.

Executing a power status change instruction will change to the restricted (low power) status regardless of conditions of the safety door or operation mode. The restricted (low power) status ensures the safety of the operator and reduces the possibility of peripheral equipment destruction or damage caused by careless operation.

Dynamic Brake

The dynamic brake circuit includes relays that short the motor armatures. The dynamic brake circuit is activated when there is an Emergency Stop input or when any of the following errors is detected: encoder cable disconnection, motor overload, irregular motor torque, motor speed error, servo error (positioning or speed overflow), irregular CPU, memory check-sum error and overheat condition inside the Motor Driver Module.

Encoder Cable Disconnection Error Detection

The dynamic brake circuit is activated when the Motor Encoder Signal cable is disconnected.

Motor Overload Detection

The dynamic brake circuit is activated when the system detects that the load on the motor has exceeded its capacity.

Irregular Motor Torque (out-of-control manipulator) Detection

The dynamic brake circuit is activated when irregularity with motor torque (motor output) is detected (in which case the Manipulator is out of control).

Motor Speed Error Detection

The dynamic brake circuit is activated when the system detects that the motor is running at incorrect speed.

Positioning Overflow -Servo Error- Detection

The dynamic brake circuit is activated when the system detects that the difference between the Manipulator's actual position and commanded position exceeds the margin of error allowed.

Speed Overflow -Servo Error- Detection

The dynamic brake circuit is activated when the Manipulator's actual speed is detected to mark an overflow (the actual speed is outside the nominal range) error.

CPU Irregularity Detection

Irregularity of CPU that controls the motor is detected by the watchdog timer. The system CPU and the motor controlling CPU inside the Controller are also designed to constantly check each other for any discrepancies. If a discrepancy is detected, the dynamic brake circuit is activated.

Memory Check-sum Error Detection

The dynamic brake circuit is activated when a memory check-sum error is detected.

Overheat Detection at the Motor Driver Module

The dynamic brake circuit is activated when the temperature of the power device inside the Motor Driver module is above the nominal limit.

Relay Deposition Detection

The dynamic brake circuit is activated when relay deposition is detected.

Over-Voltage Detection

The dynamic brake circuit is activated when the voltage of the Controller is above the normal limit.

AC Power Supply Voltage Drop Detection

The dynamic brake circuit is activated when the drop of the power supply voltage is detected.

Temperature Anomaly Detection

The temperature anomaly is detected.

Fan Malfunction Detection

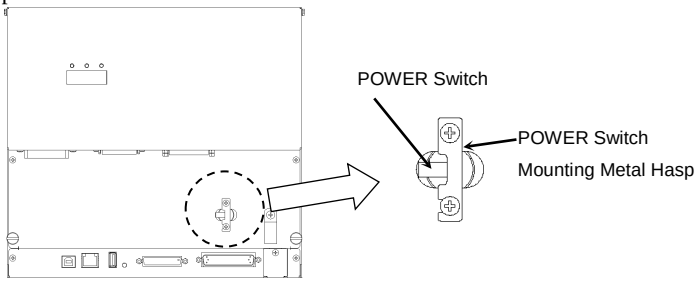
Malfunction of the fan rotation speed is detected.

1.8 Lockout / Tagout

Lockout / tagout is a method to prevent anyone from turning ON the robot system by mistake while someone else is within the safeguarded area for maintenance or repair. When performing maintenance and repair, lockout and tagout using the following procedure.

(1) Turn OFF the POWER switch.

(2) Secure the POWER switch mounting metal hasp in the POWER switch OFF position with screws.



(3) Unplug the power supply plug of the Controller from the power supply socket.

(4) Attach a note to the POWER switch or the power supply plug to prevent anyone from turning ON the robot system by mistake.

RC180-UL:
For maintenance and repair, make sure to lockout and tagout the external disconnecting means.

1.9 Manipulator Specifications

G1

Item		4-axis spec	
		G1-171*	G1-221*
Mounting type		Table Top	
Arm length	Arm #1, #2	175 mm	225 mm
	Arm #1	75 mm	125 mm
	Arm #2	100 mm	
Weight (cables not included)		8 kg	
Driving method	All joints	AC servo motor	
Max. operating speed *1	Joint #1, #2	2630 mm/s	3000 mm/s
	Joint #3 (Z)	1200 mm/s	
	Joint #4 (U)	3000 deg/s	
Repeatability	Joint #1, #2	± 0.005 mm	± 0.008 mm
	Joint #3 (Z)	± 0.01 mm	
	Joint #4 (U)	± 0.01 deg.	
Max. motion range	Joint #1	± 125 deg.	
	Joint #2 (Cleanroom model)	± 140 deg. (± 140 deg.)	± 152 deg. (±149 deg.)
	Z stroke (Cleanroom model)	± 100 (80) mm	
	Joint #4	± 360 deg.	
Max. pulse range (pulse)	Joint #1	– 1019449 ~ 6262329 pulse	
	Joint #2 (Cleanroom model)	± 2548623 (± 2548623)	± 2767076 (± 2712463)
	Joint #3 (Cleanroom model)	– 1092267 to 0 (– 873813 to 0)	
	Joint #4	– 393216 to 393216	
Resolution	Joint #1	3.43322E-05 deg./pulse	
	Joint #2	5.49316E-05 deg./pulse	
	Joint #3	9.15527E-05 mm/pulse	
	Joint #4	9.15527E-04 deg./pulse	
Motor power consumption		All joints: 50 W	
Payload	Rated	0.5 kg	
	Maximum	1 kg	
Joint #4 allowable moment of inertia *2	Rated	0.0003 kg·m^2	
	Maximum	0.004 kg·m^2	
Shaft diameter		ø 8 mm	
Mounting hole		125×88 (4-M6)	

Item		4-axis spec	
		G1-171*	G1-221*
Joint #3 down force		50 N	
Installed wire for customer use		24 pin (9+15)	
Installed pneumatic tube for customer use		1 pneumatic tube (ø 4 mm) : 0.59 MPa (6 kgf/cm^2 : 86 psi) 2 pneumatic tubes (ø 6 mm) : 0.59 MPa (6 kgf/cm^2 : 86 psi)	
Environmental requirements	Ambient temperature	5 to 40 degree C (with minimum temperature variation)	
	Ambient relative humidity	10 to 80% RH (no condensation)	
	Vibration level	4.9 m/s^2 (0.5G) or less	
Noise level *3		65dB	
Installation environment		Cleanroom + ESD (ISO Class 3) *4	
Assignable Value ( ) Default values	Speed	1 to (5) to 100	
	Accel *5	1 to (10) to 120	
	SpeedS	1 to (50) to 2000	
	AccelS	1 to (200) to 25000	
	Fine	0 to (10000) to 65000	
	Weight	0,100 to (0.5,100) to 1,100	
Safety standard		UL1740 (Third Edition, Dated December 7, 2007) CE Mark EMC Directive Machinery Directive RoHS Directive KC Mark / KCs Mark	

Item		3-axis spec	
		G1-171*Z	G1-221*Z
Mounting type		Table Top	
Arm length	Arm #1, #2	175 mm	225 mm
	Arm #1	75 mm	125 mm
	Arm #2	100 mm	
Weight (cables not included)		8 kg	
Driving method	All joints	AC servo motor	
Max. operating speed *1	Joint #1, #2	2630 mm/s	3000 mm/s
	Joint #3 (Z)	1200 mm/s	
	Joint #4 (U)	3000 deg/s	
Repeatability	Joint #1, #2	± 0.005 mm	± 0.008 mm
	Joint #3 (Z)	± 0.01 mm	
	Joint #4 (U)	-	
Max. motion range	Joint #1	± 125 deg	
	Joint #2 (Cleanroom model)	± 135 deg. (± 123 deg.)	± 135 deg. (± 132 deg.)
	Z stroke (Cleanroom model)	± 100 (80) mm	
	Joint #4	-	
Max. pulse range (pulse)	Joint #1	– 1019449 to 6262329 pulse	
	Joint #2 (Cleanroom model)	± 2457600 (± 2239147)	± 2457600 (± 2402987)
	Joint #3 (Cleanroom model)	– 1092267 to 0 (– 873813 to 0)	
	Joint #4	– 393216 to 393216	
Resolution	Joint #1	3.43322E-05 deg/pulse	
	Joint #2	5.49316E-05 deg/pulse	
	Joint #3	9.15527E-05 mm/pulse	
	Joint #4	9.15527E-04 deg/pulse	
Motor power consumption		All joints: 50 W	
Payload	Rated	0.5 kg	
	Maximum	1.5 kg	

Item		3-axis spec	
		G1-171*Z	G1-221*Z
Joint #4 allowable moment of inertia *2	Rated	-	
	Maximum	-	
Shaft diameter		ø 8 mm	
Mounting hole		125×88 (4-M6)	
Joint #3 down force		50 N	
Installed wire for customer use		24 pin (9+15)	
Installed pneumatic tube for customer use		1 pneumatic tube (ø 4 mm): : 0.59 MPa (6 kgf/cm^2 : 86 psi) 2 pneumatic tubes (ø 6 mm): : 0.59 MPa (6 kgf/cm^2 : 86 psi)	
Environmental requirements	Ambient temperature	5 to 40 degree C (with minimum temperature variation)	
	Ambient relative humidity	10 to 80% RH (no condensation)	
	Vibration level	4.9 m/s^2 (0.5 G) or less	
Noise level *3		65 dB	
Installation environment		Cleanroom + ESD (ISO Class 3) *4	
Assignable Value ( ) Default values	Speed	1 to (5) to 100	
	Accel *5	1 to (10) to 120	
	SpeedS	1 to (50) to 2000	
	AccelS	1 to (200) to 25000	
	Fine	0 to (10000) to 65000	
	Weight	0,100 to (0.5,100) to 1.5,100	
Safety standard		UL1740 (Third Edition, Dated December 7, 2007) CE Mark EMC Directive Machinery Directive RoHS Directive KC Mark / KCs Mark	

*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: Conditions of Manipulator during measurement as follows:

Operating conditions : Under rated load, 4-joints simultaneous motion, maximum speed, maximum acceleration, and duty 50%.

Measurement point : In front of the Manipulator, 1000 mm apart from the motion range, 50 mm above the base-installed surface.

*4: The exhaust system in the Cleanroom-model Manipulator draws air from the base interior and arm cover interior.

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. Seal firmly the exhaust port and the exhaust tube with vinyl tape.

If the exhaust flow is not sufficient, dust particle emission may exceed the specified maximum level.

Cleanliness level : Class ISO 3 (ISO14644-1)
Amount of Dust (0.1 µm diameter or larger) in 28317 cm^3 (1cft)
sample-air around the center of the motion rang: 10 particles or less.)

Exhaust System : Exhaust port : Inner diameter: ø8 mm
Exhaust tube : Polyurethane tube
Outer diameter ø8 mm
or Inner diameter ø16mm or larger
Recommended exhaust flow rate: approx. 1000 cm^3/s (Normal)

ESD specification uses resin materials with antistatic treatment. This model controls adhesion of dust due to electrification.

*5: 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.

G3

Item		G3 series Manipulator		
Arm length	Arm #1, #2	250 mm	300 mm	350 mm
	Arm #1	120 mm	170 mm	220 mm
	Arm #2	130 mm	130 mm	130 mm
Max. operating speed *1	Joint #1, #2	3550 mm/s	3950 mm/s	4350 mm/s
	Joints #3	1100 mm/s		
	Joint #4	3000 deg/s		
Repeatability	Joint #1, #2	± 0.008 mm	± 0.01 mm	± 0.01 mm
	Joint #3	± 0.01 mm		
	Joint #4	± 0.005 deg		
Payload	Rated	1 kg		
	Maximum	3 kg		
Joints #4 allowable moment of inertia *2	Rated	0.005 kg·m^2		
	Maximum	0.05 kg·m^2		
Resolution	Joint #1	0.0000343323 deg/pulse		
	Joint #2	0.0000549316 deg/pulse		
	Joint #3	0.0000878906 mm/pulse		
	Joint #4	0.000240928 deg/pulse		
Hand	Shaft diameter	ø 16 mm		
	Through hole	ø 11 mm		
Mounting hole	Table top mounting	120 × 120 mm (4-M8)		
	Multiple mounting	Wall mounting : 174 × 70 mm (4-M8)		
		Ceiling mounting : 120 × 120 mm (4-M8) / custom specification		
Weight (cables not included)		14 kg : 31 lb		
Driving method	All joints	AC servo motor		
Motor power consumption	Joint #1	200 W		
	Joint #2	150 W		
	Joint #3	150 W		
	Joint #4	150 W		
Option	Mounting type	-	Multiple mounting	
	Installation environment	Cleanroom & ESD *3		
Joint #3 down force		150 N		
Installed wire for customer use		15 (15 pin: D-sub) 15 cores		
Installed pneumatic tube for customer use		2 pneumatic tubes (ø6 mm) : 0.59 MPa (6 kgf/cm^2 : 86 psi)		
		1 pneumatic tubes (ø4 mm) : 0.59 MPa (6 kgf/cm^2 : 86 psi)		
Environmental requirements	Ambient temperature	5 to 40 deg. C (with minimum temperature variation)		
	Ambient relative humidity	10 to 80% (no condensation)		
Noise level *4		L_{Aeq} = 70 dB (A)		

Item		G3 series Manipulator
Assignable Value ( ) Default values	Speed	1 to (5) to 100
	Accel *5	1 to (10) to 120
	SpeedS	1 to (50) to 2000
	AccelS	1 to (200) to 25000
	Fine	0 to (10000) to 65000
	Weight	0,130 to (1,130) 3,130
Safety standard		UL1740 (Third Edition, Dated December 7, 2007) CE Mark EMC Directive Machinery Directive RoHS Directive KC Mark / KCs Mark

Max. motion range (deg) (mm) / Max. pulse range (pulse)

Standard-model / Table Top Mounting

Item				G3-251S	G3-301S-*	G3-351S-*
Max. motion range (deg), (mm)	Straight	Joint #1		± 140		
		Joint #2		± 141	± 142	
	Curved	Joint #1	Right hand	-	– 125 to 150	– 110 to 165
			Left hand	-	– 150 to 125	– 165 to 110
		Joint #2	Right hand	-	– 135 to 150	– 120 to 165
			Left hand	-	– 150 to 135	– 165 to 120
	Common	Joint #3		150 mm		
		Joint #4		± 360		
Max. pulse range (pulse)	Straight	Joint #1		– 1456356 to 6699236		
		Joint #2		± 2566827	± 2585032	
	Curved	Joint #1	Right hand	-	– 1019449 to 6990507	– 582543 to 7427414
			Left hand	-	– 1747627 to 6262329	– 2184534 to 5825423
		Joint #2	Right hand	-	– 2457600 to 2730667	– 2184534 to 3003734
			Left hand	-	– 2730667 to 2457600	– 3003734 to 2184534
	Common	Joint #3		– 1706667 to 0		
		Joint #4		± 1494221		

Standard-model / Multiple Mounting

Item				G3-301SM	G3-351SM-*
Max. motion range (deg), (mm)	Straight	Joint #1		± 115	± 120
		Joint #2		± 135	± 142
	Curved	Joint #1	Right hand	-	– 105 to 130
			Left hand	-	– 130 to 105
		Joint #2	Right hand	-	– 120 to 160
			Left hand	-	– 160 to 120
	Common	Joint #3		150 mm	
		Joint #4		± 360	
Max. pulse range (pulse)	Straight	Joint #1		– 728178 to 5971058	– 873814 to 6116694
		Joint #2		± 2457600	± 2585032
	Curved	Joint #1	Right hand	-	– 436907 to 6407965
			Left hand	-	– 1165085 to 5679787
		Joint #2	Right hand	-	– 2184534 to 2912712
			Left hand	-	– 2912712 to 2184534
	Common	Joint #3		–1706667 to 0	
		Joint #4		± 1494221	

Cleanroom-model / Table Top Mounting

Item				G3-251C	G3-301C-*	G3-351C-*
Max. motion range (deg), (mm)	Straight	Joint #1		± 140		
		Joint #2		± 137	± 141	± 142
	Curved	Joint #1	Right hand	-	– 125 to 150	– 110 to 165
			Left hand	-	– 150 to 125	– 165 to 110
		Joint #2	Right hand	-	– 135 to 145	– 120 to 160
			Left hand	-	– 145 to 135	– 160 to 120
	Common	Joint #3		120 mm		
		Joint #4		± 360		
Max. pulse range (pulse)	Straight	Joint #1		– 1456356 to 6699236		
		Joint #2		± 2494009	± 2566827	± 2585032
	Curved	Joint #1	Right hand	-	– 1019449 to 6990507	– 582543 to 7427414
			Left hand	-	– 1747627 to 6262329	– 2184534 to 5825423
		Joint #2	Right hand	-	– 2457600 to 2639645	– 2184534 to 2912712
			Left hand	-	– 2639645 to 2457600	– 2912712 to 2184534
	Common	Joint #3		–1365334 to 0		
		Joint #4		± 1494221		

Cleanroom-model / Multiple Mounting

Item				G3-301CM	G3-351CM-*
Max. motion range (deg), (mm)	Straight	Joint #1		± 115	± 120
		Joint #2		± 135	± 142
	Curved	Joint #1	Right hand	-	– 105 to 130
			Left hand	-	– 130 to 105
		Joint #2	Right hand	-	– 120 to 150
			Left hand	-	– 150 to 120
	Common	Joint #3		120 mm	
		Joint #4		± 360	
Max. pulse range (pulse)	Straight	Joint #1		– 728178 to 5971058	– 873814 to 6116694
		Joint #2		± 2457600	± 2585032
	Curved	Joint #1	Right hand	-	– 436907 to 6407965
			Left hand	-	– 1165085 to 5679787
		Joint #2	Right hand	-	– 2184534 to 2730667
			Left hand	-	– 2730667 to 2187534
	Common	Joint #3		–1365334 to 0	
		Joint #4		± 1494221	

*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.
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)
Amount of dust (0.1 µm diameter or larger) in 28317 cm^3 (1cft)
sample-air around the center of the motion rang: 10 particles or less.
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 cm^3/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, and duty 50%.
Measurement point : In front of the Manipulator, 1000 mm apart from the motion range, 50 mm above the base-installed surface.

*5 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.

G6

Item			G6-****
Mounting type			Table Top
Environment			Cleanroom-model + ESD *1, Protected-model *2
Arm length	Arm #1, #2	45	450 mm
		55	550 mm
		65	650 mm
	Arm #3	1	180 mm : G6-**1S*, D* 150 mm : G6-**1C*, P*, D* with bellows option
		3	330 mm : G6-**3S*, D* 300 mm : G6-**3C*, P*, D* with bellows option
Weight (not include the weight of cables)		45/55	27 kg : 60 lb
		65	28 kg : 62 lb
Driving method	All joints		AC servo motor
Max. operating speed *3	Joint #1, #2	45	6440 mm/s
		55	7170 mm/s
		65	7900 mm/s
	Joint #3	1	1100 mm/s
		3	2350 mm/s
	Joint #4		2400 deg/s
Repeatability	Joint #1, #2		±0.015 mm
	Joint #3		±0.01 mm
	Joint #4		±0.005 deg
Max. motion range	Joint #1	45	±152 deg
		55	
		65	
	Joint #2	45	±142 to 147.5 deg *a
		55	±147.5 deg
		65	±147.5 deg
	Joint #3	1	180 mm : G6-**1S*, D* 150 mm : G6-**1C*, P*, D* with bellows option
		3	330 mm : G6-**3S*, D* 300 mm : G6-**3C*, P*, D* with bellows option
	Joint #4		±360 deg

Item			G6-****
Maximum pulse range (pulse)	Joint #1	45	-1805881 to +7048761
		55	
		65	
	Joint #2	45	±2585031 to 2685156 *a
		55	±2685156
		65	±2685156
	Joint #3	1	-1976708 : G6-**1S*, D* -1647257 : G6-**1C*, P*, D* with bellows option
		3	-1811982 : G6-**3S*, D* -1647257 : G6-**3C*, P*, D* with bellows option
	Joint #4		±1961226

*a : G6-45*** Joint #2

		Max. motion range	Max. pulse range
G6-45*S*, D*	Z 0 to –270	147.5 deg	±2685156 pulse
	Z –270 to –330	145 deg	±2639645 pulse
G6-45*C*, P*, D* with bellows option	Z 0 to –240	147.5 deg	±2685156 pulse
	Z –240 to –300	142 deg	±2585031 pulse

Item			G6-****R	G6-****W
Mounting type			Ceiling	Wall
Environment			Cleanroom-model + ESD [*1], Protected-model [*2]	
Arm length	Arm #1, #2	45	450 mm	
		55	550 mm	
		65	650 mm	
	Arm #3	1	180 mm : G6-**1S*, D* 150 mm : G6-**1C*, P*, D* with bellows option	
		3	330 mm : G6-**3S*, D* 300 mm : G6-**3C*, P*, D* with bellows option	
Weight (not include the weight of cables)		45/55	27 kg : 60 lb	29 kg : 64 lb
		65	28 kg : 62 lb	29.5 kg : 65 lb
Driving method	All joints		AC servo motor	
Max. operating speed [*3]	Joint #1, #2	45	6440 mm/s	
		55	7170 mm/s	
		65	7900 mm/s	
	Joint #3	1	1100 mm/s	
		3	2350 mm/s	
	Joint #4		2400 deg/s	
Repeatability	Joint #1, #2		±0.015 mm	
	Joint #3		±0.01 mm	
	Joint #4		±0.005 deg	
Max. motion range	Joint #1	45	±120 deg	±105 deg
		55	±152 deg	±135 deg
		65		±148 deg
	Joint #2	45	±130 deg	
		55	±147.5 deg : S ±145 deg : C*, P*, D* with bellows option	
		65	±147.5 deg	
	Joint #3	1	180 mm : G6-**1S*, D* 150 mm : G6-**1C*, P*, D* with bellows option	
		3	330 mm : G6-**3S*, D* 300 mm : G6-**3C*, P*, D* with bellows option	
	Joint #4		±360 deg	

<table>
<tr><th colspan="3">Item</th><th>G6-****R</th><th>G6-****W</th></tr>
<tr><td colspan="3">Mounting type</td><td>Ceiling</td><td>Wall</td></tr>
<tr><td rowspan="8">Maximum pulse range (pulse)</td><td rowspan="3">Joint #1</td><td>45</td><td>-873814 to +6116694</td><td>-436907 to +5679787</td></tr>
<tr><td>55</td><td rowspan="2">-1805881 to +7048761</td><td>-1310720 to +6553600</td></tr>
<tr><td>65</td><td>-1689373 to +6932253</td></tr>
<tr><td rowspan="3">Joint #2</td><td>45</td><td colspan="2">±2366578</td></tr>
<tr><td rowspan="2">55</td><td colspan="2">±2685156 : S</td></tr>
<tr><td colspan="2">±2639645 : C*, P*, D* with bellows option</td></tr>
<tr><td>65</td><td colspan="2">±2685156</td></tr>
<tr><td rowspan="2">Joint #3</td><td>1</td><td colspan="2">-1976708 : G6-**1S*, D*
-1647257 : G6-**1C*, P*, D* with bellows option</td></tr>
<tr><td>3</td><td colspan="2">-1811982 : G6-**3S*, D*
-1647257 : G6-**3C*, P*, D* with bellows option</td></tr>
<tr><td colspan="2">Joint #4</td><td colspan="2">±1961226</td></tr>
</table>

Item			G6-*****
Resolution	Joint #1		0.0000343 deg/pulse
	Joint #2		0.0000549 deg/pulse
	Joint #3	1	0.0000911 mm/pulse
		3	0.0001821 mm/pulse
	Joint #4		0.0001836 deg/pulse
Motor power consumption	Joint #1		400 W
	Joint #2		400 W
	Joint #3		200 W
	Joint #4		100 W
Payload	Rated		3 kg
	Maximum		6 kg
Joint #4 allowable moment of inertia *4	Rated		0.01 kg·m^2
	Maximum		0.12 kg·m^2
Hand	Shaft diameter		ø20 mm
	Through hole		ø14 mm
Joint #3 down force			150 N
Installed wire for customer use			24 (15 pin + 9 pin : D-sub)
Installed pneumatic tube for customer use			2 pneumatic tubes (ø6 mm) : 0.59 MPa (6 kgf/cm^2 : 86 psi)
			2 pneumatic tubes (ø4 mm) : 0.59 MPa (6 kgf/cm^2 : 86 psi)
Environmental requirements	Ambient temperature		5 to 40deg. C (with minimum temperature variation)
	Ambient relative humidity		10 to 80% (no condensation)
Noise level *5			L_{Aeq} = 70 dB(A)
Assignable Value ( ) Default values	Speed		1 to (5) to 100
	Accel *6		1 to (10) to 120
	SpeedS		1 to (50) to 2000
	AccelS		1 to (200) to 25000
	Fine		0 to (10000) to 65000
	Weight		0,250 to (3,250) to 6,250
Safety standard			UL1740 (Third Edition, Dated December 7, 2007) CE Mark EMC Directive Machinery Directive RoHS Directive KC Mark / KCs Mark

*1: The exhaust system in the Cleanroom-model Manipulator (G6-***C*) draws air from the base interior and arm cover interior.
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)
Amount of Dust (0.1 μm diameter or larger) in 28317 cm^3 (1cft) sample-air around the center of the motion rang: 10 particles or less.)
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 ø16 mm or larger
Recommended exhaust flow rate: Approx. 1000 cm^3/s (Normal)

ESD specification uses resin materials with antistatic treatment. This model controls adhesion of dust due to electrification.

*2: IP (International Protection) for the Protected-model Manipulator indicates International Standard of the protection level against dust and water.

Normal G6-***D* Manipulators do not have bellows. The normal G6-***D* Manipulator (without bellows option) operates under adverse conditions with oily mist.

If necessary, select the bellows option at shipment.

The Manipulators with bellows (option) comply with grade of protection IP54 (IEC 60529, JIS C0920).

Model	Degree of protection		
G6-***D* with bellows option	IP54	Dust: 5	Dust shall not ingress in a quantity to interfere with satisfactory operation of the equipment.
		Water: 4	Water splashing against the enclosure from any direction shall have no harmful effect.
G6-***P*	IP65	Dust: 6	No ingress of dust.
		Water: 5	Water projected by a nozzle against enclosure from any direction shall have no harmful effects.

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

*4: 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.

*5: Conditions of Manipulator during measurement as follows:

Operating conditions : Under rated load, 4-joints simultaneous motion, maximum speed, maximum acceleration, and duty 50%.

Measurement point : In front of the Manipulator, 1000 mm apart from the motion range, 50 mm above the base-installed surface.

*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.

G10/G20

Item			G10/G20-****
Mounting type			Table Top
Environment			Cleanroom-model + ESD [*1] / Protected-model [*2]
Arm length	Arm #1, #2	65	650 mm (G10 only)
		85	850 mm (G10 / G20)
		A0	1000 mm (G20 only)
	Arm #3	1	180 mm : G10/G20-**1S*, D* 150 mm : G10/G20-**1C*, P*, D* with bellows option
		4	420 mm : G10/G20-**4S* , D* 390 mm : G10/G20-**4C* , P*, D* with bellows option
Weight (not include the weight of cables)	G10	65	46 kg: 102 lb
	G10/G20	85	48 kg: 106 lb
	G20	A0	50 kg: 111 lb
Driving method	All joints		AC servo motor
Max. operating speed [*3]	Joint #1, #2	65	8800 mm/s
		85	11000 mm/s
		A0	11500 mm/sec
	Joint #3	1	1100 mm/s
		4	2350 mm/s
	Joint #4	G10	2400 deg/s
		G20	1700 deg/s
Repeatability	Joint #1, #2		±0.025 mm
	Joint #3		±0.01 mm
	Joint #4		±0.005 deg
Max. motion range	Joint #1	65	±152 deg
		85	
		A0	
	Joint #2	65	±152.5 deg *a
		85	
		A0	
	Joint #3	1	180 mm : G10/G20-**1S*, D* 150 mm : G10/G20-**1C*, P*, D* with bellows option
		4	420 mm : G10/G20-**4S*, D* 390 mm : G10/G20-**4C*, P*, D* with bellows option
	Joint #4		±360 deg

Item			G10/G20-****
Max. pulse range (pulse)	Joint #1	65	-1805881 to +7048761
		85	
		A0	
	Joint #2	65	±2776178 *a
		85	
		A0	
	Joint #3	1	-1946420 : G10/G20-**1S*, D* -1622016 : G10/G20-**1C*, P*, D* with bellows option
		4	-2270823 : G10/G20-**4S*, D* -2108621 : G10/G20-**4C*, P*, D* with bellows option
	Joint #4	G10	±1951517
		G20	±2752512

NOTE The length of Arm #1 + #2 varies in different Manipulator models.
65 : 650 mm G10 only
85 : 850 mm G10 / G20
A0 : 1000 mm G20 only

Item			G10/G20-****R	G10/G20-*****W
Mounting type			Ceiling	Wall
Environment			Cleanroom-model + ESD *1 Protected-model *2	
Arm length	Arm #1, #2	65	650 mm (G10 only)	
		85	850 mm (G10 / G20)	
		A0	1000 mm (G20 only)	
	Arm #3	1	180 mm : G10/G20-**1S*, D* 150 mm : G10/G20-**1C*, P*, D* with bellows option	
		4	420 mm : G10/G20-**4S*, D* 390 mm : G10/G20-**4C*, P*, D* with bellows option	
Weight (not include the weight of cables)	G10	65	46 kg: 102 lb	51 kg: 113 lb
	G10/G20	85	48 kg: 106 lb	53 kg: 117 lb
	G20	A0	50 kg: 111 lb	55 kg: 122 lb
Driving method	All joints		AC servo motor	
Max. operating speed *3	Joints #1, #2	65	8800 mm/s	
		85	11000 mm/s	
		A0	11500mm/sec	
	Joint #3	1	1100 mm/s	
		4	2350 mm/s	
	Joint #4	G10	2400 deg/s	
		G20	1700 deg/s	
Repeatability	Joint #1, #2		±0.025 mm	
	Joint #3		±0.01 mm	
	Joint #4		±0.005 deg	
Max. motion range	Joint #1	65	±107 deg	±107 deg
		85	±152 deg	
		A0		
	Joint #2	65	±130 deg	
		85	±152.5 deg *a	
		A0		
	Joint #3	1	180 mm : G10/G20-**1S*, D* 150 mm : G10/G20-**1C*, P*, D* with bellows option	
		4	420 mm : G10/G20-**4S*, D* 390 mm : G10/G20-**4C*, P*, D* with bellows option	
	Joint #4		±360 deg	

Item			G10/G20-****R	G10/G20-*****W
Max. pulse range (pulse)	Joint #1	65	-495161 to + 5738041	-495161 to +5738041
		85	-1805881 to +7048761	
		A0		
	Joint #2	65	±2366578	
		85	±2776178 *a	
		A0		
	Joint #3	1	-1946420 : G10/G20-**1S*, D* -1622016 : G10/G20-**1C*, P*, D* with bellows option	
		4	-2270823 : G10/G20-**4S*, D* -2108621 : G10/G20-**4C*, P*, D* with bellows option	
	Joint #4	G10	±1951517	
		G20	±2752512	

*a : The Joint #2 values for the following manipulators

	Max. motion range	Max. pulse range
G10/G20-85C, P, D with bellows option (Z: –360 to –390 only) G10/G20-85CW, PW, DW with bellows option G10/G20-85CR, PR, DR with bellows option	±151 deg	±2748871

Item			G10-*****	G20-*****
Resolution	Joint #1		0.0000343 deg/pulse	
	Joint #2		0.0000549 deg/pulse	
	Joint #3	1	0.0000925 mm/pulse	
		4	0.000185 mm/pulse	
	Joint #4		0.0001845 deg/pulse	0.0001308 deg/pulse
Motor power consumption	Joint #1		750 W	
	Joint #2		600 W	
	Joint #3		400 W	
	Joint #4		150 W	
Payload	Rated		5 kg	10 kg
	Maximum		10 kg	20 kg
Joint #4 allowable moment of inertia *4	Rated		0.02 kg·m^2	0.05 kg·m^2
	Maximum		0.25 kg·m^2	0.45 kg·m^2
Hand	Shaft diameter		ø25 mm	
	Through hole		ø18 mm	
Joint #3 down force			250 N	
Installed wire for customer use			24 (15 pin + 9 pin : D-sub)	
Installed pneumatic tube for customer use			2 pneumatic tubes (ø6 mm) : 0.59 MPa (6 kgf/cm^2 : 86 psi)	
			2 pneumatic tubes (ø4 mm) : 0.59 MPa (6 kgf/cm^2 : 86 psi)	
Environmental requirements	Ambient temperature		5 to 40 degC (with minimum temperature variation)	
	Ambient relative humidity		10 to 80% (no condensation)	
Noise level *5			L_{Aeq} = 70 dB(A)	
Assignable Value ( ) Default values	Speed		1 to (5) to 100	
	Accel *6		1 to (10) to 120	
	SpeedS		1 to (50) to 2000	
	AccelS		1 to (200) to 25000	
	Fine		0 to (10000) to 65000	
	Weight		0,400 to (10,400) to 20,400	
Safety standard			UL1740 (Third Edition, Dated December 7, 2007) CE Mark EMC Directive Machinery Directive RoHS Directive KC Mark / KCs Mark	

*1: The exhaust system in the Cleanroom-model Manipulator (G10/G20-***C*) draws air from the base interior and arm cover interior.
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)
Amount of dust (0.1 µm diameter or larger) in 28317 cm^3 (1cft) sample-air around the center of the motion rang: 10 particles or less.)
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 cm^3/s (Normal)
ESD specification uses resin materials with antistatic treatment. This model controls adhesion of dust due to electrification.

*2: IP (International Protection) for the Protected-model Manipulator indicates International Standard of the protection level against dust and water.

Normal G10/G20-***D* Manipulators do not have bellows. The normal G10/G20-***D* Manipulator (without bellows option) operates under adverse conditions with oily mist.

If necessary, select the bellows option at shipment.

The Manipulators with bellows (option) comply with grade of protection IP54 (IEC 60529, JIS C0920).

Model	Degree of protection		
G10/G20-***D* with bellows option	IP54	Dust: 5	Dust shall not ingress in a quantity to interfere with satisfactory operation of the equipment.
		Water: 4	Water splashing against the enclosure from any direction shall have no harmful effect.
G10/G20-***P*	IP65	Dust: 6	No ingress of dust.
		Water: 5	Water projected by a nozzle against enclosure from any direction shall have no harmful effects.

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

*4: 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.

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

*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.

RS3

Item			RS3-351*
Arm length	Arm #1, #2		350 mm
	Arm #1		175 mm
	Arm #2		175 mm
Max. operating speed *1	Joint #1, #2		6237 mm/s
	Joint #3		1100 mm/s
	Joint #4		2600 deg/s
Repeatability	Joint #1, #2		± 0.01 mm
	Joint #3		± 0.01 mm
	Joint #4		± 0.01 deg
Payload	Rated		1 kg
	Maximum		3 kg
Joint #4 allowable moment of inertia *2	Rated		0.005 kg·m^2
	Maximum		0.05 kg·m^2
Max. motion range	Joint #1		± 225 deg
	Joint #2		± 225 deg
	Joint #3	RS*-**1S	130 mm
		RS*-**1C	100 mm
	Joint #4		± 720 deg
Max. pulse range (pulse)	Joint #1		– 2560000 to + 5973334 pulse
	Joint #2		± 4177920 pulse
	Joint #3	RS*-**1S	– 1479112 pulse to 0 pulse
		RS*-**1C	– 1137778 pulse to 0 pulse
	Joint #4		± 3145728 pulse
Resolution	Joint #1		0.0000527 deg/pulse
	Joint #2		0.0000538 deg/pulse
	Joint #3		0.0000879 mm/pulse
	Joint #4		0.000229 deg/pulse
Hand	Shaft diameter		ø 16 mm
	Through hole		ø 11 mm
Mounting hole			6-M6
Weight (cables not included)			17 kg: 38 lb
Driving method	All joints		AC servo motor
Motor power consumption	Joint #1		400 W
	Joint #2		200 W
	Joint #3		150 W
	Joint #4		100 W
Option	Installation environment		Cleanroom & ESD *3
Joint #3 down force			150 N
Installed wire for customer use			15 wires: D-sub / 15 pin connectors

Item		RS3-351*
Installed pneumatic tube for customer use		2 pneumatic tubes (ø 6 mm) : 0.59 MPa (6 kgf/cm^2 : 86 psi)
		1 pneumatic tube (ø 4 mm) : 0.59 MPa (6 kgf/cm^2 : 86 psi)
Environmental requirements	Ambient temperature	5 to 40 degC (with minimum temperature variation)
	Ambient relative humidity	10 to 80% RH (no condensation)
Noise level [*4]		LAeq = 65 dB(A) or under
Assignable Value ( ) Default values	Speed	1 to (5) to 100
	Accel [*5]	1 to (10) to 120
	SpeedS	1 to (50) to 2000
	AccelS	1 to (200) to 25000
	Fine	0 to (10000) to 65000
	Weight	0,175 to (1,175) to 3,175
Safety standard		UL1740 (Third Edition, Dated December 7, 2007) CE Mark EMC Directive Machinery Directive RoHS Directive KC Mark / KCs Mark

*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.
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)
Amount of Dust (0.1 µm diameter or larger) in 28317 cm^3 (1cft) sample-air around the center of the motion rang: 10 particles or less.)
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 cm^3/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, and duty 50%.
Measurement point	: In front of the Manipulator, 1000 mm apart from the motion range, 50 mm above the base-installed surface.

*5: 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.

RS4

Item			RS4-551*
Arm length	Arm #1, #2		550 mm
	Arm #1		275 mm
	Arm #2		275 mm
Max. operating speed *1	Joint #1, #2		7400 mm/s
	Joint #3		1100 mm/s
	Joint #4		2600 deg/s
Repeatability	Joint #1, #2		± 0.015 mm
	Joint #3		± 0.01 mm
	Joint #4		± 0.01 deg
Payload	Rated		1 kg
	Maximum		4 kg
Joint #4 allowable moment of inertia *2	Rated		0.005 kg·m^2
	Maximum		0.05 kg·m^2
Max. motion range	Joint #1		± 225 deg
	Joint #2		± 225 deg
	Joint #3	RS*-**1S	130 mm
		RS*-**1C	100 mm
	Joint #4		± 720 deg
Max. pulse range (pulse)	Joint #1		– 4096000 to + 9557334 pulse
	Joint #2		± 4177920 pulse
	Joint #3	RS*-**1S	– 1479112 pulse to 0 pulse
		RS*-**1C	– 1137778 pulse to 0 pulse
	Joint #4		± 3145728 pulse
Resolution	Joint #1		0.0000330 deg/pulse
	Joint #2		0.0000538 deg/pulse
	Joint #3		0.0000879 mm/pulse
	Joint #4		0.000229 deg/pulse
Hand diameter	Shaft diameter		ø 16 mm
	Through hole		ø 11 mm
Mounting hole			6-M6
Weight (cables not included)			19 kg: 42 lb
Driving method	All joints		AC servo motor
Motor power consumption	Joint #1		400 W
	Joint #2		200 W
	Joint #3		150 W
	Joint #4		100 W
Option	Environment		Cleanroom & ESD *3
Joint #3 down force			150 N
Installed wire for customer use			15 wires: D-sub / 15 pin connectors

Item		RS4-551*
Installed pneumatic tube for customer use		2 pneumatic tubes (ø 6 mm) : 0.59 MPa (6 kgf/cm^2 : 86 psi)
		1 pneumatic tube (ø 4 mm) : 0.59 MPa (6 kgf/cm^2 : 86 psi)
Environmental requirements	Ambient temperature	5 to 40 degC (with minimum temperature variation)
	Ambient relative humidity	10 to 80% RH (no condensation)
Noise level *4		LAeq = 65 dB(A) or less
Assignable Value ( ) Default values	Speed	1 to (5) to 100
	Accel *5	1 to (10) to 120
	SpeedS	1 to (50) to 2000
	AccelS	1 to (200) to 25000
	Fine	0 to (10000) to 65000
	Weight	0,275 to (1,275) to 4,275
Safety standard		UL1740 (Third Edition, Dated December 7, 2007) CE Mark EMC Directive Machinery Directive RoHS Directive KC Mark / KCs Mark

*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)

Amount of Dust (0.1 µm diameter or larger) in 28317 cm^3 (1cft)
sample-air around the center of the motion rang: 10 particles or less.)

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 cm^3/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, and duty 50%.
Measurement point	: In front of the Manipulator, 1000 mm apart from the motion range, 50 mm above the base-installed surface.

*5 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.

C3

Item		Specification	
Mounting type		Table Top, Ceiling, Skewed mounting	Wall mounting
Weight (not include the weight of cablesor shipping jigs)		27 kg (59.5 lb.)	
Driving method	All joints	AC servo motor	
Max. operating speed *1	Joint #1	450 deg/s	
	Joint #2	450 deg/s	
	Joint #3	514 deg/s	
	Joint #4	553 deg/s	
	Joint #5	553 deg/s	
	Joint #6	720 deg/s	
Repeatability	Joint #1 to #6	± 0.02 mm	
Max. motion range	Joint #1	±170 deg (± 180 deg without the mechanical stop)	±30 deg
	Joint #2	– 160 deg to + 65 deg	
	Joint #3	– 51 deg to + 225 deg	
	Joint #4	± 200 deg	
	Joint #5	± 135 deg	
	Joint #6	± 360 deg	
Max. pulse range	Joint #1	± 4951609 (± 5242880 without the mechanical stop)	± 873814
	Joint #2	– 4660338 + 1893263	
	Joint #3	– 1299798 + 5734400	
	Joint #4	± 4700057	
	Joint #5	± 3217222	
	Joint #6	± 6553600	
Resolution	Joint #1	0.00000429 deg /pulse	
	Joint #2	0.00000429 deg /pulse	
	Joint #3	0.00000490 deg /pulse	
	Joint #4	0.00000531 deg /pulse	
	Joint #5	0.00000524 deg /pulse	
	Joint #6	0.00000686 deg /pulse	

Item		Specification
Motor power consumption	Joint #1	400 W
	Joint #2	400 W
	Joint #3	150 W
	Joint #4	50 W
	Joint #5	50 W
	Joint #6	50 W
Payload*2	Rated	1 kg
	Maximum	3 kg (5 kg with arm downward positioning)
Allowable moment	Joints #4	4.41 N·m (0.45 kgf·m)
	Joint #5	4.41 N·m (0.45 kgf·m)
	Joint #6	2.94 N·m (0.3 kgf·m)
Allowable moment of inertia ($GD^2/4$) *3	Joint #4	0.15 $kg{\cdot}m^2$
	Joint #5	0.15 $kg{\cdot}m^2$
	Joint #6	0.1 $kg{\cdot}m^2$
Installed wire for customer use		9 wires (D-sub)
Installed pneumatic tube for customer use *4		4 pneumatic tubes, Allowable pressure : 0.59 MPa (6 kgf/cm^2) (89 psi)
Environmental requirements *5	Ambient Temperature	5 to 40 deg C
	Ambient relative humidity	20 to 80 % (no condensation)
	Vibration	4.9 $m{\cdot}s^2$ (0.5 G) or less
Noise level *6		LAeq = 76 dB (A) or under
Environment		Standard / Cleanroom model & ESD *7
Default values (Max. setting values)	Speed	5 (100)
	Accel	5, 5 (120, 120)
	SpeedS	50 (2000)
	AccelS	200 (25000)
	Fine	10000, 10000, 10000, 10000, 10000, 10000 (65535, 65535, 65535, 65535, 65535, 65535)
	Weight	1, 0
Safety standard		UL1740 (Third Edition, Dated December 7, 2007) CE Mark EMC Directive Machinery Directive RoHS Directive KC Mark / KCs Mark

*1 In case of PTP control

*2 If the payload exceeds the maximum payload, refer to the section "*Restrictions on payload exceeding the maximum payload*" in *C3 series Manipulator Manual: Setup & Operation 4.3.1 WEIGHT Setting*.

*3 If the center of gravity is at the center of each arm. If the center of gravity is not at the center of each arm, set the eccentric quantity using INERTIA command.

*4 For details of the installed pneumatic tube for customer use, refer to *C3 series Manipulator Manual: Setup & Operation 3.6 User Wires and Pneumatic Tubes*.

*5 For details of the environmental requirements, refer to *C3 series Manipulator Manual: Setup & Operation 3.1 Environmental Conditions.*

*6 Conditions of Manipulator during measurement as follows:

Operating conditions: Under rated load, 6 arms simultaneous motion, maximum speed, maximum acceleration, and duty 50%.

Measurement point: 1000 mm apart from the rear of Manipulator

*7: The exhaust system in the Cleanroom-model Manipulator draws air from the base interior and arm cover interior.

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 covers.

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)
(Number of particles of 0.1μm or larger in a sample air ($28317cm^3$:1cft) around the center of the motion area = less than 10 particles)

Exhaust System : Fitting for ø8 mm pneumatic tube
Refer to *C3 series Manipulator Manual: Setup & Operation: 3.6 User Wires and Pneumatic Tubes.*
60 L/min vacuum

Exhaust tube : Polyurethane tube
Outer diameter: ø8 mm (Inner diameter: ø5 to 6 mm)

ESD specification uses resin materials with antistatic treatment. This model controls adhesion of dust due to electrification.

S5

Item		Specification		
Model		S5-A701S	S5-A701C	S5-A701P
Model Name		S5		
Degree of protection		-	-	IP65
Cleanliness level (ISO class)		-	Class 4	-
Weight (not including cables, shipping jigs)		36 kg : 80 lb.		
Driving method	All arms	AC servo motor		
Max. operating speed *1	Arm #1	6.56 rad/s, 376 deg/s		
	Arm #2	6.11 rad/s, 350 deg/s		
	Arm #3	6.98 rad/s, 400 deg/s		
	Arm #4	7.85 rad/s, 450 deg/s		
	Arm #5	7.85 rad/s, 450 deg/s		
	Arm #6	12.57 rad/s, 720 deg/s		
Repeatability	Arm #1 to #6	±0.02 mm		
Max. motion range	Arm #1	±170 deg (Wall mounting: ±30 deg)		
	Arm #2	–150 deg, +65 deg		
	Arm #3	–70 deg, +190 deg		
	Arm #4	±190 deg		
	Arm #5	±135 deg		
	Arm #6	±360 deg		
Max. pulse range (pulse)	Arm #1	±5920402 pulse (Wall mounting: ±1044777 pulse)		
	Arm #2	+2524350 pulse –5825423 pulse		
	Arm #3	+6149057 pulse –2265442 pulse		
	Arm #4	±5534152 pulse		
	Arm #5	±3932160 pulse		
	Arm #6	±6553600 pulse		
Resolution	Arm #1	0.00002871 deg/pulse		
	Arm #2	0.00002574 deg/pulse		
	Arm #3	0.00003089 deg/pulse		
	Arm #4	0.00003433 deg/pulse		
	Arm #5	0.00003433 deg/pulse		
	Arm #6	0.00005493 deg/pulse		
Motor power consumption	Arm #1	400 W		
	Arm #2	400 W		
	Arm #3	200 W		
	Arm #4	50 W		
	Arm #5	50 W		
	Arm #6	50 W		
Payload *2	Rated	2 kg		
	Maximum	(with conditions) 5 (7) kg		

Item		Specification		
Model		S5-A901S	S5-A901C	S5-A901P
Model Name		S5L		
Degree of protection		-	-	IP65
Cleanliness level (ISO class)		-	Class 4	-
Weight (not including cables, shipping jigs)		38 kg: 84 lb.		
Driving method	All arms	AC servo motor		
Max. operating speed *1	Arm #1	4.71 rad/s, 270 deg/s		
	Arm #2	4.88 rad/s, 280 deg/s		
	Arm #3	5.23 rad/s, 300 deg/s		
	Arm #4	7.85 rad/s, 450 deg/s		
	Arm #5	7.85 rad/s, 450 deg/s		
	Arm #6	12.57 rad/s, 720 deg/s		
Repeatability	Arm #1 to #6	±0.03 mm		
Max. motion range	Arm #1	±170 deg (Wall mounting: ±30 deg)		
	Arm #2	–150 deg, +65 deg		
	Arm #3	–72 deg, +190 deg		
	Arm #4	±190 deg		
	Arm #5	±135 deg		
	Arm #6	±360 deg		
Max. pulse range	Arm #1	±8120639 pulse (Wall mounting: ±1433054 pulse)		
	Arm #2	+3155438 pulse –7281778 pulse		
	Arm #3	+7686321 pulse –2912712 pulse		
	Arm #4	±5534152 pulse		
	Arm #5	±3932160 pulse		
	Arm #6	±6553600 pulse		
Resolution	Arm #1	0.00002093 deg/pulse		
	Arm #2	0.00002059 deg/pulse		
	Arm #3	0.00002471 deg/pulse		
	Arm #4	0.00003433 deg/pulse		
	Arm #5	0.00003433 deg/pulse		
	Arm #6	0.00005493 deg/pulse		
Motor power consumption	Arm #1	400 W		
	Arm #2	400 W		
	Arm #3	200 W		
	Arm #4	50 W		
	Arm #5	50 W		
	Arm #6	50 W		
Payload *2	Rated	2 kg		
	Maximum	(with conditions) 5 (7) kg		

Item		Specification
Model Name		S5 / S5L
Allowable moment	Arm #4	12 N·m (1.22 kgf·m)
	Arm #5	12 N·m (1.22 kgf·m)
	Arm #6	7 N·m (0.71 kgf·m)
Allowable moment of inertia ($GD^2/4$) *3	Arm #4	0.3 kg·m^2
	Arm #5	0.3 kg·m^2
	Arm #6	0.1 kg·m^2
Installed wire for customer use		15 wires : D-sub 15 pin connector
Installed pneumatic tube for customer use		2 pneumatic tubes (ø6 mm), Allowable pressure: 0.49 MPa (5kgf/cm^2) (71 psi)
Environmental requirements *4	Ambient temperature	0 deg.C to 45 deg.C (with minimum temperature variation)
	Ambient relative humidity	20% to 80% (no condensation)
Noise level *5		L_{Aeq} = 80 dB (A) or under
Default values (Max. setting values)	SPEED	5 (100)
	ACCEL	5, 5 (100, 100)
	SPEEDS	50 (2000)
	ACCELS	200 (25000)
	FINE	10000, 10000, 10000, 10000, 10000, 10000 (65535, 65535, 65535, 65535, 65535, 65535)
	WEIGHT	2, 0
Safety standard		CE Mark EMC Directive Machinery Directive RoHS Directive KC Mark / KCs Mark

*1 In the case of PTP control

*2 When the setting payload is more than 5 kg and less than or equal to 7 kg, refer to the section "*Restrictions on payload exceeding 5 kg (more than 5 kg and less than or equal to 7 kg)*" in *S5 series Manipulator Manual: Setup & Operation 4.3.1 WEIGHT Setting*.

*3 In the case where the center of gravity is at the center of each arm. If the center of gravity is not at the center of each arm, set the eccentric quantity using INERTIA command.

*4 For details of the environmental requirements, refer to *S5 series Manipulator Manual: Setup & Operation 3.1 Environmental Conditions*.

*5 Conditions of Manipulator at measurement are as follows:

Operating conditions:	Under rated load, 6 arms simultaneous motion, maximum speed, maximum acceleration, and duty 50%.
Measurement point:	1000 mm apart from the rear of Manipulator

1.10 Motion Range Setting by Mechanical Stops

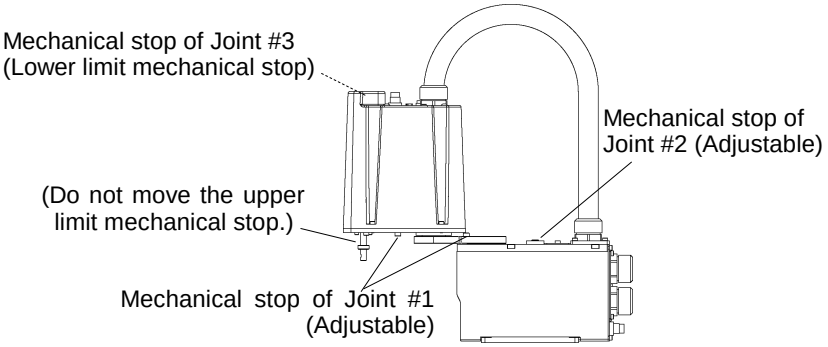
Mechanical stops physically limit the absolute area that the Manipulator can move.

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.

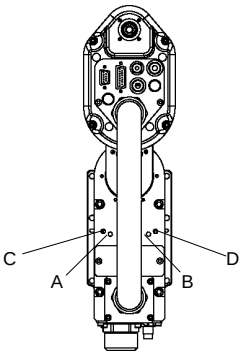
Joints #3 can be set to any length less than the maximum stroke.

Positions of the mechanical stoppers vary by manipulator model. For details, refer to the manual for each manipulator.

G1



Joint #1

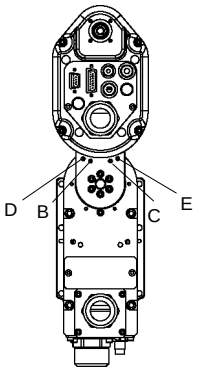


(° = degree)

Model	A	B	C	D
All	+125°	-125°	+120°	-120°

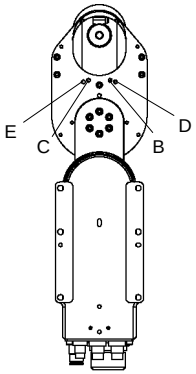
Joint #2

G1-171*



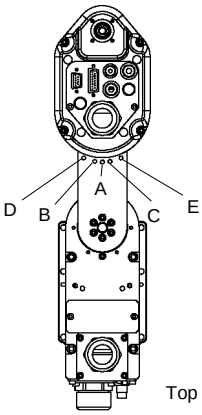
Top

G1-171CZ



Bottom

G1-221*



Top

(° = degree)

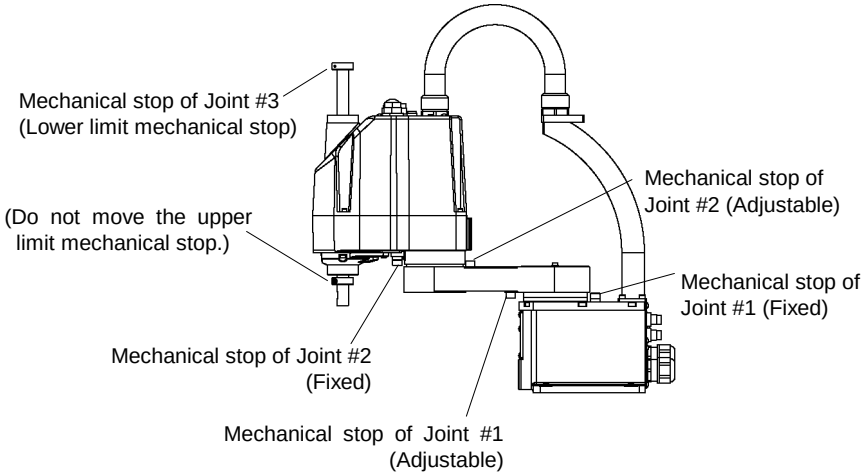
Model		A	B *1	C *1	D	E
4-axis spec	G1-171S	-	+140°	–140°	+130°	–130°
	G1-171C	-	+140°	–140°	+130°	–130°
	G1-221S	±152	+140°	–140°	+125°	–125°
	G1-221C	±149	+140°	–140°	+125°	–125°
3-axis spec	G1-171SZ	-	+135°	–135°	+125°	–125°
	G1-171CZ *2	-	+123°	–123°	+115°	–115°
	G1-221SZ	-	+135°	–135°	+120°	–120°
	G1-221CZ	-	+132°	–132°	+120°	–120°

*1 Standard position of the mechanical stop

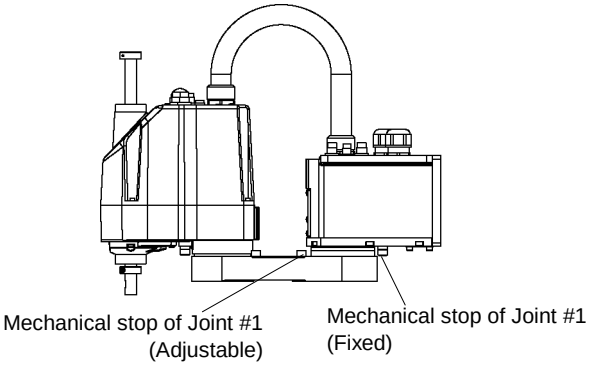
*2 Limits the motion range using the bolts in the Arm #2 bottom to prevent the bellows from contacting the manipulator body.

G3

Table Top Mounting



Multiple Mounting



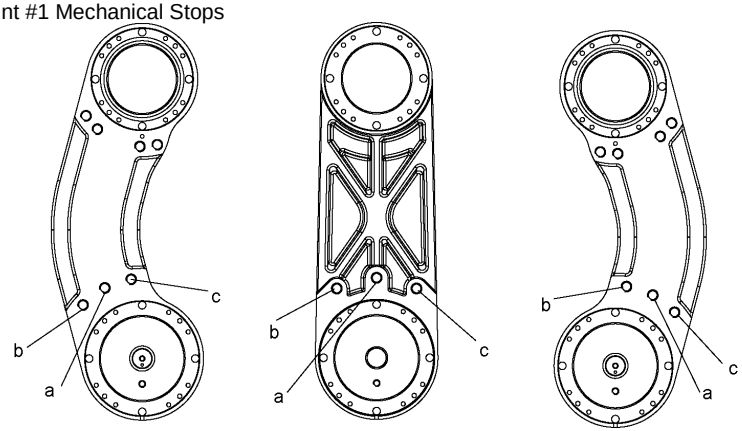
* The different mechanical stop positions from Table Top mounting are indicated for Multiple mounting.

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



R L

Views from the bottom of Arm #1

Model	Arm	a	b	c
G3-**1S, C	250	±140°	-110°	+110°
	300	±140°	-110°	+110°
	350	±140°	-110°	+110°
G3-**1S, C-R	300	-125° ~ +150°	-105°	+130°
	350	-110° ~ +165°	-90°	+145°
G3-**1S, C-L	300	-150° ~ +125°	-130°	+105°
	350	-165° ~ +110°	-145°	+90°
G3-**1SM, CM	300	±115°	-100°	+100°
	350	±120°	-105°	+105°
G3-351SM, CM-R	350	-105° ~ +130°	-95°	+120°
G3-351SM, CM-L	350	-130° ~ +105°	-120°	+95°

Setting Angle	+90°	+95°	+100°	+105°	+110°	+115°	+120°
Pulse Value	5242880	5388516	5534151	5679787	5825423	5971058	6116694

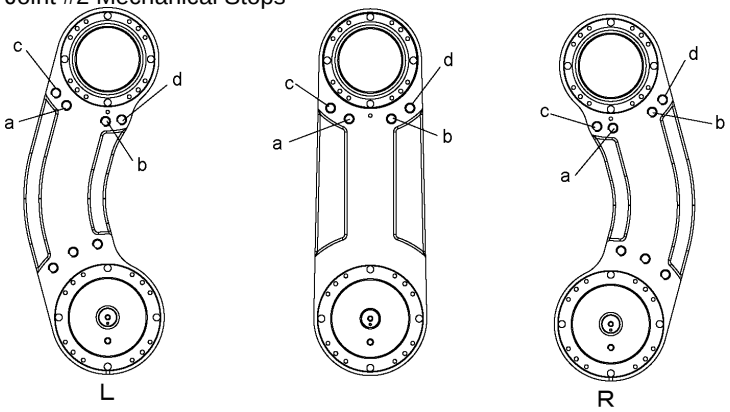
Setting Angle	+125°	+130°	+140°	+145°	+150°	+165°
Pulse Value	6262329	6407965	6699236	6844872	6990507	7427414

Setting Angle	-90°	-95°	-100°	-105°	-110°	-115	-120°
Pulse Value	0	-145636	-291271	-436907	-582542	-728178	-873813

Setting Angle	-125°	-130°	-140°	-145°	-150°	+165°
Pulse Value	-1019449	-1165085	-1456356	-1601991	-1747627	-2184533

(°: degree)

Joint #2 Mechanical Stops



Views from the top of Arm #1

Model	Arm	a	b	c	d
G3-**1S, C	250	+141°	-141°	+120°	-120°
	300	+142°	-142°	+120°	-120°
	350	+142°	-142°	+120°	-120°
G3-**1S, C-R	300	+150°	-135°	+130°	-115°
	350	+165°	-120°	+145°	-100°
G3-**1S, C-L	300	+135°	-150°	+115°	-130°
	350	+120°	-165°	+100°	-145°
G3-**1SM, CM	300	+135°	-135°	+115°	-115°
	350	+142°	-142°	+120°	-120°
G3-351SM, CM-R	350	+160°	-120°	+150°	-110°
G3-351SM, CM-L	350	+120°	-160°	+110°	-150°

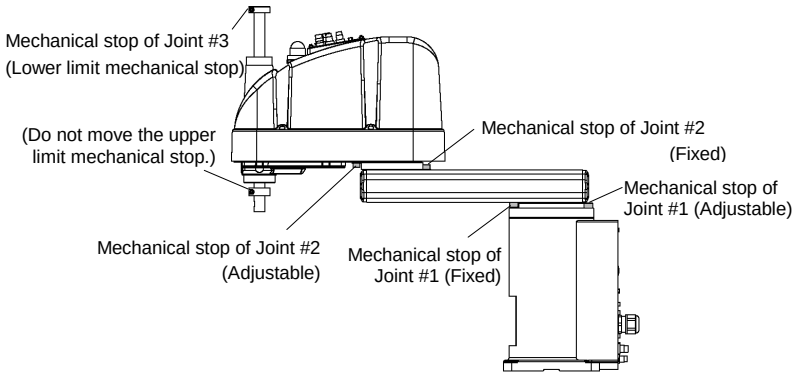
Setting Angle	+100°	+110°	+115°	+120°	+130°	+135°
Pulse Value	1820444	2002488	2093511	2184533	2366577	2457600
Setting Angle	+141°	+142°	+145°	+150°	+160°	+165°
Pulse Value	2566826	2585031	2639644	2730666	2912711	3003733
Setting Angle	-100°	-100°	-115°	-120°	-130°	-135°
Pulse Value	-1820444	-2002488	-2093511	-2184533	-2366577	-2457600
Setting Angle	-141°	-142°	-145°	-150°	-160°	-165°
Pulse Value	-2566826	-2585031	-2639644	-2730666	-2912711	-3003733

(°: degree)

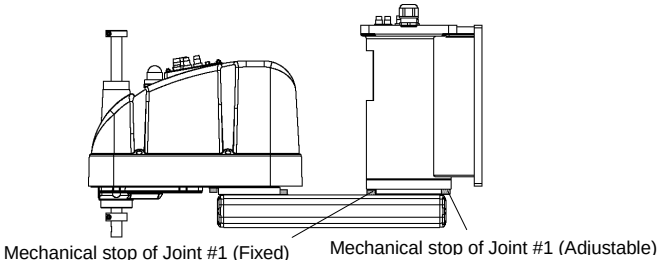
NOTE In case of Multiple Mounting, it is impossible to limit the operating range completely. Because it may hit the wall within the setting range of mechanical stops.

G6

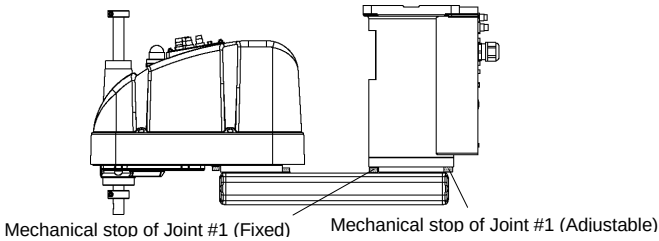
Table Top Mounting



Wall Mounting

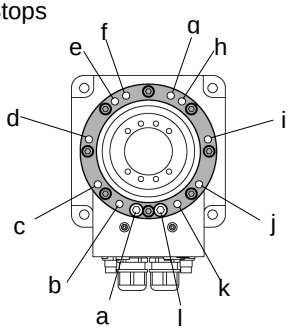


Ceiling Mounting



* The different mechanical stop positions from Table Top mounting are indicated for Wall mounting and Ceiling mounting.

Joint #1 Mechanical Stops



Joint #1

Mounting	Arm Length	a	b	c	d	e	f
Table Top	45, 55, 65	+152°	+135°	+105°	+60°	+20°	+5°
Ceiling	55, 65						
Wall	65		+148°				
	55		+135°				
Ceiling	45		+120°		+75°	+30°	
Wall	45						

Mounting	Arm Length	g	h	i	j	k	l
Table Top	45, 55, 65	-5°	-20°	-60°	-105°	-135°	-152°
Ceiling	55, 65						
Wall	65					-148°	
	55					-135°	
Ceiling	45		-30°	-75°		-120°	
Wall	45						

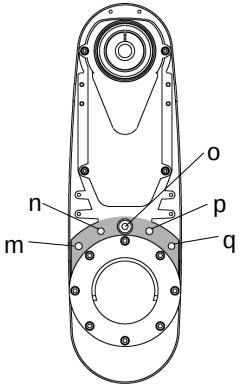
Setting Angle	+152°	+148°	+135°	+120°	+105°	+75°	+60°
Pulse Value	7048761	6932253	6553600	6116694	5679787	4805974	4369067

Setting Angle	+30°	+20°	+5°	-5°	-20°	-30°	-60°
Pulse Value	3495254	3203983	2767076	2475805	2038898	1747627	873814

Setting Angle	-75°	-105°	-120°	-135°	-148°	-152°
Pulse Value	436907	-436907	-873814	-1310720	-1689373	-1805881

(°: degree)

Joint #2 Mechanical Stops



Joint #2

Model		Arm Length	m	n	o	p	q
Table Top, Ceiling, Wall		55, 65	+100°	+125°	+147.5°	-125°	-100°
Table Top	G6-45*S, D	45 (Z : 0 to –270)			+147.5°		
		45 (Z :–270 to –330)			+145°		
	G6-45*C, P, D bellows	45 (Z : 0 to –240)			+147.5°		
		45 (Z :–240 to –300)			+142°		
Ceiling, Wall		45			+130°		

The bellows for G6-***D* are options at shipment.

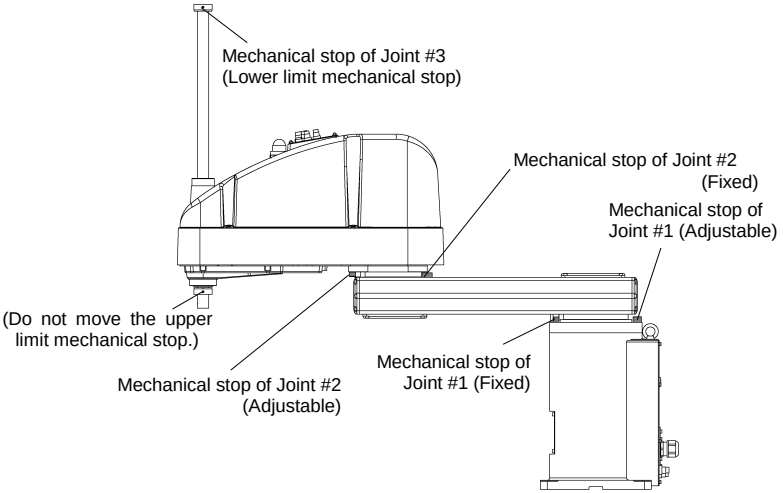
Setting Angle	+147.5°	+145°	+142°	+130°	+125°	+100°
Pulse Value	2685156	2639645	2585031	2366578	2275556	1820445

Setting Angle	-100°	-125°	-130°	-142°	-145°	-147.5°
Pulse Value	-1820445	-2275556	-2366578	-2585031	-2639644	-2685156

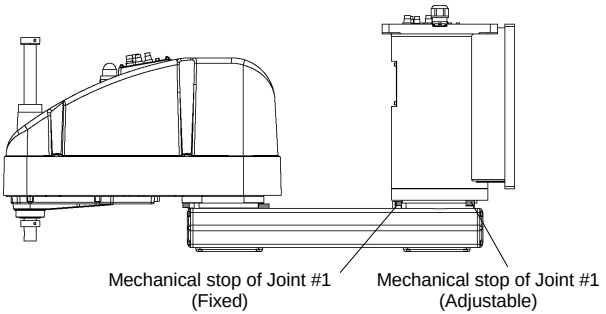
(°: degree)

G10/G20

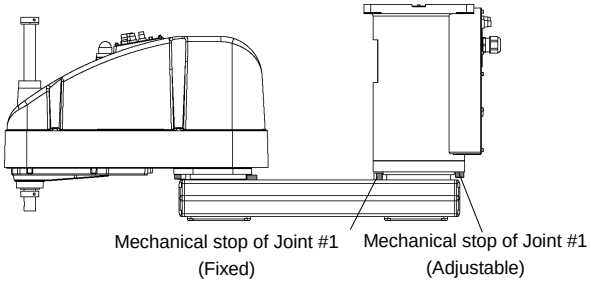
Table Top Mounting



Wall Mounting

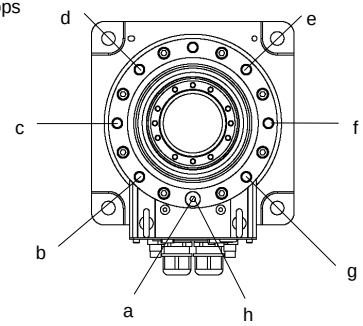


Ceiling Mounting



* The different mechanical stop positions from Table Top Mounting are indicated for Wall Mounting and Ceiling Mounting.

Joint #1 Mechanical Stops



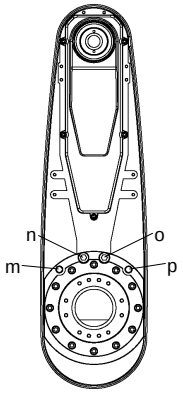
Joint #1

Mounting	Arm Length	a	b	c	d	e	f	g	h
Table Top	65, 85, A0	+152°	+107°	+60°	+15°	-15°	-60°	-107°	-152°
Ceiling	85, A0								
Ceiling	65								
Wall	65, 85, A0								

	a	b	c	d	e	f	g	h
Setting Angle	+152°	+107°	+60°	+15°	-15°	-60°	-107°	-152°
Pulse Value	+7048761	+5738041	+4369067	+3058347	+2184534	+873814	-495161	-1805881

(°: degree)

Joint #2 Mechanical Stops



Joint #2

Model		Arm Length		m	n	o	q
Table Top, Ceiling, Wall		A0		+122.5°	+152.5°	-152.5°	-122.5°
Table Top	G10/G20 -85*S, D	85					
	G10/G20 -85*C, P, D bellows	85	Z: 0 to –360				
			Z: –360 to –390	+121°	+151°	-151°	-121°
Ceiling, Wall	G10/G20 -85*SR, SW, DR, DW	85		+122.5°	+152.5°	-152.5°	-122.5°
	G10/G20 -85*CR, CW, PR, PW, DR bellows / DW bellows	85		+100°	+130°	-130°	-100°
Table Top		65		+122.5°	+152.5°	-152.5°	-122.5°
Ceiling / Wall		65		+100°	+130°	-130°	-100°

The bellows for G10/G20-***D* are options at shipment.

Setting Angle	+100°	+121°	+122.5°	+151°	+152.5°
Pulse Value	+1820445	+2202738	+2230045	+2748871	+2776178

Setting Angle	-152.5°	-151°	-122.5°	-121°	-100°
Pulse Value	-2776178	-2748871	-2230045	-2202738	-1820445

(°: degree)

NOTE

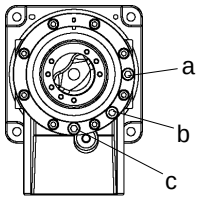
In the range Z: –360 to –390 mm, the area is limited by interference of the Manipulator body and the arm.

C3

Motion Range Setting of Arm #1

Install the bolt to the threaded hole corresponding to the angle you want to set.
Normally a mechanical stop is equipped at [b].
[a] and [c] limit the one side of motion range.
Remove the bolts when the motion range of the Arm #1 is set to ±180 deg.

M8×15 hexagon socket head cap bolt
Tightening torque 3720 N·cm (380 kgf·cm)

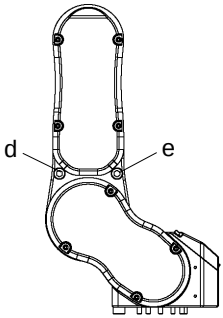


	a	b		c
Angle (deg.)	–125	±170	±180	+125
Pulse (pulse)	–3640889	±4951609	±5242880	–3640889
Bolt	Applied	Applied (Normal)	Not applied	Applied

Motion Range Setting of Arm #2

There are threaded holes corresponding to each angle on the Manipulator.
Normally there is no mechanical stop equipped.
(–160 deg. - +65 deg.)
[d] and [e] limit the one side of motion range.

M10×15 hexagon socket head cap bolt
Tightening torque 7350 N·cm (750 kgf·cm)

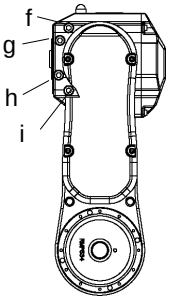


	d	e	-	-
Angle (deg.)	–143	+48	–160	+65
Pulse (pulse)	–4165177	+1398102	–4660338	+1893263
Bolt	Applied	Applied	Not applied (Normal)	Not applied (Normal)

Motion Range Setting of Arm #3

There are threaded holes corresponding to each angle on the Manipulator.

Normally mechanical stops are equipped to [g] and [h].
(+225 deg. - –51 deg.)



M8×12 hexagon socket head cap bolt
Tightening torque 3720 N·cm (380 kgf·cm)

	f	i	g	h
Angle (deg.)	+201	–27	+225	–51
Pulse (pulse)	+5122731	–688128	+5734400	–1299798
Bolt	Applied	Applied	Applied (Normal)	Applied (Normal)

1.11 End User Training

Be sure those in charge of safety management confirm that the operators who program, operate, and maintain the robot and robot system obtain proper training and have the expertise to conduct the work safely.

Training should include at least the following:

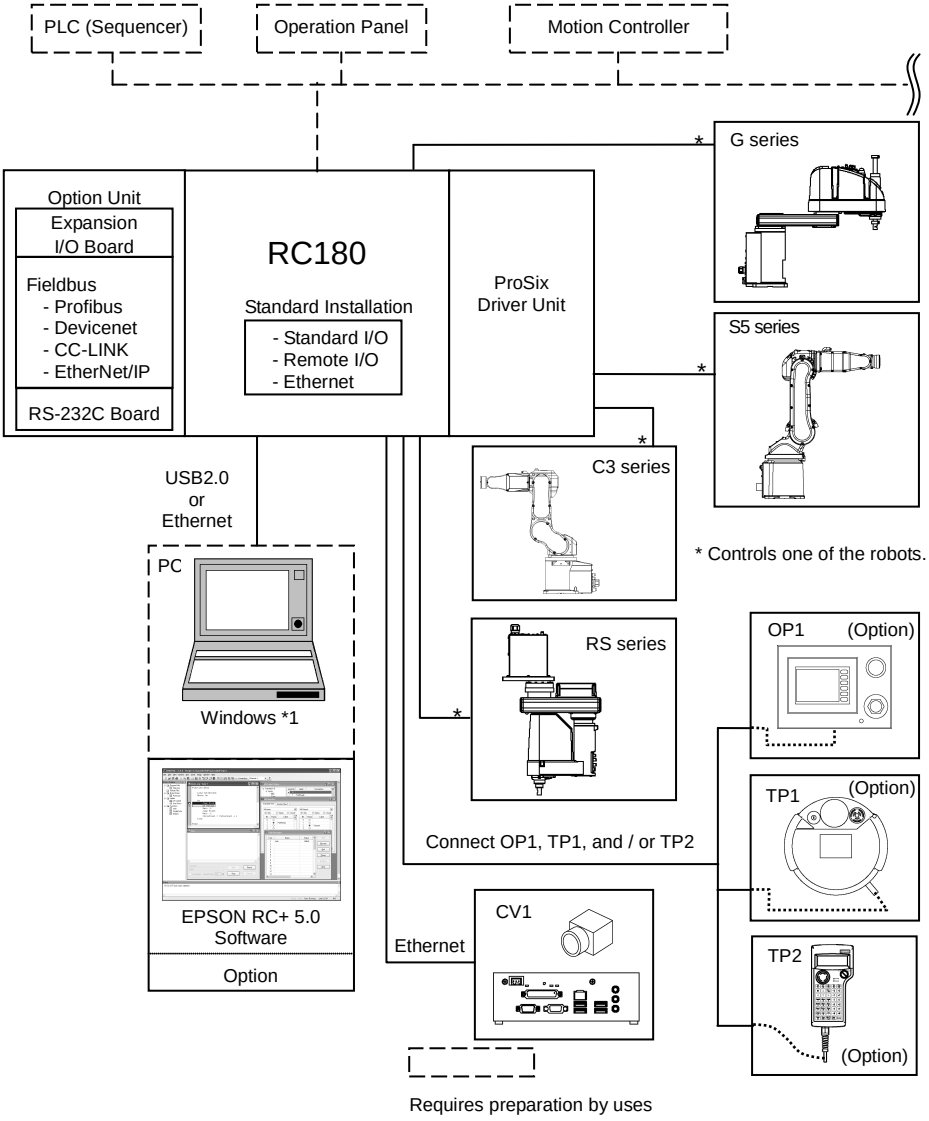
- Study of regulation safety procedures, and safety-related recommendations by robot manufacturers and system designers.
- Clear explanation of the work involved.
- Description of all control equipment required for the work and their functions.
- Explanation of potential hazards involved in the work.
- Work safety procedures and specific methods of avoiding potential hazards.
- Safety device and interlock function testing and confirmation methods are working properly.

2. Installation

This chapter contains precautions for safe and accurate installation of the robot system.

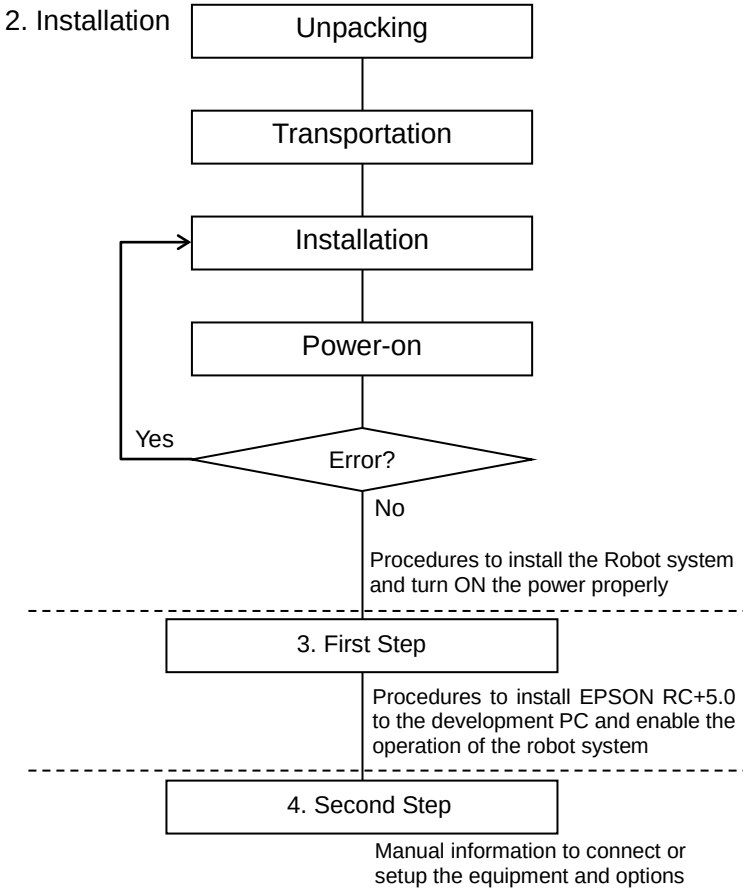
The outline to install the robot system is indicated on 2.1 Outline from Unpacking to Operation of Robot System. Refer to each section and/or the Manipulator manual and the Controller manual for unpacking, transportation, and installation.

System Example



*1 EPSON RC+ 5.0 supports the following OS.
Windows XP Professional Service Pack 3 (EPSON RC+ 5.0 Ver.5.2.0 SP3 or after is required.)
Windows Vista Business Service Pack 2 (EPSON RC+ 5.0 Ver.5.3.1 or after is required.)
Windows 7 Professional (EPSON RC+ 5.0 Ver.5.3.4 or after is required.
Windows 8.1 Pro (EPSON RC+ 5.0 Ver.5.4.6 or after is required.)

2.1 Outline from Unpacking to Operation of Robot System



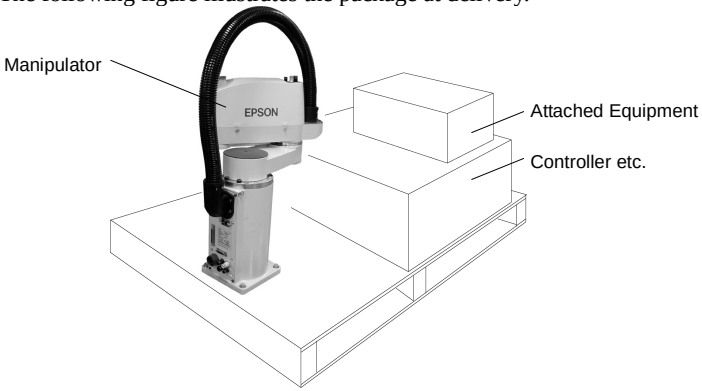
2.2 Unpacking

Installation and transportation of robots and robotic equipment shall be performed by qualified personnel and should conform to all national and local codes.

Using a cart or similar equipment, transport the Manipulator in the same conditions as it was delivered. Observe the following when unpacking the Manipulator.

2.2.1 Package Components Example

The following figure illustrates the package at delivery.



2.2.2 Unpacking Precautions

Transportation procedure

: Only authorized personnel should perform sling work and operate a crane or 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.

Vibration at transportation

: Avoid excessive vibration or shock during Manipulator transporting. Excessive vibration or shock may cause equipment damage to and/or malfunction of the Manipulator.

Anchor bolt

: When removing the anchor bolts, support the Manipulator to prevent falling. Removing the anchor bolts without supporting the Manipulator may get hands, fingers, or feet caught as the Manipulator will fall.

Wire tie

: Do not remove the wire tie securing the arm until you finish the installation. You may get your hands caught in the Manipulator when the wire tie is removed before completing the installation.

2.3 Transportation

Installation and transportation of robots and robotic equipment shall be performed by qualified personnel and should conform to all national and local codes.

2.3.1 Transportation Precautions

Transportation procedure

: Using a cart or similar equipment, transport the Manipulator in the same conditions as it was delivered. Observe the following when unpacking the Manipulator.

Only authorized personnel should perform sling work and operate a crane or 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.

Vibration at transportation

: Avoid excessive vibration or shock during Manipulator transporting. Excessive vibration or shock may cause equipment damage to and/or malfunction of the Manipulator.

Anchor bolt

: When removing the anchor bolts, support the Manipulator to prevent falling.

Removing the anchor bolts without supporting the Manipulator may get hands, fingers, or feet caught as the Manipulator will fall.

Wire tie

: Do not remove the wire tie securing the arm until you finish the installation.

You may get your hands caught in the Manipulator when the wire tie is removed before completing the installation.

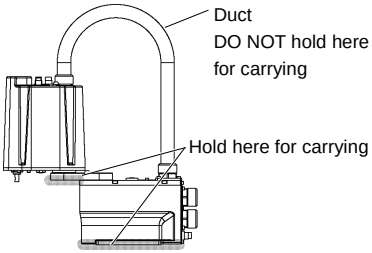
Hoisting procedure

: Stabilize the Manipulator with your hands when hoisting it. Unstable hoisting is extremely hazardous and may results in serious bodily injury and/or severe equipment damage to the robot system as the fall of the Manipulator.

2.3.2 Manipulator Transportation

G1

To carry the Manipulator, 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. Never hold the duct to carry the Manipulator.



G1-171*
approx. 8 kg :18 lb.
G1-221*
approx. 8 kg :18 lb.

G3

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.

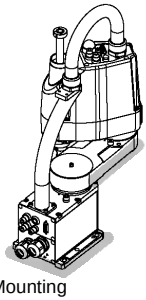
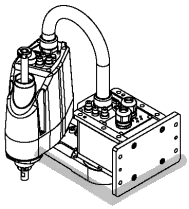


Table Top Mounting
G3-251* : approx. 14 kg: 31 lb.
G3-301* : approx. 14 kg: 31 lb.
G3-351* : approx. 14 kg: 31 lb.



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

G6

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 / 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.

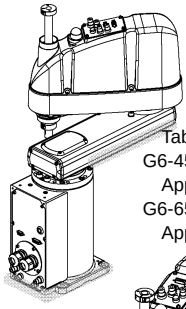
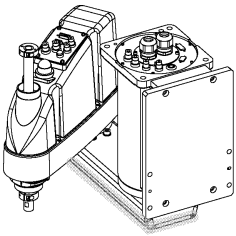
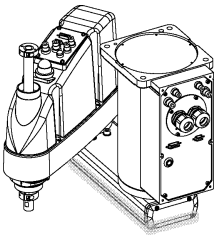


Table Top Mounting
G6-45**, G6-55**
Approx. 27 kg: 60 lb.
G6-65**
Approx. 28 kg: 62 lb.



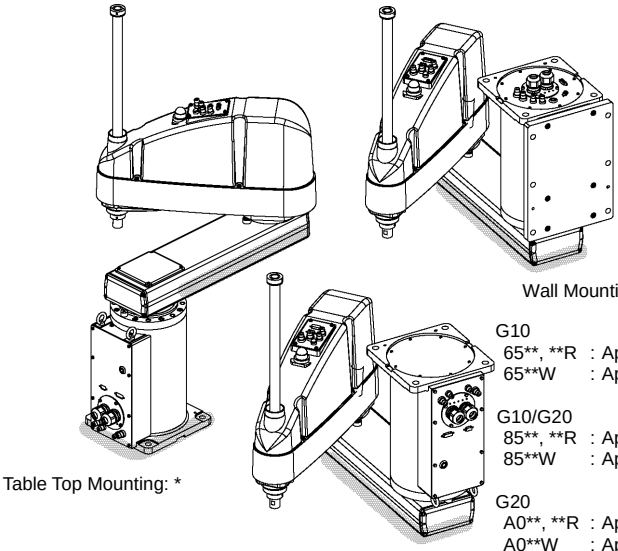
Wall Mounting
G6-45**W, G6-55**W
Approx. 29 kg: 64 lb.
G6-65**W
Approx. 29.5 kg: 65 lb.



Ceiling Mounting
G6-45**R, G6-55**R
Approx. 27 kg: 60 lb.
G6-65**R
Approx. 28 kg: 62 lb.

G10 / G20

To carry the Manipulator, secure the Manipulator to the delivery equipment, or pass belts through the eyebolts and hoist it with your hands. Make sure to hold the areas indicated in gray in the figure (bottom of Arm #1 and bottom of the base) by hand.



Wall Mounting: W

Table Top Mounting: *

Ceiling Mounting: R

G10
65**, **R : Approx. 46 kg : 102 lb
65**W : Approx. 51 kg : 113 lb

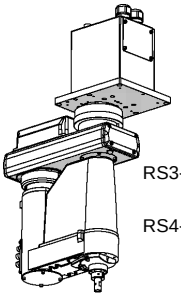
G10/G20
85**, **R : Approx. 48 kg : 106 lb
85**W : Approx. 53 kg : 117 lb

G20
A0**, **R : Approx. 50 kg : 111 lb
A0**W : Approx. 55 kg : 122 lb

RS

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.

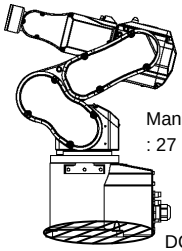


RS3-351* : approx. 17 kg : 38 lb.
(except cables)
RS4-551* : approx. 19 kg : 42 lb.
(except cables)

C3

To carry the Manipulator, have at least 2 people to work on it and secure the Manipulator to the delivery equipment or hold it by hand.

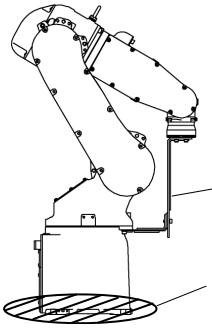
Do not hold the bottom of the base (the screened parts in the figure). Holding these parts by hand is extremely hazardous and may cause your hands and fingers to be caught.



S5

To carry the Manipulator, have at least 3 people to work on it and secure the Manipulator to the delivery equipment or hold it by hand.

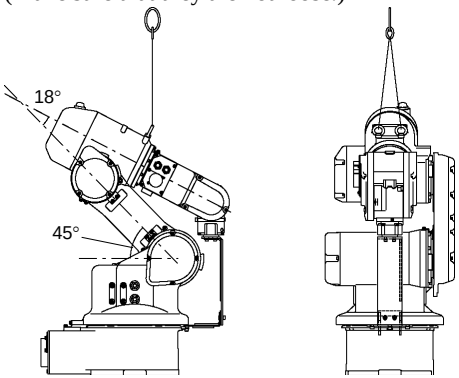
Do not hold the bottom of the base (the screened parts in the figure). Holding these parts by hand is extremely hazardous and may cause your hands and fingers to be caught or cut by the grounding electrode.



2.3.3 Using a Crane

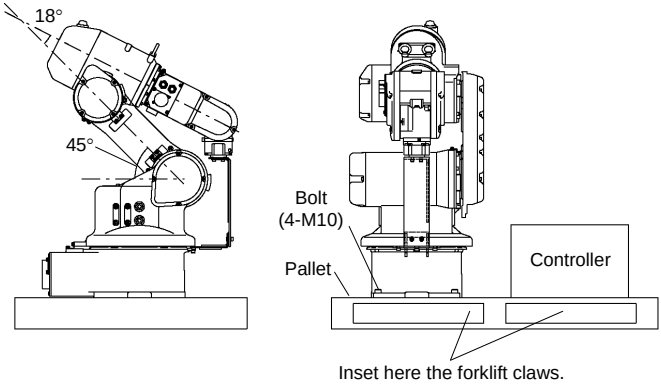
To hoist the Manipulator with a crane, secure the Manipulator with shipping bolts and jigs and posture the Manipulator as shown in the figures below (the posture at shipment from the manufacturer).

Use a cable threaded through the eyebolts attached to the Manipulator as shown. (Make sure that they are not loose.)



2.3.4 Using a Forklift

Position the Manipulator as shown in the figures below (the posture at shipment from the manufacturer) and secure it onto a pallet with shipping bolts and jigs. Insert the forklift claws under the pallet and transport the Manipulator together with the pallet. The pallet must have enough strength to bear the weight of the Manipulator. Transporting of the Manipulator must be performed slowly in order to avoid overturning or slippage.



2.4. Manipulator Installation

Installation and transportation of robots and robotic equipment shall be performed by qualified personnel and should conform to all national and local codes.

2.4.1 Installation Precautions

Safeguard installation

: 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*.

Space between safeguard and Manipulator

: Install the Manipulator at a location with sufficient space so that a tool or a work piece on the end effector does not reach a wall or a safeguard when the Manipulator extends its arm fully while holding a work piece. Installing the Manipulator at a location with insufficient space is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system as a tool or a work piece may collide with a wall and a safeguard.

Manipulator check before installation

: Before installing and operating the Manipulator, make sure that all parts of the Manipulator are in place and have no external defects. Missing or defective parts may cause improper operation of the Manipulator. Improper operation of the Manipulator is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system.

Side mounting and ceiling mounting

: When mounting the Manipulator on a wall or ceiling, secure the Manipulator to the wall or ceiling that has enough strength and rigidity. Mounting the Manipulator on a wall or ceiling that has insufficient strength and rigidity is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system as the Manipulator may fall or vibrate.

Side mounting and ceiling mounting

: When mounting the Manipulator on a wall or ceiling, for safety purposes, attach the support to the Manipulator base to prevent the Manipulator from falling. If the Manipulator falls, it is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system.

For Protected-model

: Connect the power cable connection and the signal cable connector to the Manipulator immediately after the Manipulator installation. The Manipulator without connecting them may result in electric shock and/or malfunction of the robot system as it cannot ensure IP65.

2.4.2 Environment

In order to optimize the robot system's performance for safety, the Controller must be placed in an environment that satisfies the following conditions:

NOTE

- The Controller is not designed for clean-room specification. If it must be installed in a clean room, be sure to install it in a proper enclosure with adequate ventilation and cooling.
- Install Controller in a location that allows easy connection / disconnection of cables.

Item	Condition
Ambient temperature	5 to 40 deg.C (with minimal variation)
Ambient relative humidity	20% to 80% (with no condensation)
First transient burst noise	2 kV or less (Power supply wire) 1 kV or les (Signal wire)
Electrostatic noise	4 kV or less
Base table	Use a base table that is at least 100 mm off the floor. Placing the Controller directly on the floor could allow dust penetration leading to malfunction.

2.4.3 Noise Level

Noise level by movement of manipulator.

Manipulator	Level dB(A)	Operating conditions	Measurement point
G1 RS3 RS4	65 or less	Under rated load, 4-joints, simultaneous motion, maximum speed, maximum acceleration, and duty 50%	In front of the Manipulator, 1000 mm apart from the motion range, 50 mm above the base-installed surface
G3 G6 G10 G20	70 or less		
C3	76 or less	Under rated load, All arm simultaneous operation, maximum speed, maximum acceleration, and duty 50%	1000mm apart from the Back of the Manipulator
S5	80 or less		

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

G, RS series

	G					RS	
	G1	G3	G6	G10	G20	RS3	RS4
Max. Reaction torque on the horizontal plate (Nm)	100	300	500	1000	1000	500	500
Max. Horizontal reaction force (N)	200	2000	2500	4500	7500	1200	1400
Max. Vertical reaction force (N)	300	1000	1500	2000	2000	1100	1100
Threaded holes for Mounting screw	M6	M8	M8	M12	M12	M6	M6

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.

C3, S5 series

	C3	S5	
		701	901
Max. Reaction torque on the horizontal plate (Nm)	500	600	900
Max. Horizontal reaction force (N)	800	1000	1400
Max. Reaction torque on the vertical plate (Nm)	600	800	900
Max. Vertical reaction force (N)	2500	3000	3500
Threaded holes for Mounting screw	M8	M10	M10

The plate for the Manipulator mounting face should be 30 mm thick or more and made of steel to reduce vibration. The surface roughness of the steel plate should be 25 μm or less.

Use mounting bolts with specifications conforming to ISO898-1 property class: 10.9 or 12.9.

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

2.4.5 Installation Procedure

NOTE

When the Manipulator is Clean-model, unpack it outside of the clean room. Secure the Manipulator not to fall, and then wipe off the dust on the Manipulator with a little alcohol or distilled water on a lint-free cloth. After that, carry the Manipulator in the clean room. Connect an exhaust tube to the exhaust port after installation.

G1

There are 4 threaded holes for the Manipulator base. Use M6 mounting bolts conforming to the strength, ISO898-1 property class: 6.9.

Tightening torque: 13 N·m (133 kgf·cm)

G1-177* 8kg: 18lb.

G1-221* 8kg: 18lb.

G3 : Table Top Mounting-

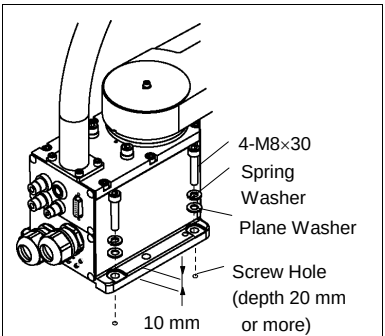
CAUTION	■ Install the Table Top Mounting Manipulator with two or more people. The Manipulator weights are as follows. Be careful not to get hands, fingers, or feet caught and/or have equipment damaged by a fall of the Manipulator. G3-251* : approx. 14 kg: 31 lb. G3-301* : approx. 14 kg: 31 lb. G3-351*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

(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.

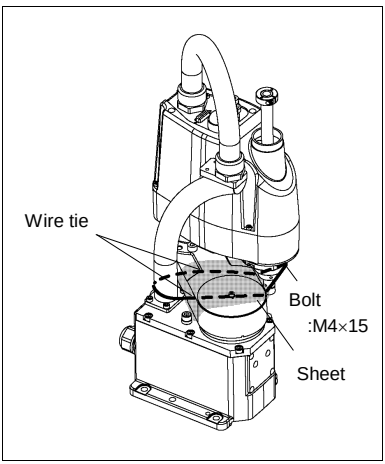
Tightening torque
: 32.0 N·m (326 kgf·cm)



(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).

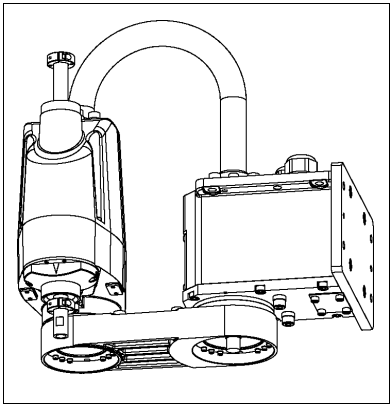
(4) Remove the shipping bolt and jigs.



G3 : 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. G3-301*M : approx. 14 kg: 31 lb. 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.

(1) Unpack the manipulator with retaining the arm posture.



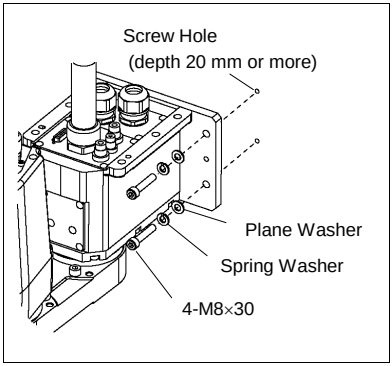
(2) Secure the base to the wall with four bolts.

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)

(3) Remove the shipping bolt and jigs.



G6 : Table Top Mounting

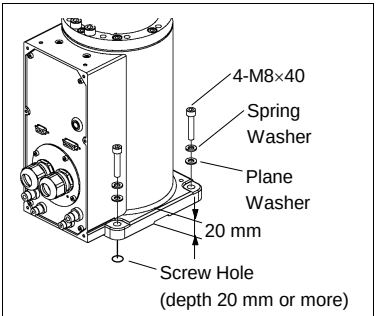
WARNING	■ Install the Table Top Mounting Manipulator with two or more people. The Manipulator weights are as follows. Be careful not to get hands, fingers, or feet caught and/or have equipment damaged by a fall of the Manipulator. G6-45** : Approximately 27 kg: 60 lb. G6-55** : Approximately 27 kg: 60 lb. G6-65** : Approximately 28 kg: 62 lb.

(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.

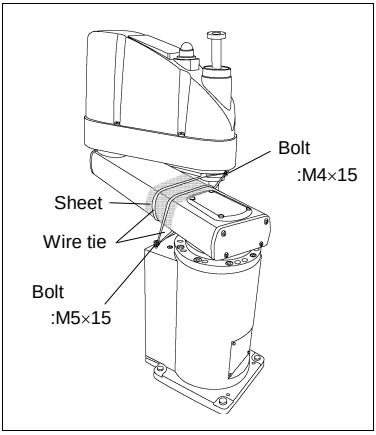
Tightening torque
: 32.0 N·m (326 kgf·cm)



(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).

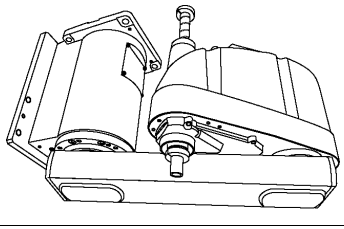
(4) Remove the shipping bolt and jigs.



G6 : Wall Mounting

WARNING	■ Install the Wall 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. G6-45**W : Approximately 29 kg: 64 lb. G6-55**W : Approximately 29 kg: 64 lb. G6-65**W : Approximately 29.5 kg: 65 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.

(1) Unpack the manipulator with retaining the arm posture.



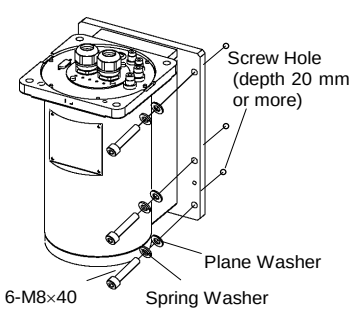
(2) Secure the base to the wall with six bolts.

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)

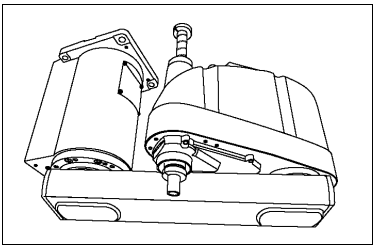
(3) Remove the shipping bolt and jigs.



G6 : Ceiling Mounting

WARNING	■ Install the Ceiling 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. G6-45**R : Approximately 27 kg: 60 lb. G6-55**R : Approximately 27 kg: 60 lb. G6-65**R : Approximately 28 kg: 62 lb. ■ When installing the Manipulator to the ceiling, support the Manipulator, and then secure the anchor bolts. Removing the support without securing the anchor bolts properly is extremely hazardous and may result in fall of the Manipulator.

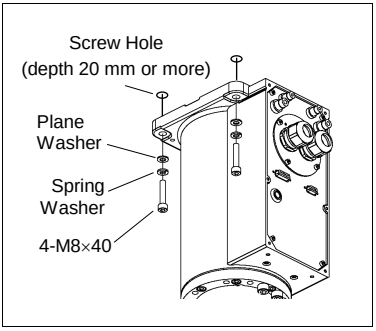
(1) Unpack the manipulator with retaining the arm posture.



(2) Secure the base to the ceiling 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)



(3) Remove the shipping bolt and jigs.

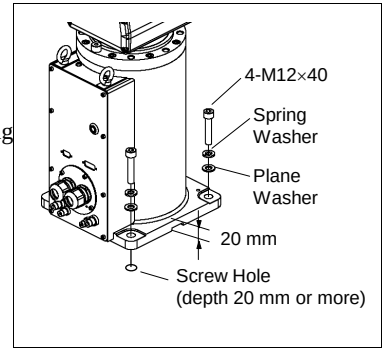
G10/G20 : Table Top Mounting

CAUTION	■ Install the Table Top Mounting Manipulator with four 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. G10-65** : Approximately 46 kg :102 lb. G10/G20-85** : Approximately 48 kg :106 lb. G20-A0** : Approximately 50 kg :111 lb.

(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.

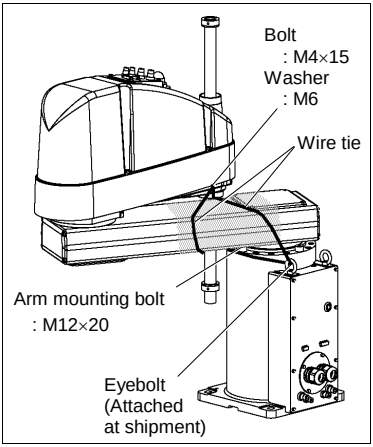
Tightening torque
: 73.5 N·m (750 kgf·cm)



(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).

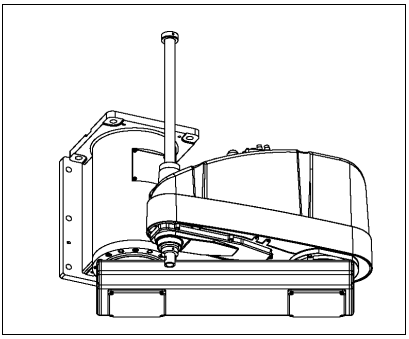
(4) Remove the shipping bolt and jigs.



G10/G20 : Wall Mounting

WARNING	■ Install the Wall Mounting Manipulator with four 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. G10-65**W : Approximately 51 kg :113 lb. G10/G20-85**W : Approximately 53 kg :117 lb. G20-A0**W : Approximately 55 kg :122 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.

(1) Unpack the manipulator with retaining the arm posture.



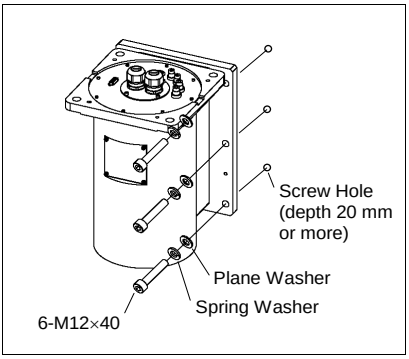
(2) Secure the base to the wall with six bolts.

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

NOTE

Tightening torque
: 32.0 N·m (326 kgf·cm)

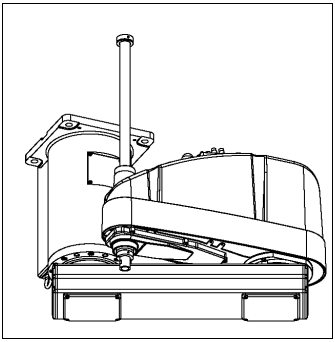
(3) Remove the shipping bolt and jigs.



G10/G20 : Ceiling Mounting

WARNING	■ Install the Ceiling Mounting Manipulator with four 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. G10-65**R : Approximately 46 kg :102 lb. G10/G20-85**R: Approximately 48 kg :106 lb. G20-A0**R : Approximately 50 kg :111 lb. ■ When installing the Manipulator to the ceiling, support the Manipulator, and then secure the anchor bolts. Removing the support without securing the anchor bolts properly is extremely hazardous and may result in fall of the Manipulator.

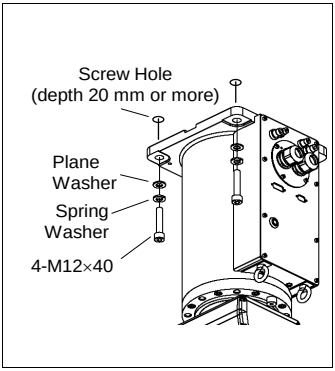
(1) Unpack the manipulator with retaining the arm posture.



(2) Secure the base to the ceiling 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)

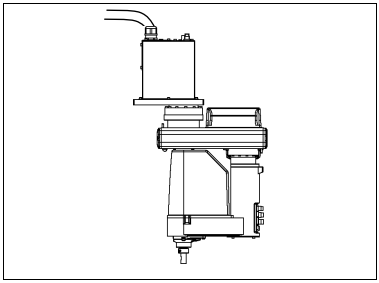


(3) Remove the shipping bolt and jigs.

RS

CAUTION	■ Install the Manipulator with two or more people. The Manipulator weights are as follows. Be careful not to get hands, fingers, or feet caught and/or have equipment damaged by a fall of the Manipulator. RS3-351*: approx. 17 kg : 38 lb. (except cables) RS4-551*: approx. 19 kg : 42 lb. (except cables) ■ When installing the Manipulator to the ceiling, support the Manipulator, and then secure the anchor bolts. Removing the support without securing the anchor bolts properly is extremely hazardous and may result in fall of the Manipulator.

(1) Unpack the Manipulator with retaining the arm posture.

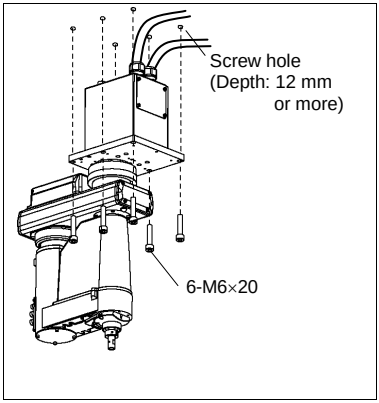


(2) Secure the base to the wall with 6 bolts.

NOTE

Intensity of the bolts should be equivalent to ISO898-1 Property Class 10.9 or 12.9.

Tightening torque
: 13.0 N·m (133 kgf·cm)



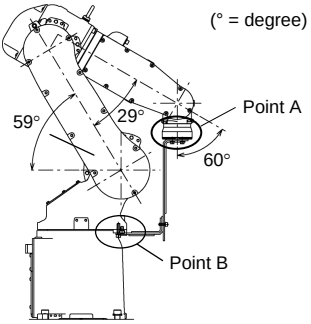
(3) Remove the shipping bolt and jigs.

S5

The shipping bolts and jigs are attached to the Manipulator as shown the figure below (points A, B) for protecting the Manipulator from various external forces during transportation.
Be sure to remove the bolts from the Point A first, and then, remove the bolts from Point B.
The jigs are painted yellow.

Point A : 6-M5×14 hexagon socket head cap bolts
with plain washers and disc spring washers

Point B : 2-M6×10 hexagon socket head cap bolts
with plain washers and disc spring washers



C3

There are four threaded holes for the Manipulator base.
Use M8 mounting bolts conforming to the strength of ISO898-1 property class 12.9.

2.5 Controller Installation

2.5.1 Installation Precautions

Environment conditions

: The Controller must be used within the environmental conditions described in their manuals. This product has been designed and manufactured strictly for use in a normal indoor environment. Using the product in the environment that exceeds the conditions may not only shorten the life cycle of the product but also cause serious safety problems.

For Clean-room installation

: The Controller is not designed for clean-room specification. If it must be installed in a clean room, make sure to install it in the proper enclosure with adequate ventilation and cooling.

Installation procedure

: Before performing any installation procedure, turn OFF the Controller and related equipment, and then pull out 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.

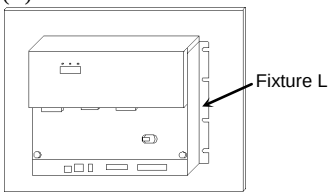
Cable

: 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 a contact failure is extremely hazardous and may result in electric shock and/or improper function of the system.

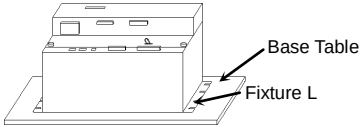
2.5.2 Installation

- Mount the Controller mounting screws with 80 to 110 Ncm torque.
- Install the controller on a flat surface such as wall, floor, and controller box in the direction shown from (A) to (D).

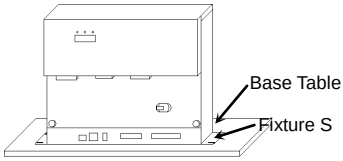
(A)



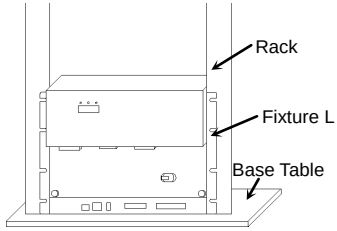
(B)



(C)



(D)

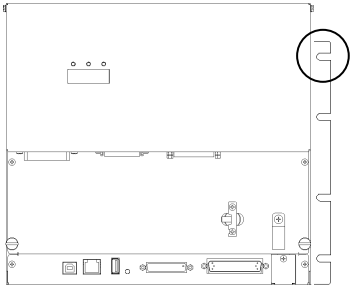


There are two types of fixtures. Mount the fixture to the Controller with the four attached screws.

Fixture L: Used in (A), (B), and (D) / Fixture S: Used in (C)

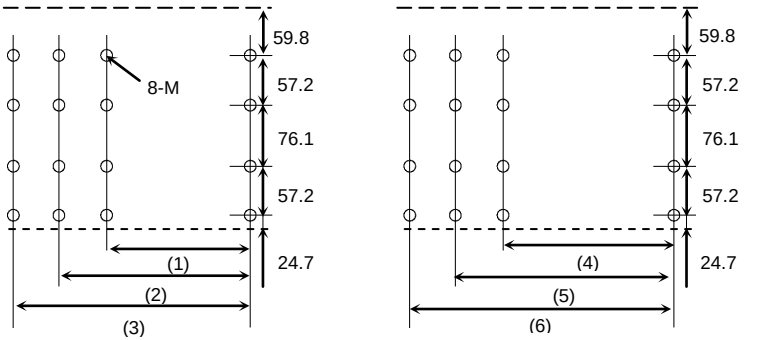
NOTE

The length from the edge of fixture L differs by the side. Refer to the following figure and mount the side with shorter distance from the edge to the screw hole on the Upper side.

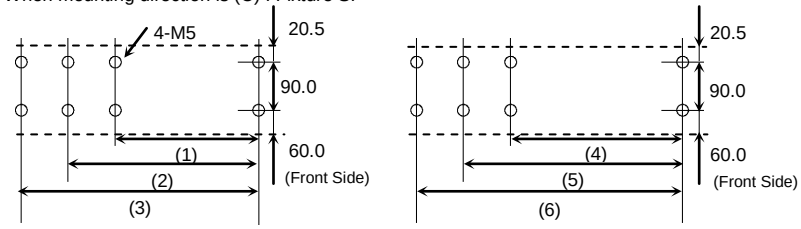


- For Controller installation to the Controller box or the base table, process screw hole drilling as follows.

When mounting direction is (A) or (B) Outline of the RC180 Unit [mm]



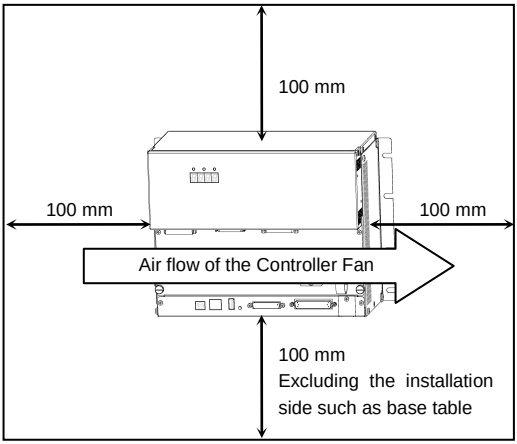
When mounting direction is (C) : Fixture S:



No screw hole processing is required for mounting direction (D).
Secure it to the rack with screws and nuts.

	Controller Only	Controller + ProSix Driver Unit
No Option Unit	(1) 323 mm	(4) 398 mm
Option Unit ×1	(2) 378 mm	(5) 453 mm
Option Unit ×2	(3) 433 mm	(6) 508 mm

- Ensure the draft around the in/out and also install the controller by keeping the distance as follows to prevent the nose influence from other equipment such as large contactor and relay.

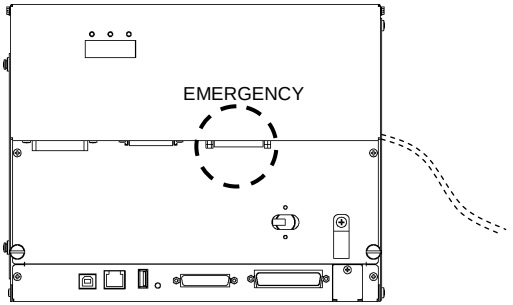


- Hot air with higher temperature than the ambient temperature (about 10 deg.C) comes out from the in/out of the Controller.
  Make sure that heat sensitive devices are not placed near the outlet.

2.6 Connection to EMERGENCY Connector (Controller)

Connect a safeguard switch or Emergency Stop switch to the Controller EMERGENCY connector for safety.
When nothing is connected to the EMERGENCY connector, Controller does not operate normally.

WARNING	■ Before connecting the connector, make sure that the pins are not bent. Connecting with the pins bent may damage the connector and result in malfunction of the robot system.



2.6.1 Safety Door Switch and Latch Release Switch

The EMERGENCY connector has input terminals for the Safety Door switch and the Emergency Stop switch. Be sure to use these input terminals to keep the system safe.

Connector	Standard
EMERGENCY connector (Controller side)	D-sub25 Pin (male) Mounting style #4-40

2.6.2 Safety Door Switch

WARNING	■ The interlock of the Safety Door must be functioning when the robot system is operated. Do not operate the system under the condition that the switch cannot be turned ON/OFF (e.g. The tape is put around the switch.). Operating the robot system when the switch is not functioning properly is extremely hazardous and may cause serious safety problems as the Safety Door input cannot fulfill its intended function.

In order to maintain a safe working zone, a safeguard must be erected around the Manipulator. The safeguard must have an interlock switch at the entrance to the working zoon. The Safety Door that is described in this manual is one of the safeguards and an interlock of the Safety Door is called a Safety Door switch. Connect the Safety Door switch to the Safety Door input terminal on the EMERGENCY connector.

The Safety Door switch has safety features such as temporary hold-up of the program or the operation-prohibited status that are activated whenever the Safety Door is opened.

Observe the following in designing the Safety Door switch and the Safety Door.

- For the Safety Door switch, select a switch that opens as the Safety Door opens, and not by the spring of the switch itself.
- The signal from the Safety Door (Safety Door input) is designed to input to two redundant signals. If the signals at the two inputs differ by two seconds or more, the system recognizes it to be a critical error. Therefore, make sure that the Safety Door switch has two separate redundant circuits and that each connects to the specified pins at the EMERGENCY connector on the Controller.
- The Safety Door must be designed and installed so that it does not close accidentally.

2.6.3 Latch Release Switch

The controller software latches the following conditions:

- The safety door is open.
- The operation mode is “TEACH”.

The EMERGENCY connector has an input terminal for a latch release switch that cancels the latched conditions.

Open : The latch release switch latches conditions that the safety door is open or the operation mode is “TEACH”.

Closed : The latch release switch releases the latched conditions.

NOTE

When the latched TEACH mode is released while the safety door is open, the status of Manipulator power is operation-prohibited because the safety door is open at that time.
To execute a Manipulator operation, close the safety door again, and then close the latch release input.

2.6.4 Checking Latch Release Switch Operation

NOTE

Refer to *3.2 Development PC and Controller Connection* and connect the development PC and Controller before checking the function.

After connecting the safety door switch and latch release switch to the EMERGENCY connector, be sure to check the switch operation for safety by following the procedures described below before operating the Manipulator.

(1) Turn ON the Controller while the safety door is open in order to boot the controller software.
(2) Make sure that “Safety” is displayed on the EPSON RC+ 5.0 status bar.
(3) Close the safety door, and turn ON the switch connecting to the latch release input.
Make sure that the “Safety” is dimmed on the status bar.

The information that the safety door is open can be latched by software based on the latch release input condition.

Open : The latch release switch latches condition that the safety door is open. To cancel the condition, close the safety door, and then close the safety door latch release input.

Closed : The latch release switch does not latch the condition that the safety door is open.

NOTE

The latch release input also functions to acknowledge the change of TEACH mode.

In order to change the latched condition of the TEACH mode, turn the mode selector key switch on the Teach Pendant to “Auto”. Then, close the latch release input.

2.6.5 Emergency Stop Switch

If it is desired to create an external Emergency Stop switch(es) in addition to the Emergency Stop on the Teach Pendant and Operator Panel, make sure to connect such Emergency Stop switch(es) to the Emergency Stop input terminal on the EMERGENCY connector.

The Emergency Stop switch connected must comply with the related safety standards (such as IEC60947-5-5) and the following:

- It must be a push button switch that is “normally closed”.
- A button that does not automatically return or resume.
- The button must be mushroom-shaped and red.
- The button must have a double contact that is “normally closed”.

NOTE

The signal from the Emergency Stop switch is designed to use two redundant circuits.
If the signals at the two circuits differ by two seconds or more, the system recognizes it as a critical error. Therefore, make sure that the Emergency Stop switch has double contacts and that each circuit connects to the specified pins on the EMERGENCY connector at the Controller. Refer to the *2.6.8 Circuit Diagrams.*

2.6.6 Checking Emergency Stop Switch Operation

NOTE

Refer to *3.2 Development PC and Controller Connection* and connect the development PC and Controller before checking the function.

Once the Emergency Stop switch is connected to the EMERGENCY connector, continue the following procedure to make sure that the switch functions properly. For the safety of the operator, the Manipulator must not be powered ON until the following test is completed.

(1) Turn ON the Controller to boot the controller software while pressing the Emergency Stop switch.

(2) Make sure that the seven-segment LED on the Controller displays  .

(3) Make sure that “E.Stop” is displayed on the EPSON RC+ 5.0 status bar.

(4) Release the Emergency Stop Switch.

(5) Select EPSON RC+ 5.0-[Tools]-[Robot Manager]-[Control Panel] and click the <Reset> button to execute the RESET command.

(6) Make sure that  LED is turned OFF and that “E-Stop” is dimmed on the main window status bar.

2.6.7 Pin Assignments

The EMERGENCY connector pin assignments are as follows:

Pin No.	Signal	Function	Pin No.	Signal	Function
1	ESW11	Emergency Stop switch contact (1) *3	14	ESW21	Emergency Stop switch contact (2) *3
2	ESW12	Emergency Stop switch contact (1) *3	15	ESW22	Emergency Stop switch contact (2) *3
3	ESTOP1+	Emergency Stop circuit 1 (+)	16	ESTOP2+	Emergency Stop circuit 2 (+)
4	ESTOP1–	Emergency Stop circuit 1 (-)	17	ESTOP2–	Emergency Stop circuit 2 (-)
5	NC	*1	18	SDLATCH1	Safety Door Latch Release
6	NC	*1	19	SDLATCH2	Safety Door Latch Release
7	SD11	Safety Door input (1) *2	20	SD21	Safety Door input (2) *2
8	SD12	Safety Door input (1) *2	21	SD22	Safety Door input (2) *2
9	24V	+24V output	22	24V	+24V output
10	24V	+24V output	23	24V	+24V output
11	24VGND	+24V GND output	24	24VGND	+24V GND output
12	24VGND	+24V GND output	25	24VGND	+24V GND output
13	NC				

*1 Do not connect anything to these pins.

*2 A critical error occurs if the input values from the Safety Door 1 and Safety Door 2 are different for two or more seconds. They must be connected to the same switch with two sets of contacts.

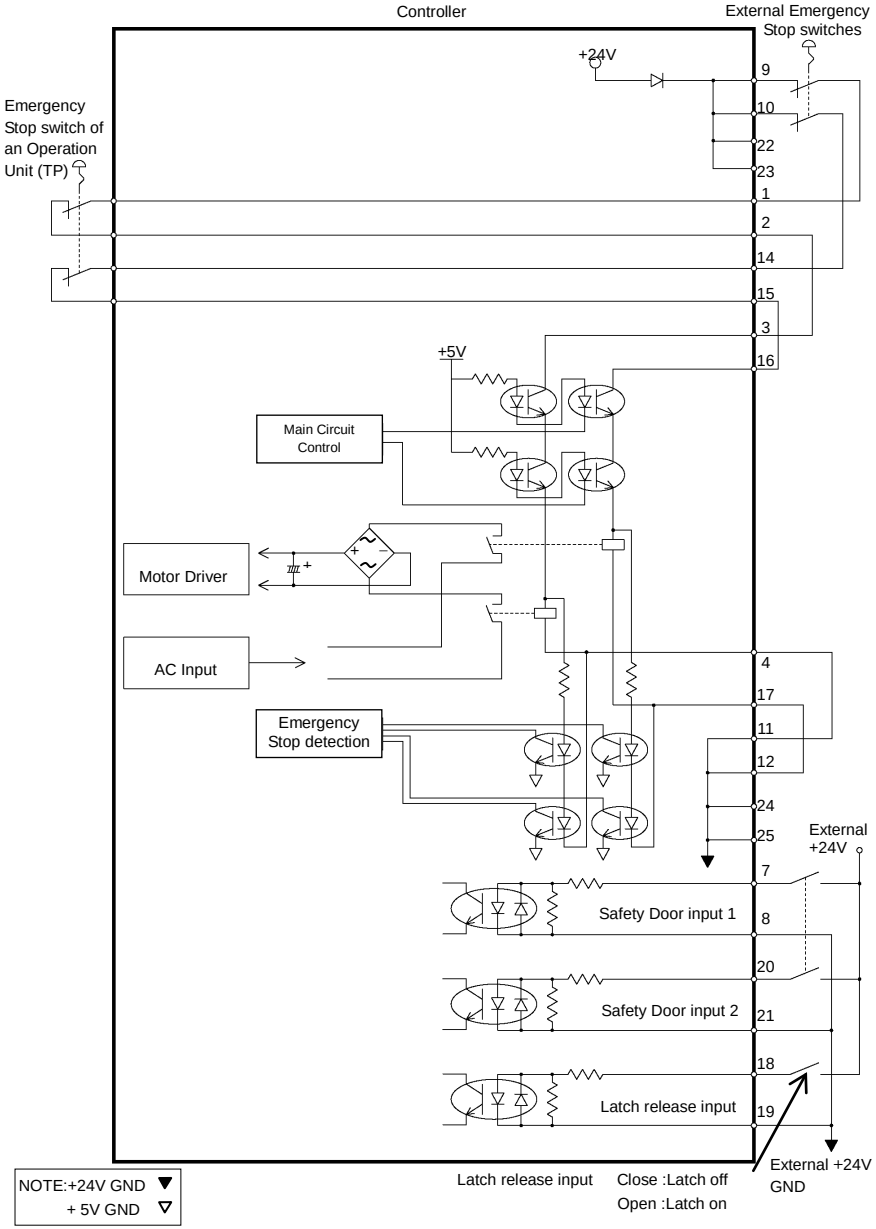
*3 A critical error occurs if the input values from the Emergency Stop switch contact 1 and Emergency Stop switch contact 2 are different for two or more seconds. They must be connected the same switch with two sets of contacts.

Emergency Stop switch output rated load	+30 V 0.3 A or under	1-2, 14-15 pin
Emergency Stop rated input voltage range Emergency Stop rated input current	+24 V ±10% 47.5 mA/+24V input	3-4, 16-17 pin
Safety Door rated input voltage range Safety Door rated input current	+24 V ±10% 10 mA/+24 V input	7-8, 20-21 pin
Latch Release rated input voltage range Latch Release rated input current	+24 V ±10% 10 mA/+24 V input	18-19 pin

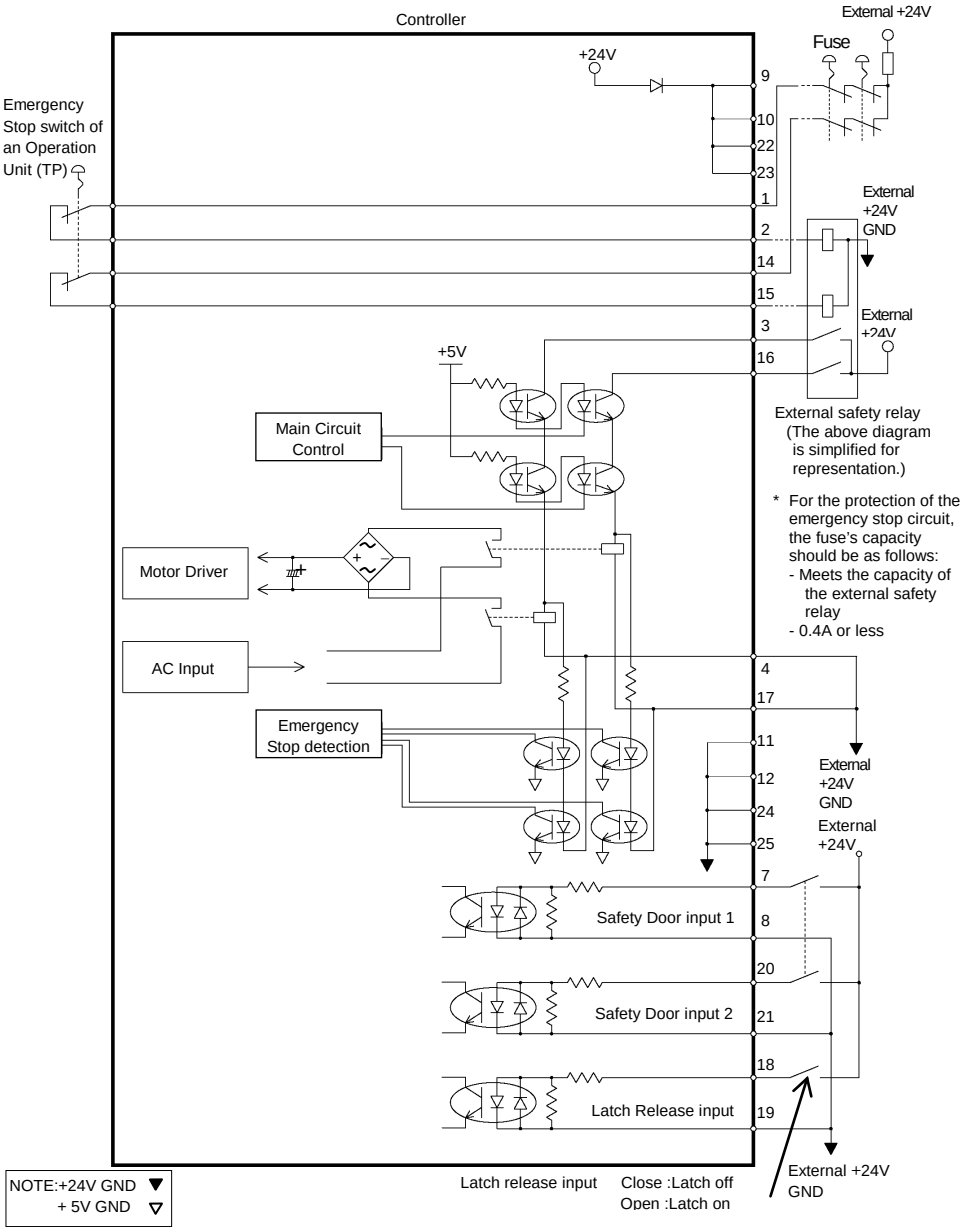
NOTE The total electrical resistance of the Emergency Stop switches and their circuit should be 1 Ω or less.

2.6.8 Circuit Diagrams

Example 1: External emergency stop switch typical application



Example 2: External safety relay typical application



2.7 Power supply, AC power cable, Breaker

2.7.1 Power Supply

Ensure that the available power meets following specifications.

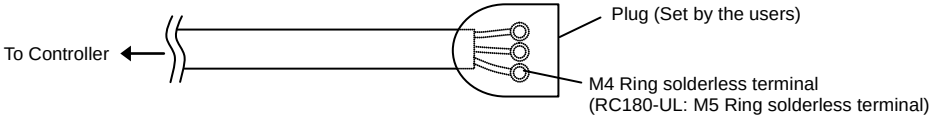
Item	Specification
Voltage	200 to 240 VAC
Phase	Single phase
Frequency	50/60 Hz
Momentary Power Interrupt	10 msec. Or less
Power Consumption	Max. 2.5 kVA Actual consumption depends on the model, motion, and load of the Manipulator. For approximate power consumption of each model, refer to the followings. C3 : 1.2 kVA S5 : 1.2 kVA G1 : 0.5 kVA G3 : 1.1 kVA G6 : 1.5 kVA G10 : 2.4 kVA G20 : 2.4 kVA RS3 : 1.2 kVA RS4 : 1.4 kVA Refer to Manipulator manual for Manipulator rated consumption.
Peak Current	When power is turned ON: approximately 150 A (2 msec.) When motor is ON :approximately 60 A (5 msec.)
Leakage Current	Max. 10 mA
Ground Resistance	100 Ω or less

Install an earth leakage circuit breaker or a circuit breaker in the AC power cable line at 15 A or less rated electric current. Both should be a two-pole disconnect type. If you install an earth leakage circuit breaker, make sure to use an inverter type that does not operate by induction of a 10 kHz or more leakage current. If you install a circuit breaker, please select one that will handle the above mentioned “peak current”.

The power receptacle shall be installed near the equipment and shall be easily accessible.

2.7.2 AC Power Cable

WARNING	■ Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source. To shut off power to the robot system, pull out the power plug from the power source. Performing any work while connecting the AC power cable to a factory power source is extremely hazardous and may result in electric shock and/or malfunction of the robot system. ■ Make sure that cable manufacturing and connection are done by a qualified personal. When proceeding, be sure to connect the earth wire of the AC power cable colored green/yellow on the Controller to the earth terminal of the factory power supply. The equipment must be grounded properly at all times to avoid the risk of electric shock. Always use a power plug and receptacle for power connecting cable. Never connect the Controller directly to the factory power supply. (Field wiring)



The AC plug in not attached to the AC power cable delivered at shipment.
Refer to the wire connection specification and attach a proper plug to the cable that is suitable for the factory power supply. (A plug is prepared as option.)

Cable Wire Connection Specification

Purpose	Color
AC power wire (2 cables)	Black
Ground wire	Green / Yellow

Cable length: 3 m (Standard)

2.7.3 Breaker

For RC180-UL

 WARNING	■ Branch Circuit protection (Rated current: 15 A or less) shall be installed in the external AC power supplying side in accordance with the National Electrical Code. A disconnecting means shall be installed in accordance with the National Electrical Code and provide the ability for lockout and tagout.

2.8 Connecting Manipulator and Controller

2.8.1 Connecting Precautions

Before Connection

: Before connecting the connector, make sure that the pins are not bent. Connecting with the pins bent may damage the connector and result in malfunction of the robot system.

Connecting procedure

: Before performing any connecting procedure, turn OFF the Controller and related equipment, and then pull out 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.

Cable

: 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.

Connection

: When connecting the Manipulator and 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 safety problems.
The serial number of supported Manipulator is labeled on the controller.
If the G series Manipulator is connected to the Controller for the PS series (ProSix), it may result in malfunction of the Manipulator.

Wiring

: 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.

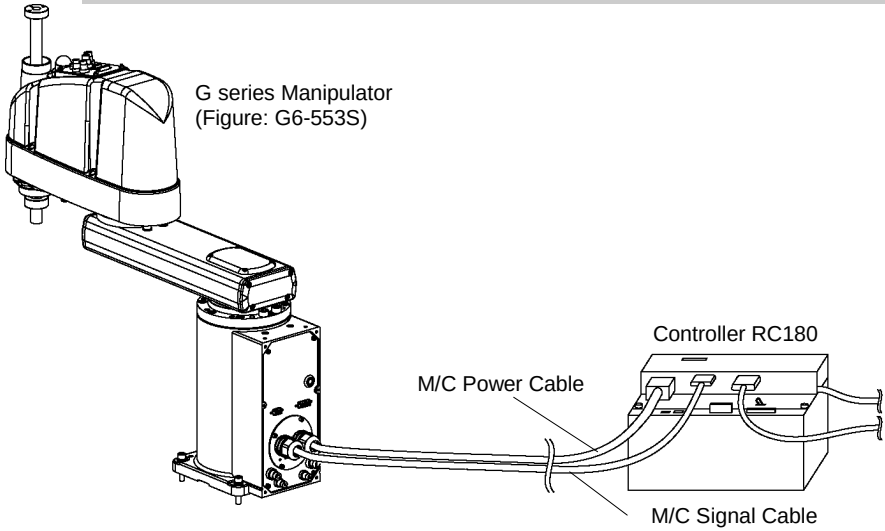
For Clean-model

: When the Manipulator is a Clean-model, use it with an exhaust system.
For details, refer to the Manipulator manual.

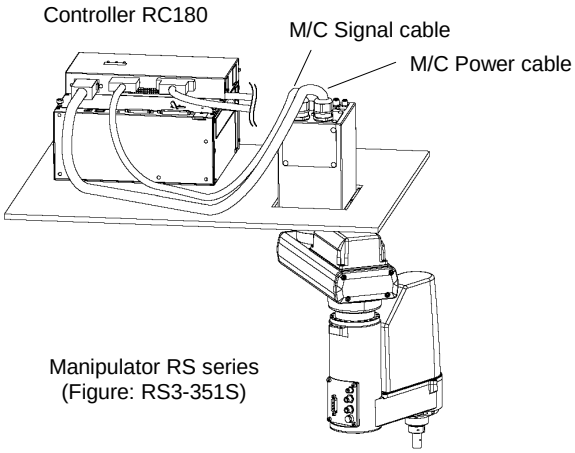
For Protected-model

: Connect the power cable connection and the signal cable connector to the Manipulator immediately after the Manipulator installation. The Manipulator without connecting them may result in electric shock and/or malfunction of the robot system as it cannot ensure IP65.

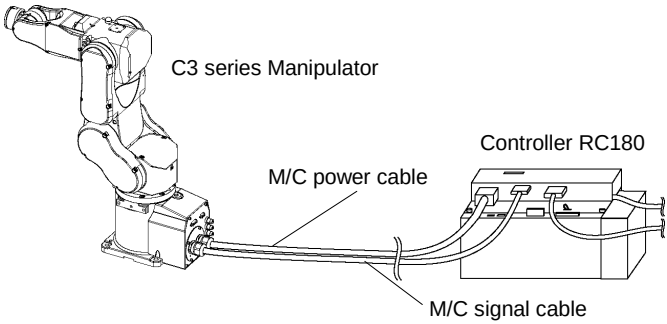
G series



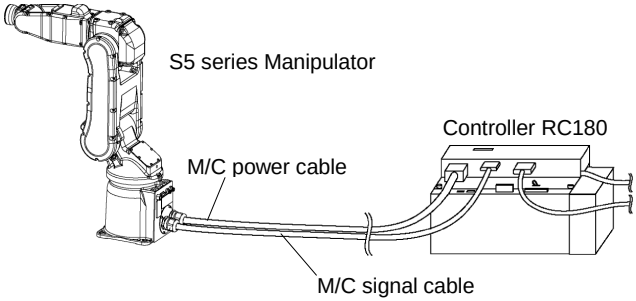
RS series



C3 series



S5 series



2.9 Power-on

2.9.1 Power-on Precautions

Manipulator check

: Before operating the Manipulator, make sure that all parts of the Manipulator are in place and have no external defects. Missing or defective parts may cause improper operation of the Manipulator. Improper operation of the Manipulator is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system.

Shipping bolts and jigs check before turning ON

: Before first turning ON the power, be sure to remove the shipping bolts and jigs from the Manipulator. Turning ON the power while the shipping bolts and jigs are attached may result in equipment damage to the Manipulator.

Power activation

: Anchor the Manipulator before turning ON the power to or operating the Manipulator. Turning ON the power to or operating the Manipulator that is not anchored is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system as the Manipulator may fall down

When supplying the power again

: When supplying the power to the controller again, turn OFF the controller and wait for 5 seconds or more. Then, turn ON the controller again.

2.9.2 Power ON Procedure

(1) Check the M/C power cable connection.

(2) Check the M/C signal cable connection.

(3) Check the EMERGENCY connector connection.

(4) Connect the TP/OP bypass plug to the TP/OP port.

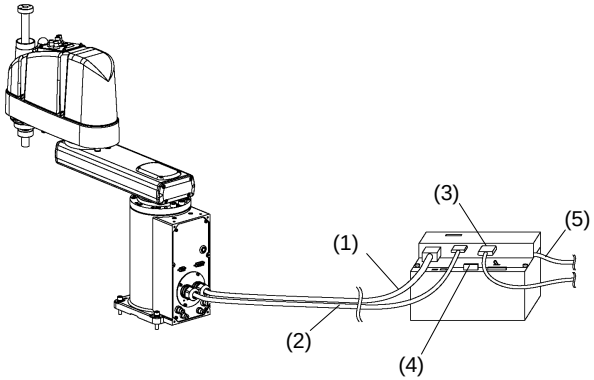
(5) Connect the AC power cable to the power supply socket.

(6) Switch the controller POWER switch to the right to turn ON the power.
(POWER switch is not available for RC180-UL. Instead, turn ON the external disconnecting means.)

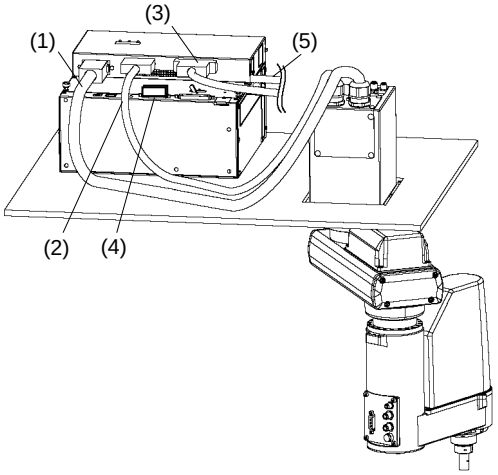
(7) The seven-segment LED blinks as  approximately 30 seconds after Controller starts up normally.

When an error appears, check the connection in step (1) to (5) to turn ON the power again.
If an error appears after checking the connection contact the supplier.

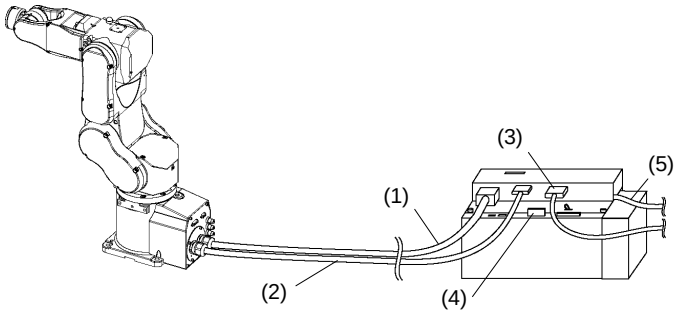
G series (Figure: G6-553S)



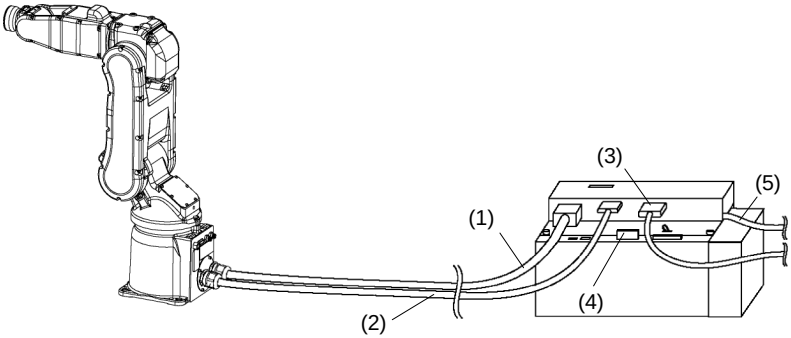
RS series (Figure: RS3-351S)

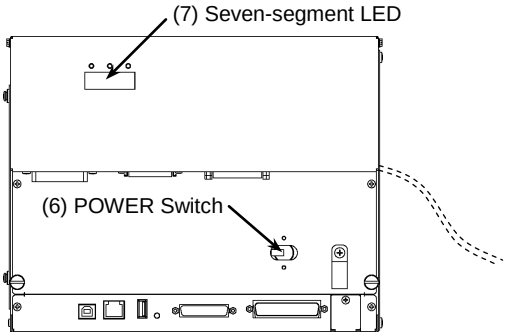


C3 series



S5 series





* POWER switch is not available for RC180-UL.
Instead, turn ON the external disconnecting means.

3. First Step

This section indicates the procedure to install the development PC EPSON RC+ 5.0, and execute simple program after connecting the development PC and Controller with a USB.
Make sure that the Robot system is installed safely by following the description in *1. Safety* and *2. Installation*. Then, operate the Robot system in the following procedures.

3.1 Installing EPSON RC+ 5.0 Software

NOTE

The EPSON RC+ 5.0 software needs to be installed on your development PC.

EPSON RC+ 5.0 supports the following OS.

Windows XP Professional Service Pack 3

(EPSON RC+ 5.0 Ver.5.2.0 SP3 or later is required.)

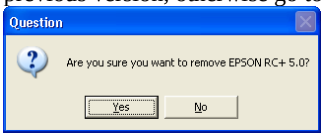
Windows Vista Business Service Pack 2

(EPSON RC+ 5.0 Ver.5.3.1 or later is required.)

Windows 7 Professional (EPSON RC+ 5.0 Ver.5.3.4 or later is required.)

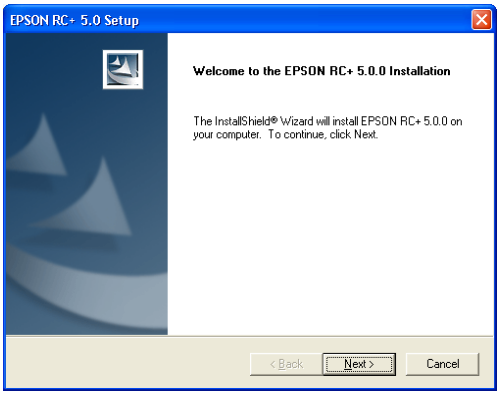
Windows 8.1 Pro (EPSON RC+ 5.0 Ver.5.4.6 or later is required.)

1. Insert the EPSON RC+ 5.0 Setup CD in the CD drive.
2. If EPSON RC+ 5.0 was previously installed, you will be asked to uninstall the previous version, otherwise go to step 3.

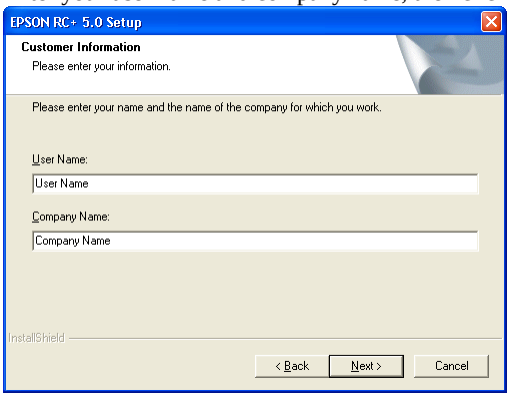


After uninstalling, you will be prompted to restart the computer. Start the setup program again by double-clicking the installer CD icon in My Computer, or by re-inserting the CD.

3. The welcome dialog will be displayed as shown below. Click the **Next** button to continue.



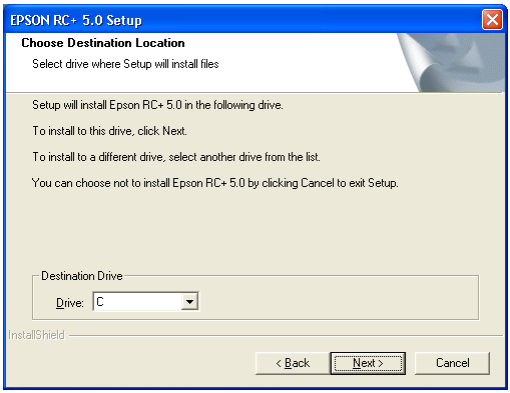
4. Enter your user name and company name, then click Next.



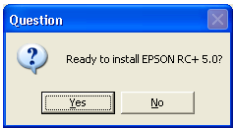
5. Select the drive where you want to install EPSON RC+ 5.0 and click **Next**.

NOTE

The installation directory is called EpsonRC50 and cannot be changed.



6. You will be prompted to confirm installation. Click **Yes** to continue.



7. If required, Windows Installer and Microsoft .NET Framework 2.0 are installed on your system. This may take several minutes.

NOTE

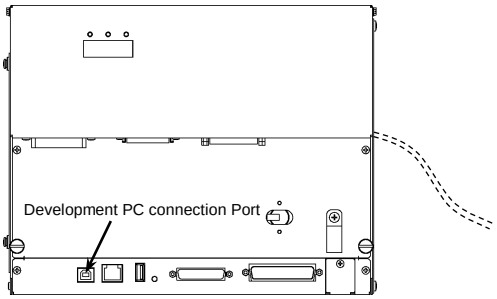
Adobe Reader needs to be installed on your PC in order to view the EPSON RC+ 5.0 manuals. If the installer cannot find Adobe Reader on your system, it will be installed at this time. Follow the instructions in the Adobe installer. Do not restart the system after the Adobe Reader installation has completed.

8. After the installation has completed, you may be prompted to restart your computer.

The EPSON RC+ 5.0 software installation is now completed.

3.2 Development PC and Controller Connection

Connect the development PC and the USB port for connection (USB B series connector).



NOTE

For other details of development PC and Controller connection, refer to *EPSON RC+ 5.0 User's Guide 5.12.1 PC to Controller Communications Command*.

For RC180, be sure to install the EPSON RC+5.0 to the development PC first, then connect the development PC and RC180 with the USB cable.
If RC180 and the development PC are connected without installing the EPSON RC+5.0 to the development PC, [Add New Hardware Wizard] appears. If this wizard appears, click the <Cancel> button.

3.2.1 About Development PC Connection Port

Development PC connection port supports following USB.

- USB2.0 HighSpeed/FullSpeed (Speed auto selection, or FullSpeed mode)
- USB1.1 FullSpeed

Interface Standard : USB specification Ver.2.0 compliant
(USB Ver.1.1 upward compatible)

Connect the Controller and development PC by a USB cable to develop the robot system or set the Controller configuration with the EPSON RC+ 5.0 software installed in the development PC.

Development PC connection port supports hot plug feature. Cables insert and remove from the development PC and the Controller is available when the power is ON. However, stop occurs when USB cable is removed from the Controller or the development PC during connection.

3.2.2 Precaution

When connecting the development PC and the Controller, make sure of the followings.

- Connect the development PC and the Controller with 5 m or shorter USB cable.
  Do not use the USB hub or extension cable.
- Make sure that no other devices except development PC is used for development PC connection port.
- Use PC or USB cable that supports USB2.0 HighSpeed mode to operate in USB2.0 HighSpeed mode.
- Do not pull or bend the cable strongly.
- Do not allow unnecessary strain on the cable.
- When development PC and the Controller is connected, do not insert or remove other USB devices from the development PC. Connection with the Controller may disconnect.

3.2.3 Software Setup and Connection Check

Connection of the development PC and the Controller is indicated.

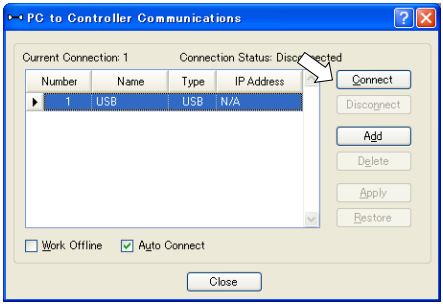
(1) Make sure that software EPSON RC+ 5.0 (Ver.5.2 or later) or later is installed to the Controller connected to the development PC. (Install the software when it is not installed.)

(2) Connect the development PC and the Controller by the USB cable.

(3) Turn ON the Controller.

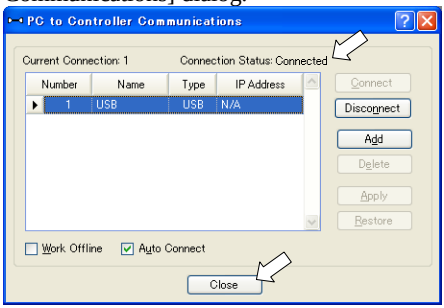
(4) Start the software EPSON RC+ 5.0.

(5) Select the EPSON RC+ 5.0 menu-[Setup]-[PC to Controller Communications] to display the [PC to Controller Communications] dialog.



(6) Select the “No.1 USB” and click the <Connect> button.

(7) After development PC and the Controller connection is completed, “Connected” is displayed in the [Connection status:]. Make sure that “Connected” is displayed and click the <Close> button to close the [PC to Controller Communications] dialog.



Connection of the development PC and the Controller is completed. Now robot system can be used from EPSON RC+ 5.0.

3.2.4 Backup the Initial Condition of the Controller

Backup the Controller data configured before shipment.

Follow these steps to backup the project and system configuration:

(1) From the [Project] menu, select [Copy].

(2) Change the [Destination Drive] to a certain drive.

(3) Click <OK>. The project will be copied to the external media.

(4) From the [Tools] menu, select [Controller].

(5) Click on the <Backup Controller> button.

(6) Select the certain drive.

(7) Click <OK>. The system configuration will be backed up on the external media.

3.2.5 Disconnection of Development PC and Controller

Disconnection of the development PC and the Controller is indicated.

(1) Select the EPSON RC+ 5.0 menu-[Setup]-[PC to Controller Communications] to display the [PC to Controller Communications] dialog.

(2) Click the <Disconnect> button.
Controller and the development PC is disconnected and USB cable can be removed.

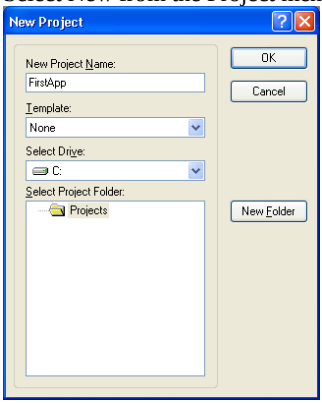
NOTE

If USB cable is removed when the Controller and the development PC is connected, stop occurs to the Robot. Make sure to click the <Disconnect> button in the [PC to Controller Communications] dialog before USB cable is removed.

3.3 Writing your first program

After installing the controller, robot, and EPSON RC+ 5.0 software on your PC, follow these instructions to create a simple application program so that you will become more familiar with the EPSON RC+ 5.0 development environment.

1. Connect your PC to the RC180 Controller
   Install a USB cable between your PC and the Controller. Refer to the *3.2 Development PC Connection Port*.
2. Start EPSON RC+ 5.0 Simple Mode
   Double-click the EPSON RC+ 5.0 Simple icon on the desktop.
3. Create a new project
   (1) Select New from the Project menu.



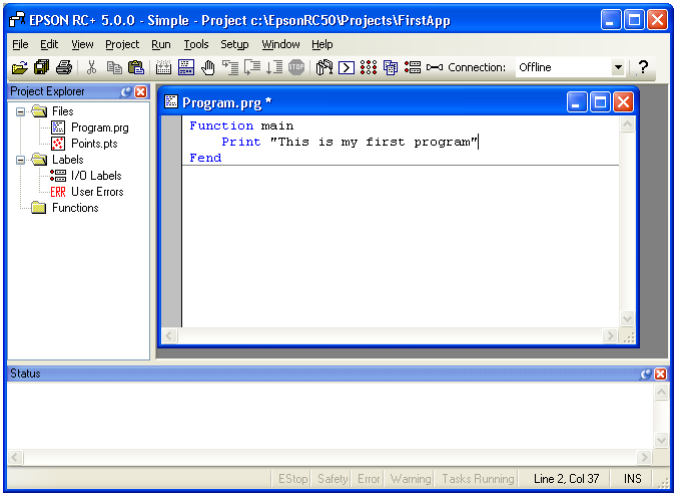
   (2) Type in a name for a project, for example, FirstApp.

   (3) Click OK to create the new project.
   When the new project is created, a program called Program.prg is created. You will see a window open with the title Program.prg with a cursor flashing in the upper left corner. Now you are ready to start entering your first program.

4. Edit the program

Type in the following program lines in the Program.prg edit window.

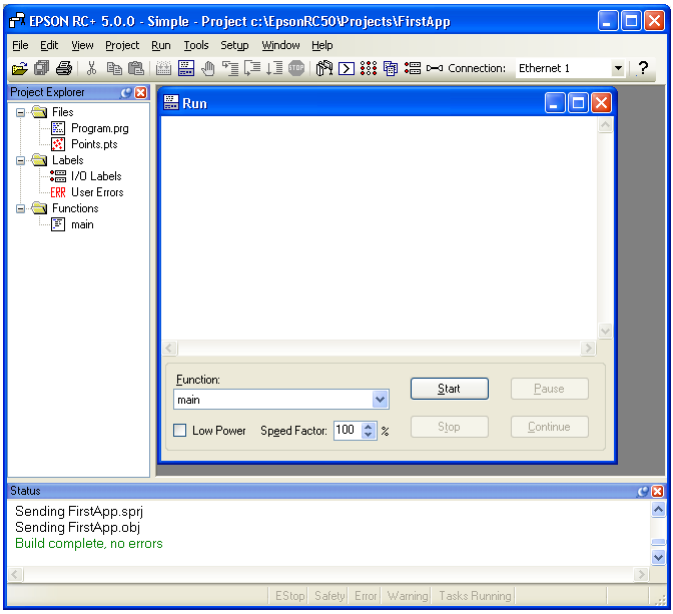
```
Function main
    Print "This is my first program."
Fend
```



5. Run the program

Press F5 to run the program. (F5 is the hot key for the [Run Window] selection of the [Run] menu). You will see the Status window located at the bottom of the main window showing the build operation status.

During project build, your program is compiled and linked. Then communications is established with the controller and project files are sent to the controller. If there are no errors during build, the Run window will appear.



Click the Start button on the Run window to run the program.

You should see text similar to the following displayed in the Status window:

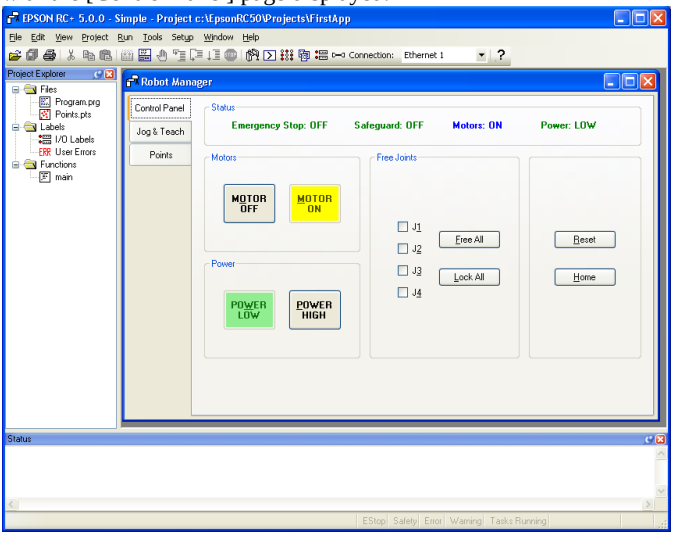
```
08:24:18 Task main started
08:24:18 All tasks stopped
```

On the Run window, you will see the output of the print statement.

Now let's teach some robot points and modify the program to move the robot.

6. Teach robot points

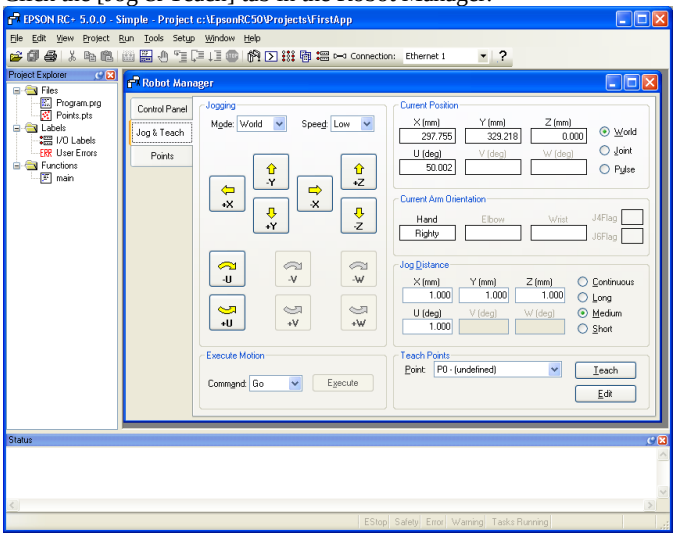
(1) Ensure that it is safe to operate the robot. Click the <Robot Manager> button on the toolbar. You will see the [Robot Manager] window with the [Control Panel] page displayed.



(2) Click on the <Motor On> button to turn on the robot motors. You will be prompted to confirm the operation.

(3) Answer <Yes> to continue.

(4) Click the [Jog & Teach] tab in the Robot Manager.



(5) Click the <Teach> button in the lower right corner to teach point P0. You will be prompted for a point label and description.

(6) Jog the robot by clicking the <+Y> jog button. Hold the button down to continue jogging. Let go when the robot is about half way out in the work envelope.

(7) Jog the robot down by clicking the <-Z> button.

(8) Now change the current point to P1 by selecting P1 in the Point dropdown list next to the <Teach> button.

(9) Click the <Teach> button. You will see a confirmation message to teach the point.

(10) Answer <Yes>.

(11) Click the <+X> button to jog the robot in the +X direction.

(12) Change the current point to P2 by selecting P2 in the Point dropdown list.

(13) Click the <Teach> button. You will see a confirmation message to teach the point.

(14) Answer <Yes>.

(15) Click the <Save> Project  toolbar button to save the changes.

7. Modify the program to include robot motion commands

(1) Insert three new Go statements into the Program.prg program as shown below:

```
Function main
    Print "This is my first program."
    Go P1
    Go P2
    Go P0
Fend
```

(2) Press F5 to display the [Run] window.

(3) Click on the <Start> button to run the program.

The robot should move to each of the points you taught.

8. Modify the program to change speed of robot motion commands

(1) Insert the Power, Speed, and Accel commands as shown in the program below:

```
Function main
    Print "This is my first program."
      Power High
      Speed 20
      Accel 20, 20
      Go P1
      Go P2
      Go P0
Fend
```

(2) Press F5 to display the [Run] window.

(3) Click on the <Start> button to run the program.
The robot should go to each of the points you taught at 20% of speed, acceleration, and deceleration. The Power High statement enables your program to run the robot at high (normal) power, which in turn allows the robot speed and acceleration to be increased.

9. Backup the project and system configuration

Even though this is only a sample project, we will backup the project and controller configuration. This is easy to do with EPSON RC+ 5.0. It is important that you keep regular backups of your applications on external media such as USB memory.

Follow these steps to backup the project and system configuration:

(1) From the [Project] menu, select [Copy].
(2) Change the [Destination Drive] to a certain drive.
(3) Click <OK>. The project will be copied to the external media.
(4) From the [Tools] menu, select [Controller].
(5) Click on the <Backup Controller> button.
(6) Select the certain drive.
(7) Click <OK>. The system configuration will be backed up on the external media.

Now that you have written your first program.

4. Second Step

Setup other necessary functions after operating the robot system as indicated in *3. First Step*.
Manuals that indicate necessary setups and procedures are guided in this section.
(For descriptions of each manual, refer to *6. Manual*.)

4.1 Connection with External Equipment

4.1.1 Remote Control

EPSON RC+ 5.0 User's Guide
10. Remote Control
ROBOT CONTROLLER RC180 manual
Setup & Operation 11. I/O Remote Set Up

I/O
EPSON RC+ 5.0 User's Guide
9. I/O Setup
ROBOT CONTROLLER RC180 manual
Setup & Operation 10. I/O Connector
Setup & Operation 12.2 Expansion I/O Board (Option)

Fieldbus I/O (Option)
ROBOT CONTROLLER RC180
Setup & Operation 12.3 Fieldbus I/O Board

4.1.2 Ethernet

EPSON RC+ 5.0 User's Guide
4.5.3 Ethernet Communication
ROBOT CONTROLLER RC180 manual
Setup & Operation 7. LAN Ethernet) Port

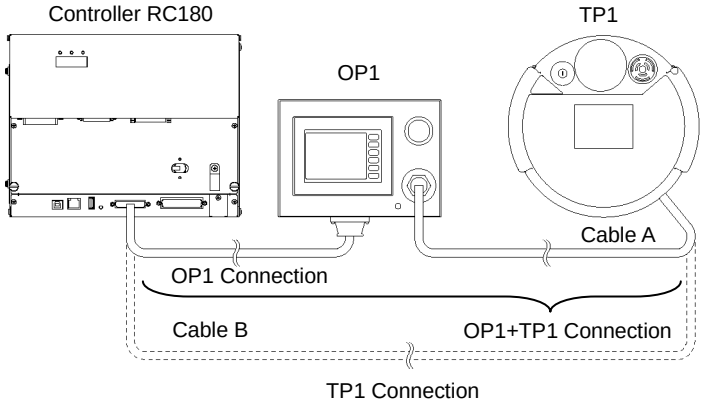
4.1.3 RS-232C (Option)

EPSON RC+ 5.0 User's Guide
11. RS-232C Communication
ROBOT CONTROLLER RC180 manual
Setup & Operation 12.4 RS-232C Board

4.2 Ethernet Connection of Development PC and Controller

EPSON RC+ 5.0 User's Guide
4.5.3 Ethernet Communication
ROBOT CONTROLLER RC180 manual
Setup & Operation 7. LAN (Ethernet) Port

4.3 Connection and Display Language of Option TP1 and OP1



4.3.1 TP1

Connection

ROBOT CONTROLLER RC180 manual
Setup & Operation 8. TP/OP Port
RC180 Option TP1 Function & Installation 3. Installation

NOTE
Cable A and cable B have different connector shapes.

Changing Display Language

RC180 Option TP1 manual
Operation 3.6 Program Mode
Operation 3.6.11 Change Display Language

NOTE
Setup procedure is also indicated in *For TP1 Purchaser* packed with the product.

4.3.2 OP1

Connection

ROBOT CONTROLLER RC180 manual
Setup & Operation 8. TP/OP Port
RC180 Option OP1 manual
3. Installation

Changing Display Language

RC180 Option OP1 manual
4.8 Setup Screen

NOTE
Setup procedure is also indicated in *Operation Panel OP1 Safety and Installation* packed with the product.

5. 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.

5.1 Maintenance Inspection

5.1.1 Manipulator

G, C3, RS series

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

	Inspection Point					
	Daily	Monthly	Quarterly	Biannual	Annual	Overhaul (replacement)
1 month (250 h)	Inspect every day	√				
2 months (500 h)		√				
3 months (750 h)		√	√			
4 months (1000 h)		√				
5 months (1250 h)		√				
6 months (1500 h)		√	√	√		
7 months (1750 h)		√				
8 months (2000 h)		√				
9 months (2250 h)		√	√			
10 months (2500 h)		√				
11 months (2750 h)		√				
12 months (3000 h)		√	√	√	√	
13 months (3250 h)		√				
⋮	⋮	⋮	⋮	⋮	⋮	
20,000 h						√

h = hour

S5 series

Inspection points are divided into five stages: daily, four months, two years, four years, and eight years. If the Manipulator is operated for predetermined hours of operation, perform maintenance inspections.

Inspection	Inspection Interval	Hours of operation
Daily	Inspect every day	
4-month	4 months	1000 hours
24-month	24 months	6000 hours
48-month	48 months	12000 hours
96-month	96 months	24000 hours

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

Inspection Point	Inspection Place	Daily	Monthly	Quarterly	Biannual	Annual
Check looseness or backlash of bolts/screws. Tighten them if necessary. (For the tightening torque, refer to *Tightening Hexagon Socket Head Cap Bolts*.)	End effector mounting bolts	√	√	√	√	√
	Manipulator mounting bolts	√	√	√	√	√
	Each arm locking bolts	√	√	√	√	√
	Bolts/screws around shaft					√
	Bolts/screws securing motors, reduction gear units, etc.					√
Check looseness of connectors. If the connectors are loosen, push it securely or tighten.	External connectors on Manipulator (on the connector plates etc.)	√	√	√	√	√
	Manipulator cable unit		√	√	√	√
Visually check for external defects. Clean up if necessary.	External appearance of Manipulator	√	√	√	√	√
	External cables		√	√	√	√

Inspection Point	Inspection Place	Daily	Monthly	Quarterly	Biannual	Annual
Check for bends or improper location. Repair or place it properly if necessary.	Safeguard etc.	√	√	√	√	√
Check tension of timing belts. Tighten it if necessary.	Inside of Arm #2: G1 G3 G6 G10 G20 RS Inside of Base and Arm #1, 2, 3, 4 : C3				√	√
Grease conditions	Refer to *5.4 Greasing*.					
Battery	Refer to *5.5 Handling and Disposal of Batteries*					

Inspection While the Power is ON (Manipulator is operating)

Manipulator (G, C3, RS series)

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

Manipulator (S5 series)

Inspection Point	Inspection Space	Interval
Check for tram mark misalignment or damage at the home position. (Visual)	Tram mark	Daily
Clean the area of motion range for each joint if dust or spatter is present. Check for damage and outside cracks. (Visual)	Motion range and Manipulator	Daily
Tighten loose bolts. Replace if necessary. (Use Spanner, Wrench)	Base plate mounting bolts	4 month
Tighten loose screws. Replace if necessary (Use Spanner, Wrench)	Cover mounting screws	4 month
Check for loose connectors. (Manual)	Base connectors	4 month
Check for proper belt tension and wear. (Manual)	Joint #1 - Joint #6 timing belts	48 month
Check for conduction between the main connector of base and intermediate connector. Check for wear of protective spring. (Visual, Multimeter)	Cable unit	48 month
Replace the battery unit when an error warning that low battery status is occurring at startup of the software or every three years.	Battery unit	—

5.1.2 Controller

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

Inspection Point	Inspection Place	Daily	Monthly	Quarterly	Biannual	Annual
Visually check for external defects. Clean up if necessary.	External appearance of Controller	√	√	√	√	√
Clean the fan filter	-		√	√	√	√
Battery	-	Every 5 years				

Inspection While the Power is ON (Manipulator is operating)

Inspection Point	Inspection Place	Daily	Monthly	Quarterly	Biannual	Annual
Check whether unusual sound or vibration is occurring.	Entire Controller	√	√	√	√	√
Make a backup of data.	Project and system data	Whenever data is changed.				

5.2 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.

NOTE

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.
The parts consumption management is available for the following Manipulator types:
G series (G1, G3, G6, G10, G20)
RS series (RS3, RS4)

For details, refer to the following manual.

Robot Controller RC180 "Appendix. Alarm"

Note:

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

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

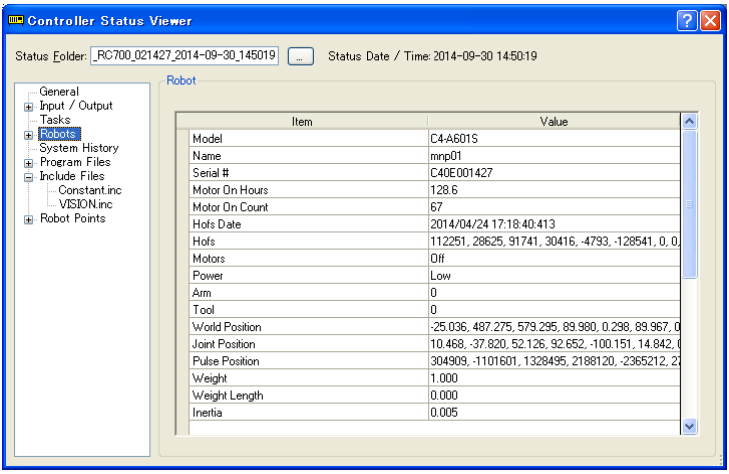
(1) Select EPSON RC+ menu-[Tools]-[Controller] to open the [Controller Tools] dialog.

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

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

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

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



For the parts subject to overhaul, refer to Manipulator manual: Maintenance section: Maintenance Parts List.

For details of replacement of each part, refer to the Manipulator manual: Maintenance section.

Please contact the distributors of your region for further information.

5.3 Tightening Hexagon Socket Head Cap Bolts

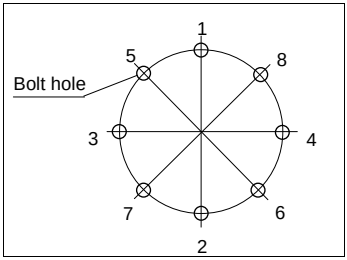
Hexagon socket head cap bolts are used in places where mechanical strength is required. (A hexagon socket head cap bolt will be called a “bolt” in this manual.) These bolts are fastened with the tightening torques shown in the following table. When it is necessary to refasten these bolts in some procedures in this manual (except special cases as noted), use a torque wrench so that the bolts are fastened with the appropriate tightening torques as shown below.

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

Refer below for the set screw.

Set Screw	Tightening Torque
M3	1.5 ± 0.1 N·m (16 ± 1 kgf·cm)
M4	2.4 ± 0.1 N·m (26 ± 1 kgf·cm)
M5	3.9 ± 0.2 N·m (40 ± 2 kgf·cm)
M6	8.0 ± 0.4 N·m (82 ± 4 kgf·cm)

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.

5.4 Greasing

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

Parts and Interval when the greasing is necessary have been described. Refer to the manipulator manual for details of the greasing procedure.

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

NOTE 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.
The parts consumption management is available for the following Manipulator types:
G series (G1, G3, G6, G10, G20)
RS series (RS3, RS4)

For details, refer to the following manual.

Robot Controller RC180 "Appendix. Alarm"

G, RS series

	Greasing part	Greasing Interval	Remarks
Joint #1, #2	Reduction gear units	Overhaul timing	
Joint #3	Ball screw spline shaft	At 100 km of operation (50 km for first greasing)	
Joint #4	Backlash less gear	At greasing of Joint #3	Only G10

Joint #1, 2 reduction gear units

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

Joint #3 Ball screw spline shaft

The recommended greasing interval is at 100 Km of operation. However, perform greasing at 50 km of operation for the first time of greasing.

C3 series

	Greasing part	Greasing Interval
Joint #1, #2, #3, #4	Reduction gear units	Overhaul timing
Joint #6	Bevel gear	Once a year (every 8000 hours)

Joint #1, 2, 3, 4 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.

S5 series

	Greasing part	Greasing Interval
Joint #1, #2, #3, #4, #5, #6	Reduction gear units	Every 6000 hours

5.5 Handling and Disposal of Batteries

 CAUTION	■ 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. ・Battery Charge ・Deformation by Pressure ・Disassembly ・Short-circuit (Polarity; Positive/Negative) ・Incorrect Installation ・Heating (85°C or more) ・Exposing to Fire ・Soldering the terminal of the lithium battery directly ・Forced Discharge ■ 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.

 WARNING	■ Do not insert or pull out the motor connectors while the power to the robot system is turned ON. Inserting or pulling out 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, pull out 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 pull out 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.

Robot Controller

Before starting battery replacement, turn on the controller for approximately one minute. Perform the replacement within 10 minutes to prevent data loss.
Make sure to use the designated lithium battery.

Manipulator

When the lithium battery power is low, an error will occur to warn the user about the low battery status when the Controller is turned ON (when software is started up).
When the error occurs, the position data in motors will be lost and all joints need to be completely calibrated again.

The life span of the lithium battery varies depending on the energizing hours and installation environment of the Controller. The general life spans of the batteries are as follows. 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.

Manipulator	Battery life
C3 series	1.5 years
S5, RS, G1, G3, G6, G10, G20 series	3 years

NOTE

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.
The parts consumption management is available for the following Manipulator types:
G series (G1, G3, G6, G10, G20)
RS series (RS3, RS4)

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 the error of the Power-low warning is not occurred, the calibration of the all joints is not necessary. However, when the position is out of place after the battery replacement, perform the calibration.
Be sure to use the designated lithium battery and the battery board.
Be sure to set the correct polar when installing the battery.

6. Manuals

Descriptions of manual contents are indicated in this section.
Manuals are supplied by Acrobat PDF to use the Robot system.

Select EPSON RC+ 5.0-[Help]-[PDF Manual] to view the PDF manuals from a PC. (Click <Start>-[Program]-[EPSON RC+ 5.0] from the Windows desktop.)

Software

EPSON RC+ 5.0 User's Guide

This manual indicates descriptions of the Robot system and program development software.

- Safety
- Robot System Operation and Configuration
- Operation of Program Development Software EPSON RC+ GUI
- SPEL+ Language and Application
- Configuration of Robot, I/O, Communication etc.

EPSON RC+ 5.0 SPEL+ Language Reference

This manual indicates descriptions of the SPEL+ language for robot program.

- Details of the commands
- Error Messages
- Precaution of EPSON RC+ 4.0 Compatibility etc.

Software Options

Following manuals contain information on the software options and commands.

- VB Guide 5.0
- Vision Guide 5.0
- Vision Guide 5.0 Properties and Results Reference
- GUI Builder 5.0
- Remote Control Reference

Controller

ROBOT CONTROLLER RC180

This manual indicates descriptions of the Robot Controller RC180 and Robot system.

- Safety
- Specification, Installation, Operation, and Setup
- Backup and Restore
- Maintenance
- Verifying Robot System Operation
- Error Codes etc.

Controller Options

RC180 Option Teach Pendant TP1

RC90/RC180 Option Teach Pendant TP2

This manual indicates descriptions of option Teach Pendant.

- Safety
- Specification, Installation, Operation, and Setup
- Teaching Procedure
- TEACH/AUTO mode
- Troubleshooting etc.

RC180 Option Operator Pedant OP1

This manual indicates descriptions of option Operator Panel.

- Safety
- Specification, Installation, and Operation
- Programming for Operator Panel
- Maintenance and Inspection etc.

Manipulator

The manuals indicate descriptions of the manipulator(s) you purchased. There are manuals for each manipulator.

EPSON SCARA ROBOT : G1, G3, G6, G10/G20, RS

EPSON ProSix : C3, S5

- Safety
- Specification, Installation, Setting
- Maintenance
- Calibration etc.

7. Directives and Norms

These products conform to the following directives and norms.

For more details of Controllers and Manipulators, please refer to each manual.

Product Name	Model
Controller	RC180
Manipulator	G series RS series C3 series S5 series

Name	Definition
Directive 2006/42/EC	Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC
Directive 2004/108/EC	Directive 2004/108/EC relating to electromagnetic compatibility and repealing Directive 89/336/EEC
EN ISO 12100 (2010)	Safety of machinery -- General principles for design -- Risk assessment and risk reduction
EN ISO 10218-1 (2011)	Robots and robotic devices -- Safety requirements for industrial robots -- Part 1: Robots
EN 60204-1 (/A1:2009)	Safety of machinery -- Electrical equipment of machines -- Part 1: General requirements
EN ISO 13849-1 (2008) *	Safety of machinery -- Safety - related parts of control systems -- Part 1: General principles for design
EN ISO 13850 (2008)	Safety of machinery -- Emergency stop -- principles for design
EN 55011 (2009)	Industrial, scientific and medical (ISM) radio-frequency equipment -- Electromagnetic disturbance characteristics -- Limits and methods of measurement
EN 61000-6-2 (2005)	Electromagnetic compatibility (EMC) -- Part 6-2: Generic standards -- Immunity for industrial environments

* Emergency stop circuit category3, PL d
Safety Door circuit category3, PL d