EPSON

Industrial Robot: SCARA Robots
RS-C Series Manual

Original instructions

Rev.3
ENM263R8447F

Table of Contents

1. Introduction

1.1 Introduction

Thank you for purchasing this Epson robot system. This manual provides the information necessary for correctly using the robot system.
Before using the system, please read this manual and related manuals to ensure correct use.
After reading this manual, store it in an easily accessible location for future reference.

Epson conducts rigorous testing and inspection to ensure that the performance of our robot systems meets our standards. Please note that if the Epson robot system is used outside the operating conditions described in the manual, the product will not perform up to its basic performance.

This manual describes potential hazards and problems that are foreseen. To use the Epson robot system safely and correctly, be sure to follow the safety information contained in this manual.

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1.4 Manufacturer

SEIKO EPSON CORPORATION

1.5 Contact Information

Contact information details are listed in the "Supplier" section in the following manual.
Note that the contact information may vary depending on your region.
"Safety Manual - Contact Information"

The Safety Manual is also available at the following site.
URL: https://download.epson.biz/robots/

1.6 Disposal

When disposing of this product, please do so in accordance with the laws and regulations of your country.

1.7 Before Use

Before using this manual, be sure that you understand the following information.

Control system configuration

The RS Manipulator is made up of a combination of the following Controller and software.

Controller	Software
RC800-A	Epson RC+ 8.0 or later

Due to the different control methods, the Manipulator may behave differently during operations such as an emergency stop depending on your Controller. For details, refer to the information in this manual.

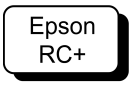
Controller power on (off)

In this manual, an instruction to "Turn on (off) the Controller power" means to turn on (or off) the power for the hardware that makes up your Controller. For details about Controller configuration, refer to the table above.

Motor shape

The motors of the Manipulators shown in this manual may differ in shape from your Manipulator due to the specifications.

Setting from the software



This manual contains the procedures for configuring the settings from the software.
Use of this software is indicated by the above mark.

1.8 Manual Types for This Product

This describes the typical types of manuals for this product and presents an overview of their content.

- **Safety Manual**

  This manual contains safety-related information intended for all people who use this product. It also guides the user through the process from unpacking to usage and the manuals that should be referred to next.
  Please read this manual first.
  - Safety information and residual risks of robot systems
  - Declaration of Conformity
  - Training
  - Process from unpacking to usage

- **Robot Controller Safety Function Manual**

  This describes the procedures for configuring the safety functions of this product and the configuration software. It is primarily intended for those who design robot systems.

- **RC800-A Manual**

This manual describes the installation of the entire robot system and explains the specifications and functions of the Controller. It is primarily intended for those who design robot systems.

- Robot system installation procedure (specific details on the process from unpacking to usage)
- Controller daily inspection points
- Controller specifications and basic functions

- **RS Series Manual**

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

  - Manipulator installation, technical information needed for design, function and specification tables, etc.
  - Manipulator daily inspection points

- **Status Code/Error Code List**

  This provides the code numbers displayed on the Controller and messages displayed in the message area of the software. It is primarily intended for those who design and program robot systems.

- **Epson RC+ User's Guide**

  This manual presents an overview of the program development software.

- **Epson RC+ SPEL+ Language Reference**

  This manual explains the robot programming language SPEL+.

Other manuals

Manuals are available for each option.

Maintenance and servicing manuals

Manuals for maintenance and servicing are not included with the product. Maintenance should be performed by people who have received maintenance training provided by Epson and the suppliers. For more information, please contact the supplier.

2. RS4-C and RS6-C Manipulators

This chapter contains information for setup and operation of the Manipulators. Please read this chapter thoroughly before setting up and operating the Manipulators.

2.1 Safety

The Manipulator and its related equipment should be unpacked and transported by people who have received installation training provided by Epson and the suppliers. Also, the laws and regulations of the country where the product is installed must be followed.
Before use, please read this manual and other related manuals to ensure correct use.
After reading this manual, store it in an easily accessible location for future reference.

2.1.1 Conventions Used in This Manual

The following symbols are used in this manual to indicate important safety information. Be sure to read the descriptions shown with each symbol.

⚠ WARNING

This symbol indicates an imminently hazardous situation which, if operation is not performed properly, will result in death or serious injury.

⚠ WARNING

This symbol indicates a potentially hazardous situation which, if operation is not performed properly, could result in an injury due to electric shock.

⚠ CAUTION

This symbol indicates a potentially hazardous situation which, if operation is not performed properly, may result in an injury or in property damage only.

2.1.2 Design and Installation Safety

This product is intended for transporting and assembling parts in a safely isolated area.
The robot system should be designed and installed by people who have received installation training provided by Epson and the suppliers.
To ensure safety, be sure to install safeguards for the robot system. For details on safeguards, refer to "Safety - Design and Installation Safety" in the Epson RC+ User's Guide.

Design personnel should refer to the following manuals:
"Safety Manual"
"Controller Manual"
"Manipulator Manual"

Refer to the following section for the installation safety information.
Environment and Installation
Be sure to read this section and follow the safety information before installation to ensure that the installation work is performed safely.

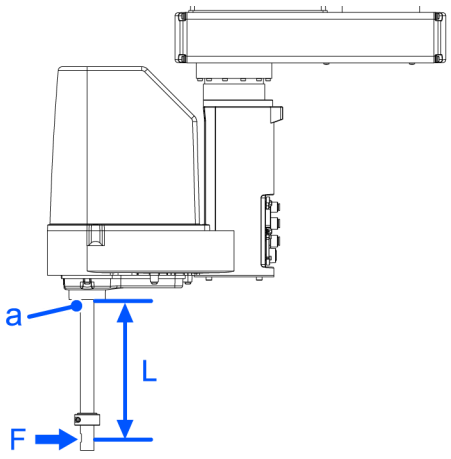
2.1.2.1 Strength of the Ball Screw Spline

If a load exceeding the allowable bending load is applied to the ball screw spline, it may not work properly due to deformation or breakage of the shaft.
If a load exceeding the allowable value is applied to the ball screw spline, the ball screw spline unit must be replaced.
The allowable load varies depending on the distance over which the load is applied. To calculate the allowable load, refer to the formula below.

Allowable bending moment
RS4-C: M=13,000N · mm
RS6-C: M=34,000N · mm

Calculation example: 130 N load applied at 100 mm from the end of the spline nut

Moment
M=F·L=100·130=13,000 N·mm



Symbol	Description
a	The end of the spline nut

KEY POINTS

When installing, be sure to provide sufficient working space.

2.1.3 Operation Safety

The following items are safety precautions for operating personnel:

⚠ WARNING

- Be sure to read the Safety Manual before use. Operating the robot system without understanding the safety information can be extremely dangerous and may result in serious injury or severe equipment damage.
- Do not enter the work envelope while the power is turned on. Even if the Manipulator appears to have stopped, it can start moving, which can be extremely dangerous and pose a serious safety hazard.
- Before operating the robot system, make sure that no one is inside the safety barriers. The robot system can be operated in the teaching operation mode even when someone is inside the safety barriers. Even though the motion of the Manipulator is always restricted (low speed and low power) to ensure operator safety, an unexpected movement by the Manipulator can be extremely dangerous and may cause serious safety problems.
- If the Manipulator makes any abnormal movements during operation of the robot system, do not hesitate to immediately press the emergency stop switch.

⚠ WARNING

- To perform the power supply lockout, remove the power plug. Be sure to connect the AC power cable to a power outlet. Do not connect it directly to a factory power source.
- Before performing any replacement work, inform others in the area that you are working, and then turn off the Controller and related equipment, and unplug the power cable from the power source. Performing any work procedure with the power turned on is extremely dangerous and may result in electric shock and/or malfunction of the robot system.
- Do not connect or disconnect the connector of the motor while the power is turned on. There is a risk the Manipulator may malfunction, which is extremely dangerous. Also, performing any work procedure with the power turned on may result in electric shock and/or malfunction of the robot system.

⚠ CAUTION

- As a general rule, the robot system should be operated by only one person. If it is necessary to operate with more than one person, ensure that all personnel communicate with each other and take all necessary safety precautions.
- Joints #1, #2, and #4:
  If the Manipulator is operated repeatedly with an operating angle of 5° or less, the bearings used in the joints are likely to cause oil film shortage. Repeated operation may cause premature damage. To prevent premature damage, operate the Manipulator to move each joint to an angle of 50° or more about once per hour.
  Joint #3
  If the up-and-down motion of the hand is 10 mm or less, move the hand about half or more of its maximum stroke about once per hour.
- When the robot is operating, vibration (resonance) may occur continuously during operation depending on the combination of the arm orientation and hand load. Vibration occurs due to the natural vibration frequency of the arm and can be reduced by taking the following measures:
  - Changing the robot speed

- Changing the teach points
- Changing the hand load

2.1.4 Emergency Stop

Each robot system needs equipment that will allow the operator to immediately stop the system's operation. Install an emergency stop device by using emergency stop input from the Controller or other equipment.

Before using the emergency stop switch, be aware of the following points.

- The emergency stop switch should be used to stop the Manipulator only in case of emergencies.
- Besides pressing the emergency stop switch when an emergency occurs, to stop the Manipulator during program operation, use the Pause or STOP (program stop) statements assigned to a standard I/O.
  The Pause and STOP statements do not turn off motor energization, and so the brake is not locked.

To place the robot system in emergency stop mode in a non-emergency (normal) situation, press the emergency stop switch while the Manipulator is not operating.

Do not press the emergency stop switch unnecessarily while the Manipulator is operating normally.
It could shorten the lifespan of the following components.

- Brakes
  The brakes will be locked, which will shorten the lifespan of the brakes due to worn brake friction plates.
  - Normal brake lifespan:
    About 2 years (when the brakes are used 100 times/day)
    or about 20,000 times
- Reduction gears
  An emergency stop applies an impact to the reduction gear, which can shorten its life.

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

- Reduced life and damage to reduction gear
- Position shift at the joints

If a power outage or other unavoidable Controller power-off occurs during Manipulator operation, check the following points after power is restored.

- Damage in reduction gear
- Shifting of the joints from their proper positions

If there was any shifting, maintenance is required. For more information, please contact the supplier.

Stopping distance of emergency stop

The Manipulator during operation cannot stop immediately after the emergency stop switch is pressed. Also, the stopping time and movement distance vary depending on the following factors.

- Hand weight, WEIGHT setting, ACCEL setting, workpiece weight, SPEED setting, movement posture, etc.

For the stopping time and movement distance of the Manipulator, refer to the following section.
Appendix B: Stopping Time and Stopping Distance at Emergency Stop

2.1.5 Safeguard (SG)

To maintain a safe working zone, safety barriers must be set up around the Manipulator, and safeguards must be installed at the entrance and exit of the safety barriers.
The term "safeguard" as used in this manual refers to a safety device with an interlock that allows entry into the safety barriers. Specifically, this includes safety door switches, safety barriers, light curtains, safety gates, safety floor mats, and so on. The safeguard is an input that informs the Robot Controller that an operator may be inside the safeguard area. You must assign at least one Safeguard (SG) in Safety Function Manager.

When the safeguard is opened, Protective Stop operates to change to the safeguard open state (display: SO).

- Safeguard open
  Operations are prohibited. Further robot operation is not possible until either the safeguard is closed, the latched state is released, and a command is executed, or the TEACH or TEST operation mode is turned on and the enable circuit is activated.
- Safeguard closed
  The robot can operate automatically in an unrestricted (high power) state.

> ⚠ WARNING
>
> - If a third party accidentally releases the safeguard while an operator is working inside the safety barriers, this may result in a hazardous situation. To protect the operator working inside the safety barriers, implement measures to lock out or tag out the latch release switch.
> - To protect operators working near the robot, be sure to connect a safeguard switch and make sure that it works properly.

Installing safety barriers

When installing safety barriers within the maximum range of the Manipulator, combine safety functions such as SLP. Carefully take into account the size of the hand and the workpieces to be held so that no interference occurs between the operating parts and the safety barriers.

Installing safeguards

Design the safeguards so that they satisfy the following requirements:

- When using a key switch type safety device, use a switch that forcibly opens the interlock contacts. Do not use switches that open their contacts using the spring force of the interlock.
- When using an interlock mechanism, do not disable the interlock mechanism.

Considering the stopping distance

During operation, the Manipulator cannot stop immediately even if the safeguard is opened. Also, the stopping time and movement distance vary depending on the following factors.
Hand weight, WEIGHT setting, ACCEL setting, workpiece weight, SPEED setting, movement posture, etc.

For the stopping time and movement distance of the Manipulator, refer to the following section.
Appendix C: Stopping Time and Stopping Distance When Safeguard is Open

Precautions for safeguard operation

Do not open the safeguard unnecessarily while the motor is energized. Frequent safeguard inputs will reduce the life of the relay.

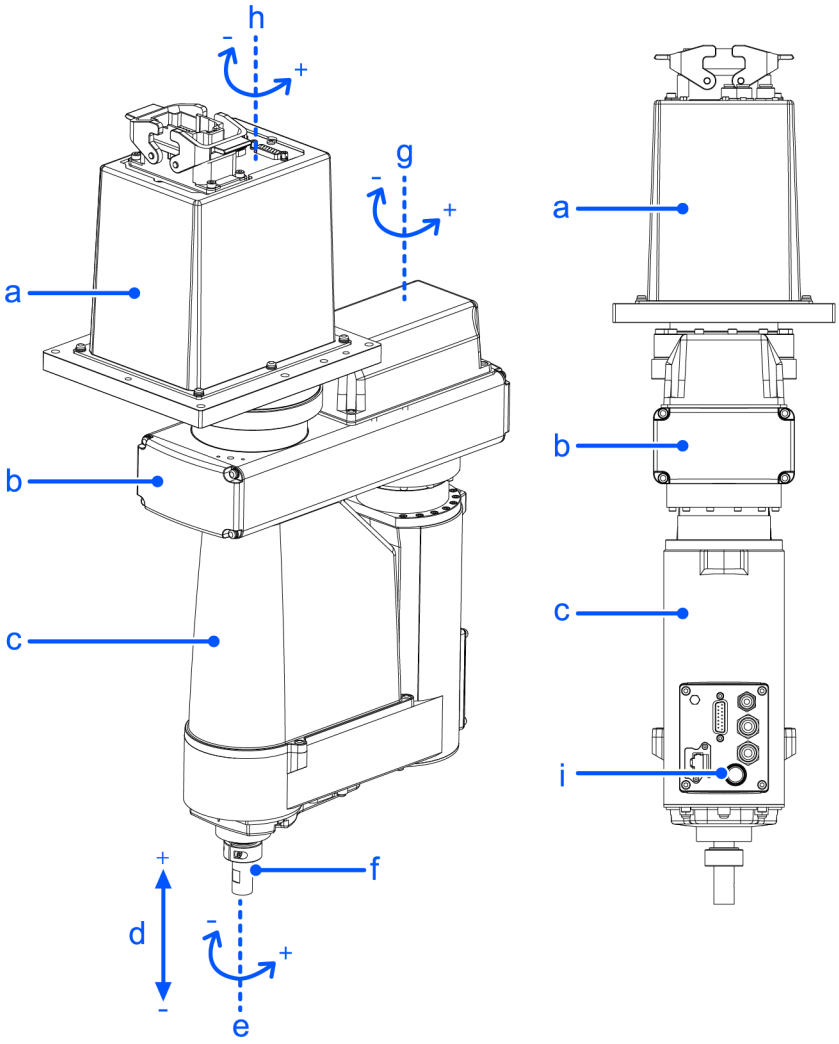
- Normal relay lifespan: About 20,000 times

2.1.6 Arm Movement Method in the Emergency Stop State

In the emergency stop state, move the Manipulator joints directly 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 or down by hand because the electromagnetic brake is activated.
  Move the joint while pressing down the brake release switch.
- **Joint #4**
  Rotate the shaft by hand.

RS4-C351*



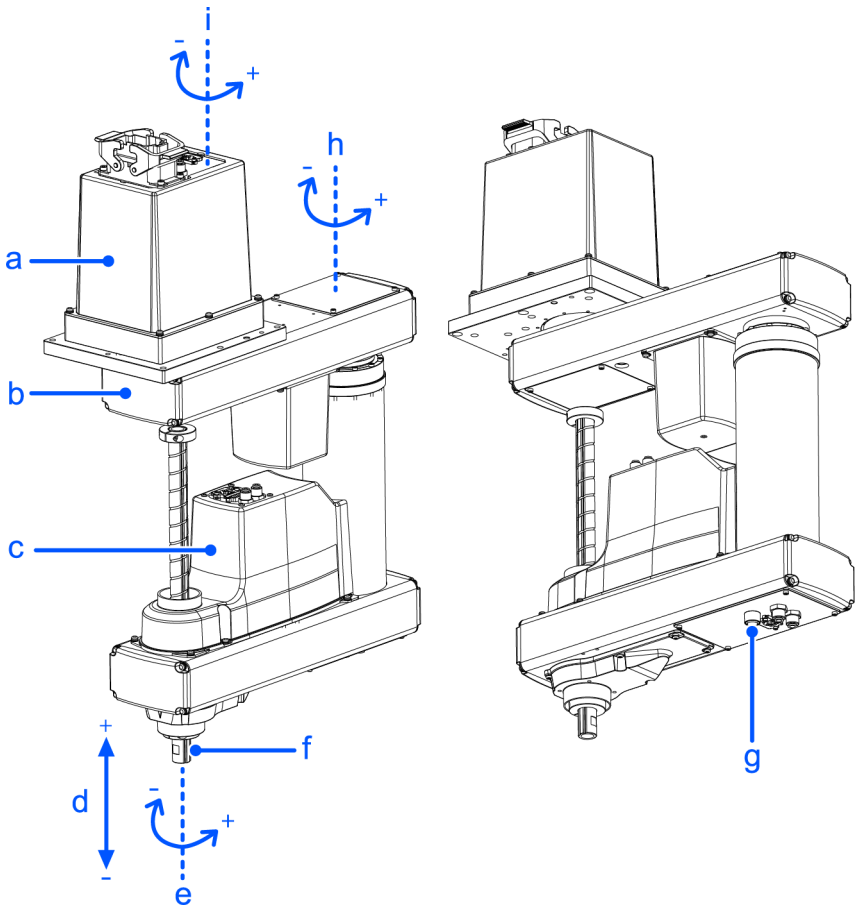
Symbol	Description
a	Base
b	Arm #1

Symbol	Description
c	Arm #2
d	Joint #3 (up/down movement)
e	Joint #4 (rotation)
f	Shaft
g	Joint #2 (rotation)
h	Joint #1 (rotation)
i	Joint #3 brake release switch

KEY POINTS

When pressing the brake release switch, watch for the shaft descending or rotating under the weight of the hand.

RS6-C552*



Symbol	Description
a	Base
b	Arm #1
c	Arm #2
d	Joint #3 (up/down movement)
e	Joint #4 (rotation)
f	Shaft
g	Joint #3 and Joint #4 brake release switch
h	Joint #2 (rotation)
i	Joint #1 (rotation)

KEY POINTS

When pressing the brake release switch, watch for the shaft descending or rotating under the weight of the hand.

2.1.7 AccelS Setting for CP Motion

To make the Manipulator move in a CP motion, make the appropriate AccelS settings in the SPEL program based on the tip load and Z-axis height.

KEY POINTS

If the AccelS settings are not properly configured, the following problems may occur.

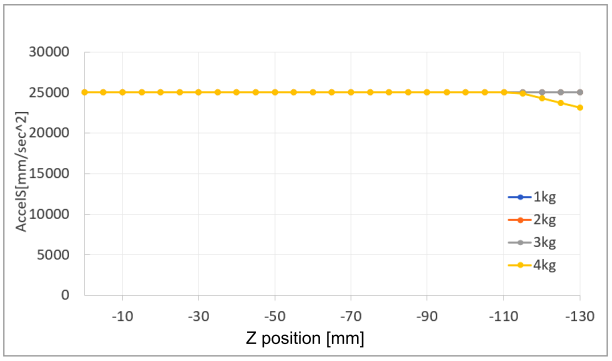
- Shortened lifespan and damage to the ball screw spline

Set AccelS as shown below based on the Z-axis height.

AccelS setting values by the Z-axis height and tip load

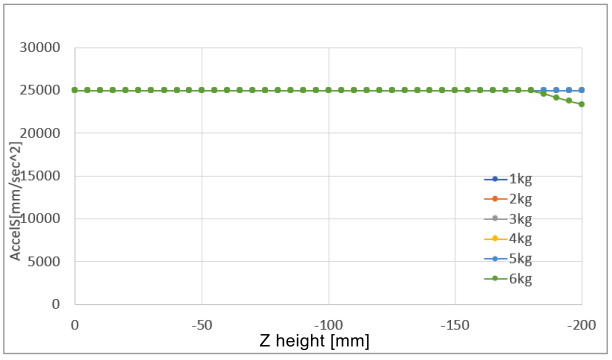
RS4-C

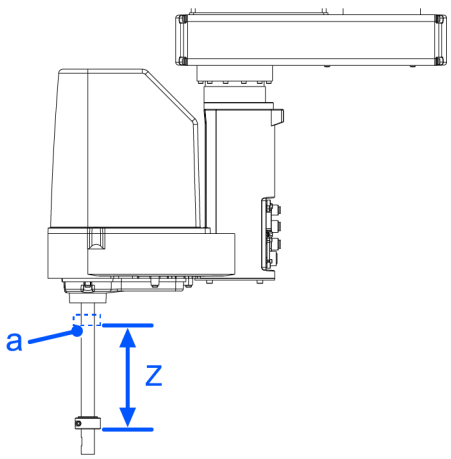
Maximum AccelS correction values by the Z-axis height and tip load



RS6-C

Maximum AccelS correction values by the Z-axis height and tip load





Symbol	Description
a	Z-axis height 0 (origin position)

Also, if a CP motion was performed with incorrect values set, check the following point.

- No deformation or bending of the shaft of the ball screw spline

2.1.8 Warning Labels

The Manipulator has the following warning labels.
Specific hazards exist in the vicinity of areas with the warning labels. Be thoroughly careful in handling.
To ensure that the Manipulator is operated and maintained safely, be sure to follow the safety information and warnings indicated on the warning labels. Also, do not tear, damage, or remove these warning labels.

2.1.8.1 Warning Labels

A

Touching any internal electrified parts while the power is turned on may cause electric shock.

B

The surface of the Manipulator is hot during and after operation, and there is a risk of burns.

2.1.8.2 Information Labels

1

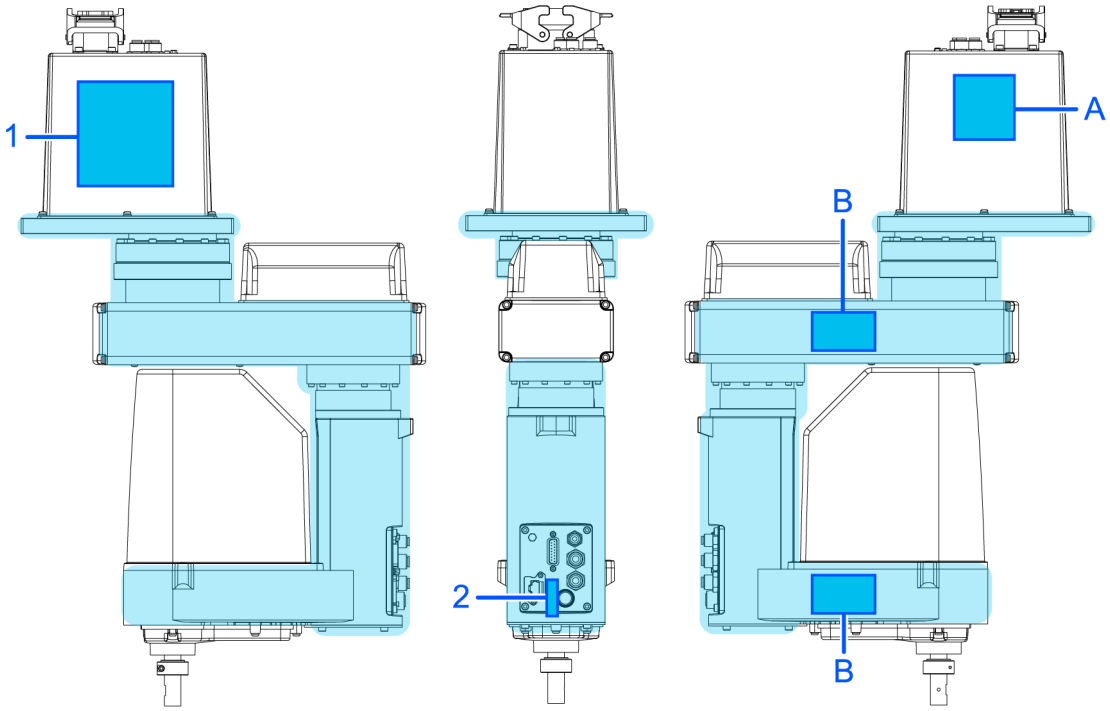
This indicates the product name, model name, serial number, information of supported laws and regulations, product specifications (Weight, MAX.REACH, MAX.PAYLOAD, AIR PRESSURE, Motor Power), Main document No., manufacturer, importer, date of manufacture, country of manufacture, and the like.
For details, see the label affixed to the product.

2

Indicates the position of a brake release button.

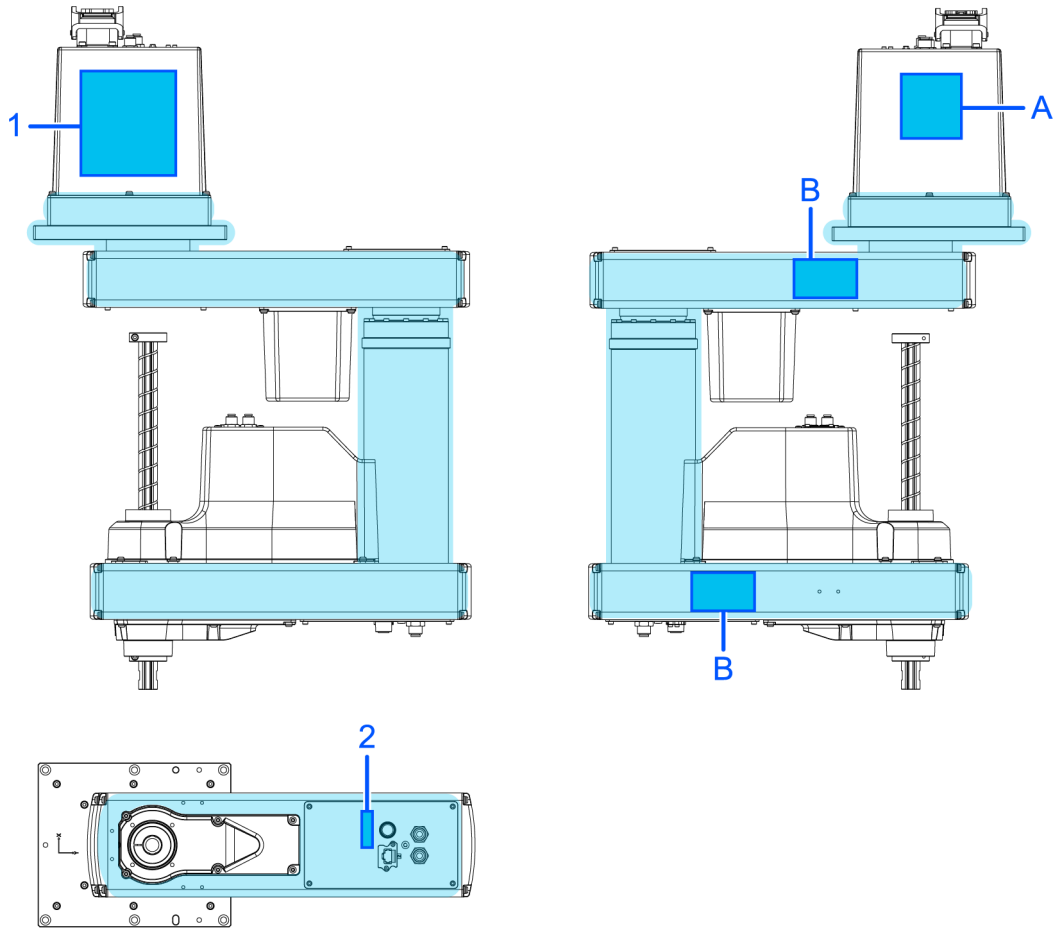
2.1.8.3 Labelled Locations

RS4-C



: hot surface

RS6-C



: hot surface

2.1.9 Responses for Emergencies or Malfunctions

2.1.9.1 When a Collision with the Manipulator Occurs

If the Manipulator has collided with a mechanical stop, peripheral device, or other object, discontinue use and contact the supplier.
Also, if the Manipulator collides with mechanical stops or peripheral devices, the following problems may occur.

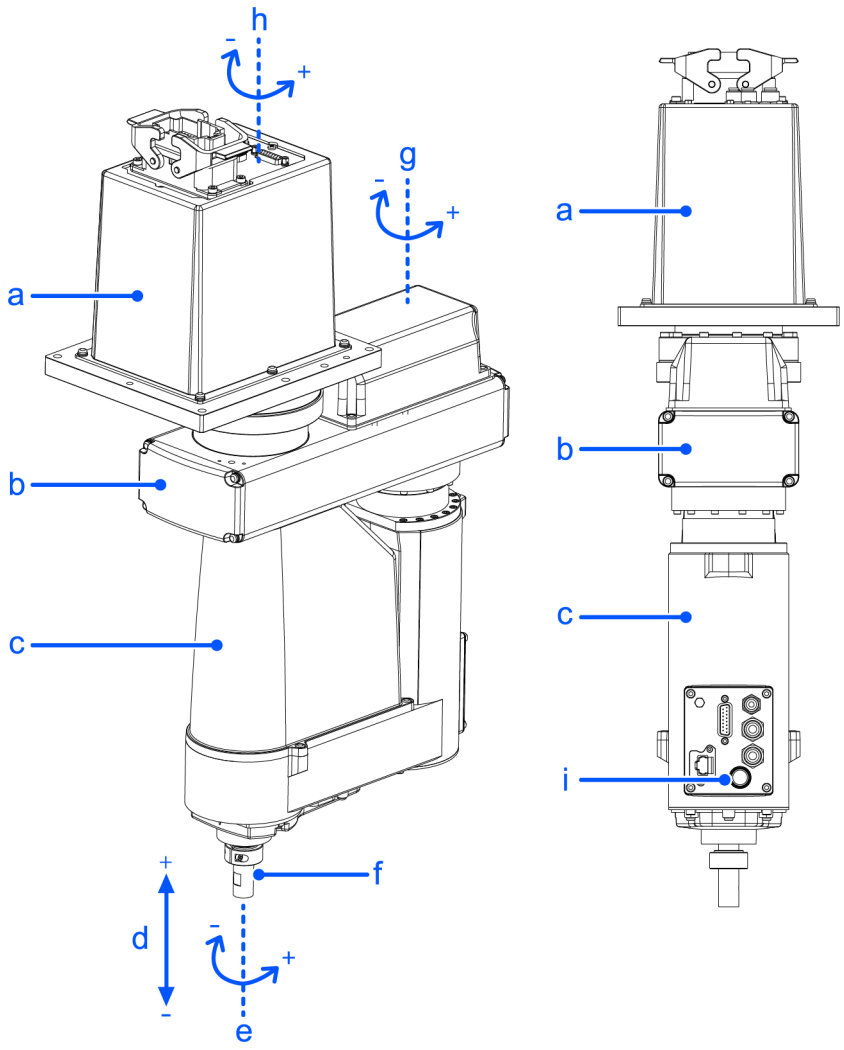
- Reduction of the life and damage of the reduction gear unit
- Position gap at the joints

2.1.9.2 Entanglement with the Manipulator

If an operator gets caught between the Manipulator and a mechanical part such as a base table, press the emergency stop switch to release the operator by using the following method.

- Operator body is entangled with a robot arm
  The brake is not functioning. Move the arm manually.
- Operator body is entangled with the shaft
  The brake is functioning. Press the brake release switch, and move the shaft.

RS4-C351*



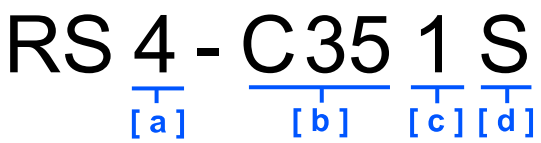
Symbol	Description
a	Base
b	Arm #1
c	Arm #2
d	Joint #3 (up/down movement)
e	Joint #4 (rotation)
f	Shaft
g	Joint #2 (rotation)
h	Joint #1 (rotation)
i	Joint #3 brake release switch

⚠ CAUTION

- While the brake release switch is being pressed, in addition to Joint #3, Joint #4 may also move due to its own weight. Be careful of the shaft descending and rotating.

2.2 Specifications

2.2.1 Model Number



- **a: Payload**
  4: 4 kg
  6: 6 kg
- **b: Arm length**
  35: 350 mm
  55: 550 mm
- **c: Joint #3 stroke**
  1: 130 mm (RS4-C351S), 100 mm (RS4-C351C)
  2: 200 mm (RS6-C552S), 150 mm (RS6-C552C)
- **d: Environmental specifications**
  S: Standard
  C: Cleanroom & ESD (anti-static)

Environmental specifications

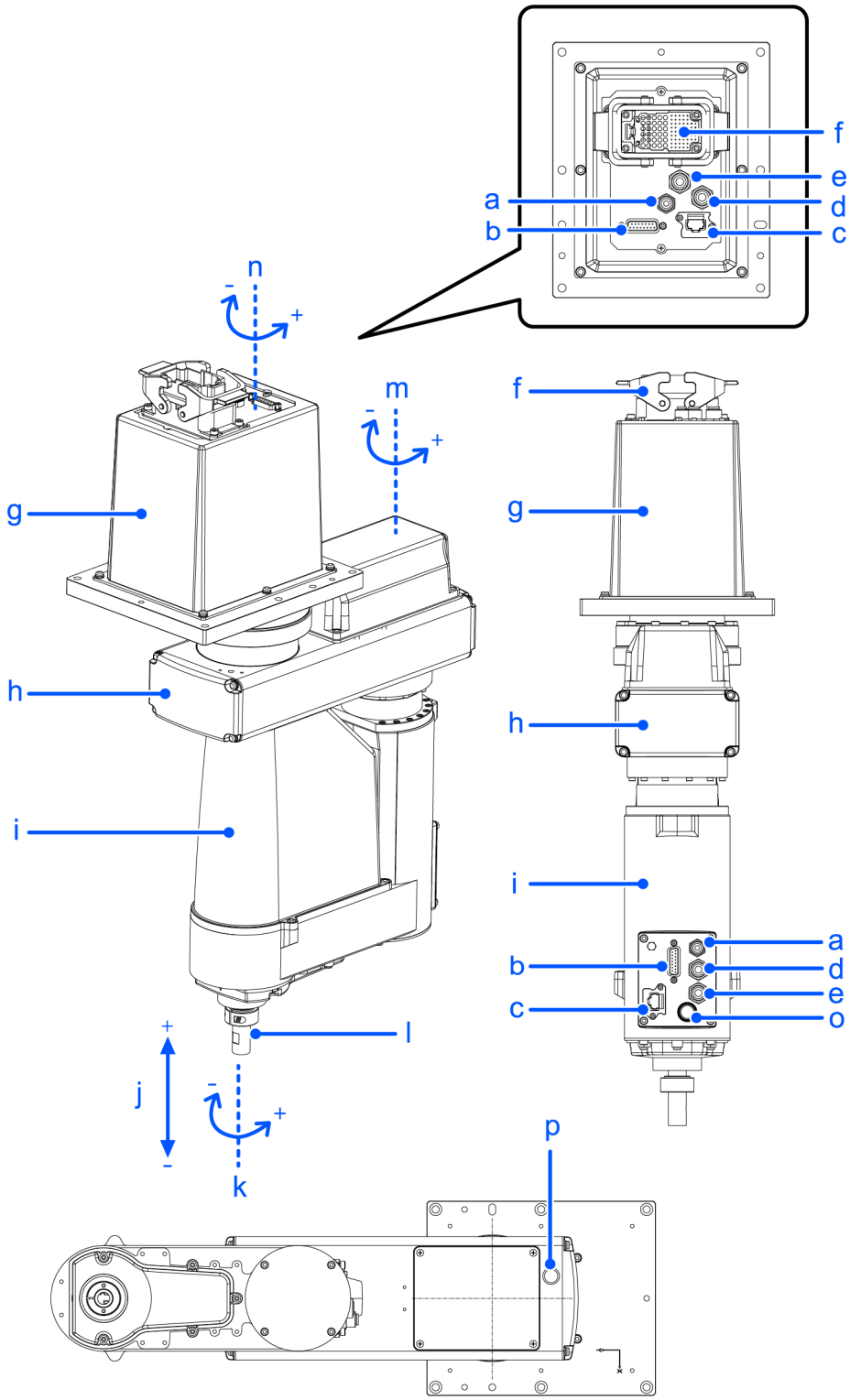
- Cleanroom model:
  Manipulators with cleanroom specifications are designed based on the standard model, but as an additional feature, have reduced dust emissions from the Manipulator to enable use in cleanroom environments.

For details on the specifications, refer to the following section.
Appendix A: Specifications Table

2.2.2 Names of Parts and Their Dimensions

2.2.2.1 RS4-C351*

Standard model RS4-C351S



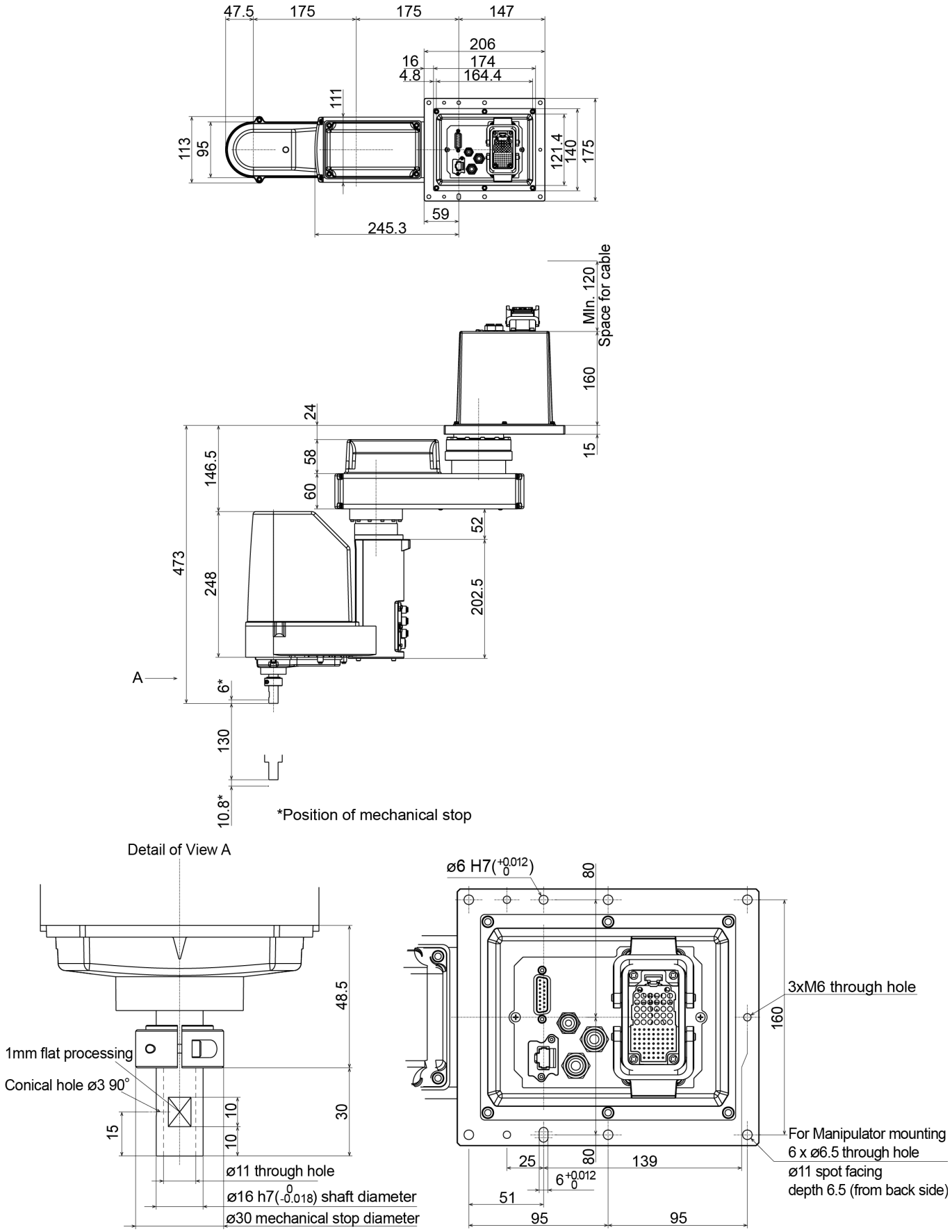
Symbol	Description
a	Fitting for ø4 mm tube (white)

Symbol	Description
b	User connector (15-pin D-sub connector)
c	User connector (RJ45 connector)
d	Fitting for ø6 mm tube (white)
e	Fitting for ø6 mm tube (black, blue)
f	MC connector
g	Base
h	Arm #1
i	Arm #2
j	Joint #3 (up/down movement)
k	Joint #4 (rotation)
l	Shaft
m	Joint #2 (rotation)
n	Joint #1 (rotation)
o	Brake release switch
p	LED lamp

KEY POINTS

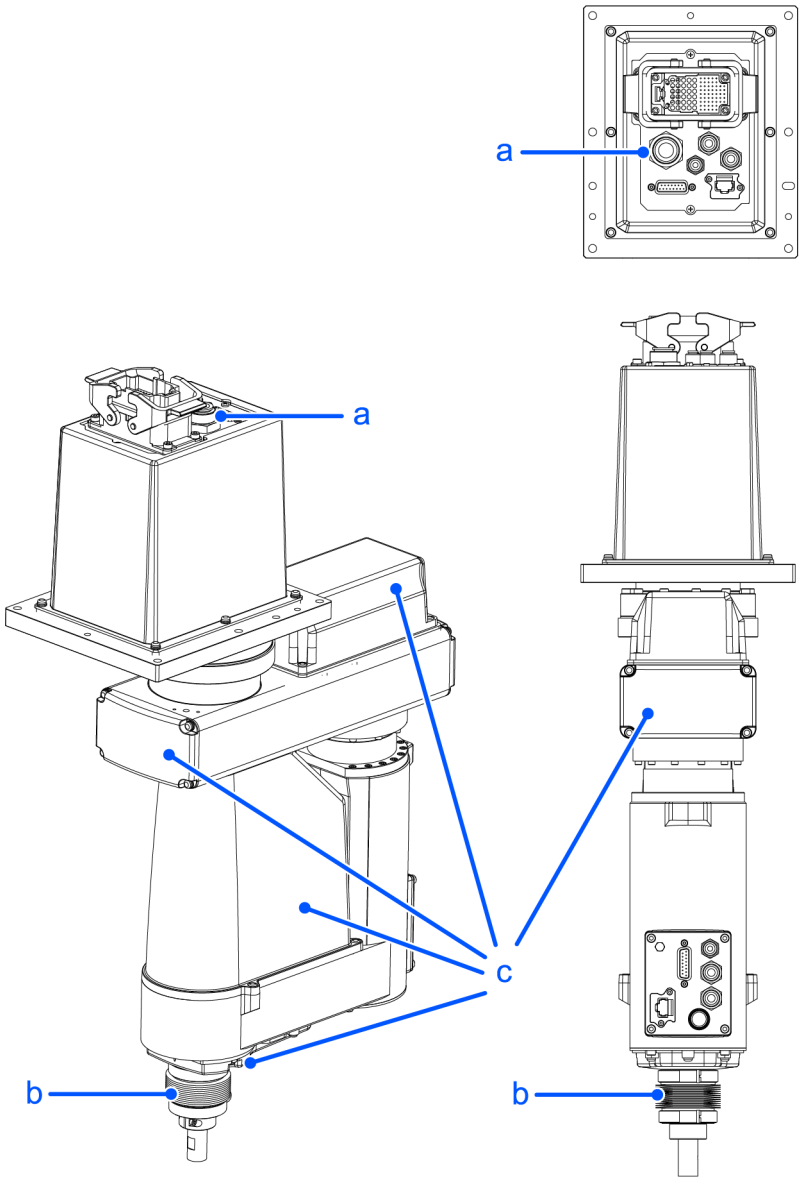
- When the brake release switch is pressed in emergency mode, the brake for Joint #3 is released.
- When the LED lamp is on or the Controller is power is on, a current is being applied to the Manipulator. Before starting any maintenance work, be sure to turn off the Controller and inform others in the surrounding area that work is in progress. Performing any work procedure with the power turned on is extremely dangerous and may result in electric shock and/or malfunction of the robot system.

Standard model RS4-C351S



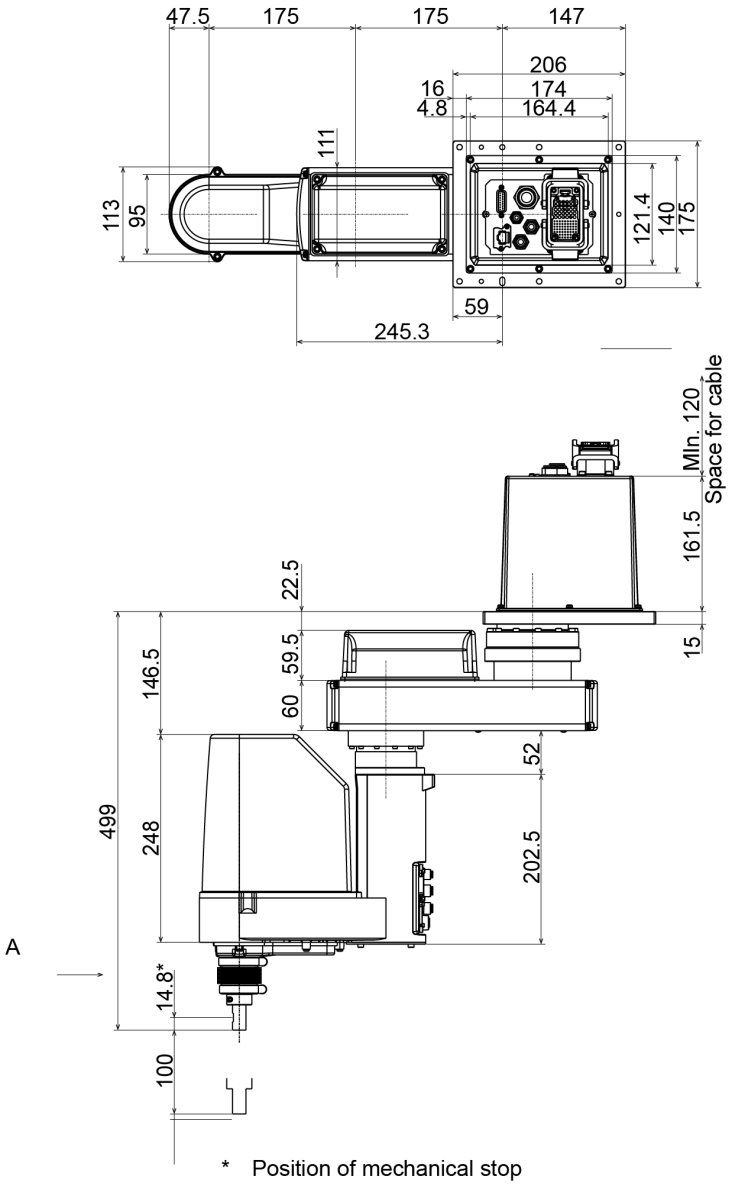
Cleanroom model RS4-C351C

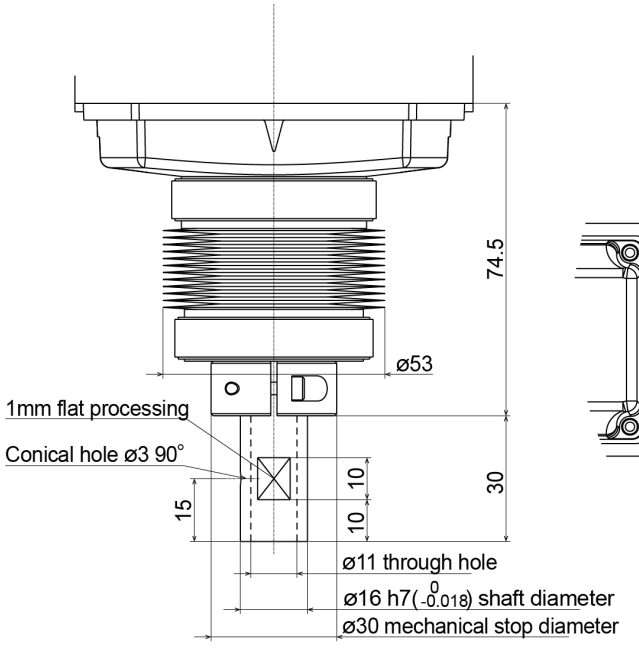
The parts of the cleanroom model exterior shown below differ from the standard model.



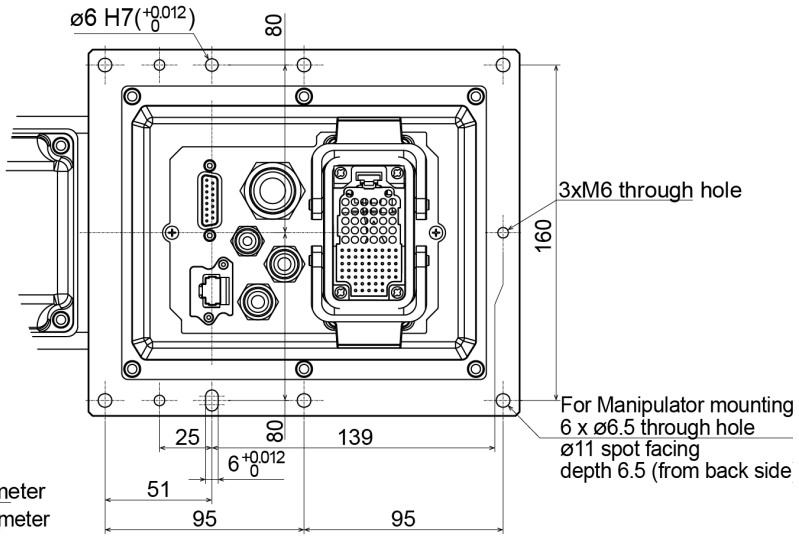
Symbol	Description
a	Exhaust port
b	Bellows
c	Plating covers (anti-static specifications)

Cleanroom model RS4-C351C





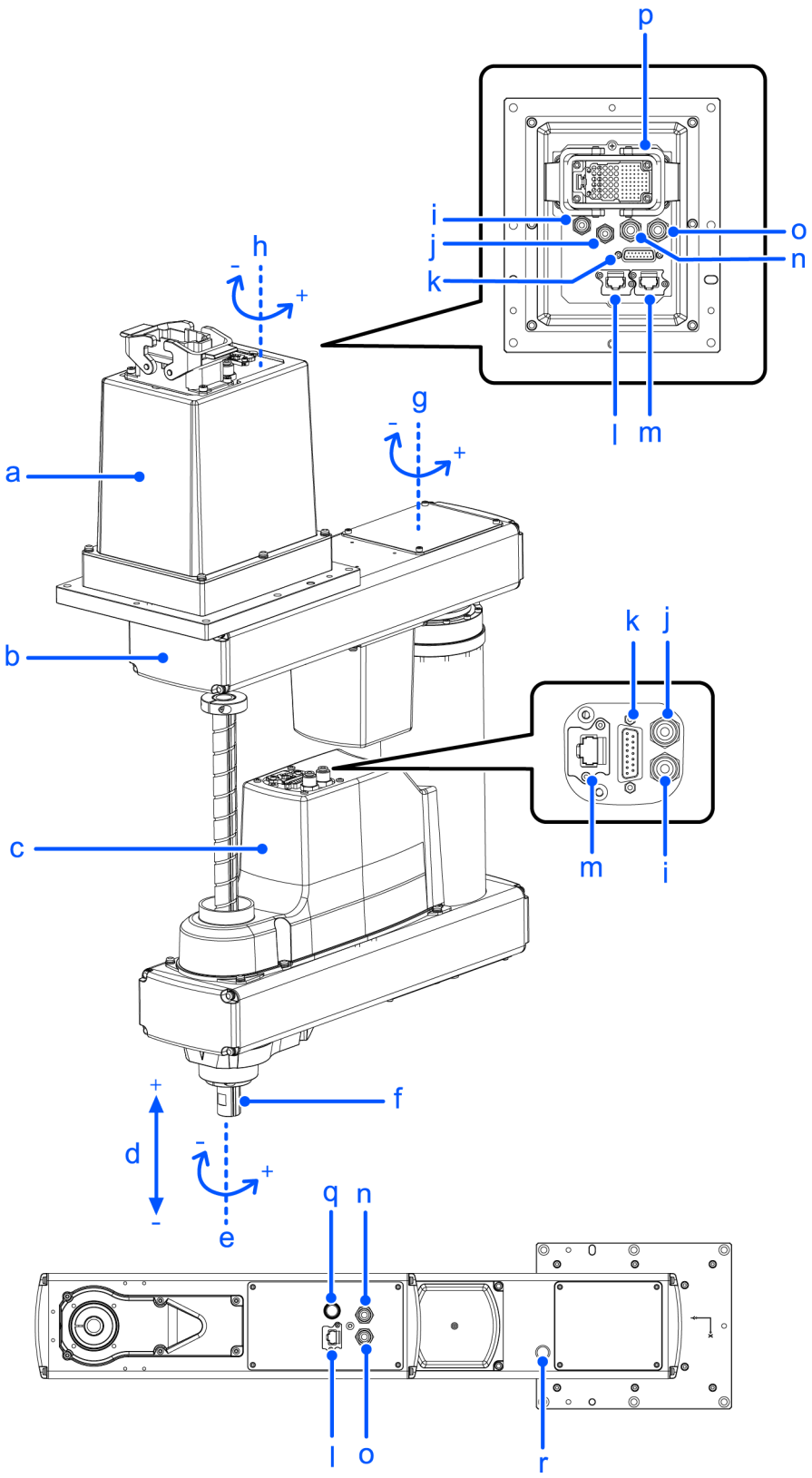
Detail of View A
Scale 1:1



Scale 1:2

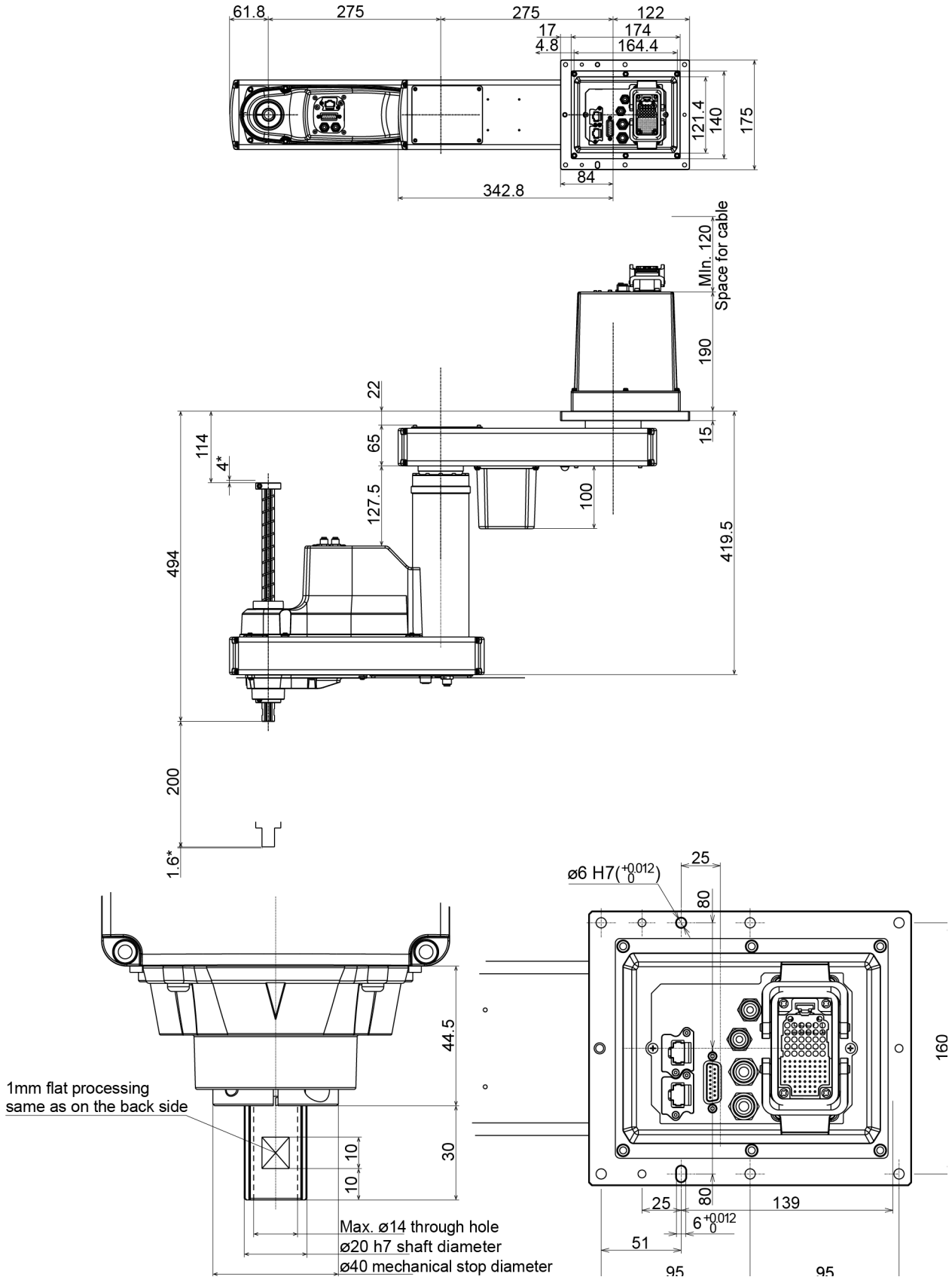
2.2.2.2 RS6-C552*

Standard model RS6-C552S



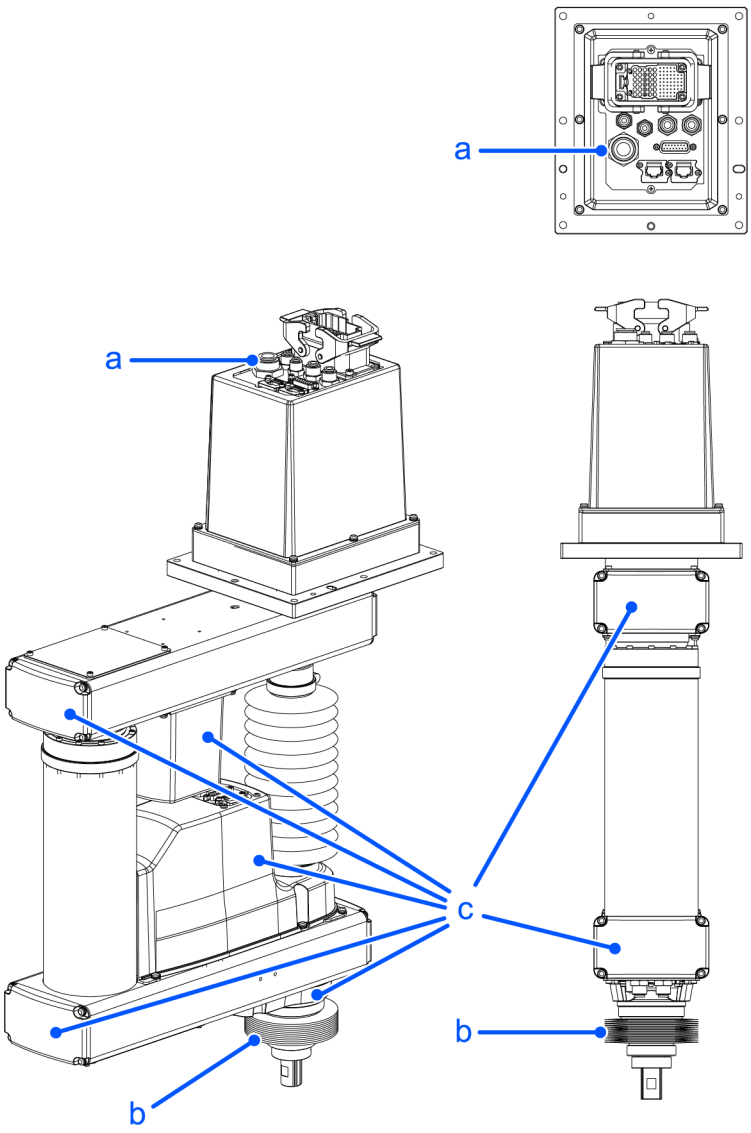
Symbol	Description
a	Base
b	Arm #1
c	Arm #2
d	Joint #3 (up/down movement)
e	Joint #4 (rotation)
f	Shaft
g	Joint #2 (rotation)
h	Joint #1 (rotation)
i	Fitting for ø4 mm tube (white)
j	Fitting for ø4 mm tube (black, blue)
k	User connector (15-pin D-sub connector)
l	User connector (RJ45 connector No. 2)
m	User connector (RJ45 connector No. 1)
n	Fitting for ø6 mm tube (white)
o	Fitting for ø6 mm tube (black, blue)
p	MC connector
q	Brake release switch
r	LED lamp

Standard model RS6-C552S



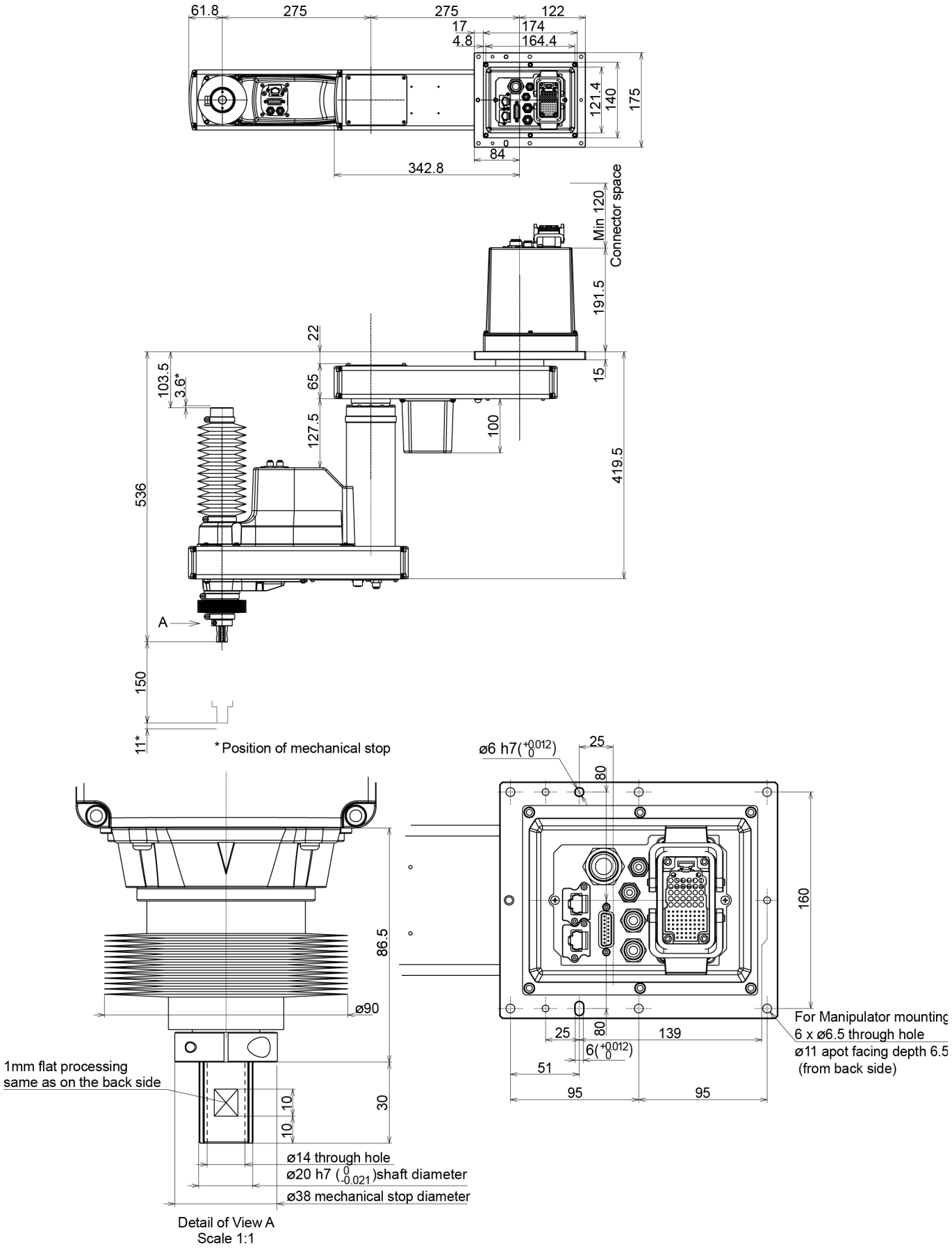
Cleanroom model RS6-C552C

The parts of the cleanroom model exterior shown below differ from the standard model.



Symbol	Description
a	Exhaust port
b	Bellows
c	Plating covers (anti-static specifications)

Cleanroom model RS6-C552C



2.2.3 Specifications Table

For the specifications tables of each model, refer to the following section.
Appendix A: Specifications Table

2.2.4 How to Set the Model

The Manipulator model for your system has been set before shipment from the factory.
Normally, the model does not need to be changed when you receive your system.

⚠ CAUTION

- If changing the setting of the Manipulator model, be responsible and absolutely certain that the wrong Manipulator model is not set. Incorrect setting of the Manipulator model may result in abnormal or no operation by the Manipulator and could even cause safety problems.

KEY POINTS

If a custom specifications number (MT***) or (X***) is written on the face plate (serial number label), the Manipulator has custom specifications.

Models with custom specifications may require a different setting procedure. Check the custom specifications number and contact the supplier for more information.

The Manipulator model is set from software. For details, refer to the following manual.
"Epson RC+ User's Guide - Robot Configuration"

2.3 Environment and Installation

The robot system should be designed and installed by people who have received installation training provided by Epson and the suppliers. Also, the laws and regulations of the installation country must be followed.

2.3.1 Environment

To ensure that the robot system operates and maintains maximum performance and to ensure its safe use, the robot system should be installed in an environment that meets the following requirements.

Item	Conditions
Ambient temperature*1	Installation: 5 to 40°C Transportation and storage temperature:– 20 to 60°C
Ambient relative humidity	Installation: 10 to 80% (no condensation) Transport, storage: 10 to 90% (no condensation)
Fast transient burst noise	1 kV or less (Signal wire)
Electrostatic noise	4 kV or less
Altitude	1000 m or less
Environment	- Install indoors. - Keep away from direct sunlight. - Keep away from dust, oily smoke, salinity, metal powder, and other contaminants. - Keep away from flammable or corrosive liquids and gases. - Keep away from water. - Keep away from shocks or vibrations. - Keep away from sources of electric noise. - Keep away from explosive areas. - Keep away from large quantities of radiation.

KEY POINTS

Manipulators are not designed for use in adverse environments. If the Manipulator will be used in a location that does not meet the above requirements, please contact the supplier.

*1 The ambient temperature requirement is for the Manipulator only. For details on the environment requirements for the connected Controller, refer to the following manual.
"Controller Manual"
When used in a low-temperature environment near the minimum temperature specified in the product specifications, or when the unit is idle for a long period of time during holidays or at night, a collision detection error or similar error may occur immediately after the start of operation due to high resistance in the drive unit. In such cases, warm-up operation for about 10 minutes is recommended.

KEY POINTS

If there are conductive objects such as fences or ladders within 2.5 m of the Manipulator, these objects must be grounded.

Special environmental requirements

Manipulator surfaces are generally oil-resistant, but if special oils are to be used, oil resistance should be checked before use. For more information, please contact the supplier.

In environments with rapid changes in temperature and humidity, condensation may form inside the Manipulator.

When handling food directly, it is necessary to make sure that the Manipulator is not likely to contaminate the food. For more information, please contact the supplier.

The Manipulator cannot be used in corrosive environments where acids or alkalis are present. In environments where rust can easily form, such as those exposed to salt, rust may also form on the Manipulator.

⚠ WARNING

- Always use a circuit breaker for the Controller's power supply. Failure to use a circuit breaker may result in an electrical shock hazard or malfunction due to an electrical leakage.
  Select the correct circuit breaker based on the Controller that you are using. For more information, refer to the following manual.
  "Controller Manual"

⚠ CAUTION

- When cleaning the Manipulator, do not rub it strongly with alcohol or benzene. Coated surfaces may lose their luster.

2.3.2 Base table

A base table for anchoring the Manipulator must be fabricated by the customer.

The shape and size of the base table vary depending on the application of the robot system. As a reference when designing the base table, the requirements from the Manipulator side are shown here.

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

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

- Maximum torque on horizontal surface: 400 N · m (RS4-C351*), 700 N · m (RS6-C552*)
- Maximum reaction force in horizontal direction: 1100 N (RS4-C351*), 1900 N (RS6-C552*)
- Maximum reaction force in vertical direction: 1200 N (RS4-C351*), 1000 N (RS6-C552*)

⚠ CAUTION

If the vibration of the base table is large, reduce the acceleration/deceleration or increase the rigidity of the base table to reduce the vibration. Continued use in a state of large vibration may cause loosening of fastening parts or excessive load on mechanical parts, which may shorten the lifespan.

M6 threaded holes are used for mounting the Manipulator on the base table.
Use bolts for mounting the Manipulator that have a strength compliant with ISO 898-1 property class 10.9 or 12.9. For details on the dimensions, refer to the following sections.

Names of Parts and Their Dimensions

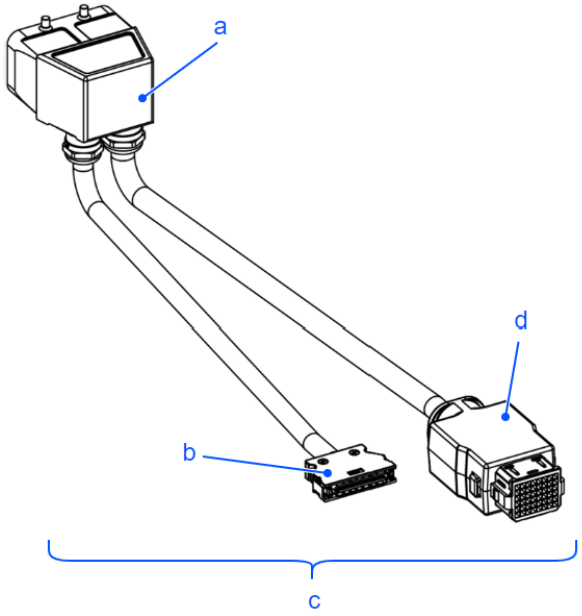
Manipulator Mounting Dimensions

The plate for the Manipulator mounting face should be at least 20 mm thick and made of steel for reducing vibrations. A surface roughness of 25 µm or less at the maximum height is appropriate.

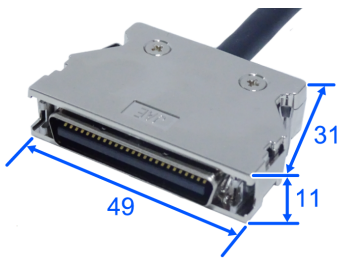
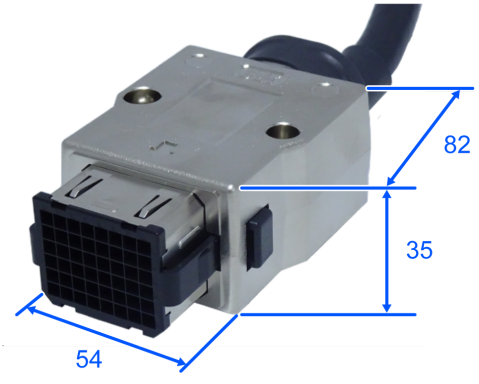
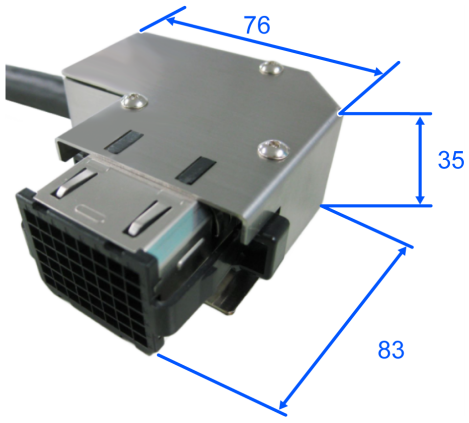
The base table must be secured to the floor or wall to prevent it from moving.

The Manipulator mounting surface should have a flatness of 0.5 mm or less and an inclination of 0.5° or less. If the installation surface does not have the proper flatness, the base of the Manipulator may be damaged or the robot may be unable to operate at maximum performance.
When using a leveler to adjust the height of the base table, use a screw with an M16 diameter or more.

If passing cables through the holes in the base table, refer to the connector dimensions in the figures below.



Symbol	Description
a	M/C cable hood
b	Signal connector
c	M/C power cable
d	Power connector

Signal Connector	Power Connector (Straight)	Power Connector (L-shaped)
		

(Unit: mm)

The M/C cables are attached to the Manipulator. They cannot be removed. Do not forcibly remove them.

If a maintenance window cannot be installed on the base table, then the Manipulator must be removed from the base table when performing maintenance. When designing the base table, take into consideration the ease of maintenance.

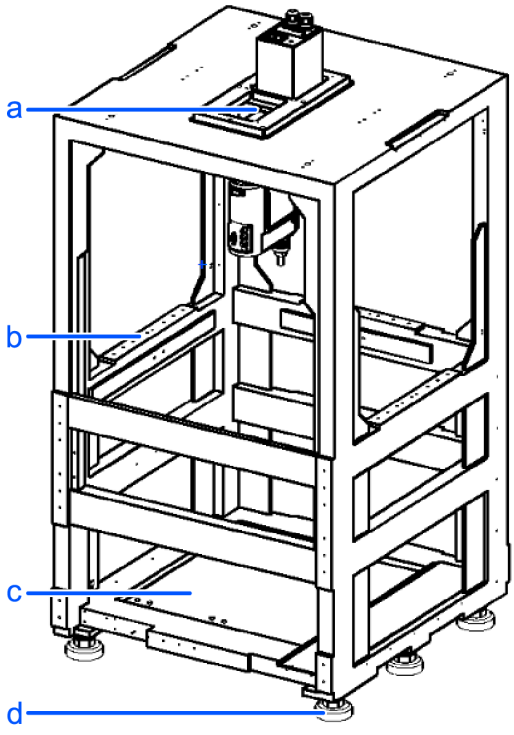
For details on the environmental requirements for the space when housing the Controller in the base table, refer to the following manual.
"Controller Manual"

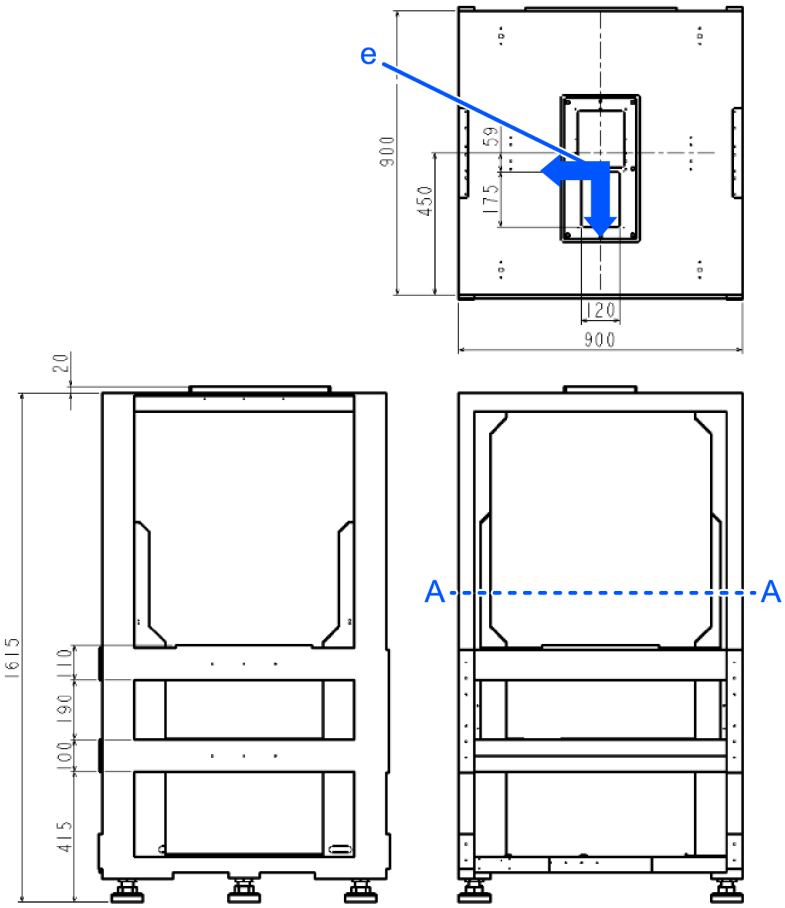
⚠ WARNING

- To ensure safety, be sure to install safety barriers for the robot system. For details, refer to the following section.
  Safeguard (SG)

Example base table design

The following is a design example of a base table that ensures rigidity so as not to affect the vibration of the RS4-C when the RS4-C is moved at its maximum acceleration and deceleration.





Symbol	Description
a	Maintenance window *
b	Operating surface height
c	Space for Controller installation

Symbol	Description
d	Adjuster bolt
e	Rotation center of Joint #1

*: Space must be provided to remove the cover of Arm #1

Base table weight: Approx. 300 kg
Frame material: Steel pipe square, 100 × 50 mm, thickness: 3.2 mm
Adjuster bolt : M36
Second moment of area (cross-section view of A-A): Ix = 1.2×10^9 mm^4 Iy = 1.2×10^9 mm^4

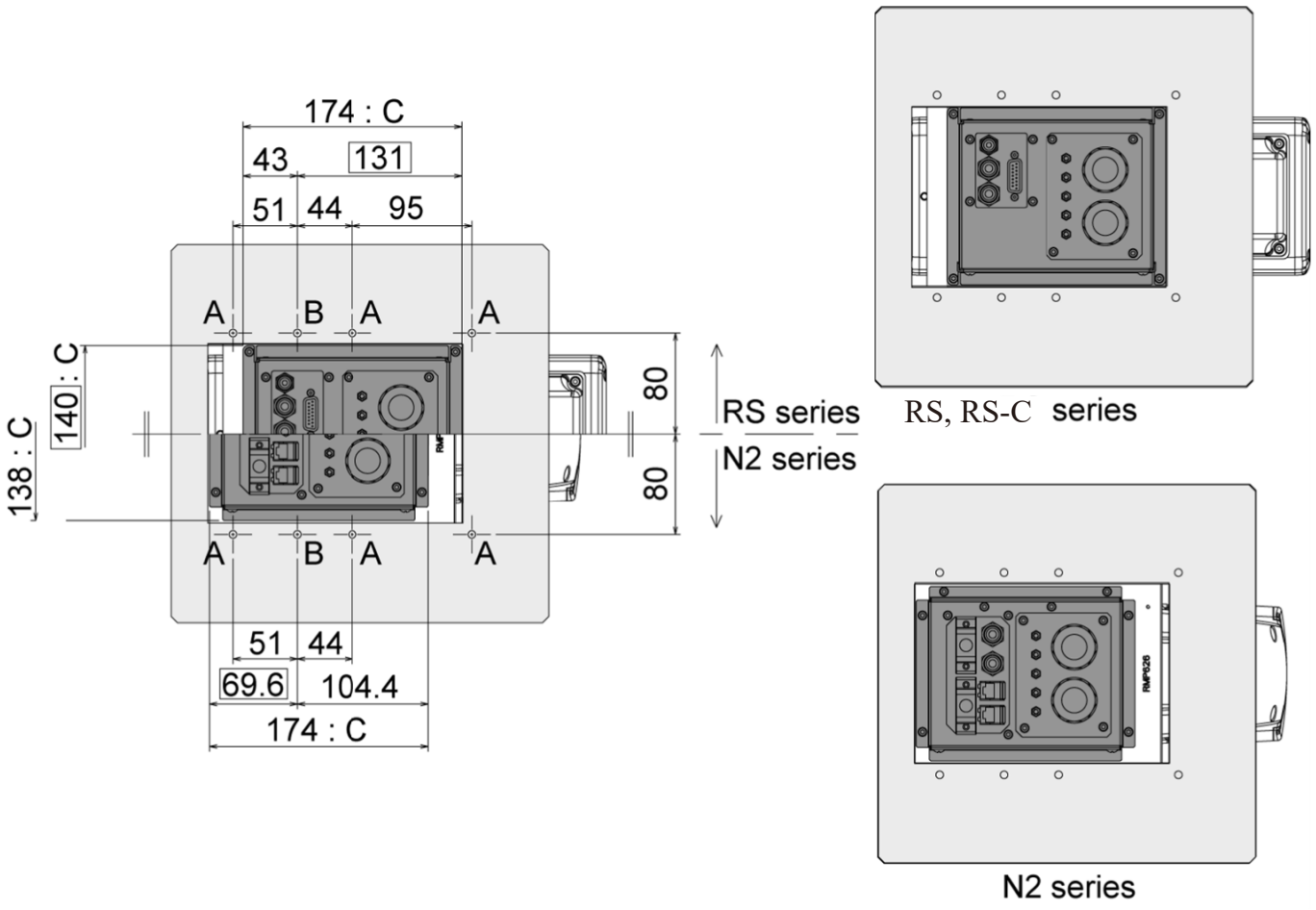
- Use a small aspect ratio of the base table height and width.
- The Controller and other equipment should be installed on the bottom of the base table to lower the center of gravity of the base table.
- Openings should be reinforced with crossbeams or the like and made as small as possible.
- Conditions vary depending on the height and width of the base table, the position of the crossbeams, the center of gravity, and other factors.

Example of space for base

This is an example of space for a base to allow installation of either the RS, RS-C or N2 series.
Design the base table as shown below to the extent that it does not interfere with the positioning holes or mounting holes.

Height: 140 mm or more.
Width: 131 mm or more and 69.6 mm or more from the reference hole.

(Units: mm)



Symbol	Description
A	Hole for mounting
B	Positioning hole
C	Manipulator cover exterior

2.3.3 Manipulator Mounting Dimensions

The maximum envelope shown in the figure shows a case where the radius of the hand is 50 mm or less. If the radius of the hand exceeds 50 mm, define the radius as the distance to the outer edge of the maximum envelope. In addition to the hand, if a camera, solenoid valve, or other component attached to the arm is large, set the maximum envelope to include the range that the component may reach.

Also, besides the area required for installation of the Manipulator, Controller, peripheral equipment, and other devices, the following space should be provided at a minimum.

- Space for teaching
- Space for maintenance and inspection (Space for working safely in the safety barriers)
  For maintenance, there must be an area for opening covers and the like.

Allow a minimum space of 50 mm from the maximum envelope to the safeguard.

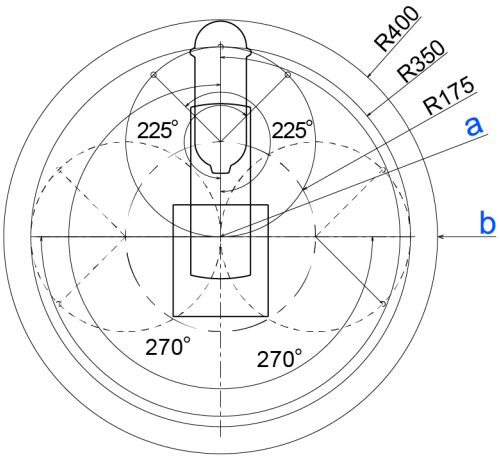
KEY POINTS

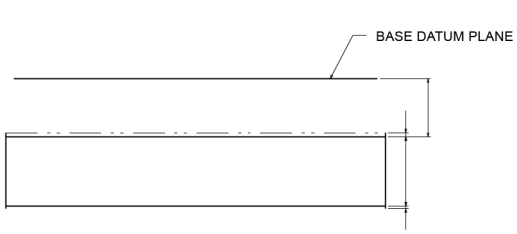
- When installing the cables, be sure to maintain sufficient distance from obstacles.
- For the minimum bend radius of the M/C cable, refer to the following section.
  Appendix A: Specifications Table
- Also, leave enough space for other cables so that they are not forced to bend at extreme angles.

⚠ WARNING

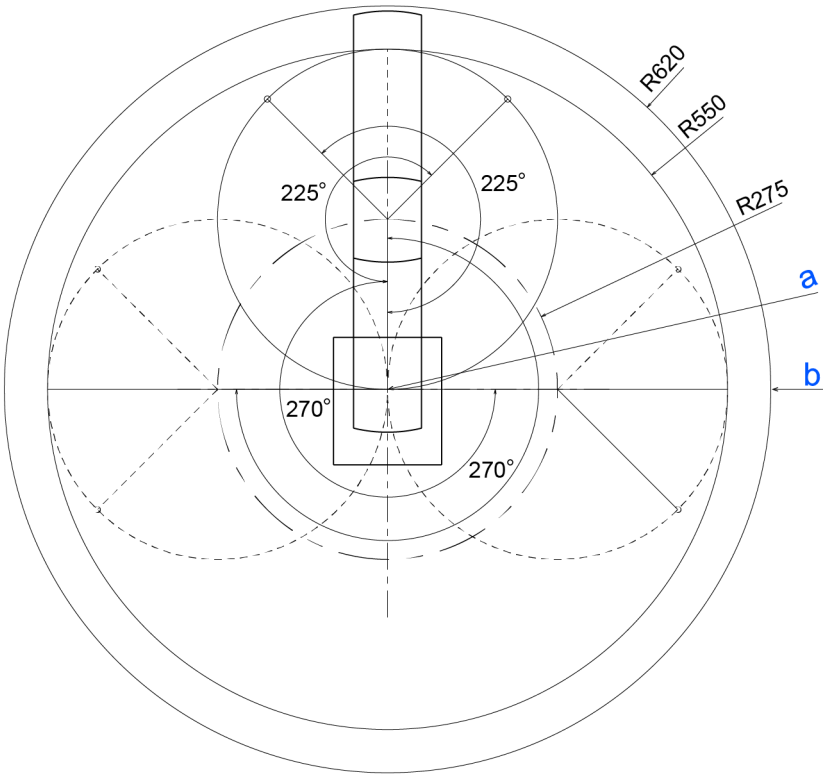
- Install the Manipulator in a location with enough space so that a tool or a workpiece tip does not reach a wall or safety barriers when the Manipulator extends its arm while holding a workpiece. If the tool or the workpiece tip reaches a wall or safety barriers, it is extremely hazardous and may result in serious bodily injury to operators and/or severe equipment damage.
  The distance between the safety barriers and the tool or workpiece should be set according to ISO 10218-2.
  For the stopping time and stopping distance, refer to the following sections.
  Appendix B: Stopping Time and Stopping Distance at Emergency Stop
  Appendix C: Stopping Time and Stopping Distance When Safeguard is Open

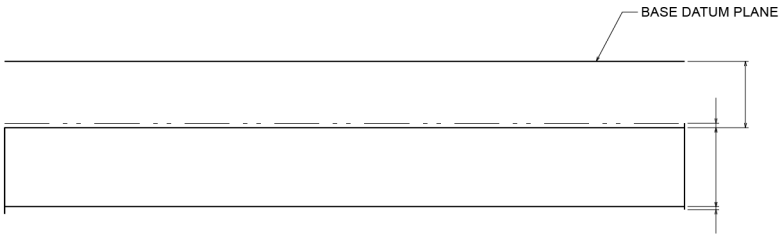
RS4-C351*





RS6-C552*





Symbol	Description
a	Center of Joint #3
b	Maximum zone

	RS4-C351 *	RS6-C552*
Arm #1 length	175 mm	275 mm
Arm #2 length	175 mm	275 mm
Joint #1 motion angle	± 270 deg	
Joint #2 motion angle	±225 deg	

2.3.4 From Unpacking to Installation

2.3.4.1 Safety Information for the Flow from Unpacking to Installation

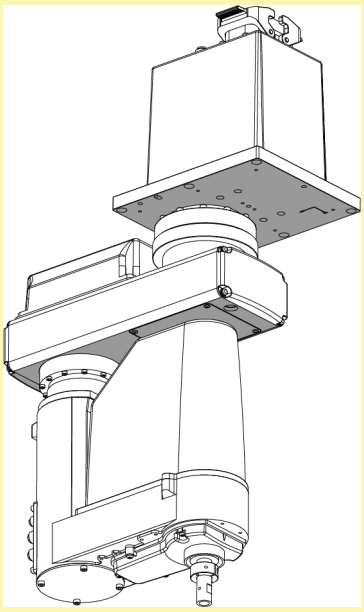
Transportation and installation of the Manipulator and related equipment should be performed by people who have received installation training provided by Epson or its suppliers. Also, the laws and regulations of the installation country must be followed.

⚠ WARNING

- Only qualified personnel should perform sling work and operate a crane or a forklift. When these operations are performed by unqualified personnel, it is extremely hazardous and may result in serious bodily injury to operators and/or severe equipment damage.

⚠ CAUTION

- Use a cart or the like to transport the Manipulator in the same status as it was delivered.
- After removing the fixing bolts securing the Manipulator to the transportation pallet, the Manipulator can fall. Be careful not to get your hands or feet caught in between the Manipulator.
- The arm is secured in place with cable ties. To prevent hands or other body parts from getting pinched in the robot arm, do not remove the cable ties until installation is complete.
- The Manipulator should be transported by two or more people, either secured to transporting equipment or carried by placing their hands the shaded sections (the bottom of Arm #1 and bottom of the base).
  When holding Arm #1 or the bottom of the base by hand, be extremely careful not to get your hands or fingers caught.
  - RS4-C351*: Approx. 16 kg (35 lb)
  - RS6-C552* : Approx. 20 kg (44 lb)



- If you lift up the Manipulator, put your hands on it to balance it.

- When transporting the Manipulator over long distances, secure it directly to transporting equipment so that it will not fall. If necessary, pack the Manipulator using the same packaging as delivery.

⚠ CAUTION

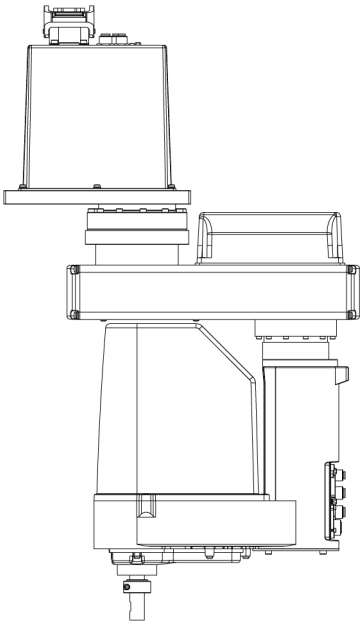
- When installing, be sure to provide sufficient working space.
- The Manipulator must be installed in such a way that avoids interference with surrounding buildings, structures, and other machines and equipment. If not properly installed, it may collide with other machines or create a trapping hazard.
- Resonance (resonating sound or minute vibrations) may occur during Manipulator operation depending on the rigidity of the base table. If the resonance occurs, improve the rigidity of the base table or change the speed or acceleration and deceleration settings of the Manipulator.

2.3.4.2 Standard Environmental Specifications

⚠ CAUTION

- Be sure to always use two or more people when relocating the Manipulator. The Manipulator weights are as follows. Be careful not to get hands or feet caught or have equipment damaged due to dropping of the Manipulator.
  - RS4-C351*: Approx. 16 kg (35 lb)
  - RS6-C552*: Approx. 20 kg (44 lb)
- When installing the Manipulator on a ceiling or similar structure, support the Manipulator until all of the anchor bolts are secured in place. Removing the support before the anchor bolts are fully secured is extremely hazardous and may cause the Manipulator to fall.

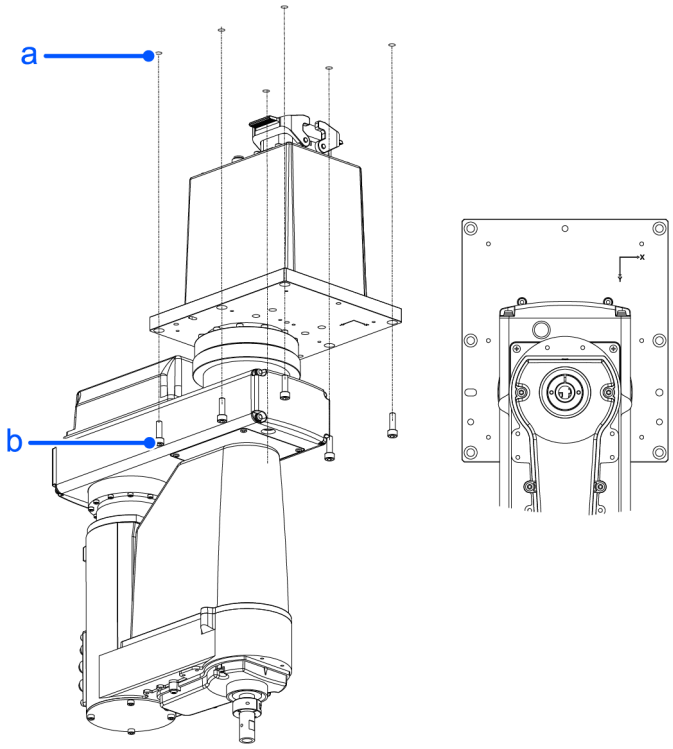
1. With the arm folded, take out the Manipulator from the packing box.



2. Secure the base to the base table using six bolts.
   Tightening torque: 13.0 N·m (133 kgf·cm)

KEY POINTS

- RS4-C351*: Remove the protective tape first.
- Use bolts with strength specifications compliant with ISO 898-1 property class: 10.9 or 12.9.
- Check the origin direction by referring to the coordinate axes listed on the base.

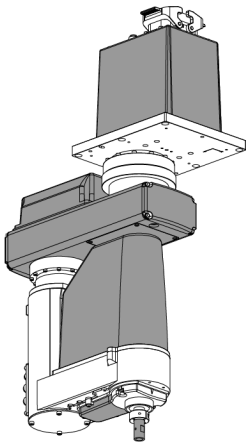


Symbol	Description
a	Threaded hole (12 mm or more depth)
b	6 × M6 × 20

3. Remove the transportation fixtures.

2.3.4.3 Cleanroom model

1. Unpack the Manipulator outside of the cleanroom.
2. Lay the Manipulator down to prevent it from falling or tipping over. When doing so, place it so that stress is not applied to the shaded sections (the ball screw spline and cover sections).



1. Wipe off any dust on the Manipulator using a lint-free cloth that was dipped in ethyl alcohol or distilled water.
2. Carry the Manipulator into the cleanroom.
3. Refer to the installation procedure for the respective Manipulator model, and install the Manipulator.
4. Connect an exhaust tube to the exhaust port.

2.3.5 Connecting the Cables

⚠ WARNING

- To perform the power supply lockout, remove the power plug. Be sure to connect the AC power cable to a power outlet. Do not connect it directly to a factory power source.
- Before performing any replacement work, inform others in the area that you are working, and then turn off the Controller and related equipment, and unplug the power cable from the power source. Performing any work procedure with the power turned on is extremely dangerous and may result in electric shock and/or malfunction of the robot system.
- Be sure to connect the cables properly. Do not put heavy objects on the cables, bend or pull on the cables forcibly, or allow the cables to be pinched. Damaged cables, broken wires, or contact failure is extremely hazardous and may result in electric shock and/or malfunction of the robot system.
- The Manipulator is grounded by connecting it to the Controller. Ensure that the Controller is grounded and the cables are correctly connected. If the ground wire is improperly connected to ground, it may result in the fire or electric shock.

⚠ CAUTION

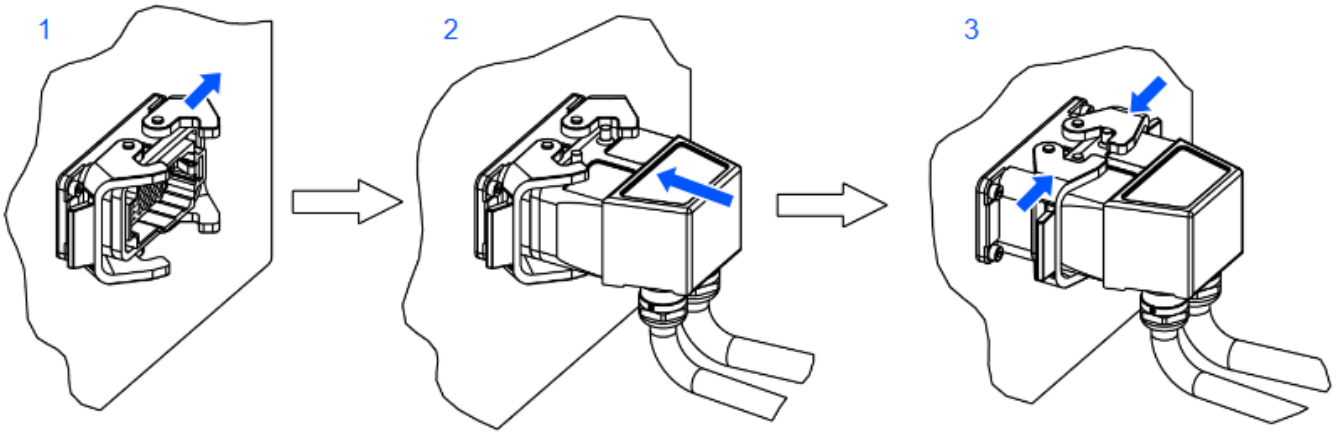
- When connecting the Manipulator and the Controller, check that the serial numbers match for each device. Improper connection between the Manipulator and the Controller may not only lead to malfunction of the robot system but also serious safety problems. The connection method between the Manipulator and the Controller varies depending on the Controller. For details on the connections, refer to the following manual.
  "Controller Manual"
- Connecting a G series Manipulator, E2 series Manipulator, or RS series Manipulator to a 6-Axis robot Controller can damage the Manipulator.

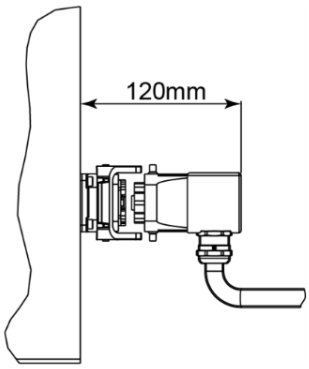
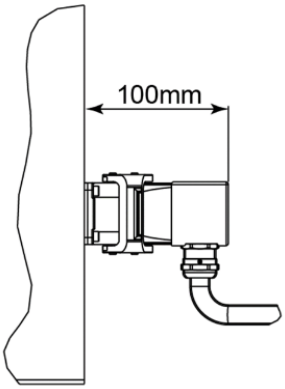
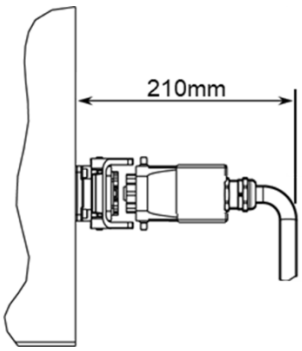
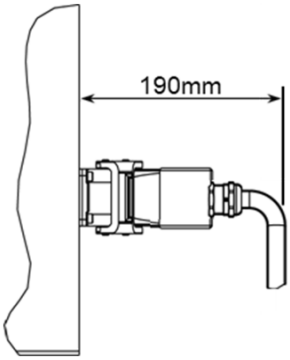
When the Manipulator is a model with cleanroom specifications, an exhaust system must be connected. The exhaust system is described in the following section.
Appendix A: Specifications Table

Connection procedure for Manipulator and M/C cable

Insert the M/C cable hood into the M/C cable housing on the top of the Manipulator, and secure it with the lock attached to the housing.

1. Open the lock plates on both sides of the M/C cable housing.
2. Insert the M/C cable hood all the way to the back.
3. Close the lock plates on both sides of the M/C cable housing.

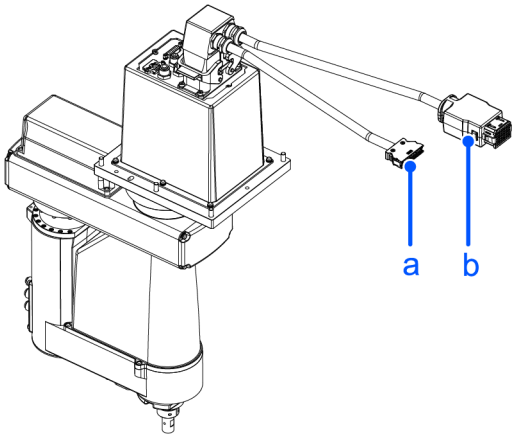


L-shape (Standard)		Straight	
Minimum Distance Required for Insertion and Removal	Distance When Mounted	Minimum Distance Required for Insertion and Removal	Distance When Mounted
			

Connecting the M/C cable and the Controller

Connect the power connector and signal connector of the M/C cable to the Controller.

Illustration: RS4-C351S



Symbol	Description
a	M/C Signal
b	M/C Power Cable

⚠ CAUTION

- When routing cables to the floor, protect them with a protector or the like. If no protection is provided, there is a risk of tripping over cables and falling.
- When connecting M/C cables, use a workbench suitable for the work. Because the work is performed at a high location, there is a risk of losing balance and falling.

2.3.6 User Wires and Pneumatic Tubes

⚠ CAUTION

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

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

Electrical Wires

	Rated Voltage	Allowable Current	Nominal Cross-Sectional Area of Conductor	Note
D-sub 15-pin	AC/DC 30 V	1A	0.211 mm^2	Shielded
RJ45	-	-	-	Equivalent to CAT5e

		Manufacturer	Type	
15 pin	Suitable connector	JAE	DA-15PF-N	(Solder type)
	Clamp hood	JAE	DA-C8-J10-F2-1R	(Connector setscrew: #4-40 NC)

Pins with the same number, indicated on the connectors on both ends of the cables, are connected.

8-pin (RJ45) equivalent to Cat.5e

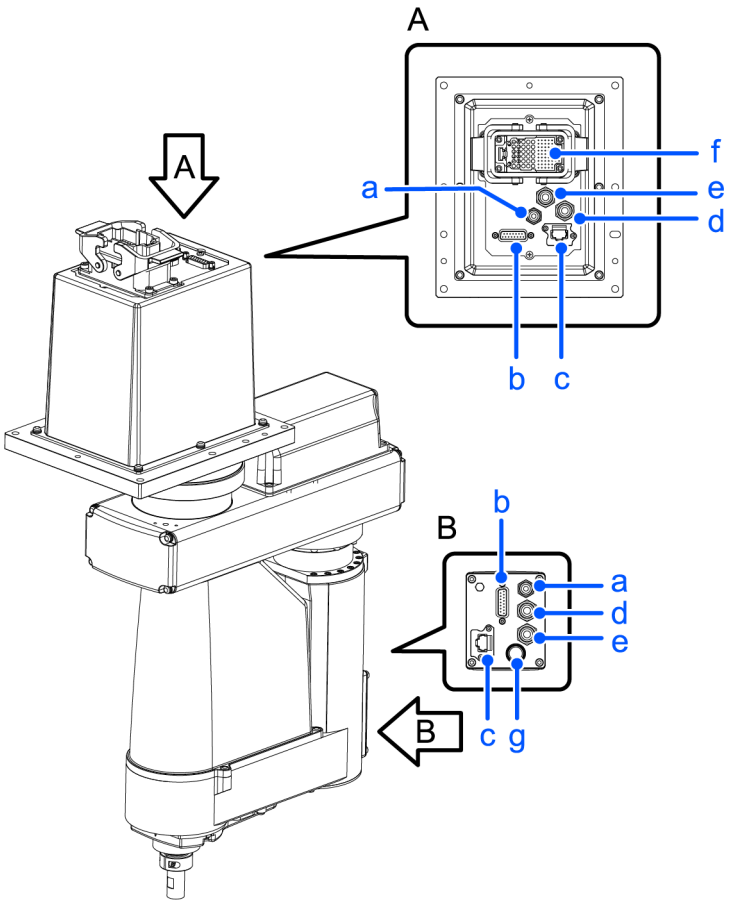
An Ethernet cable (commercially available) can be connected to Manipulator models with standard and cleanroom & ESD specifications.

Pneumatic Tubes

Maximum Usable Pneumatic Pressure	Number of Tubes	Outer Diameter × Inner Diameter
0.59 MPa (6 kgf/cm^2: 86 psi)	2	ø6 mm × ø4 mm
	1	ø4 mm × ø2.5 mm

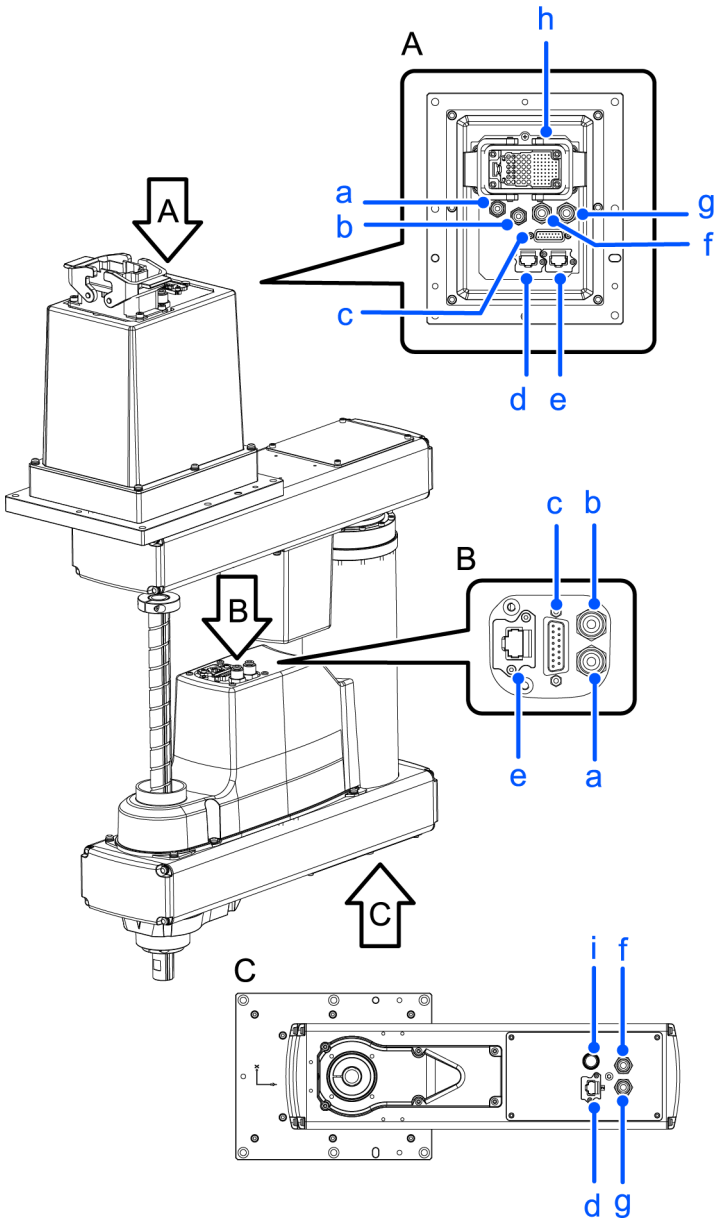
Fittings for ø6 mm and ø4 mm (outer diameter) pneumatic tubes are included for both ends of the pneumatic tubes.

RS4-C



Symbol	Description
a	Fitting for ø4 mm tube (white)
b	User connector (15-pin D-sub connector)
c	User connector (RJ45 connector)
d	Fitting for ø6 mm tube (white)
e	Fitting for ø6 mm tube (black, blue)
f	MC connector
g	Brake release switch

RS6-C



Symbol	Description
a	Fitting for ø4 mm tube (white)
b	Fitting for ø4 mm tube (black, blue)
c	User connector (15-pin D-sub connector)
d	User connector (RJ45 connector No. 2)
e	User connector (RJ45 connector No. 1)
f	Fitting for ø6 mm tube (white)
g	Fitting for ø6 mm tube (black, blue)
h	MC connector
i	Brake release switch

KEY POINTS

The motion range for Joint #4 (rotation) is ±720°. Be careful not to get wires or tubes entangled in the tip hand.

2.3.7 Relocation and Storage

2.3.7.1 Safety Information for Relocation and Storage

Pay attention to the following requirements when relocating, storing, and transporting the Manipulators.
Transportation and installation of the Manipulator and related equipment should be performed by people who have received installation training provided by Epson or its suppliers. Also, the laws and regulations of the installation country must be followed.

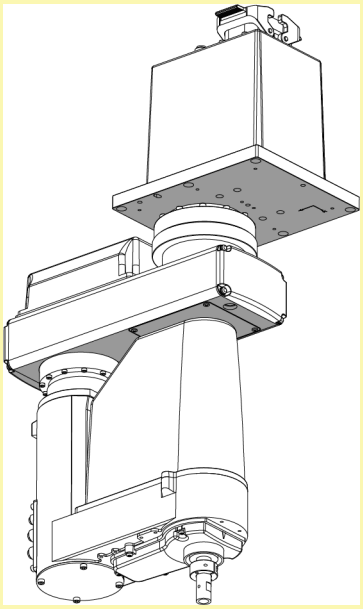
⚠ WARNING

- Only qualified personnel should perform sling work and operate a crane or a forklift. When these operations are performed by unqualified personnel, it is extremely hazardous and may result in serious bodily injury to operators and/or severe equipment damage.

⚠ CAUTION

- Before relocating, fold the arm and secure it tightly with a cable tie to prevent hands or fingers from getting caught in the Manipulator.
- When removing the anchor bolts, support the Manipulator so that it does not fall. If the anchor bolts are removed, the Manipulator will fall, which is extremely dangerous.
- The Manipulator should be transported by two or more people, either secured to transporting equipment or carried by placing their hands the shaded sections (the bottom of Arm #1 and bottom of the base). When holding Arm #1 or the bottom of the base by hand, be extremely careful not to get your hands or fingers caught.
  - RS4-C351*: Approx. 16 kg (35 lb)

- RS6-C552*: Approx. 20 kg (44 lb)



- If you lift up the Manipulator, put your hands on it to balance it. The Manipulator may fall if the balance is lost and this is extremely dangerous.

When transporting the Manipulator over long distances, secure it directly to transporting equipment so that it will not fall. If necessary, pack the Manipulator using the same packaging as delivery.
When the Manipulator is reassembled and used for a robot system again after an extended period of storage, perform a test run to verify that it works properly before starting the main operation.
Manipulators should be transported and stored under the following conditions: Temperature: -20 to +60°C, Humidity: 10 to 90% (no condensation).
If condensation has formed on the Manipulator during transportation or storage, do not turn on the power until the condensation is removed.
Do not subject the Manipulator to excessive impacts or vibrations during the transportation process.

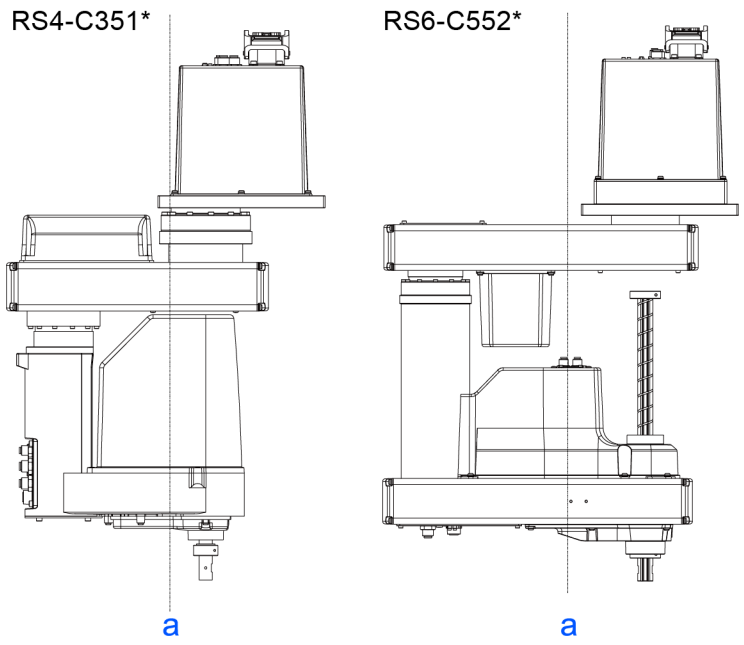
2.3.7.2 Relocation Procedure

⚠ WARNING

- Be sure to always use two or more people when installing or relocating the Manipulator. The Manipulator weights are as follows. Be careful not to get hands or feet caught or have equipment damaged due to dropping of the Manipulator.
  - RS4-C351*: Approx. 16 kg (35 lb)
  - RS6-C552*: Approx. 20 kg (44 lb)
- When removing the Manipulator from a ceiling surface or other location, be sure to support the Manipulator before removing the anchor bolts. Removing the anchor bolts without supporting the Manipulator is extremely dangerous and may cause the Manipulator to fall.

1. Turn off all power and remove the connections.

2. While supporting the bottom of Arm #1 by hand, remove the anchor bolts. Then, remove the Manipulator.



Symbol	Description
a	Center of gravity position

2.4 Setting the Hand

2.4.1 Installing the Hand

The hand (end effector) must be prepared by the customer. When installing the hand, take note of the following. For details on attaching the hand, refer to the following manual.
"Hand Function Manual"

⚠ WARNING

- Before attaching a hand or peripheral equipment, be sure to always turn off the Controller and related equipment and unplug the power cables. Performing any work procedure with the power turned on is extremely dangerous and may result in electric shock and/or malfunction of the robot system.

⚠ CAUTION

- When the hand is equipped with a workpiece gripping mechanism, ensure that the wiring and pneumatic tubes do not cause the hand to release the workpiece when the power is turned off. When the wiring and pneumatic tubes are not designed for the hand to maintain its grip on the workpiece when the power is turned off, pressing the emergency stop switch releases the workpiece, which may damage the robot system and the workpiece.
  By default, all I/Os are designed to automatically turn off (0) when the power is shut off, when an emergency stop is triggered, or by the robot system's safety function.
  However, I/Os set with the Hand function does not turn off (0) when executing the Reset statement, or when performing an emergency stop.
  For the risk of the residual air pressure, conduct a risk assessment on the equipment and take the necessary protective measures.

⚠ CAUTION

- When the hand is equipped with a chuck, ensure that the wiring or pneumatic tubes do not cause the hand to release the workpiece when the power is turned off. When the wiring or pneumatic tubes are not designed for the hand to perform chucking when the power is turned off, pressing the emergency stop switch releases the workpiece, which may damage the robot system and the workpiece.
  By default, all I/Os are designed to automatically turn off (0) when the power is shut off, when an emergency stop is triggered, or by the robot system's safety function.
  However, I/Os set with the Hand function does not turn off (0) when executing the Reset statement, or when performing an emergency stop.

Shaft

- Attach the hand to the lower end of the shaft.
  For the layout dimensions in the area around the shaft and the overall dimensions of the Manipulator, refer to the following section.
  Names of Parts and Their Dimensions

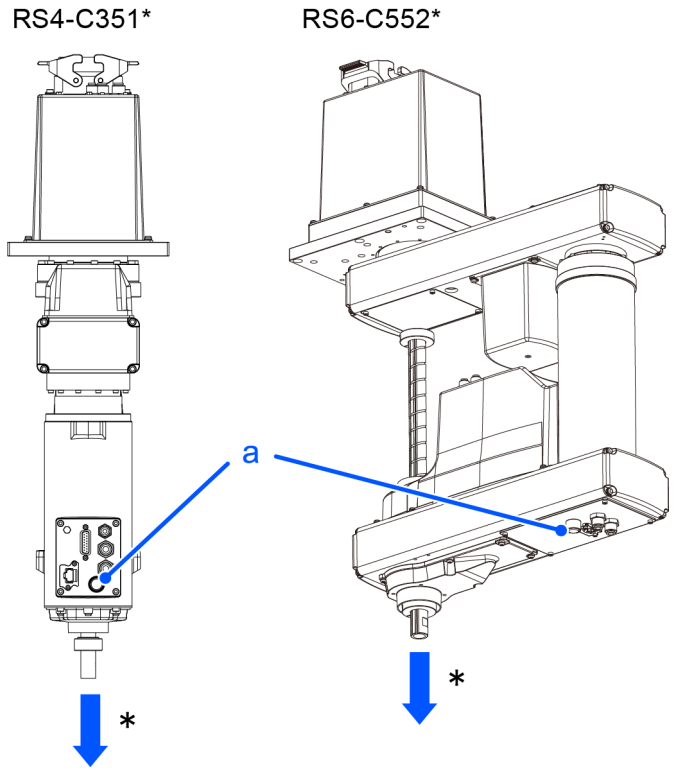
- Do not move the upper limit mechanical stop on the lower side of the shaft. When performing a Jump operation, the upper limit mechanical stop may come into contact with the Manipulator body, which may cause the Manipulator to stop functioning properly.

- When attaching the hand to the shaft, have the hand hold the shaft using M4 or larger screws.

Brake release switch

- Joint #3 cannot be moved up/down or rotated by hand because the electromagnetic brake is applied to the joint while power to the robot system is turned off. This is to prevent the shaft from descending due to the weight of the hand or hitting peripheral equipment in the event that the power is disconnected during Manipulator operation, or the motor is turned OFF even while the power is turned on.
- To move Joint #3 up/down while attaching an end effector, turn ON the Controller and press the brake release switch. Furthermore, this switch is a momentary-type; the brake is released only while the button is being pressed.
- When pressing the brake release switch, watch for the shaft descending or rotating under the weight of the hand.

  *: The shaft may drop due to the weight of the hand or other object.



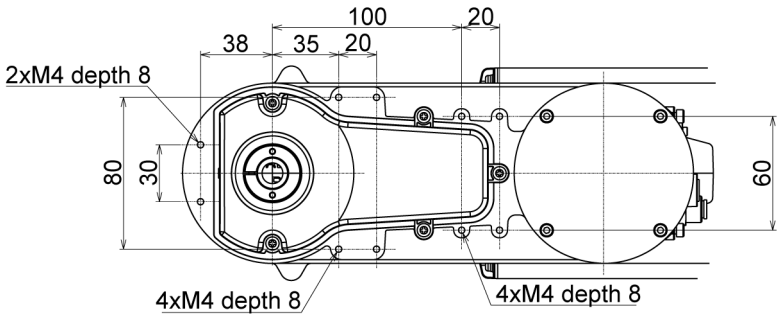
Symbol	Description
a	Brake release switch

2.4.2 Attaching Cameras and Valves

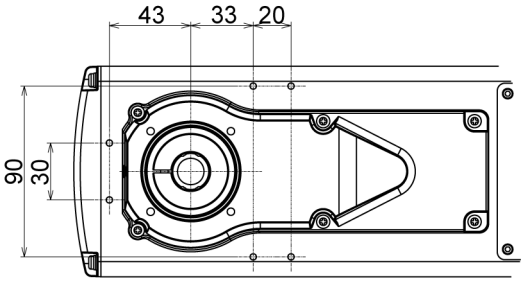
Arm #2 has threaded holes as shown in the figure below. Use the threaded holes for attaching cameras, air valves, and the like.

(Units: mm)

RS4-C



RS6-C



- When a camera or air valve is installed, the work envelope may be limited by wiring or piping. Be thoroughly careful in design and installation.
- The motion range for Joint #4 (rotation) is ±720 °. Be careful not to get wires or tubes entangled in the tip hand.

2.4.3 Weight and Inertia Settings

To ensure that the Manipulator is functioning properly, keep the load (the sum of the weights of the hand and workpiece) and the moment of inertia of the load within the rated values, and do not allow for eccentricity from the center of the Joint #4. If, for some unavoidable reason, the load or moment of inertia exceeds the rated value, or if eccentricity occurs, configure parameters as described in the "Weight setting" and "Inertia setting."
These settings optimize the Manipulator's PTP motion, reduce vibration, and shorten operation times. This also works to curb any persistent vibration that may occur when the hand and workpiece have a large moment of inertia.
You can also perform settings using the "Weight, Inertia, and Eccentricity/Offset Measurement Utility".
For details, refer to the following manual:
"Epson RC+ User's Guide - Weight, Inertia, and Eccentricity/Offset Measurement Utility"

2.4.3.1 Weight Setting

⚠ CAUTION

- The total weight of the hand and the workpiece must not exceed 4 kg for the RS4-C351* or 6 kg for the RS6-C552*. Manipulators are not designed to work with loads exceeding 4 kg for the RS4-C351* or 6 kg for the RS6-C552*. Always set the value according to the load. Setting the hand weight parameter to a value smaller than the actual weight may cause errors or impact that not only impair full functionality but also shorten the life of the mechanical components.

The allowable load weight (hand and workpiece) in the RS series is 1 kg at the default rating and 3 kg for the RS3-351* or 4 kg for the RS4-551* at the maximum. Depending on the load weight, change the setting for the hand weight parameter in the Weight statement. After the setting is changed, the maximum speed and acceleration/deceleration of the Manipulator during PTP motion that correspond to the "Hand Weight" are corrected automatically.

2.4.3.1.1 Weight of Load Attached to Shaft

The weight of the load (hand + workpiece) attached to the shaft can be set by the "Hand Weight" parameter in the Weight statement.

Epson RC+

Go to [Tools] - [Robot Manager] - [Weight] panel, and enter the value in the [Weight] text box. (This can also be set using the Weight statement in [Command Window].)

2.4.3.1.2 Weight of Load Attached to Arm

When a camera, air valve, or other object is attached to the arm, its weight is converted to the equivalent weight of the shaft and added to the weight of the load attached to shaft to set the "Hand Weight" parameter.

Equivalent weight formula

$W_M = M \times (L_M + L_1)^2/(L_1 + L_2)^2$

W_M: Equivalent weight

M: Weight of load attached to the arm

L_1: Length of Arm #1

L_2: Length of Arm #2

L_M: Distance from rotation center of Joint #2 to center of gravity of load attached to the arm

Example:

Calculates the "Hand Weight" parameter when a 0.5 kg camera is attached to the end of RS3 Arm #2 (250 mm from the center of rotation of Joint #2) with a load weight of W = 1 kg.

W=1.0

M = 0.5

L_1 = 175

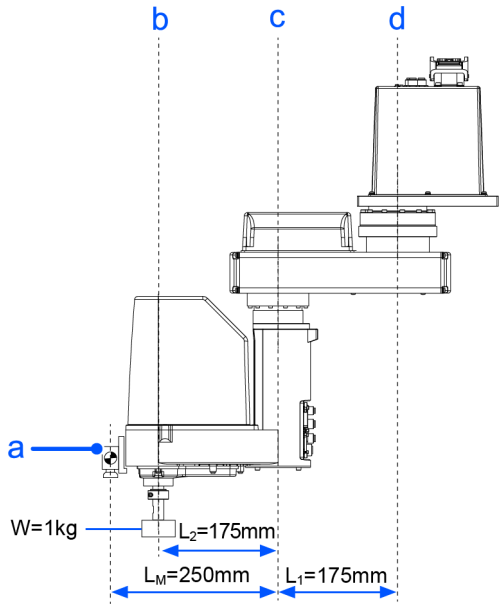
L_2 = 175

L_M = 250

$W_M=0.5\times(250+175)^2/(175+175)^2=0.74$ (Round up to two decimal places)

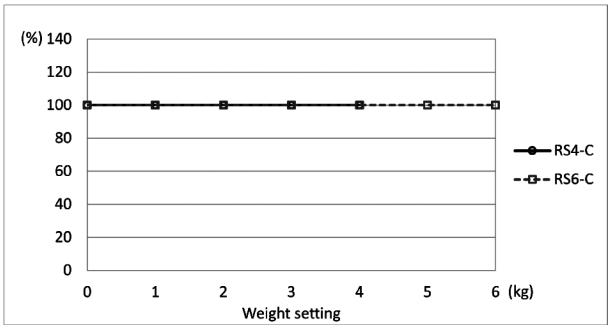
$W + W_M = 1 + +0.74 = 1.74$

Enter "1.74" for the [Hand Weight] parameter.



Symbol	Description
a	Weight of the entire camera M = 0.5 kg
b	Shaft
c	Joint #2
d	Joint #1

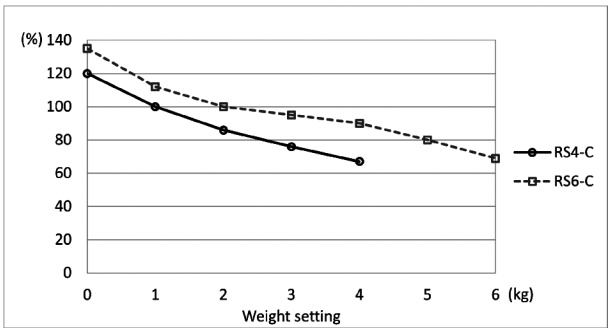
2.4.3.1.3 Automatic Speed Correction at Weight Setting



The percentages on the graph are ratios based on 100% as the speed at the rated setting.

Rating
RS4-C: 1kg
RS6-C: 2kg

2.4.3.1.4 Automatic Acceleration/Deceleration Correction at Weight Setting



The percentages on the graph are ratios based on 100% as the speed at the rated setting.

Rating
RS4-C: 1kg
RS6-C: 2kg

2.4.3.2 Inertia Setting

2.4.3.2.1 Moment of Inertia and Inertia Setting

The moment of inertia is a quantity that expresses how hard it is for an object to turn, and it is expressed in terms of values for the moment of inertia, inertia, or GD^2. When a hand or other object is attached to a shaft for operation, the moment of inertia of the load must be taken into consideration.

⚠ CAUTION

- The moment of inertia of the load (weight of the hand and workpiece) must be 0.05 kg·m^2 or less. Manipulators are not designed to work with a moment of inertia exceeding 0.05 kg·m^2 for the RS4-C or 0.12 kg·m^2 for the RS6-C. Always set the value corresponding to the moment of inertia. Setting a parameter value that is smaller than the actual moment of inertia may cause errors or impact, may prevent the Manipulator from working at full functionality, and may shorten the lifespan of mechanical parts.

The allowable moment of inertia of a load for RS series Manipulators is 0.005 kg·m^2 at the default rating and 0.05 kg·m^2 at the maximum for the RS4-C or 0.01 kg·m^2 at the default rating and 0.12 kg·m^2 at the maximum for the RS6-C. Depending on the moment of inertia, change the setting of the moment of inertia parameter for the load in the Inertia statement. After the setting is changed, the maximum acceleration/deceleration of Joint #4 during PTP motion that corresponds to the "Inertia" value is corrected automatically.

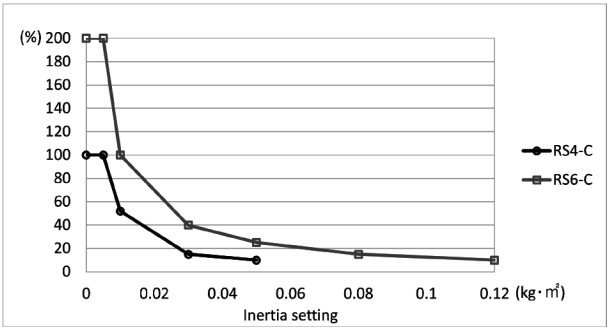
2.4.3.2.2 Moment of Inertia of Load Attached to Shaft

The moment of inertia of the load (hand + workpiece) attached to the shaft can be set by the "Inertia" parameter in the Inertia statement.

Epson RC+

Go to [Tools] - [Robot Manager] - [Inertia] panel, and enter the value in [Inertia]. (This can also be set using the Inertia statement in [Command Window].)

2.4.3.2.3 Automatic Acceleration/Deceleration Correction of Joint #4 at Inertia (Moment of Inertia) Setting



The percentages on the graph are ratios based on 100% as the speed at the rated setting.

Rating

RS4-C: 0.005 kg·m^2

RS6-C: 0.01 kg·m^2

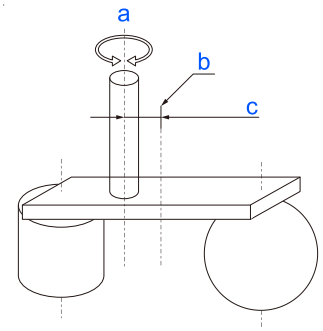
2.4.3.2.4 Eccentricity and Inertia Setting

⚠ CAUTION

- The eccentricity of the load (hand + workpiece) must be 100 mm or less.
  The RS series Manipulators are not designed to work with eccentricities exceeding 100 mm. Always set the value based on the eccentricity. Setting the eccentricity parameter to a value smaller than the actual eccentricity may cause errors or impact that not only impair full functionality but also shorten the life of the mechanical components.

The allowable eccentricity of load for RS series Manipulators is 0 mm at the default rating and 100 mm at the maximum. Depending on the load eccentricity, change the setting for the eccentricity parameter in the Inertia statement. After the setting is changed, the maximum acceleration/deceleration of the Manipulator during PTP motion that corresponds to the "Eccentricity" is corrected automatically.

Eccentricity



Symbol	Description
a	Rotation axis
b	Load center of gravity position
c	Eccentricity (100 mm or less)

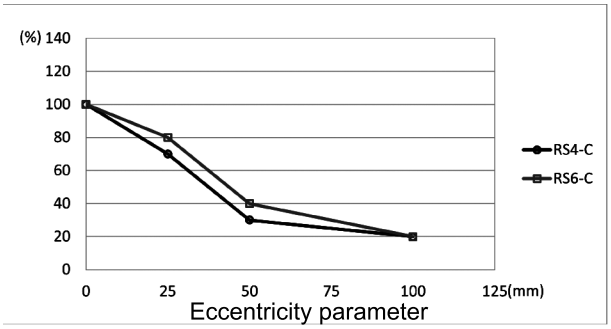
2.4.3.2.5 Eccentricity of Load Attached to Shaft

The eccentricity of the load (hand + workpiece) attached to the shaft can be set by the "Eccentricity" parameter in the Inertia statement.

Epson RC+

Go to [Tools] - [Robot Manager] - [Inertia] panel, and enter the value in [Eccentricity]. (This can also be set using the Inertia statement in [Command Window].)

2.4.3.2.6 Automatic Acceleration/Deceleration Correction at Inertia (Eccentricity) Setting



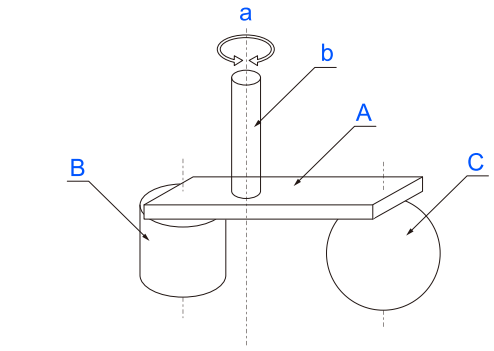
The percentages on the graph are ratios based on 100% as the speed at the rated setting.

Rating
RS4-C: 1kg
RS6-C: 2kg

2.4.3.2.7 Calculating the Moment of Inertia

An example of calculating the moment of inertia of a load (hand holding a workpiece) is shown below.

The moment of inertia of the entire load is calculated by the sum of individual parts [A] to [C].

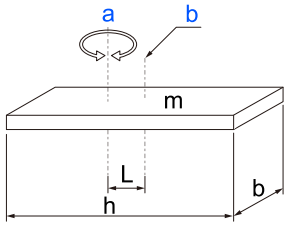


Whole moment of inertia = Moment of inertia of end effector (A) + Moment of inertia of work piece (B) + Moment of inertia of work piece (C)

Symbol	Description
A	Hand
B	Workpiece
C	Workpiece
a	Rotation axis
b	Shaft

The methods for calculating the moment of inertia for [A], [B], and [C] are shown below. Use the moment of inertia of these basic shapes as a reference to find the moment of inertia of the entire load.

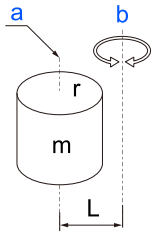
(a) Moment of inertia of a rectangular parallelepiped



$$m\frac{b^2+h^2}{12}+m\times L^2$$

Symbol	Description
a	Rotation axis
b	Center of gravity of rectangular parallelepiped

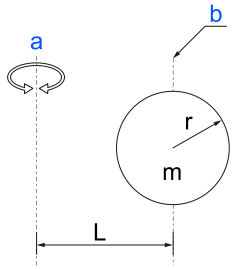
(b) Moment of inertia of a cylinder



$$m\frac{r^2}{2}+m\times L^2$$

Symbol	Description
a	Center of gravity of cylinder
b	Rotation axis

(c) Moment of inertia of a sphere



$$m\frac{2}{5}r^2+m\times L^2$$

Symbol	Description
a	Rotation axis
b	Center of gravity of sphere

2.4.4 Safety Information for Auto Acceleration of Joint #3

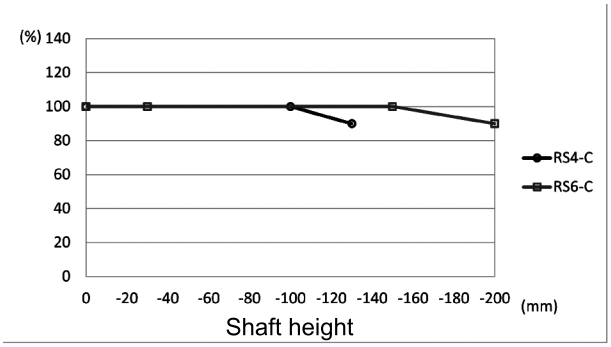
When performing horizontal movement in PTP motion, the operation time can be shorted by setting the shaft to a high position.

When performing horizontal movement in PTP motion, if the shaft height is less than a certain value, the auto acceleration function is activated, and the acceleration/deceleration of the movement is set slower for lower shaft heights. A higher shaft position results in a faster acceleration/deceleration for the movement, but the up movement time and down movement time of the shaft are also required.

Adjust the shaft height by taking into consideration the positional relationship between the current position and the target position.

The shaft height at the time of horizontal movement for the Jump statement can be set by the LimZ statement.

2.4.4.1 Automatic Acceleration/Deceleration Correction by Shaft Position



The percentages on the graph are ratios with the acceleration/deceleration at the shaft's upper limit position at the rated setting as 100%.

KEY POINTS

Horizontal movement with the shaft lowered may cause overshooting during positioning.

2.5 Work Envelope

⚠ WARNING

- Do not operate the Manipulator with the mechanical stop removed. Removing the mechanical stop is extremely dangerous because the Manipulator may move to a position outside its normal work envelope.

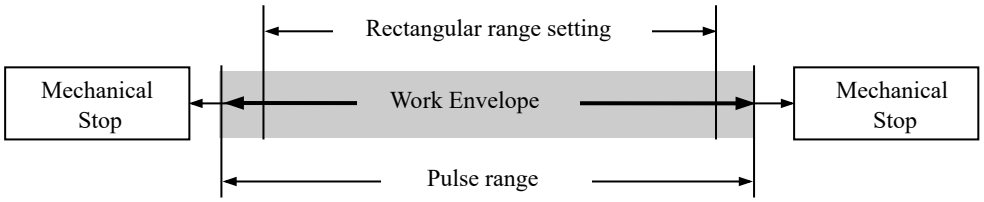
⚠ CAUTION

- When restricting the work envelope for safety reasons, be sure to make settings using both the pulse range and mechanical stop.

The work envelope is preset at the factory as explained in the following section.
Standard Work Envelope

The work envelope can be set by one of the following three methods.

1. Setting by pulse range (for all joints)
2. Setting by mechanical stops (for Joint #3)
3. Setting the rectangular range in the XY coordinate system of the Manipulator (for Joints #1 and #2)



To limit the work envelope for layout efficiency or safety reasons, make the settings as explained in the following sections.
Work Envelope Setting by Pulse Range
Setting the Mechanical Stop of Joint #3
Setting the Rectangular Range in the XY Coordinate System of the Manipulator

2.5.1 Work Envelope Setting by Pulse Range

Pulses are the basic unit of Manipulator motion. The motion range (work envelope) of the Manipulator is set by the pulse lower limit value and pulse upper limit value (pulse range) for each joint.
Pulse values are read from the encoder output of the servomotor.
For the maximum pulse range, refer to the following sections.
The pulse range must be set inside the mechanical stop settings.

- Joint #1 Maximum Pulse Range
- Joint #2 Maximum Pulse Range
- Joint #3 Maximum Pulse Range
- Joint #4 Maximum Pulse Range

KEY POINTS

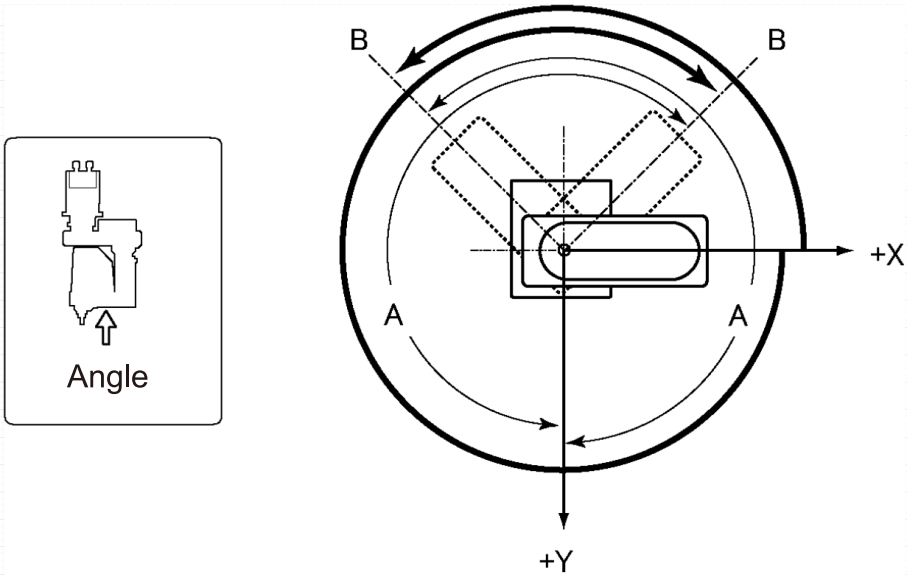
Once the Manipulator receives a motion command, it checks whether the target position specified by the command is within the pulse range before operating. If the target position is outside of the pulse range that was set, an error occurs and the Manipulator does not move.

Epson RC+

Go to [Tools] - [Robot Manager] - [Range] panel, and make the setting.
This can also be set using the Range statement in [Command Window].

2.5.1.1 Joint #1 Maximum Pulse Range

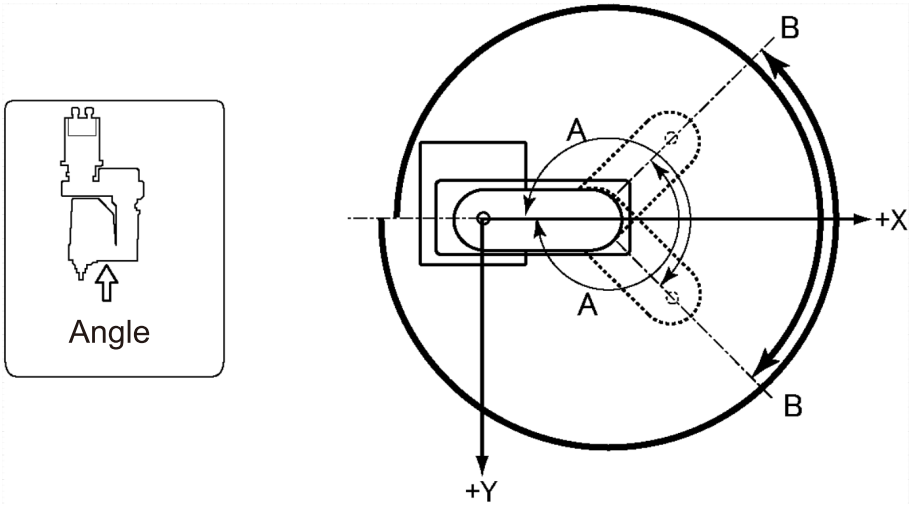
The 0 (zero) pulse position of Joint #1 is the position where Arm #1 is facing the positive (+) direction on the X-coordinate axis.
With the 0 pulse as a starting point, the counterclockwise pulse value is defined as positive (+), and the clockwise pulse value is defined as negative (-).



A: Max. motion range (deg.)
±270
B: Max. pulse range (pulse)
-3413334 to +6826667(RS4-C351*)
-5520753 to +11041506(RS6-C552*)

2.5.1.2 Joint #2 Maximum Pulse Range

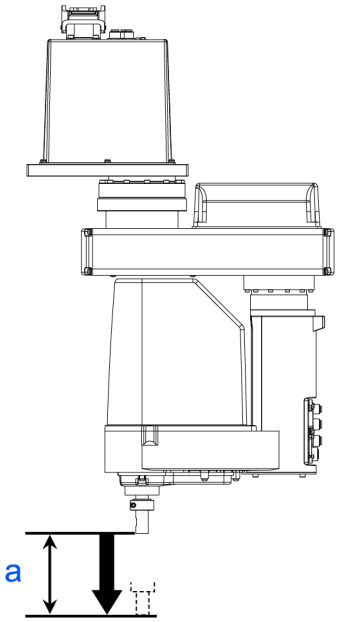
The 0 (zero) pulse position of Joint #2 is the position where Arm #2 is aligned with Arm #1. (The orientation of Arm #1 does not matter.)
With the 0 pulse as a starting point, the counterclockwise pulse value is defined as positive (+), and the clockwise pulse value is defined as negative (-).



A: Max. motion range (deg.)
±225
B: Max. pulse range (pulse)
-4177920 to +4177920 (RS4-C351*)
-4096000 to +4096000 (RS6-C552*)

2.5.1.3 Joint #3 Maximum Pulse Range

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

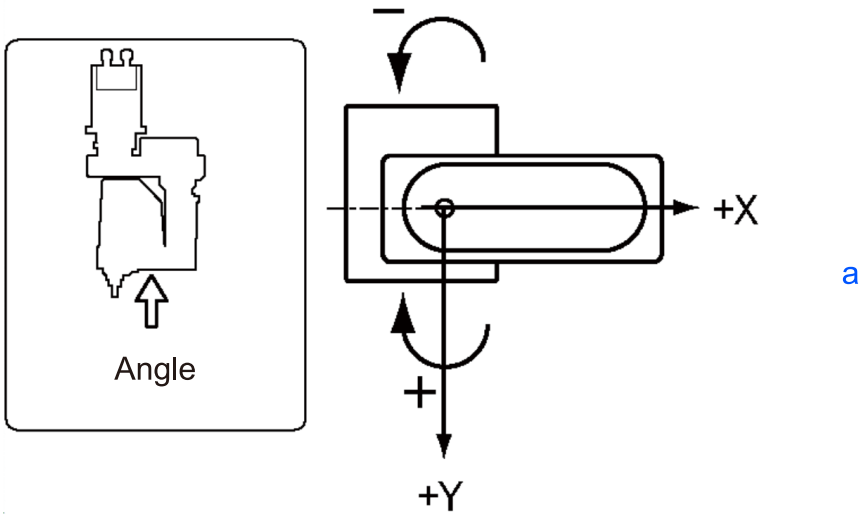


Symbol	Description
a	Upper limit: 0 pulse

Type	Joint #3 Stroke	Lower Limit Pulse
RS4-C351S	130 mm	-1479112 pulse
RS4-C351C	100 mm	-1137778 pulse
RS6-C552S	200 mm	-1820445 pulse
RS6-C552C	150 mm	-1365334 pulse

2.5.1.4 Joint #4 Maximum Pulse Range

The 0 (zero) pulse position of Joint #4 is the position where the flat surface near the end of the shaft faces toward the end of Arm #2. (The orientation of Arm #2 does not matter.)
With the 0 pulse as a starting point, the counterclockwise pulse value is defined as positive (+), and the clockwise pulse value is defined as negative (-).



Symbol	Description
a	0±3145728 pulse (RS4-C351*) 0±2634548 pulse (RS6-C552*)

2.5.2 Setting the Mechanical Stop of Joint #3

This work should be performed by people who have received installation and maintenance training provided by Epson or its suppliers.

KEY POINTS

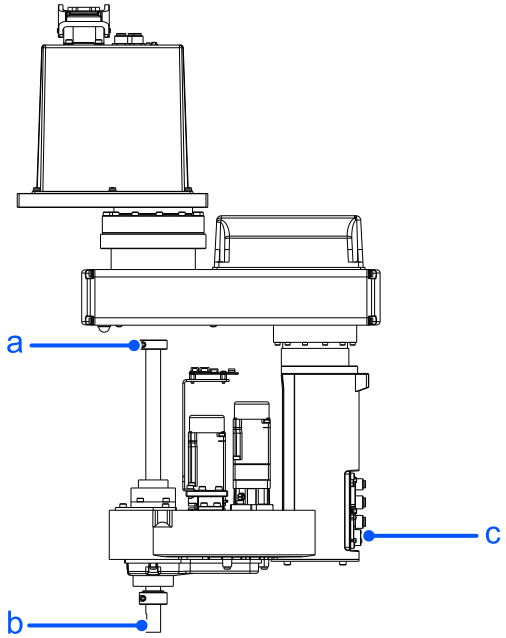
For RS6-C552C, the motion range cannot be set using the mechanical stop of Joint #3.

1. Turn on the Controller, and turn off the motors using the Motor OFF statement.
2. For RS4-C, remove the Arm #2 cover. (4-M4 × 10)
3. Push up the shaft while pressing the brake release switch.

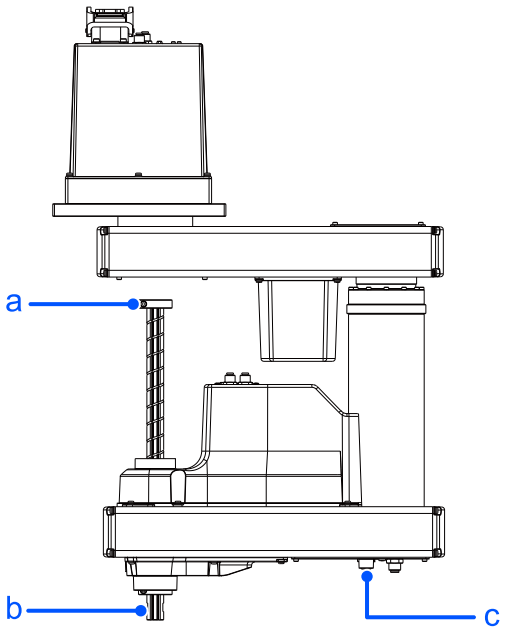
KEY POINTS

When you press the brake release switch, the shaft may lower due to the weight of the hand. Be sure to hold the shaft by hand while pressing the switch.

RS4-C351S



RS6-C552S



Symbol	Description
a	Lower limit mechanical stop mounting screw (RS4-C: M3 × 10, RS6-C552S: M4 × 15)
b	Shaft
c	Brake release switch

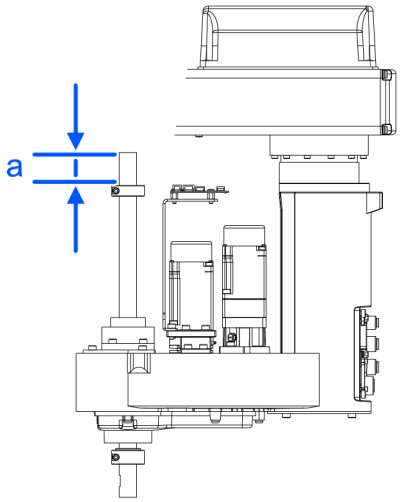
4. Turn off the Controller.
5. Loosen the lower limit mechanical stop screw (RS4-C: M3 × 10, RS6-C552S: M4 × 15).

KEY POINTS

A mechanical stop is mounted on both the top and bottom of Joint #3. However, only the position of the lower limit mechanical stop on the top can be changed. Do not remove the upper limit mechanical stop on the bottom because the origin position of Joint #3 is determined by this stop.

6. The upper end of the shaft defines the maximum stroke position. Move the lower limit mechanical stop down by the length that you want to limit the stroke.
   For example, when the lower limit mechanical stop is set at the "130 mm" stroke, the lower limit Z coordinate value is "-130". To change this value to "-100", move the lower limit mechanical stop down by 30 mm. Use calipers or similar tool to measure the distance when adjusting the mechanical stop.

RS4-C351S



Symbol	Description
a	Measurement length

7. Firmly tighten the lower limit mechanical stop screw (M3 × 10).
   Recommend tightening torque: 2.5±0.15 N・m (26±1.5 kgf・cm)
   (The recommended tightening torque to use when tightening screws (M4 × 15) on the mechanical stop part of RS6-C: 5.0±0.25 N・m (51±2.5 kgf·cm))

8. Turn on the Controller.

9. Press down Joint #3 while pressing the brake release switch, and then check the lower limit position. Do not lower the mechanical stop too far. Otherwise, the joint may not reach a target position.

10. Calculate the lower limit pulse value of the pulse range using the formula shown below, and set the value.
    The result of the calculation is always negative because the lower limit Z coordinate value is negative.
    Lower limit pulse value = (lower limit Z-coordinate value)/Joint #3 resolution (mm/pulse)**
    ** For details on the Joint #3 resolution, refer to the following section.
    Appendix A: Specifications Table

    Epson RC+

    Execute the following command in [Command Window]. Enter the value that you calculated for X.

```
>JRANGE 3,X,0      'Sets the pulse range of Joint #3
```

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

KEY POINTS

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

Epson RC+

Execute the following command in [Command Window]. Enter the value calculated in Step (10) for X.

```
>MOTOR ON          'Turns on the motor
>SPEED 5           'Sets to low speed
>PULSE 0,0,X,0     ''Moves to the lower limit pulse position of Joint #3
```

(In this example, all pulses except those for Joint #3 are "0". Substitute these "0" values with the other pulse values to specify a position where interference will not occur even when lowering Joint #3.)

2.5.3 Setting the Rectangular Range in the XY Coordinate System of the Manipulator

(For Joints #1 and #2)

Use this procedure to set the upper and lower limits of the X and Y coordinates.
This setting is a software-based limit only, and so it does not change the maximum physical range. The maximum physical range is based on the position of the mechanical stops.

Epson RC+

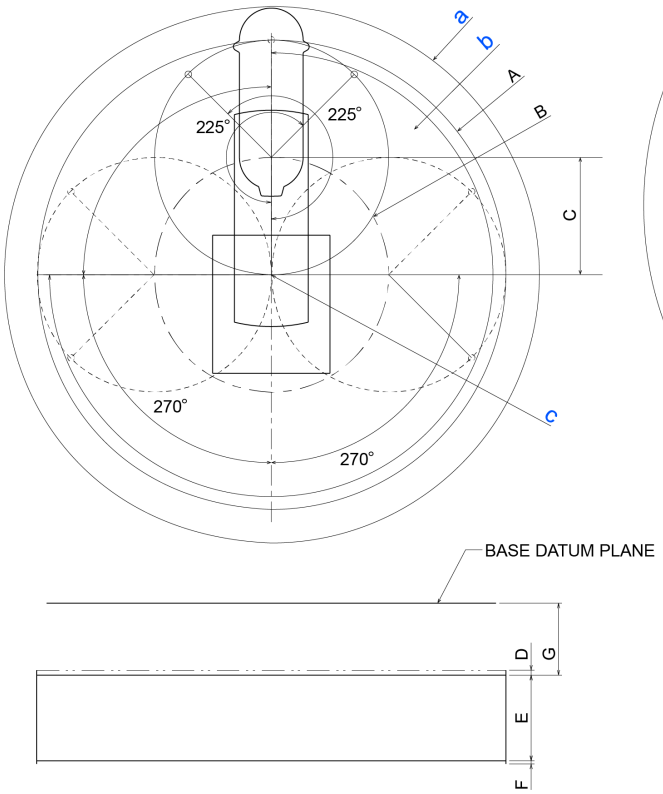
Go to [Tools] - [Robot Manager] - [XYZ Limits] panel, and make the setting. This can also be set using the XYLim statement in [Command Window].

2.5.4 Standard Work Envelope

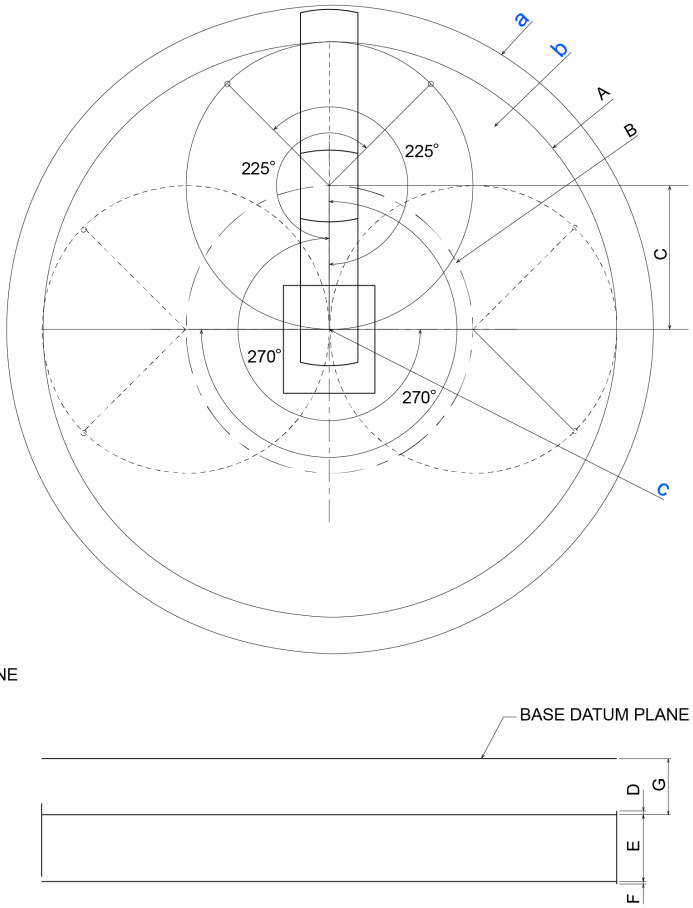
The following "work envelope" diagrams show the model with standard (maximum) specifications. When each joint motor is under servo control, the center of the Manipulator shaft’s lowest point moves in the ranges shown in the figure.

- Range to mechanical stop
  This is the range where the center of shaft's lowest point can be moved when each joint motor is not under servo control.
- Mechanical stop
  This is the stop that sets the absolute work envelope where the Manipulator cannot move beyond mechanically.
- Maximum zone
  This is the range that contains the farthest reach of the arms where interference can occur.

RS4-C351S / RS4-C351C



RS6-C552S / RS6-C552C



Symbol	Description	RS4-C351S	RS4-C351C	RS6-C552S	RS6-C552C
a	Maximum zone	R400		R620	
b	Work envelope	-		-	
c	Center of Joint #3	-		-	
A	-	R350		R550	
B	-	R175		R275	
C	Length of Arm #1 + Arm #2	175 mm		275 mm	
D	Range to upper limit mechanical stop	4.8	14.8	1.6	3.6
E	Joint #3 stroke	130	100	200	150
F	Range to lower limit mechanical stop	6	8.5	4	11
G	Distance from base mounting surface	473	499	494	536

3. Periodic Inspection

Accurate inspection work is necessary to prevent breakdowns and ensure safety.
This section explains the inspection schedule and what should be inspected.
Perform inspections according to the predetermined schedule.

3.1 RS3 and RS4 Manipulator Periodic Inspection

3.1.1 Inspection

3.1.1.1 Inspection Schedule

Inspection items are divided into five stages (daily, 1-month, 3-month, 6-month, and 12-month), with additional items added at each stage. However, if the Manipulator is powered and operated for more than 250 hours in a month, add inspection items every 250, 750, 1500, and 3000 hours.

	Inspection Item					
	Daily Inspection	1-month Inspection	3-month Inspection	6-month Inspection	12-month Inspection	Overhaul (Parts Replacement)
1 months (250 hours)	Perform daily	✓				
2 months (500 hours)		✓				
3 months (750 hours)		✓	✓			
4 months (1,000 hours)		✓				
5 months (1,250 hours)		✓				
6 months (1,500 hours)		✓	✓	✓		
7 months (1,750 hours)		✓				
8 months (2,000 hours)		✓				
9 months (2,250 hours)		✓	✓			
10 months (2,500 hours)		✓				
11 months (2,750 hours)		✓				
12 months (3,000 hours)		✓	✓	✓	✓	
13 months (3,250 hours)		✓				
⋮	⋮	⋮	⋮	⋮	⋮	⋮
(20,000 hours)						✓

3.1.1.2 Inspection Details

Inspection items

Inspection Item	Inspection Location	Daily Inspection	1-month Inspection	3-month Inspection	6-month Inspection	12-month Inspection
Loose bolts: Check for rattling	Hand mounting bolts	✓	✓	✓	✓	✓
	Manipulator installation bolts	✓	✓	✓	✓	✓
Check for loose connectors	Manipulator side external (Connector plate, etc.)	✓	✓	✓	✓	✓
Inspect for flaws Clean off adhering debris, etc.	Entire Manipulator	✓	✓	✓	✓	✓
	External cables		✓	✓	✓	✓
Correct deformations and misalignments.	Safety barriers, etc.	✓	✓	✓	✓	✓
Check brake operation	Joint #3	✓	✓	✓	✓	✓
Check for abnormal operation noise and vibration	Entire Manipulator	✓	✓	✓	✓	✓

Inspection methods

Inspection Item	Inspection Method
Check for loose or rattling bolts	Using an Allen wrench or similar tool, check that the hand mounting bolts and Manipulator installation bolts are not loose. If the bolts are loose, refer to the following section, and retighten to the proper torque. **Tightening the Hexagon Socket Head Cap Bolts**
Check for loose connectors	Check that no connectors are loose. If a connector is loose, reattach it so that it will not come off.
Inspect for flaws Clean off adhering debris, etc.	Check the appearance of the Manipulator, and clean off any dust or other foreign substances adhering to it. Check the appearance of the cables for any flaws, and make sure it is not disconnected.
Correct deformation and misalignment	Check for misalignment of safety barriers and other components. If it is misaligned, correct it to the original position.
Check brake operation	With the motor turned off, check that the shaft does not drop. If the shaft drops while the motor is turned off and the brake is not released, contact the supplier. Also, contact the supplier if the brakes do not release despite performing the brake release operation.
Check for abnormal operation noise and vibration	Check for any abnormal noises and vibrations during operation. If you notice anything unusual, contact the supplier.

3.1.2 Overhaul (Parts Replacement)

Overhauls (replacements) can only be performed by properly trained service engineers.
For details, refer to the following section.
"Safety Manual - Training"

3.1.3 Applying Grease

Ball screw splines and reduction gears require periodic greasing. Be sure to use the specified grease.

⚠ CAUTION

- Be careful that the grease does not run out. When grease runs out, scratches and other defects can occur on the slide, not only hindering maximum performance, but also requiring significant time and money to repair.
- Wear protective gear including a mask, protective goggles, and oil-resistant gloves during grease up. If grease enters the eyes or mouth or adheres to the skin, take the following measures:
  If it enters the eyes
  After rinsing the eyes thoroughly with clean water, seek medical attention.
  If it enters the mouth
  If swallowed, do not force vomiting, and seek medical attention.
  If the mouth is contaminated, rinse thoroughly with water.
  If adhered to skin
  Rinse with water and soap.

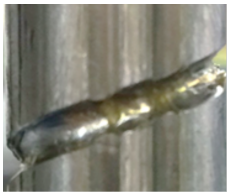
	Part	Interval	Grease	Grease Application Procedure
Joint #1 Joint #2	Reduction gear	When overhaul is performed	-	This can be performed by properly trained service engineers only. For more information, please contact the supplier.
Joint #3	Ball screw spline unit	100 km (first 50 km) run	AFB *	"Applying grease to the ball screw spline unit" (See below.)

* Use the grease below.

Product name: THK AFB-LF Grease
Manufacturer: THK Co., LTD.
URL: https://www.thk.com/

Ball screw spline unit of Joint #3

The recommended interval to perform greasing is when the unit has run 100 km. However, the interval can also be confirmed from the grease state. As shown in the figure, apply grease when the grease turns black or has dried up.

Normal grease	Blackened grease
	

For the first time only, apply grease after running for 50 km.

KEY POINTS

When using Epson RC+, the recommended interval for applying grease to the ball screw spline unit can be viewed from the [Maintenance] dialog box in Epson RC+.

Applying grease to the ball screw spline unit

	Name	Quantity	Note
Grease used	Grease for ball screw splines (AFB grease)	Appropriate amount	-
Tools used	Wiping cloth	1	For wiping off grease (Spline shaft)
	Phillips screwdriver	1	For removing the clamp band Cleanroom models only

KEY POINTS

When applying grease, be careful to cover the hand and peripheral equipment so that, if any grease falls on them, it will not affect their performance.

1. Turn on the Controller.
2. Lower the shaft to the lower limit in one of the following ways.
   - While pressing down the brake release switch, manually lower the shaft to the lower limit.

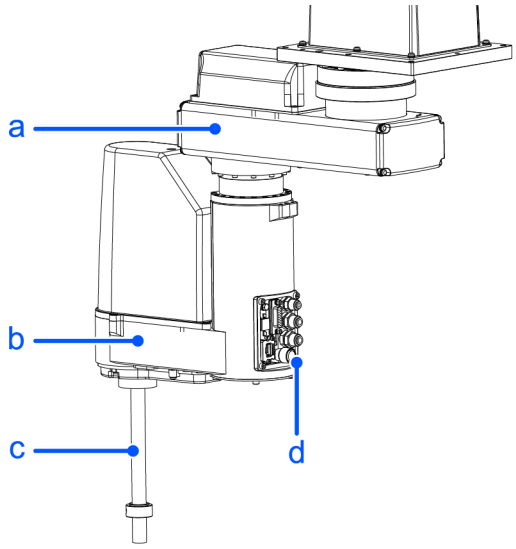
     ### KEY POINTS

     When pressing the brake release switch, watch for the shaft descending or rotating under the weight of the hand.

   - Using the Epson RC+ [Tools] - [Robot Manager] - [Jog & Teach] panel, lower the shaft to the lower limit.

     ### KEY POINTS

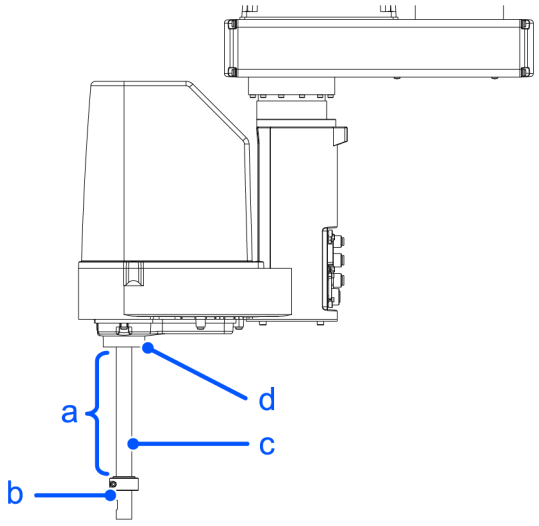
     Make sure that the hand does not interfere with peripheral equipment or other objects.



Symbol	Description
a	Arm #1
b	Arm #2
c	Shaft
d	Joint #3 brake release switch

3. Turn off the Controller.

4. Wipe off the old grease on the shaft, and apply new grease.
   The grease application area is from the end of the spline nut to the mechanical stop.

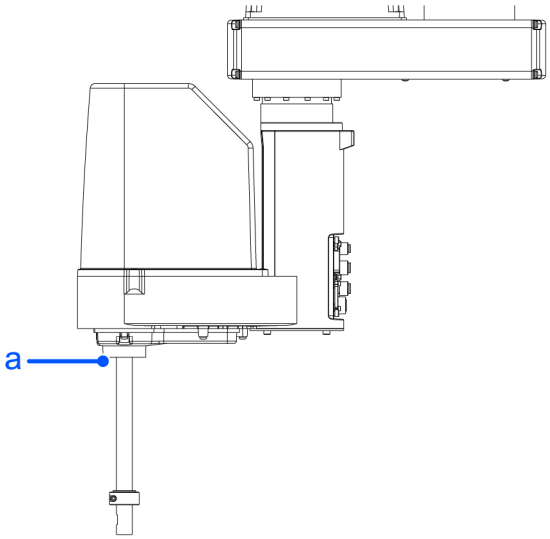


Symbol	Description
a	Application area
b	Mechanical stop
c	Shaft

Symbol	Description
d	Spline nut

5. Grease should be applied to the helical and vertical grooves of the ball screw spline so that the grooves are filled evenly.
   Example of grease application

6. Turn on the Controller.
7. Start the Robot Manager, and move the shaft to the origin position. Be careful not to hit any peripheral equipment.
8. After moving to the origin position, perform a reciprocating motion with the shaft. The reciprocating motion is performed from the upper limit to the lower limit using the low-power mode operation program. Perform the motion for about 5 minutes to allow the grease to spread.
9. Turn on the Controller.
10. Wipe off any excess grease at the spline nut end and mechanical stop section.



Symbol	Description
a	The end of the spline nut

3.1.4 Tightening the Hexagon Socket Head Cap Bolts

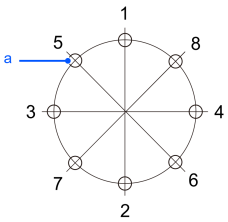
Hexagon socket head cap bolts (referred to as "bolts" below) are used in locations where mechanical strength is required. During assembly, these bolts are tightened at the tightening torques shown in the following table.
Unless otherwise specified, when retightening these bolts in the work procedures described in this manual, use a torque wrench or similar tool to obtain the tightening torques in the following table.

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)

For set screws, refer to the following table.

Set Screw	Tightening Torque
M4	2.4 ± 0.1 N·m (26 ± 1 kgf·cm)
M5	4.0 ± 0.2 N·m (41 ± 2 kgf·cm)

It is recommended that bolts arranged in a circular pattern be secured in place by tightening in criss-cross order as shown in the figure.



Symbol	Description
a	Bolt hole

When securing the bolts, do not tighten the bolts all at once, but tighten them in two or three separate rounds with an Allen wrench, and then use a torque wrench or similar tool to secure them at the tightening torques shown in the table above.

4. Appendix

This section provides detailed technical data such as the specifications, stopping time, and stopping distance for each model.

4.1 Appendix A: Specifications Table

4.1.1 RS4-C, RS6-C

Item			RS4-C351*	RS6-C552*
Machinery name			Industrial robot	
Product series			RS	
Model			RS4-C, RS6-C	
Installation method			Ceiling mounting specifications	
Environmental specifications			Cleanroom & ESD model*1	
Arm length	Arms #1 + #2		350 mm	550 mm
	Arm #1		175 mm	275 mm
	Arm #2		175 mm	275 mm
Weight (not including weight of cables)			16 kg (35 lb)	20 kg (44 lb)
Drive system	All joints		AC servo motor	
Maximum operating speed *2	Joint #1 + Joint #2		6237 mm/s	7421 mm/s
	Joint #3		1100 mm/s	1440 mm/s
	Joint #4		2600 deg/s	
Repeatability	Joint #1 + Joint #2		±0.01 mm	±0.015 mm
	Joint #3		±0.01 mm	
	Joint #4		±0.01 deg	
Max. motion range	Joint #1		±270 deg	
	Joint #2		±225 deg	
	Joint #3	S	130 mm	200 mm
		C	100 mm	150 mm
	Joint #4		±720 deg	
Max. pulse range (pulse)	Joint #1		-3413334 to 6826667	-5520753 to 11041506
	Joint #2		±4177920	±4096000
	Joint #3	S	-1479112 to 0	-1820445 to 0
		C	-1137778 to 0	-1365334 to 0
	Joint #4		±3145728	±2634548

Item		RS4-C351*	RS6-C552*
Resolution	Joint #1	0.0000527 deg/pulse	0.0000326 deg/pulse
	Joint #2	0.0000539 deg/pulse	0.0000549 deg/pulse
	Joint #3	0.0000879 mm/pulse	0.0001009 mm/pulse
	Joint #4	0.0002289 deg/pulse	0.0002733 deg/pulse
Motor rated capacity	Joint #1	400 W	
	Joint #2	200 W	400 W
	Joint #3	150 W	
	Joint #4	100 W	150 W
Payload (load)	Rating	1 kg	2 kg
	Max.	4 kg	6 kg
Joint #4 allowable moment of inertia *3	Rating	0.005 kg·m²	0.01 kg·m²
	Max.	0.05 kg·m²	0.12 kg·m²
Hand diameter	Mounted	ø 16 mm	ø 20 mm
	Hollow	ø 11 mm	ø 14 mm
Joint #3 press force		150 N	
User wiring		15 (15-pin: D-sub)	
		Ethernet CAT5e or equivalent	Ethernet CAT5e or equivalent (x2)
User piping		2 × ø6 mm pneumatic tube, Pressure resistance: 0.59 MPa (6 kgf/cm^2: 86 psi)	
		1 × ø4 mm pneumatic tube, Pressure resistance: 0.59 MPa (6 kgf/cm^2: 86 psi)	2 × ø4 mm pneumatic tube, Pressure resistance: 0.59 MPa (6 kgf/cm^2: 86 psi)
Environmental requirements	Ambient temperature *4	5 to 40°C	
	Ambient relative humidity	10 to 80% (no condensation)	
Transportation and storage	Temperature	-20 to +60°C	
	Humidity	10 to 90% (no condensation)	
Noise level *5		LAeq = 70 dB (A) or lower	
Compatible Controllers		RC800-A	
Setting value range ( )Default value	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 65535	

Item		RS4-C351*	RS6-C552*
	Weight	0 to (1) to 4	0 to (2) to 6
M/C Cable*7	Minimum bending radius	For fixing and signal	40 mm
		For fixing and power	83 mm
		For movable and signal	100 mm
		For movable and power	100 mm

*1: Manipulators with cleanroom specifications discharge the exhaust inside of the base and in the arm cover section together. Consequently, if there is a gap in the base section, the arm tip section will not be fully negative pressurized, which may result in dust generation. Do not remove the maintenance cover on the front of the base.
Fasten the exhaust port and exhaust tube firmly with vinyl tape to prevent gaps.
If the exhaust discharge rate is not sufficient, dust generation will exceed the specifications.

- Cleanliness level:
  Class ISO 3 (ISO 14644-1)
- Exhaust
  - Exhaust port dimensions: Inner diameter ø 12 mm
  - Compatible exhaust tubes
    - Polyurethane tubes
    - Outer diameter ø12 mm (Inner diameter ø8 mm)
    - Recommended exhaust discharge rate: About 1,000 cm^3/s (standard state)

ESD specifications are specifications that use conductive materials for or apply plating to the major resin parts as anti-static measures.

*2: When PTP statements are used. The maximum operating speed in CP motion is 2,000 mm/s in the horizontal plane.

*3: When the center of gravity of the load matches the Joint #4 center position
When the center of gravity position is separated from the Joint #4 center position, set the parameter using the Inertia statement.

*4: When used in a low-temperature environment near the minimum temperature specified in the product specifications, or when the unit is idle for a long period of time during holidays or at night, a collision detection error or similar error may occur immediately after the start of operation due to high resistance in the drive unit.
In such cases, warm-up operation for about 10 minutes is recommended.

*5: The conditions at measurement are as follows.

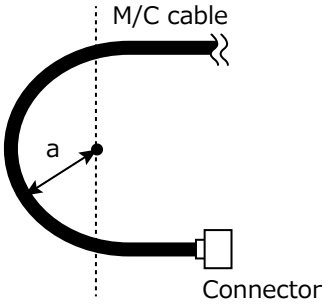
- Manipulator operating conditions
  Rated load, four-joint simultaneous operation, maximum speed, maximum acceleration/deceleration, duty 50%
- Measurement locations
  Manipulator rear side, 1,000 mm away from work envelope, and 50 mm above base mounting surface

*6: The Accel setting of "100" is the optimum setting that balances acceleration/deceleration and vibration during positioning. The Accel setting can be set to values above 100, but if you continue using the Manipulator at a high value, you may seriously shorten its lifespan, so we recommend limiting the use of such values to operations for which they are essential.

*7: Note the following points when wiring the M/C cable.

- Install the cable so as not to apply a load to the connector.

- Bend the cable at the minimum bending radius or more. The bending radius (a) and dimensions are shown in the figure below.

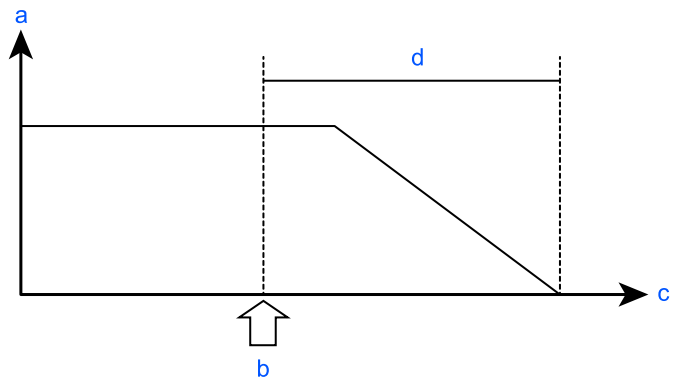


4.2 Appendix B: Stopping Time and Stopping Distance at Emergency Stop

The stopping time and stopping distance at an emergency stop are shown in the graphs for each model.

The stopping time is the length of time corresponding to the "Stopping time" in the figure below. Be sure to confirm that a safe environment is provided where the robot will be installed and operated.

For models equipped with a safety board such as RC700-E, RC800-A, the stopping time and stopping distance when using the Safety Limited Speed (SLS), Safety Limited Position (SLP), and Soft Axis Limiting are equivalent to those of the emergency stop.



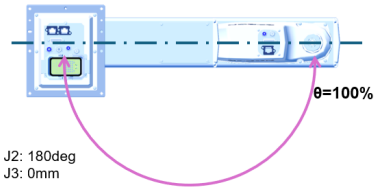
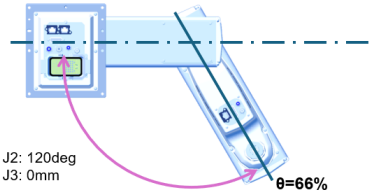
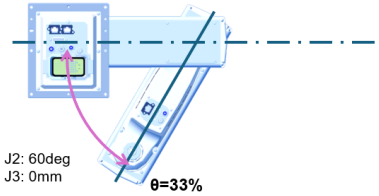
Symbol	Description
a	Motor speed
b	Emergency stop, Maximum Speed of SLS exceeded, monitoring areas and Joint Angle Limit of SLP exceeded, restricted range of Soft Axis Limiting exceeded
c	Time
d	Stopping time

Conditions

The stopping time and stopping distance depend on the parameters (setting values) that were set for the robot. These graphs show the times and distances for the following parameters.
These conditions are based on the ISO 10218-1:2011 Annex B.

- Accel: 100, 100
- Speed: 100 %, 66 %, 33 % Settings
- Weight: 100 %, 66 %, 33 % of the maximum payload, rated payload
- Arm elongation rate: 100 %, 66 %, 33 % *1
- Other settings: Default
- Motion: Singular axis motion of a Go command
- Input timing of the Stop signal: input with maximum speed. In this motion, it is the center of the motion range.

*1 Arm elongation rate
When J1 is operating, the arm elongation rate θ is as shown in the figure below.
Among the following arm elongation rate, the graph shows the results with the longest stopping time and stopping distance.
When J2 is operating, J3 is 0 mm.

Axis	θ = 100%	θ = 66%	θ = 33%
J1			

Explanation of legend

The graphs are displayed for each Weight setting value (at 100%, approx. 66%, and approx. 33% of the maximum payload, and at the rated payload).

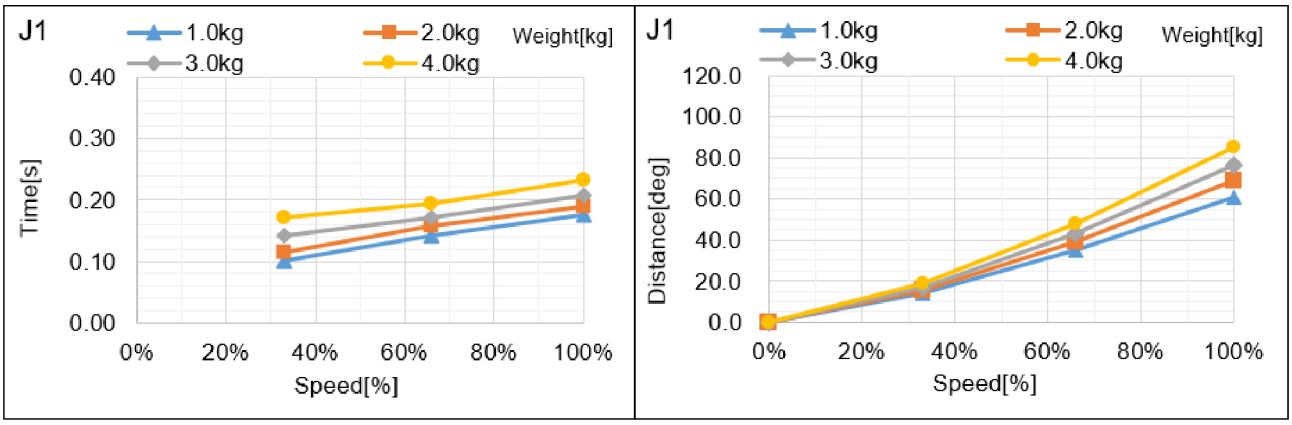
- Horizontal axis: Arm speed (Speed setting)
- Vertical axis: Stopping time and stopping distance at each arm speed
- Time (sec): Stopping time (sec)
- Distance (deg): J1 and J2 stopping distance (degree)
- Distance (mm): J3 stopping distance

When single failures are taken into account, the following adjustments are used.

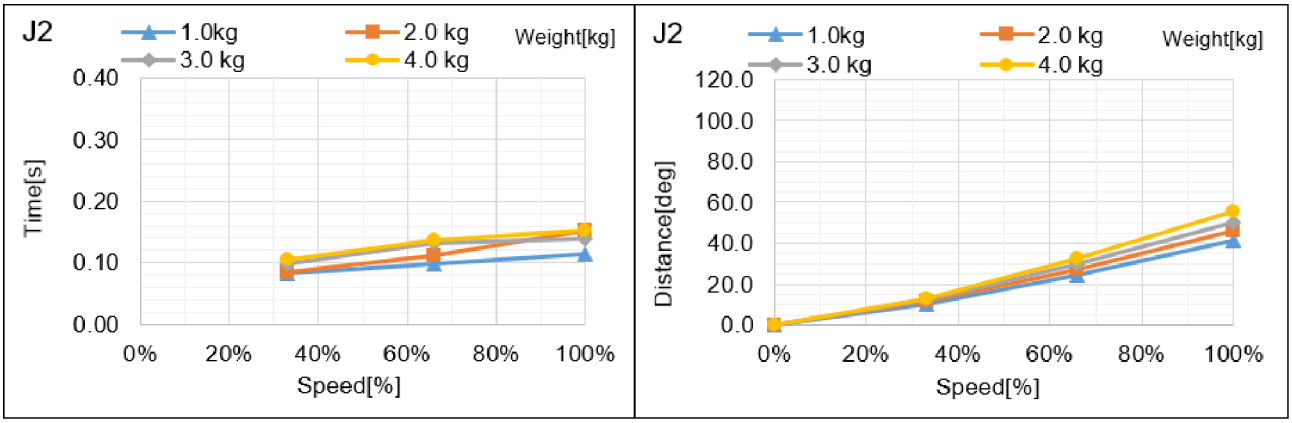
- Stopping distance and angle: Each axis reaches the mechanical stop
- Stopping time: Add 500 ms

4.2.1 RS4-C Stopping Time and Stopping Distance at Emergency Stop

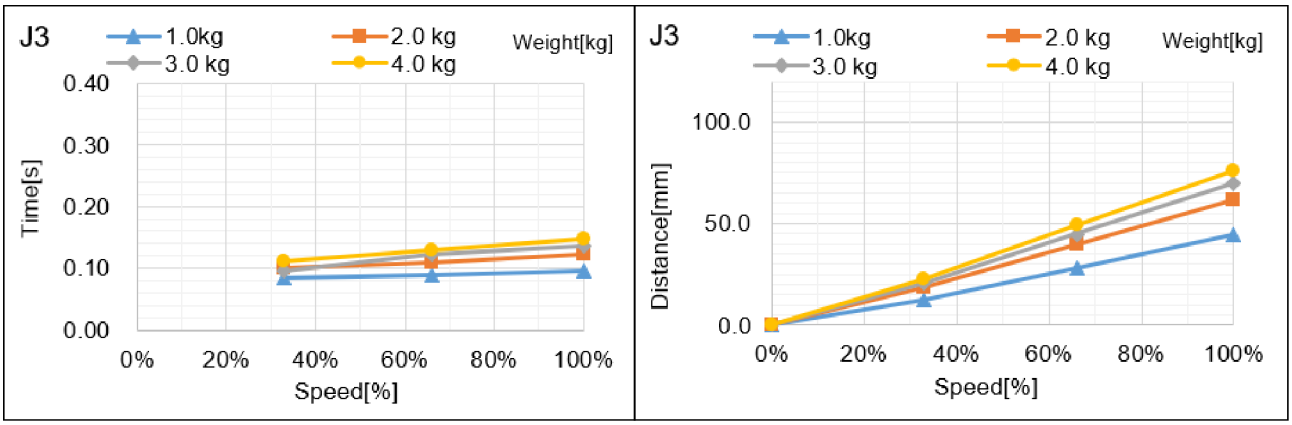
RS4-C351*: J1



RS4-C351*: J2

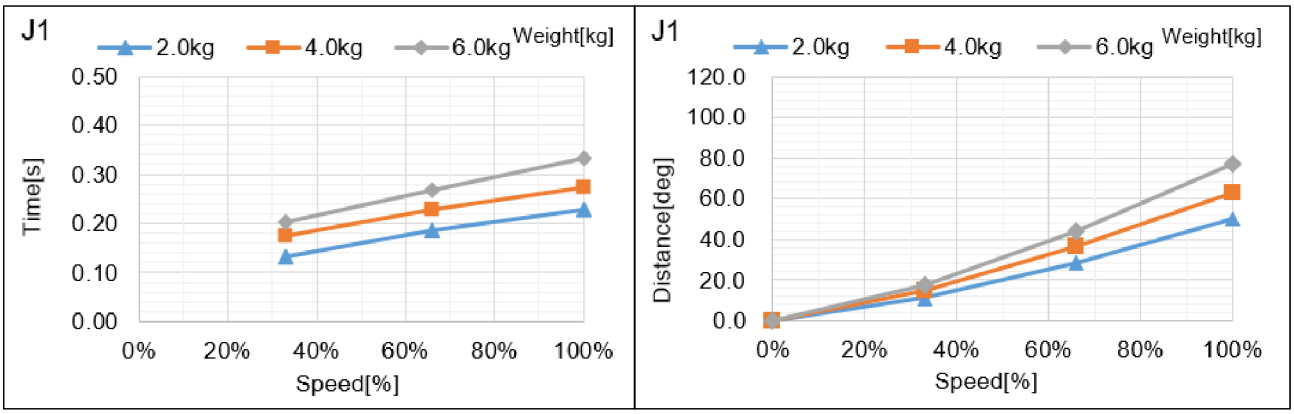


RS4-C351*: J3

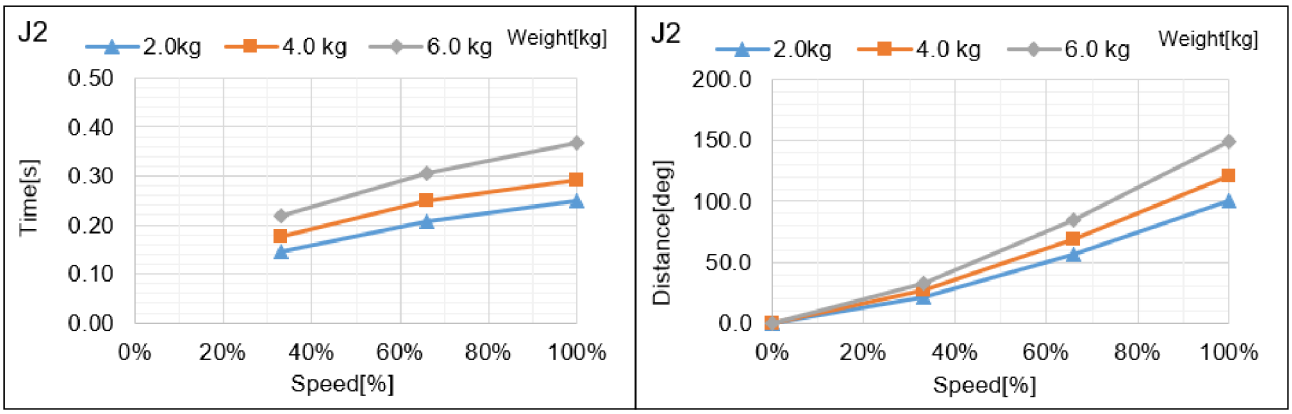


4.2.2 RS6-C Stopping Time and Stopping Distance at Emergency Stop

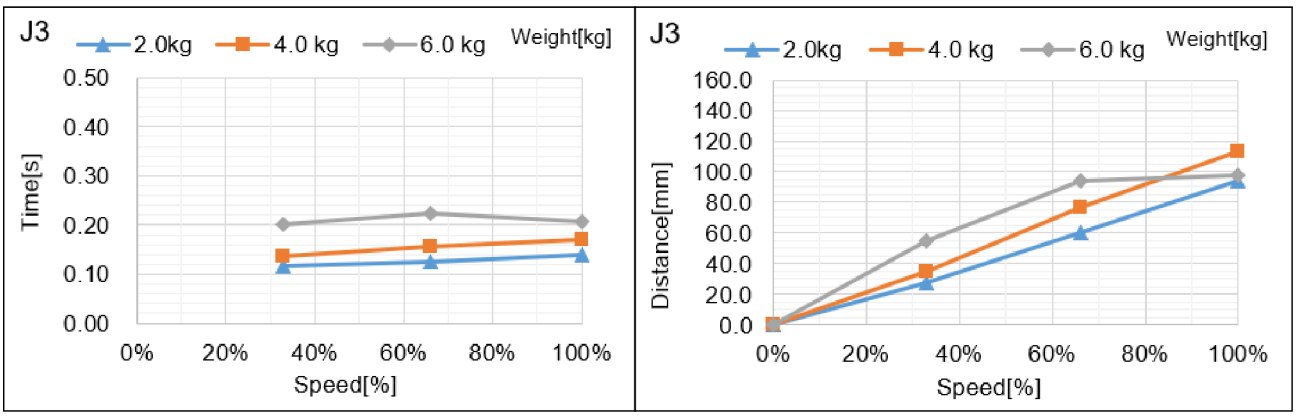
RS6-C552*: J1



RS6-C552*: J2



RS6-C552*: J3



4.2.3 Supplementary Information regarding the Stopping Time and Stopping Distance at Emergency Stop

The stopping time and stopping distance described in Appendix B was measured by the motion determined by us based on the ISO 10218-1.
Therefore, it does not guarantee the maximum value of the stopping time and stopping distance in the customer's environment.
The stopping time and stopping distance differs depending on the robot's model, motion, and input timing of the stop signal.
Make sure to always measure the stopping time and stopping distance that matches the customer's environment.

KEY POINTS

The following are included in the robot's motion and parameter.

- The motion's starting point, target point, and relay point
- Motion commands (Go, Move, Jump commands etc.)
- Weight and Inertia Settings
- Motion speed, acceleration, deceleration, and one where the motion timing changes

Also, refer to the following description.
Weight and Inertia Settings
Safety Information for Auto Acceleration of Joint #3

4.2.3.1 How to check the stopping time and stopping distance in the customer's environment

Measure the stopping time and stopping distance of the actual motion with the following method.

1. Create a motion program in the customer's environment.
2. After the motion to check the stopping time and stopping distance starts, input the stop signal at your own timing.
3. Record the time and distance from when the stop signal was input until the robot stopped.
4. Check the maximum stopping time and stopping distance by repeating 1 through 3 mentioned above.

- How to input the stop signal: Operate the stop switch manually or input the stop signal with the safety PLC.
- How to measure the stopping position: Measure with a tape measure. The angle could also be measured with the Where or RealPos command.
- How to measure the stopping time: Measure with a stop watch. The Tmr function can also be used to measure the stopping time.

⚠ CAUTION

The stopping time and stopping distance changes depending on the timing the stop signal is input.
In order to prevent collision with people or objects, perform a risk assessment based on the maximum stopping time and stopping distance and perform an equipment design.
Therefore, make sure to measure the maximum value by changing the timing of the stop signal input during the actual motion and measure repeatedly.

To shorten the stopping time and stopping distance, use the Safety Limited Speed (SLS) and limit the maximum speed.
For details on the safety limited speed, refer to the following manual.
"Safety Function Manual"

4.2.3.2 Commands that can be useful when measuring stopping time and stopping distance

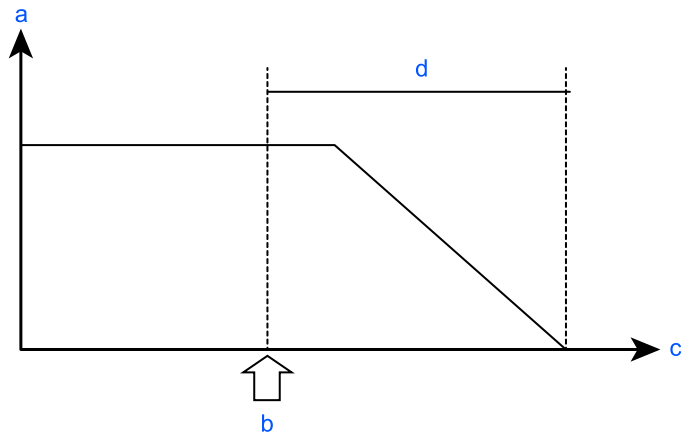
Commands	Functions
Where	Returns the data of the robot’s current position
RealPos	Returns the current position of the specified robot Unlike the motion target position of the CurPos, this obtains the position of the actual robot from the encoder in real time.
PAgl	Returns by calculating the Joint position from the specified coordinate value. P1 = RealPos 'Obtain the current position Joint1 = PAgl (P1, 1) ‘ Request the J1 angle from the current position
SF_RealSpeedS	Display the current speed from the limited speed position in mm/s.
Tmr	The Tmr function returns the elapsed time from when the timer starts in seconds.
Xqt	Runs the program specified with the function name and complete the task. The function used to measure the stopping time and stopping distance should be used to run tasks that were launched by attaching the NoEmgAbort options. You can run a task that does not stop with the emergency stop and safeguard open.

For more information, refer to the following manual.
"Epson RC+ SPEL+ Language Reference"

4.3 Appendix C: Stopping Time and Stopping Distance When Safeguard is Open

The stopping time and stopping distance when the safeguard is opened are shown in the graphs for each model.

The stopping time is the length of time corresponding to the "Stopping time" in the figure below. Be sure to confirm that a safe environment is provided where the robot will be installed and operated.



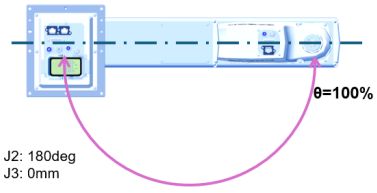
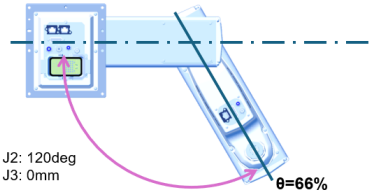
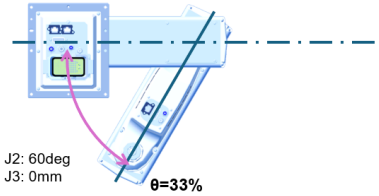
Symbol	Description
a	Motor speed
b	Safeguard open
c	Time
d	Stopping time

Conditions

The stopping time and stopping distance depend on the parameters (setting values) that were set for the robot. These graphs show the times and distances for the following parameters.
These conditions are based on the ISO 10218-1:2011 Annex B.

- Accel: 100, 100
- Speed: 100 %, 66 %, 33 % Settings
- Weight: 100 %, 66 %, 33 % of the maximum payload, rated payload
- Arm elongation rate: 100 %, 66 %, 33 % *1
- Other settings: Default
- Motion: Singular axis motion of a Go command
- Input timing of the Stop signal: input with maximum speed. In this motion, it is the center of the motion range.

*1 Arm elongation rate
When J1 is operating, the arm elongation rate θ is as shown in the figure below.
Among the following arm elongation rate, the graph shows the results with the longest stopping time and stopping distance.
When J2 is operating, J3 is 0 mm.

Axis	θ = 100%	θ = 66%	θ = 33%
J1			

Explanation of legend

The graphs are displayed for each Weight setting value (at 100%, approx. 66%, and approx. 33% of the maximum payload, and at the rated payload).

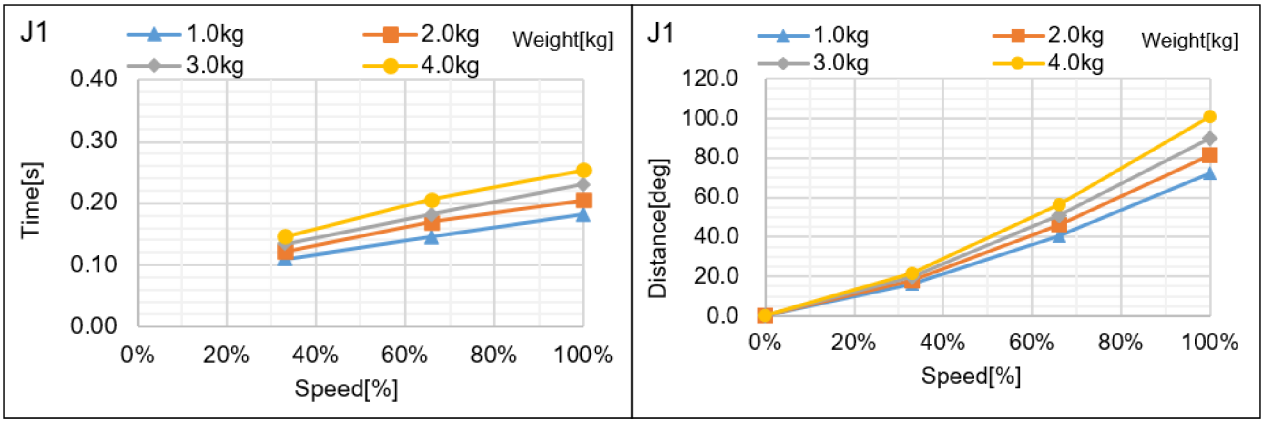
- Horizontal axis: Arm speed (Speed setting)
- Vertical axis: Stopping time and stopping distance at each arm speed
- Time (sec): Stopping time (sec)
- Distance (deg): J1 and J2 stopping distance (degree)
- Distance (mm): J3 stopping distance

When single failures are taken into account, the following adjustments are used.

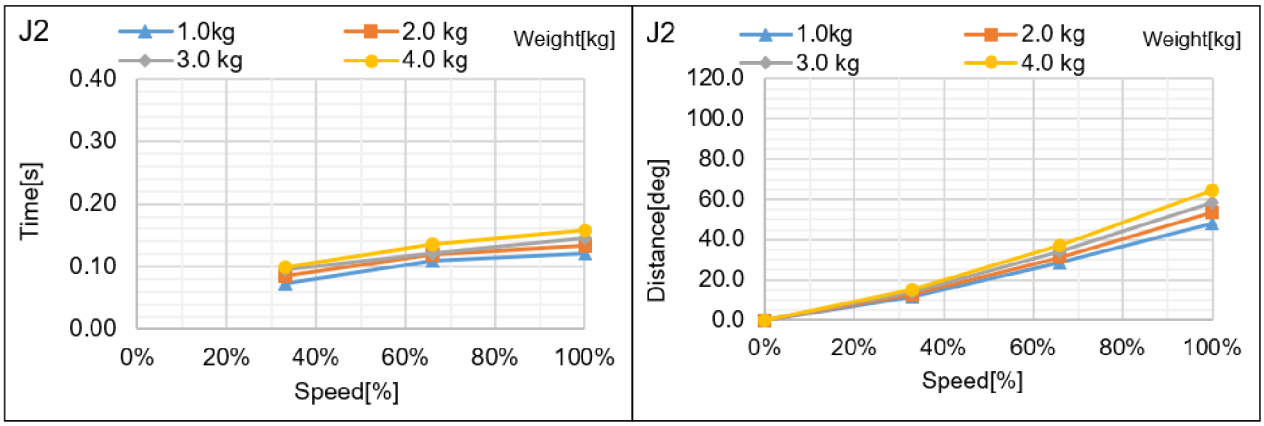
- Stopping distance and angle: Each axis reaches the mechanical stop
- Stopping time: Add 500 ms

4.3.1 RS4-C Stopping Time and Stopping Distance When Safeguard is Open

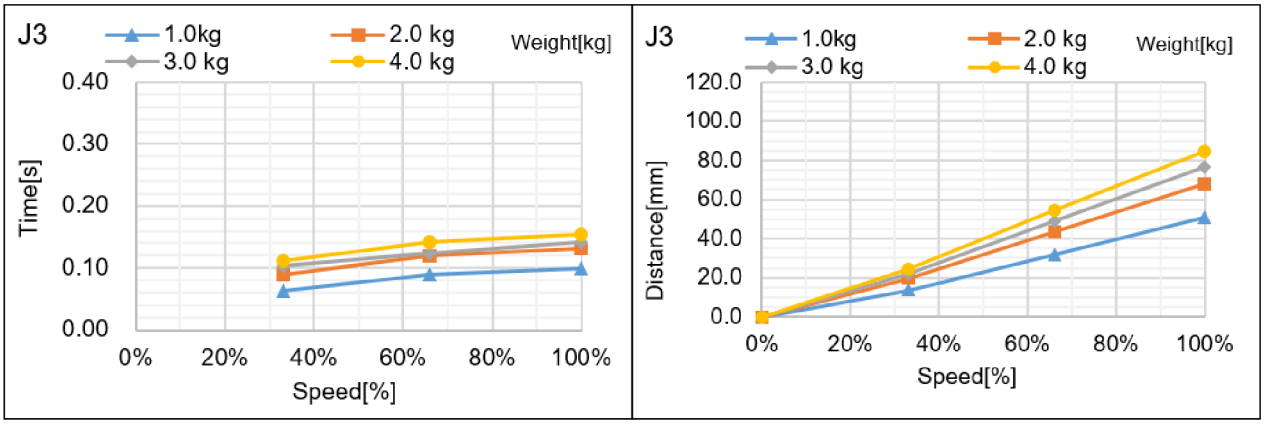
RS4-C351*: J1



RS4-C351*: J2

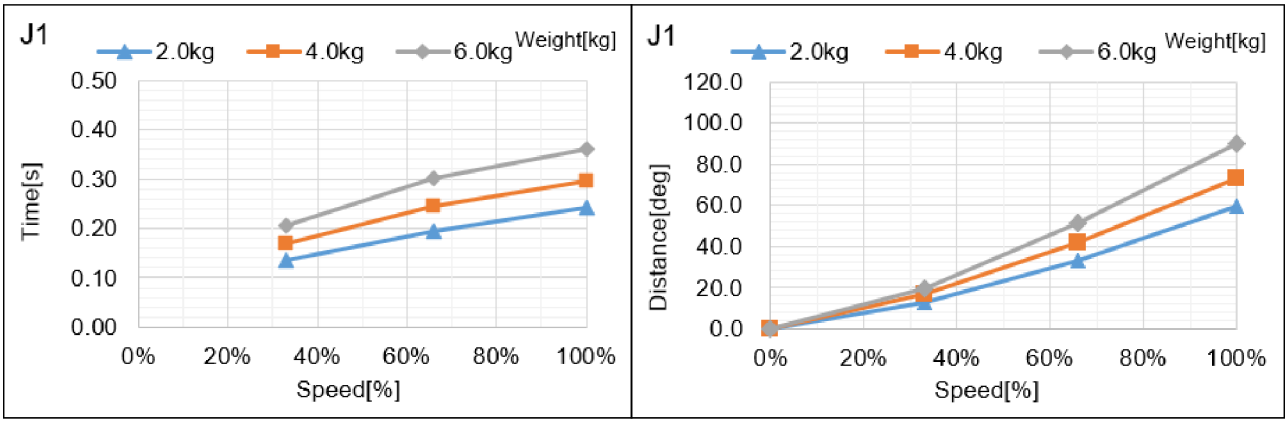


RS4-C351*: J3

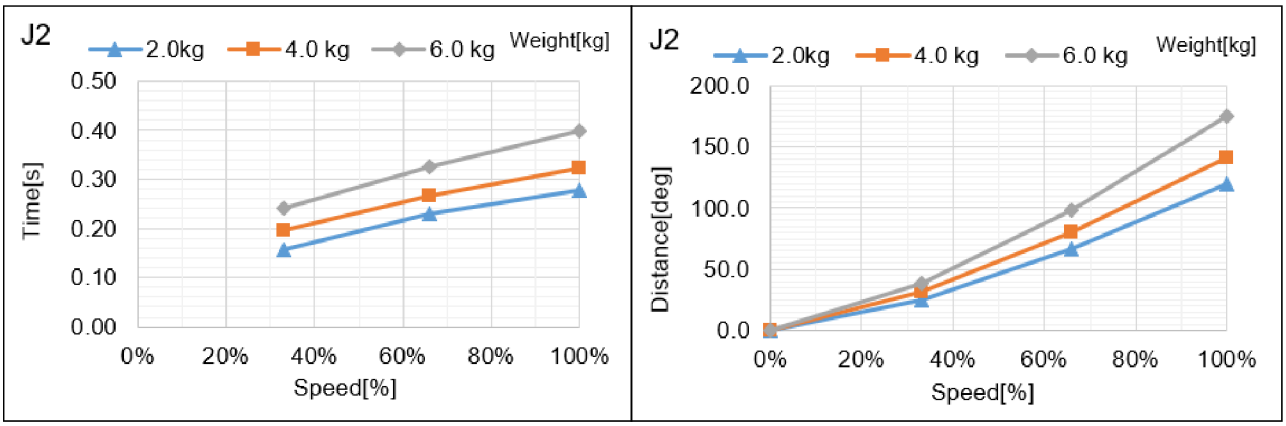


4.3.2 RS6-C Stopping Time and Stopping Distance When Safeguard is Open

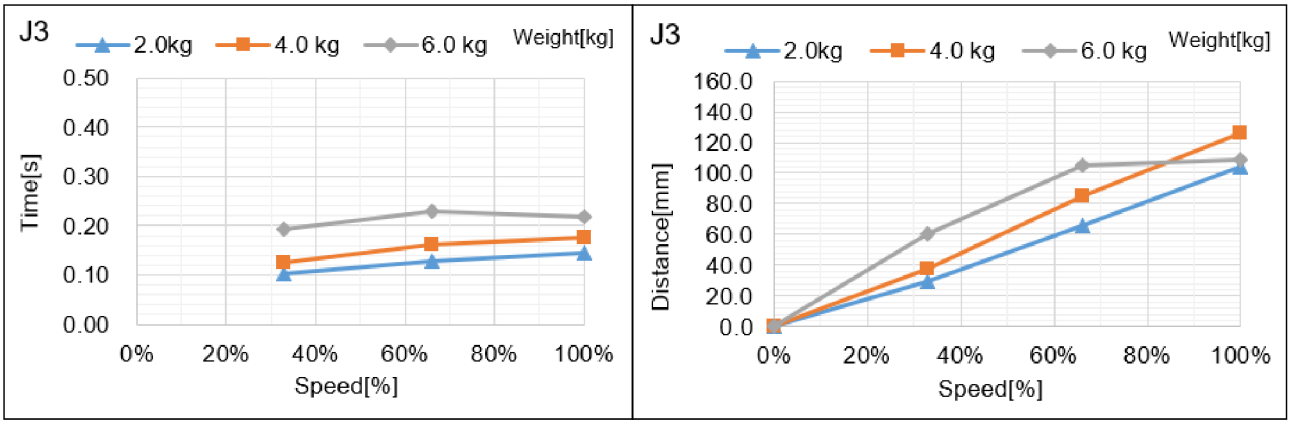
RS6-C552*: J1



RS6-C552*: J2



RS6-C552*: J3



4.3.3 Supplementary Information regarding the Stopping Time and Stopping Distance when the Safeguard is Open

The stopping time and stopping distance described in Appendix C was measured by the motion determined by us based on the ISO 10218-1.
Therefore, it does not guarantee the maximum value of the stopping time and stopping distance in the customer's environment.
The stopping time and stopping distance differs depending on the robot's model, motion, and input timing of the stop signal.
Make sure to always measure the stopping time and stopping distance that matches the customer's environment.

KEY POINTS

The following are included in the robot's motion and parameter.

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- Motion commands (Go, Move, Jump commands etc.)
- Weight and Inertia Settings
- Motion speed, acceleration, deceleration, and one where the motion timing changes

Also, refer to the following description.
Weight and Inertia Settings
Safety Information for Auto Acceleration of Joint #3

4.3.3.1 How to check the stopping time and stopping distance in the customer's environment

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- How to measure the stopping position: Measure with a tape measure. The angle could also be measured with the Where or RealPos command.
- How to measure the stopping time: Measure with a stop watch. The Tmr function can also be used to measure the stopping time.

⚠ CAUTION

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"Safety Function Manual"

4.3.3.2 Commands that can be useful when measuring stopping time and stopping distance

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Where	Returns the data of the robot’s current position
RealPos	Returns the current position of the specified robot Unlike the motion target position of the CurPos, this obtains the position of the actual robot from the encoder in real time.
PAgl	Returns by calculating the Joint position from the specified coordinate value. P1 = RealPos 'Obtain the current position Joint1 = PAgl (P1, 1) ‘ Request the J1 angle from the current position
SF_RealSpeedS	Display the current speed from the limited speed position in mm/s.
Tmr	The Tmr function returns the elapsed time from when the timer starts in seconds.
Xqt	Runs the program specified with the function name and complete the task. The function used to measure the stopping time and stopping distance should be used to run tasks that were launched by attaching the NoEmgAbort options. You can run a task that does not stop with the emergency stop and safeguard open.

For more information, refer to the following manual.
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