EPSON

Industrial Robot: SCARA Robots

LS-B series

Manual

Rev.12

ENM256R7513F

Original instructions

Industrial Robot: SCARA Robots

LS-B series Manual

Rev.12

FOREWORD

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

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

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

TRADEMARKS

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

MANUFACTURER

SEIKO EPSON CORPORATION

CONTACT INFORMATION

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

" Robot System Safety Manual Read this manual first"

DISPOSAL

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

Before Reading This Manual

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

Structure of Control System

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

LS3-B series
- Controller : RC90-B
- Software : LS3-B: EPSON RC+ 7.0 Ver.7.4.4 or later, Epson RC+ 8.0
  LS3-B401S-V1*: EPSON RC+ 7.0 Ver.7.5.1B or later, Epson RC+ 8.0
  * LS3-B401S-V1* is high speed model manipulator of LS3-B401S. This manual describes information on LS3-B401S-V1 which is different from LS3-B401S.

LS6-B series
- Controller : RC90-B
- Software : LS6-B : EPSON RC+ 7.0 Ver.7.4.3 or later, Epson RC+ 8.0
  LS6-B602S-V1* : EPSON RC+ 7.0 Ver.7.5.0 R3 or later, Epson RC+ 8.0

* LS6-B602S-V1 is high speed model manipulator of LS6-B602S. This manual describes information on LS6-B602S-V1 which is different from LS6-B602S.

LS10-B series
- Controller : RC90-B
- Software : EPSON RC+ 7.0 Ver.7.4.2 or later, Epson RC+ 8.0

LS20-B series
- Controller : RC90-B
- Software : EPSON RC+ 7.0 Ver.7.4.5 or later, Epson RC+ 8.0

Turning ON/OFF Controller

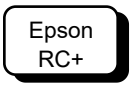
When you see the instruction “Turn ON/OFF the Controller” in this manual, be sure to turn ON/OFF all the hardware components. For the Controller composition, refer to the table above.

Shape of Motors

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

Setting by Using Software

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



Figures in this Manual

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

Pictures in this Manual

Pictures and illustrations of the manipulator in this manual may differ from using manipulator depending on the shipment date and the specifications.

The Manuals of This Product

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

Safety Manual

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

Read this manual first.

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

RC90 series Manual

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

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

LS-B series Manual (This book)

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

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

Status Code/Error Code List

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

RC90 series Maintenance Manual
LS-B series Maintenance Manual

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

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

Epson RC+ User's Guide

This manual describes general information about program development software.

Epson RC+ SPEL+ Language Reference

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

Other Manual

Manuals for each option are available.

LS3-B, LS-6B Manipulator

LS10-B Manipulator

LS20-B Manipulator

Regular Inspection

Appendix

LS3-B LS6-B Manipulator

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

1. Safety

Unpacking and transportation of the Manipulators and robotic equipment shall be performed by personnel who has taken robot system training held by us and suppliers and should conform to all national and local codes.
Please read this manual and other related manuals before installing the robot system or before connecting cables.
Keep this manual handy for easy access at all times.

1.1 Conventions

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

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

1.2 Design and Installation Safety

This product is intended for transporting and assembling parts in a safely isolated area.
Design and installation of robot system shall be performed by personnel who has taken robot system training held by us and suppliers.
To ensure safety, a safeguard must be installed for the robot system. For details on the safeguard, refer to the *Installation and Design Precautions* in the *Safety* chapter of the *Epson RC+ User's Guide*.

The following items are safety precautions for design personnel:

 WARNING	■ Personnel who design and/or construct the robot system with this product must read the "*Safety Manual"* to understand the safety requirements before designing and/or constructing the robot system. Designing and/or constructing the robot system without understanding the safety requirements is extremely hazardous, may result in serious bodily injury and/or severe equipment damage to the robot system, and may cause serious safety problems. ■ The Manipulator and the Controller must be used within the environmental conditions described in their respective manuals. This product has been designed and manufactured strictly for use in a normal indoor environment. Using the product in an environment that exceeds the specified environmental conditions may not only shorten the life cycle of the product but may also cause serious safety problems. ■ The robot system must be used within the installation requirements described in the manuals. Using the robot system outside of the installation requirements may not only shorten the life cycle of the product but also cause serious safety problems. ■ When designing or installing a robot system, wear at least the following protective gear. Working without protective gear may cause serious safety problems. Work clothes suitable for work Helmet Safety shoes

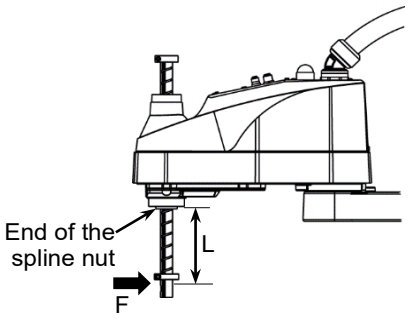
Further precautions for installation are mentioned in the chapter *3. Environments and Installation.* Please read this chapter carefully to understand safe installation procedures before installing the robots and robotic equipment.

1.2.1 Strength of the Ball Screw Spline

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

[Allowable bending moment]
LS3-B:M=13,000 N·mm
LS6-B:M=27,000 N·mm
[Moment]
M=F·L =100·100 =10,000 N·mm

Example:
If 100 N (10.2kgf) load is applied
at 100 mm from
the end of the spline nut



1.3 Operation Safety

The following items are safety precautions for qualified Operator personnel:

 WARNING	■ Please carefully read the *Safety Requirements* in the "*Safety Manual"* before operating the robot system. Operating the robot system without understanding the safety requirements is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system. ■ Do not enter the operating area of the Manipulator while the power to the robot system is turned ON. Entering the operating area with the power ON is extremely hazardous and may cause serious safety problems as the Manipulator may move even if it seems to be stopped. ■ Before operating the robot system, make sure that no one is inside the safeguarded area. The robot system can be operated in the mode for teaching even when someone is inside the safeguarded area. The motion of the Manipulator is always in restricted (low speed and low power) status to secure the safety of an operator. However, operating the robot system while someone is inside the safeguarded area is extremely hazardous and may result in serious safety problems in case that the Manipulator moves unexpectedly. ■ Immediately press the Emergency Stop switch whenever the Manipulator moves abnormally while the robot system is operated. Continuing the operation while the Manipulator moves abnormally is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system.

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

CAUTION	■ Whenever possible, only one person should operate the robot system. If it is necessary to operate the robot system with more than one person, ensure that all people involved communicate with each other as to what they are doing and take all necessary safety precautions. ■ Joint #1, #2, and #4: If the joints are operated repeatedly with the operating angle less than 5 degrees, they may get damaged early because the bearings are likely to cause oil film shortage in such situation. To prevent early breakdown, move each joint larger than 50 degrees for about once an hour. Joint #3: If the up-and-down motion of the hand is less than LS3-B: 32 mm LS6-B: 40 mm, move the joint a half of the maximum stroke for about once an hour. ■ Vibration (resonance) may occur continuously in low speed Manipulator motion (Speed: approx. 5 to 20%) depending on combination of Arm orientation and end effector load. Vibration arises from natural vibration frequency of the Arm and can be controlled by following measures. Changing Manipulator speed Changing the teach points Changing the end effector load

1.4 Emergency Stop

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

Avoid pressing the Emergency Stop switch unnecessarily while the Manipulator is running normally.

- The Manipulator may hit the peripheral equipment.
  When you press the Emergency Stop switch, the operating trajectory until the robot system stops is different from that in normal operation.
- The life of the brakes will be shortened.
  The brakes are locked and the brake friction plate is worn.
  Normal brake life cycle: About 2 years (when the brakes are used 100 times/day)
  However, the rough normal relay life is approximately 20,000 times. If you press the emergency stop switch unnecessarily, the life of the relay will be shortened.
- Impact is applied on the reduction gear unit, and it may result in the short life of the reduction gear unit.

To place the system in emergency mode during normal operation, press the Emergency Stop switch when the Manipulator is not moving. Refer to the Controller manual for instructions on how to wire the Emergency Stop switch circuit.

Do not turn OFF the Controller while the Manipulator is operating.
If you attempt to stop the Manipulator in emergency situations, make sure to stop the Manipulator using the E-STOP of the Controller.

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

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

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

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

If there is a position gap, perform calibration by referring to the *LS-B series Maintenance Manual – LS3-B LS6-B Manipulator –* 13. Calibration.

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

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

To check brake problems, refer to *Regular Inspection 1. LS3-B LS6-B Manipulator Regular Inspection.*

NOTE

Test pulse cannot be used with the emergency stop input of this model.

Stopping distance in emergency

The operating Manipulator cannot stop immediately after the Emergency Stop switch is pressed. In addition, stopping time and stopping distance vary by following factors:

Hand weight	WEIGHT Setting	ACCEL Setting
Workpiece weight	SPEED Setting	Posture etc.

For stopping time and stopping distance of the Manipulator, refer to "*Appendix B: Stopping Time and Stopping Distance in Emergency*".

1.5 Safeguard

To ensure safe operation, install a safety system using safety doors, light curtains, safety floor mats, etc.

When a closed safeguard is open during robot motion, the safeguard interlock function operates. The robot stops immediately and enters into pause state. Then, all robot motors are turned OFF. The descriptions below explain how the safeguard input works.

Safeguard open : The robot stops immediately, motors are turned OFF, and further operation is impossible until either the safeguard is closed or TEACH or TEST mode is turned ON and the enable circuit is engaged.

Safeguard closed : The robot can automatically operate in unrestricted (high power) state.

Do not open the safeguard unnecessarily while motor is ON. Frequent safeguard inputs affect the life of the relay.
Rough normal relay life: Approximately 20,000 timesFor the safeguard, do not use the E-STOP circuit.

For details of wiring instructions, refer to the following manual:

RC90 series Manual - 9. EMERGENCY

For details of Safeguard, refer to the following manual:

RC90 series Manual - 2.7.1 Connection to EMERGENCY Connector

NOTE

Test pulse cannot be used with the safeguard input of this model.

WARNING

- The EMERGENCY connector on the controller has a safeguard input circuit to connect the safety device interlock switch. To protect operators working near the robot, be sure to connect the interlock switch and make sure that it works properly.
- The time to stop the robot and the stopping distance by the safeguard interlock function will change depending on the conditions of use. Be sure to confirm that safety is ensured according to the installation environment of the robot.

Stopping distance when the safeguard is opened

The Manipulator in operation cannot stop immediately after the safeguard is opened. In addition, stopping time and stopping distance vary by following factors:

Hand weight	WEIGHT Setting	ACCEL Setting
Workpiece weight	SPEED Setting	Posture etc.

For stopping time and stopping distance of the Manipulator, refer to "*Appendix C: Stopping Time and Stopping Distance When the Safeguard is Opened*".

1.6 Emergency Movement Without Drive Power

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

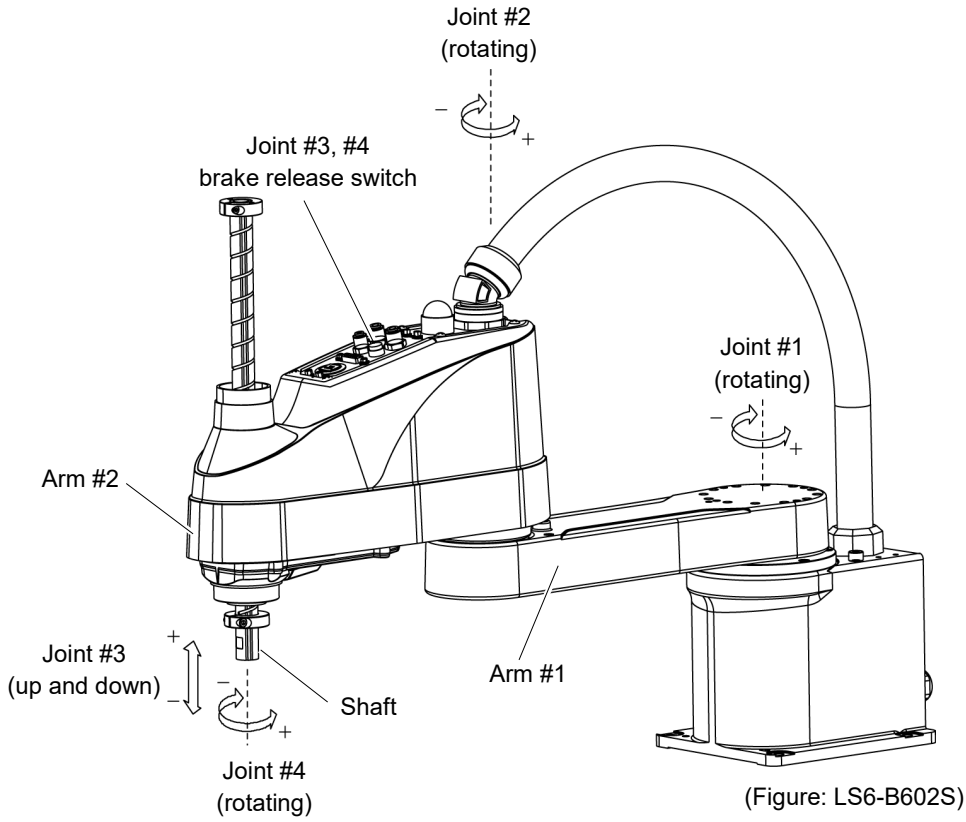
Arm #1 Push the arm by hand.

Arm #2 Push the arm by hand.

Joint #3 The joint cannot be moved up/down by hand until the electromagnetic brake applied to the joint has been released. Move the joint up/down while pressing the brake release switch.

Joint #4 LS3-B Rotate the shaft by hand.

LS6-B The shaft cannot be rotated by hand until the electromagnetic brake applied to the shaft has been released. Move the shaft while pressing the brake release switch.



(Figure: LS6-B602S)

NOTE

LS3-B: The brake release switch affects Joint #3 only. When the brake release switch is pressed in emergency mode, the brake for Joints #3 is released. Be careful of the shaft falling while the brake release switch is pressed because the shaft may be lowered by the weight of an end effector.

LS6-B: The brake release switch affects both Joints #3 and #4. When the brake release switch is pressed in emergency mode, the brake for both Joints #3 and #4 are released simultaneously.
Be careful of the shaft falling and rotating while the brake release switch is pressed because the shaft may be lowered by the weight of an end effector.

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1.7 ACCELS Setting for CP Motions

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.

NOTE ☞ If the ACCELS settings are not properly configured, the following problem occurs.

- Shortened lifespan and damage to the ball screw spline
- Stop with error (Error code: 4002)

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

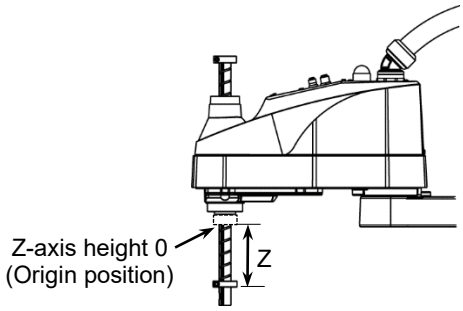
Maximum ACCELS correction values by Z-axis height and tip load

LS3-B:

Z-axis height (mm)	Tip load
	3kg or less
0 >= Z >= - 150	25000 or less

LS6-B:

Z-axis height (mm)	Tip load	
	4kg or less	6kg or less
0 >= Z >= - 150	25000 or less	25000 or less
- 150 > Z >= - 200		23000 or less



If the Manipulator is operated in CP motion with the wrong set values, make sure to check the following.

- Whether or not the ball screw spline shaft is deformed or bent

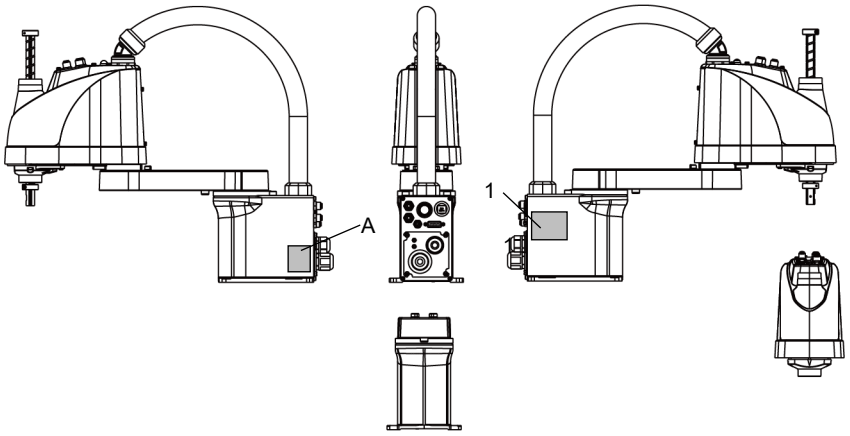
1.8 Warning Labels

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

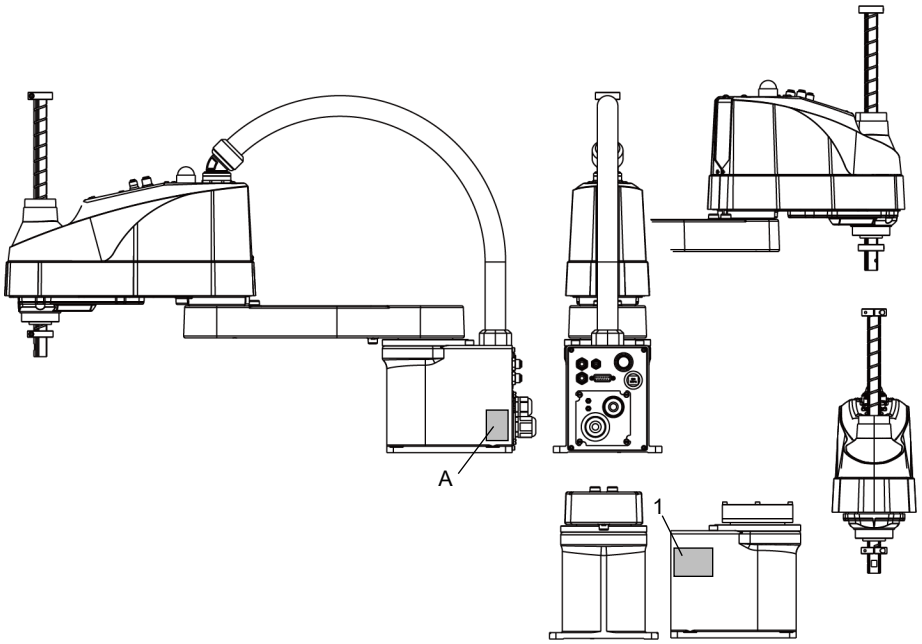
Location	Warning Label	NOTE
A		Hazardous voltage exists while the Manipulator is ON. To avoid electric shock, do not touch any internal electric parts.

Location	Label	NOTE
1	-	Indicates Product name, Model name, Manipulator's serial No., Local codes information, Specification, Manufacturer, Importer, Date of manufacture, Country of manufacture, etc. For details, refer to the attached label.

LS3-B



LS6-B



1.9 Response for Emergency or Malfunction

1.9.1 Collision

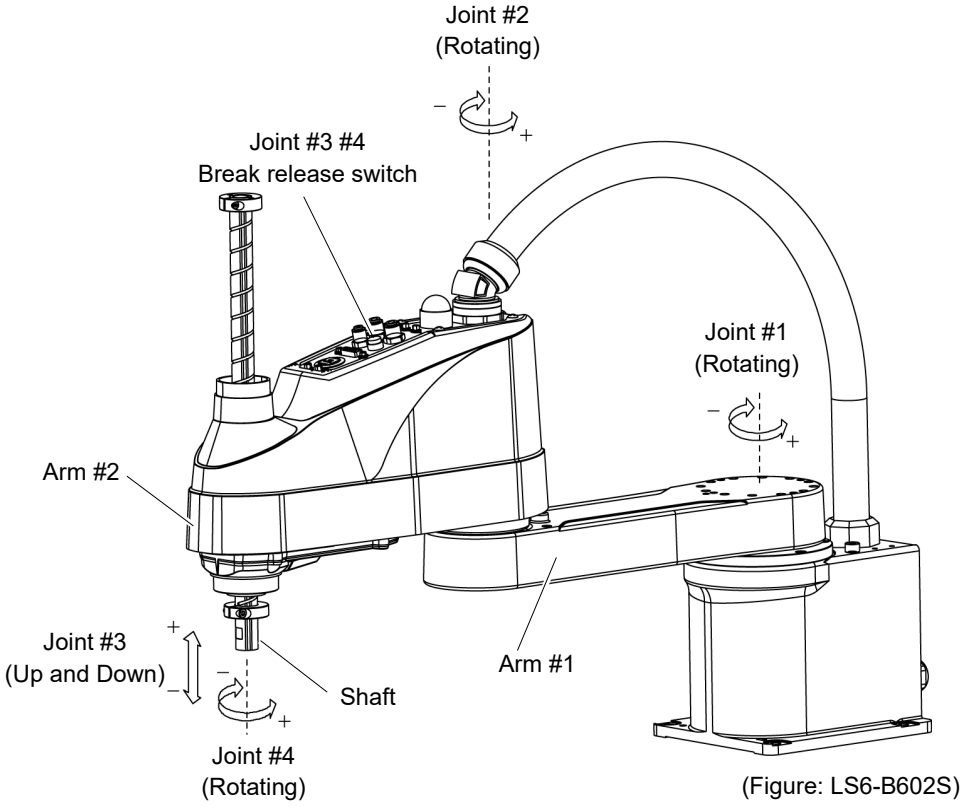
When the Manipulator collides with a mechanical stopper or peripheral device etc., discontinue use and contact the supplier.

1.9.2 Getting body caught in Manipulator

When the operator is caught between the Manipulator and a mechanical part such as a base table, press the emergency stop switch to release the brake on the subject arm, and then move the arm by hand.

Get body caught in the arms:
The break is not working. Move the arms manually.

Get body caught in the shafts:
The break is working. Press the break release switch and move the shafts.



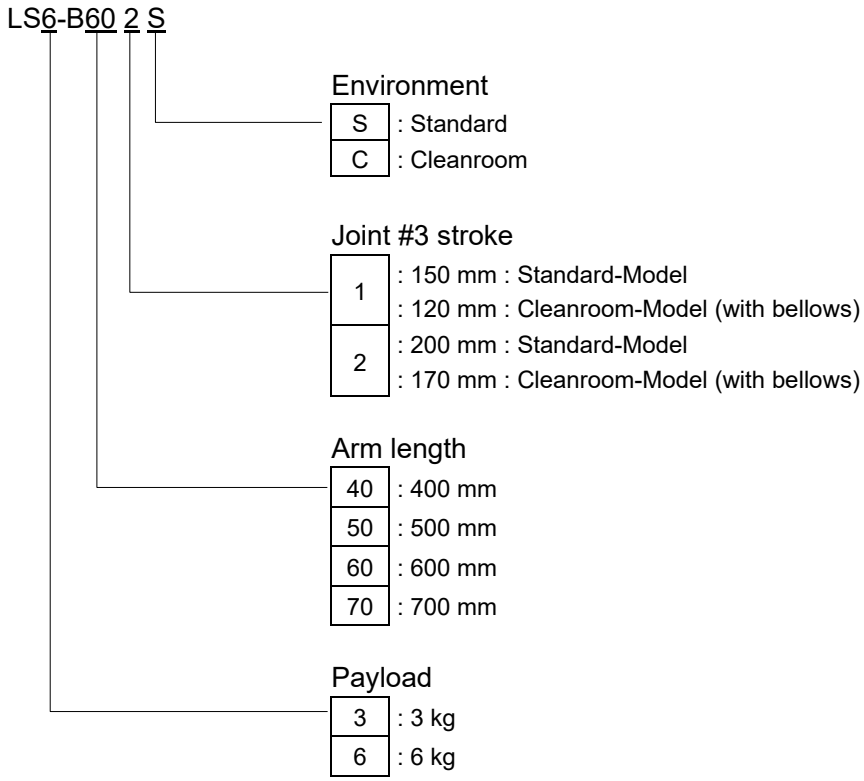
(Figure: LS6-B602S)

CAUTION	■ While pressing the break release switch, not only Joint #3 but also Joint #4 may move due to its own weight. Be careful of the shaft falling or rotating.

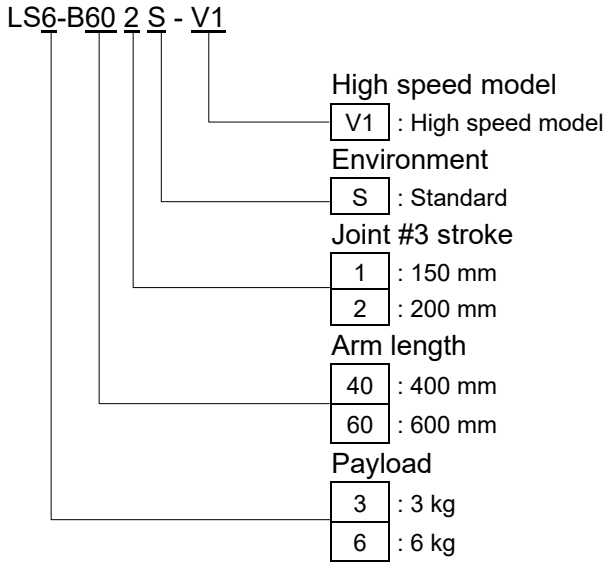
2. Specifications

2.1 Model Number

Standard model



High speed model *



* High speed model for standard environment only.
The information on LS3-B401S-V1 describes only the parts that differ from LS3-B401S.
The information on LS6-B602S-V1 describes only the parts that differ from LS6-B602S.

Environment

Cleanroom-model

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

For details on the specifications, refer to *Appendix A: Specifications*.

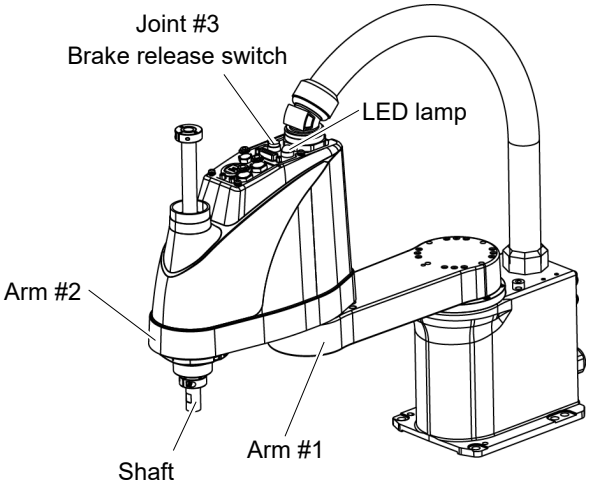
Models

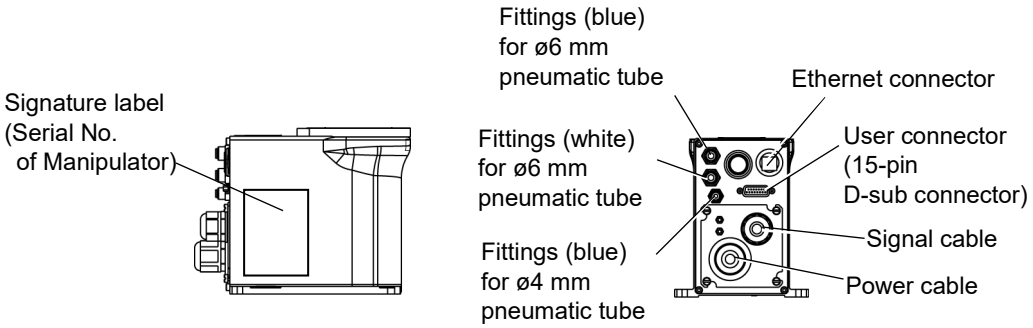
Payload	Arm length	Environment	Joint #3 stroke	Model Number
3 kg	400 mm	Standard	150 mm	LS3-B401S
		Standard	150 mm	LS3-B401S-V1
		Cleanroom	120 mm	LS3-B401C
6 kg	500 mm	Standard	200 mm	LS6-B502S
		Cleanroom	170 mm	LS6-B502C
	600 mm	Standard	200 mm	LS6-B602S
		Standard	200 mm	LS6-B602S-V1
		Cleanroom	170 mm	LS6-B602C
	700 mm	Standard	200 mm	LS6-B702S
		Cleanroom	170 mm	LS6-B702C

2.2 Part Names and Outer Dimensions

2.2.1 LS3-B

Standard Model (LS3-B401S)

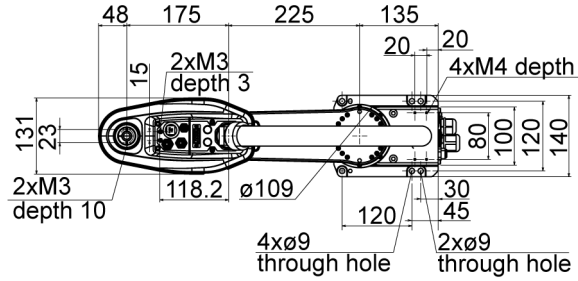


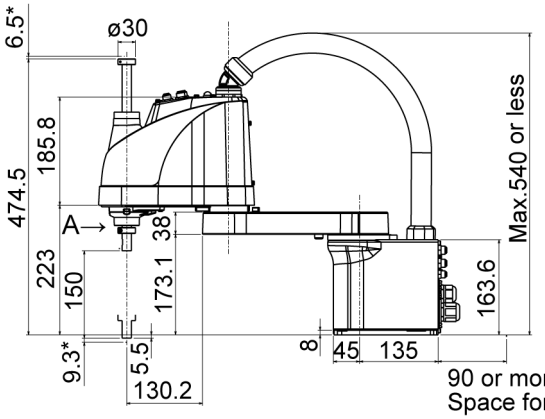


NOTE

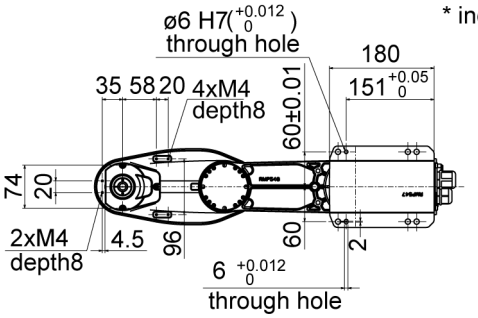
- The brake release switch affects Joints #3. When the brake release switch is pressed in emergency mode, the brake for Joint #3 is released.
- While the LED lamp is ON, current is being applied to the manipulator. Performing any work with the power ON is extremely hazardous and it may result in electric shock and/or improper function of the robot system. Make sure to turn OFF the controller power before the maintenance work

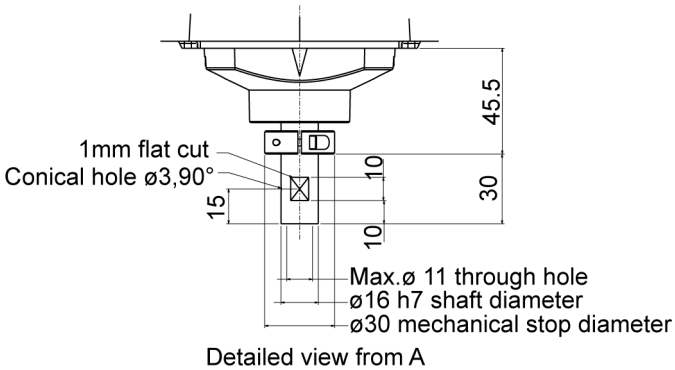
Standard Model (LS3-B401S)





* indicates mechanical stop position

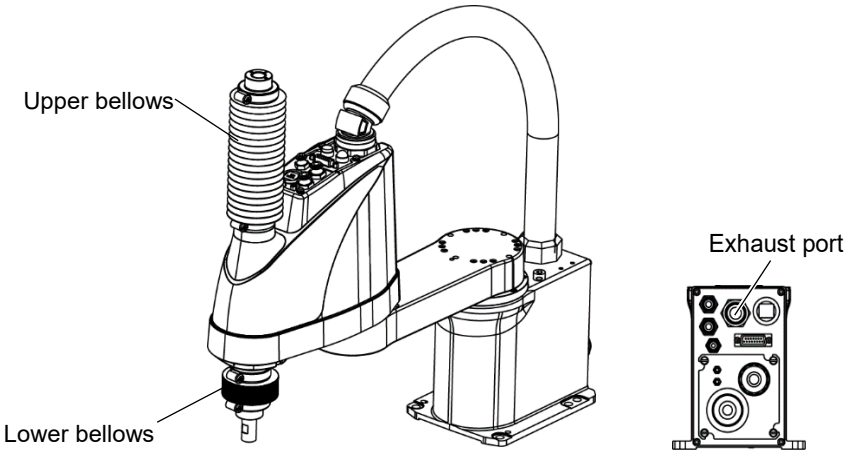




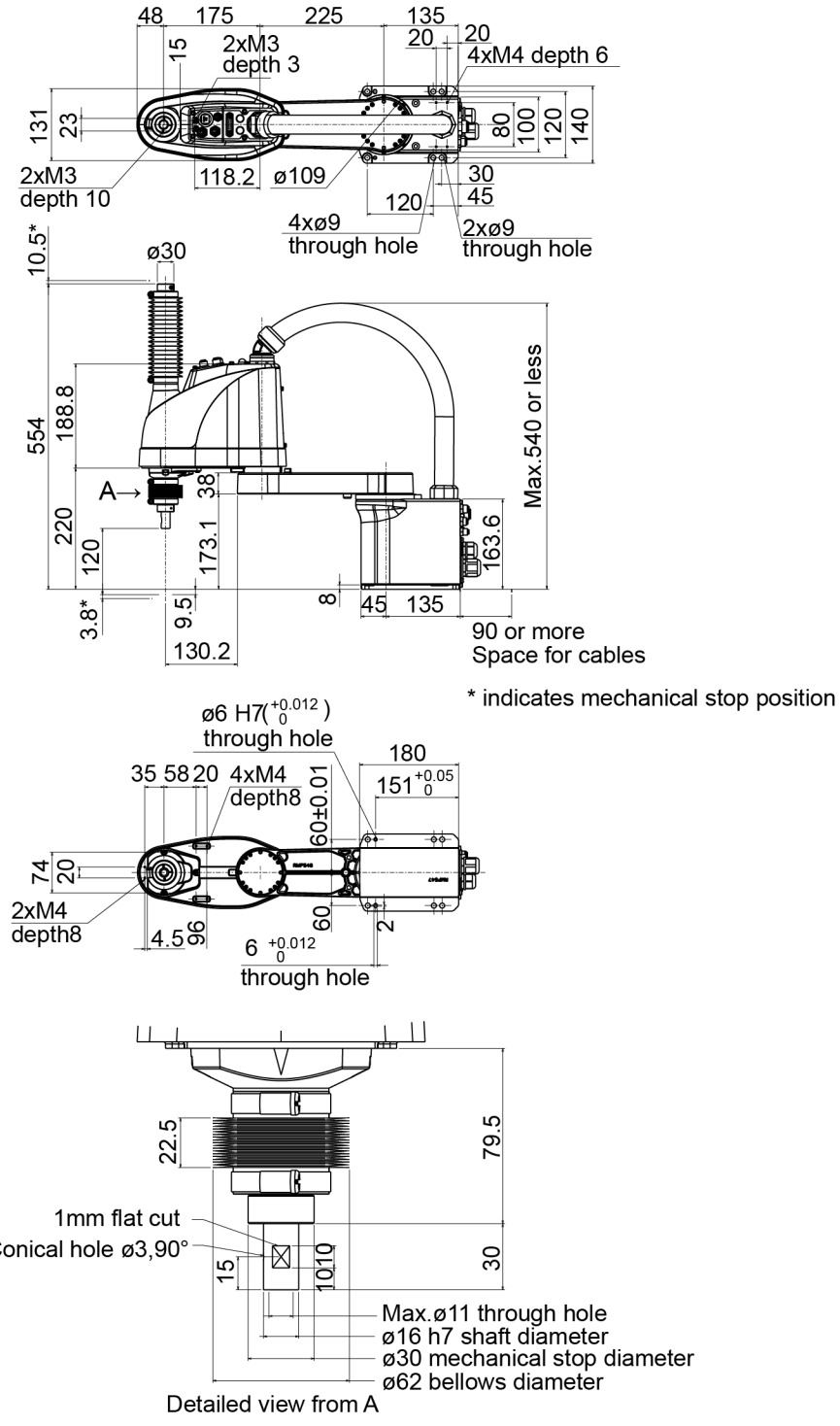
Detailed view from A

Cleanroom Model (LS3-B401C)

The following figures show the additional parts and specifications for Cleanroom-model when compared with the Standard-model in appearance.

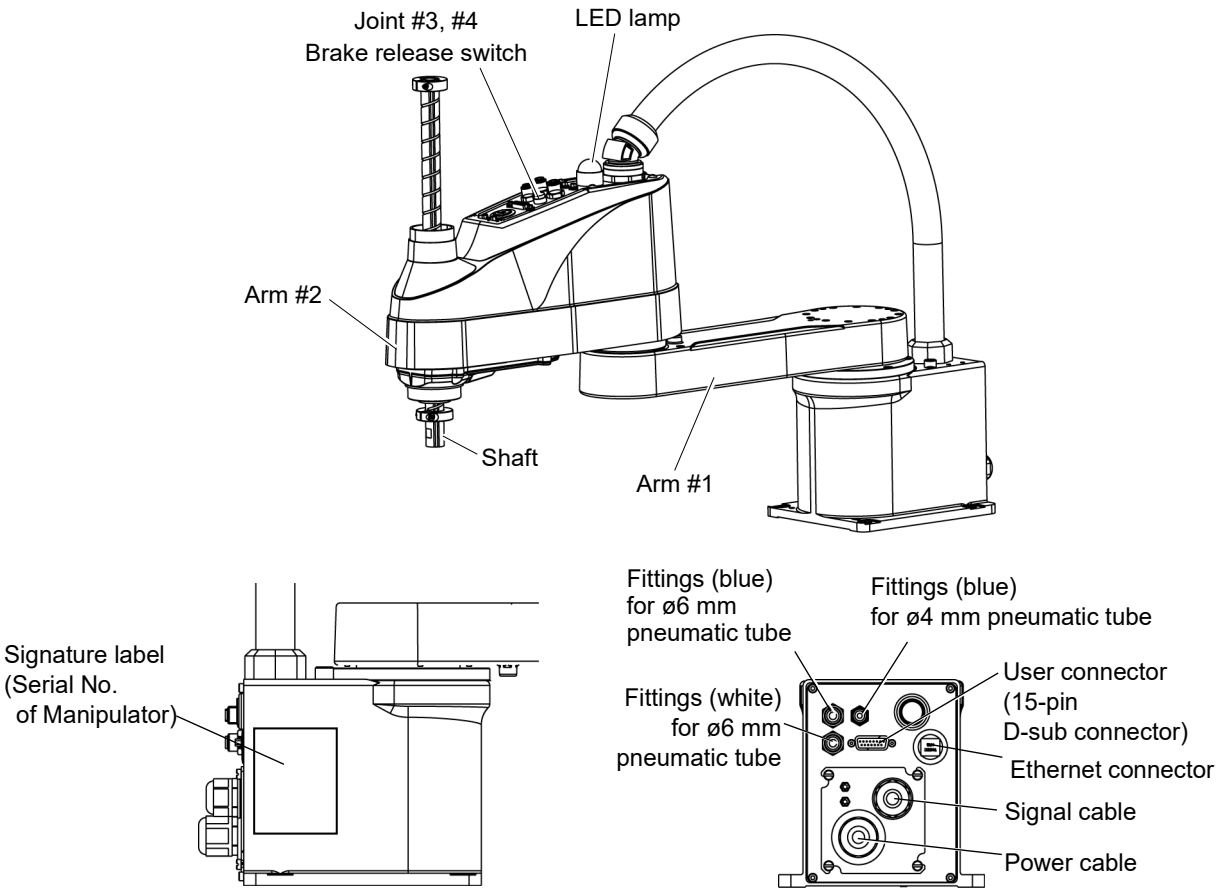


Cleanroom Model (LS3-B401C)



2.2.2 LS6-B

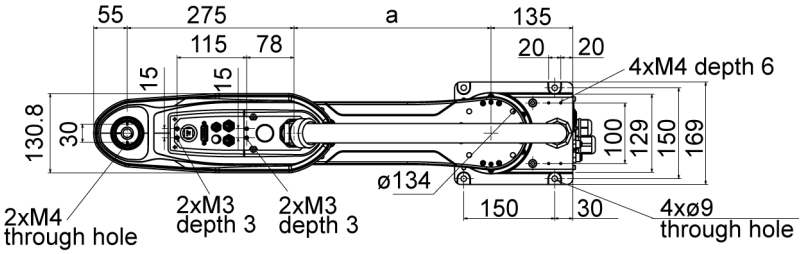
Standard-Model (LS6-B*02S)

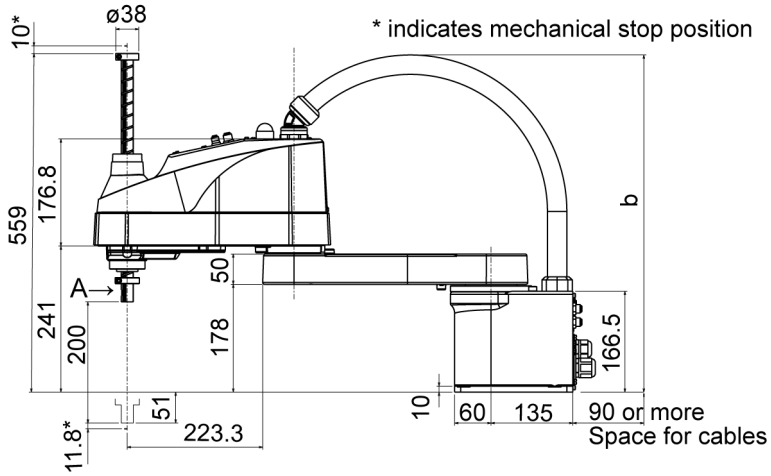


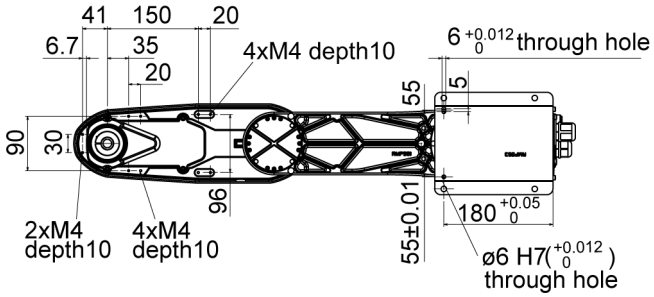
NOTE

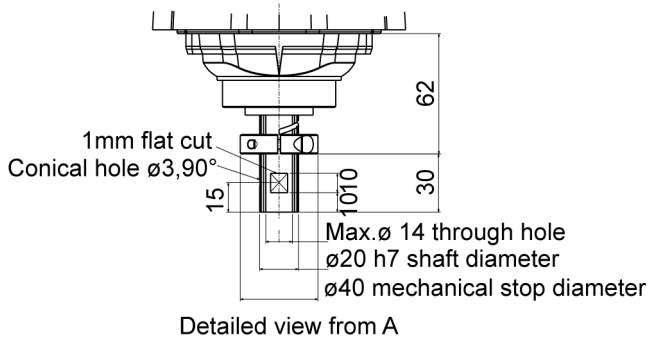
- The brake release switch affects both Joints #3 and #4. When the brake release switch is pressed in emergency mode, the brakes for both Joint #3 and Joint #4 are released simultaneously.
- While the LED lamp is ON, current is being applied to the manipulator. Performing any work with the power ON is extremely hazardous and it may result in electric shock and/or improper function of the robot system. Make sure to turn OFF the controller power before the maintenance work.

Standard Model (LS6-B*02S)







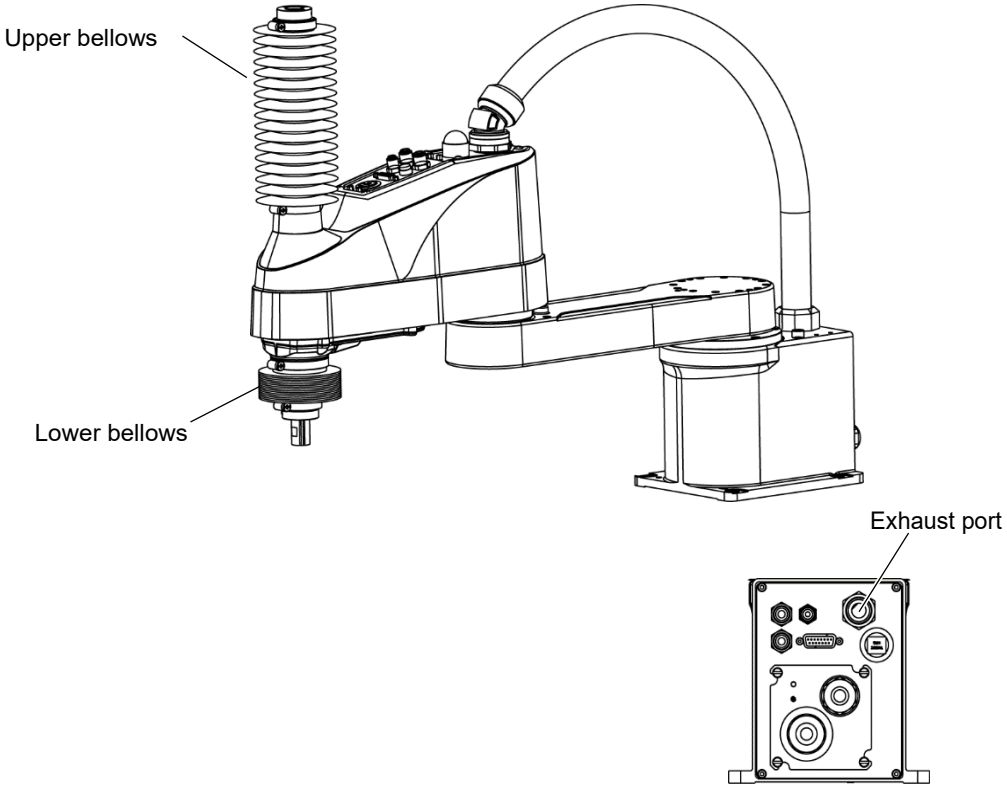


Detailed view from A

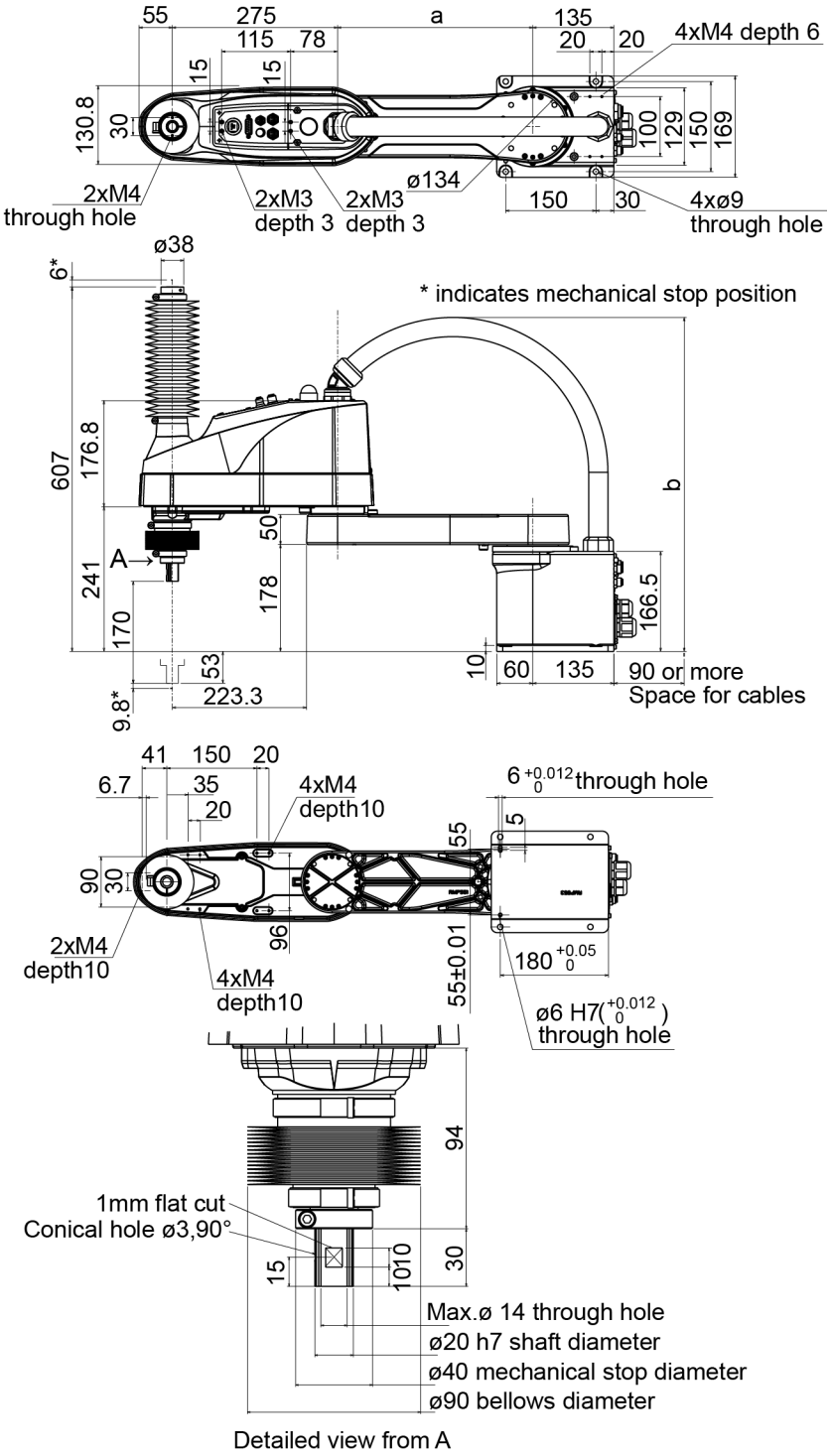
	LS6-B502S	LS6-B602S	LS6-B602S-V1	LS6-B702S
a	225	325	325	425
b	529	559	559	589

Cleanroom Model (LS6-B*02C)

The following figures show the additional parts and specifications for Cleanroom-model when compared with the Standard-model in appearance.



Cleanroom Model (LS6-B*02C)



	LS6-B502C	LS6-B602C	LS6-B702C
a	225	325	425
b	529	559	589

2.3 Specifications

For details of each manipulator specifications, refer to *Appendix A: Specifications.*

2.4 How to Set the Model

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

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

NOTE

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

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

The Manipulator model can be set from software.
Refer to the chapter *Robot Configuration* in the *Epson RC+ User's Guide*.

3. Environments and Installation

Designing and installation of the Manipulators and robotic equipment shall be performed by personnel who has taken robot system training held by us and suppliers and should conform to all national and local codes.

3.1 Environmental Conditions

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

Item	Conditions
Ambient temperature *	5 to 40°C
Ambient relative humidity	10 to 80% (no condensation)
Fast transient burst noise	1 kV or less (Signal wire)
Electrostatic noise	4 kV or less
Altitude	1000 m or lower
Environment	- Install indoors. - Keep away from direct sunlight. - Keep away from dust, oily smoke, salinity, metal powder or other contaminants - Keep away from flammable or corrosive solvents and gases - Keep away from water and oil. - Keep away from shocks or vibrations. - Keep away from sources of electric noise. - Keep away from explosive area - Keep away from a large quantity of radiation

NOTE

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

* The ambient temperature conditions are for the Manipulators only. For the Controller the Manipulators are connected to, refer to the Controller manual.
When the product is used in a low temperature environment around the minimum temperature of the product specification, or when the product is suspended for a long time on holidays or at night, a collision detection error may occur due to the large resistance of the drive unit immediately after the start of operation. In such a case, it is recommended to warm up for about 10 minutes.

Special Environmental Conditions

The surface of the Manipulator has general oil resistance. However, if your requirements specify that the Manipulator must withstand certain kinds of oil, please contact the supplier of your region.

Rapid change in temperature and humidity can cause condensation inside the Manipulator.

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

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

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

 CAUTION	■ When cleaning the Manipulator, do not rub it strongly with alcohol or benzene. It may lose luster on the coated face.

3.2 Base Table

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

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

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

	LS3-B	LS6-B
Max. reaction torque on the horizontal plate	250 N·m	350 N·m
Max. horizontal reaction force	1000 N	1700 N
Max. vertical reaction force	1000 N	1500 N

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

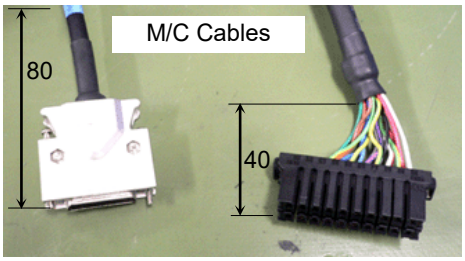
The plate for the Manipulator mounting face should be 20 mm thick or more and made of steel to reduce vibration. The surface roughness of the steel plate should be 25 µm or less.

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

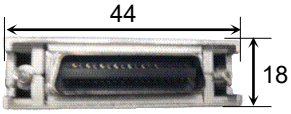
The Manipulator installation surface should have a flatness of 0.5 mm or less and an inclination of 0.5 ° or less. If the flatness of the installation surface is improper, the base may be damaged, or the robot may not fully show its performance.

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

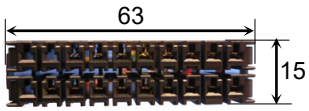
If you are passing cables through the holes on the base table, see the figures below.



(Unit : mm)



Signal Cable Connector



Power Cable Connector

NOTE

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

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

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

3.3 Mounting Dimensions

The maximum space (R) includes the radius of the end effector. If it exceeds 60 mm, define the radius as the distance to the outer edge of maximum space.
If a camera or solenoid valve extends outside of the arm, set the maximum range including the space that they may reach.

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

Space for teaching

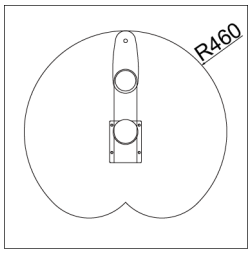
Space for maintenance and inspection
(Ensure a space to open the covers and plates for maintenance.)

Space for cables

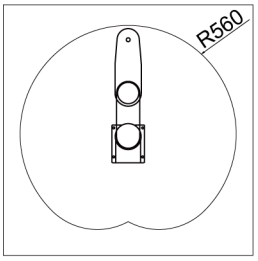
NOTE

When installing the cable, be sure to maintain sufficient distance from obstacles.
For the minimum bend radius of the MC cable, refer to "Appendix A: LS3-B Specifications" and "Appendix A: LS6-B Specifications".
In addition, leave enough space for other cables so that they are not bent forcibly.

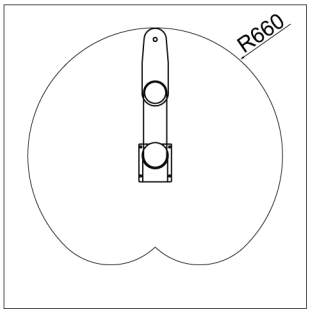
Ensure distance to the safeguard from the maximum motion range is more than 100 mm.



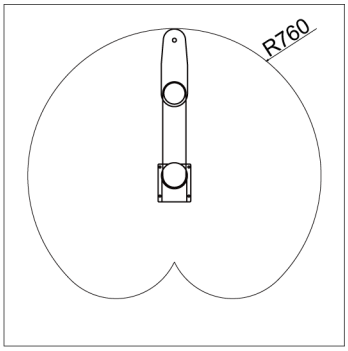
LS3-B401*



LS6-B502*



LS6-B602*



LS6-B702*

3.4 Unpacking and Transportation

Transportation and installation of the Manipulators and robotic equipment shall be performed by personnel who has taken robot system training held by us and suppliers and should conform to all national and local codes.

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

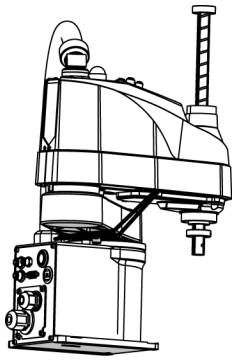
CAUTION

■ Using a cart or similar equipment, transport the Manipulator in the same manner as it was delivered.

■ After removing the bolts securing the Manipulator to the delivery equipment, the Manipulator can fall. Be careful not to get hands or fingers caught.

■ The arm is secured with a wire tie. Leave the wire tie secured until you finish the installation so as not to get hands or fingers caught.

■ To carry the Manipulator, have two or more people to work on it and secure the Manipulator to the delivery equipment or hold the areas indicated in gray in the figure (bottom of Arm #1 and bottom of the base) by hand.
When holding the bottom of the base by hand, be very careful not to get your hands or fingers caught.



LS3-B401* : approx. 14 kg : 31 lbs.
LS6-B502* : approx. 17 kg : 37.5 lbs.
LS6-B602* : approx. 17 kg : 37.5 lbs.
LS6-B602S-V1 : approx. 18 kg : 39.7 lbs.
LS6-B702* : approx. 18 kg : 39.7 lbs.

(Figure: LS6-B)

■ Stabilize the Manipulator with your hands when hoisting it.

■ When transporting the Manipulator for a long distance, secure it to the delivery equipment directly so that the Manipulator never falls.
If necessary, pack the Manipulator in the same style as it was delivered.

3.5 Installation Procedure

Installation of the Manipulators and robotic equipment shall be performed by personnel who has taken robot system training held by us and suppliers and should conform to all national and local codes.

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

3.5.1 Standard-Model

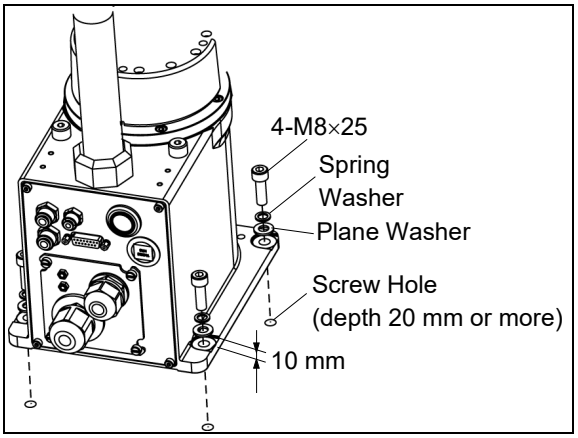
CAUTION	■ Install the Table Top Mounting Manipulator with two or more people. The Manipulator weight are as follows. Be careful not to get hands, fingers, or feet caught and/or have equipment damaged by a fall of the Manipulator. LS3-B401* : approx. 14 kg : 31 lbs. LS6-B502* : approx. 17 kg : 37.5 lbs. LS6-B602* : approx. 17 kg : 37.5 lbs. LS6-B602S-V1 : approx. 18 kg : 39.7 lbs. LS6-B702* : approx. 18 kg : 39.7 lbs.

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

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

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

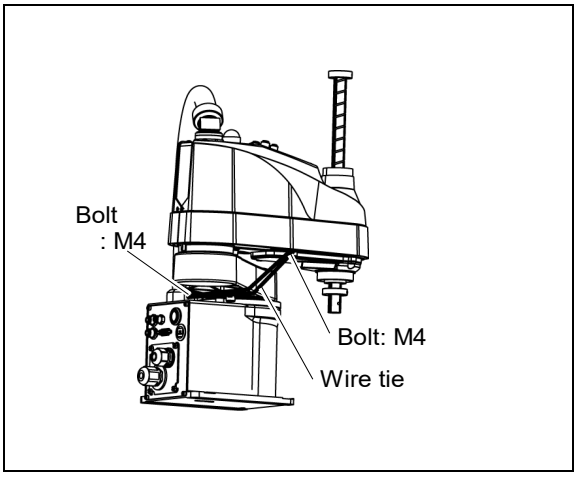
Remove the protection sheet for transportation which is attached to the arm.



(2) Using nippers, cut off the wire tie binding the shaft and arm retaining bracket on the base.

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

NOTE LS6-B series: Make sure to remove the wire tie for protection of mechanical stop.



3.5.2 Cleanroom-Model

(1) Unpack the Manipulator outside of the cleanroom.

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

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

(4) Transport the Manipulator to the clean room.

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

(6) Connect an exhaust tube to the exhaust port.

3.6 Connecting the Cables

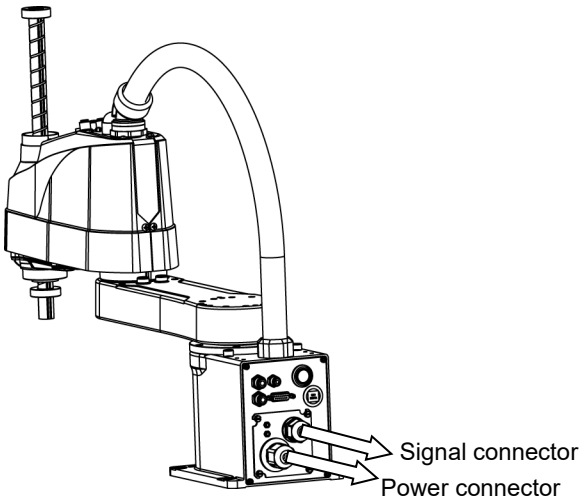
WARNING	■ To shut off power to the robot system, disconnect the power plug from the power source. Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source. ■ Before performing any replacement procedure, turn OFF the Controller and related equipment, and then disconnect the power plug from the power source. Performing any replacement procedure with the power ON is extremely hazardous and may result in electric shock and/or malfunction of the robot system. ■ Be sure to connect the cables properly. Do not allow unnecessary strain on the cables. (Do not put heavy objects on the cables. Do not bend or pull the cables forcibly.) The unnecessary strain on the cables may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system. ■ Grounding the manipulator is done by connecting with the controller. Ensure that the controller is grounded and the cables are correctly connected. If the ground wire is improperly connected to ground, it may result in the fire or electric shock.

CAUTION	■ When connecting the Manipulator to the Controller, make sure that the serial numbers on each equipment match. Improper connection between the Manipulator and Controller may not only cause improper function of the robot system but also serious safety problems. The connection method varies with the Controller used. For details on the connection, refer to the *Controller manual*.

When the Manipulator is a Cleanroom-model, be aware of the followings.
For the Manipulator of Cleanroom-model, use it with an exhaust system.
For details, refer to *Appendix A Specifications.*

Cable Connections

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



Connect and disconnect M/C cable

NOTE

In LS3-B/LS6-B series, you can connect and disconnect the M/C cable to/from the manipulator easily.

For details, refer to *LS-B series Maintenance Manual LS3-B LS6-B Manipulator 4.3 Replacing M/C Cable.*

3.7 User Wires and Pneumatic Tubes

CAUTION

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

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

Electrical Wires

Rated Voltage	Allowable Current	Wires	Nominal Sectional Area	Note
AC/DC30 V	1 A	15	0.211 mm^2	Twist pair

WARNING

- Do not apply the current more than 1A to the manipulator.

		Mfr.	Standard	
15 pin	Suitable Connector	JAE	DA-15PF-N	(Solder type)
	Clamp Hood	JAE	DA-C8-J10-F2-1R	(Connector setscrew: #4-40 NC)

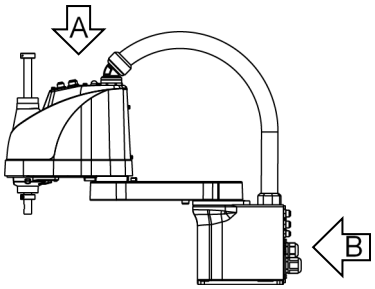
Pins with the same number, indicated on the connectors on both ends of the cables, are connected.

Pneumatic Tubes

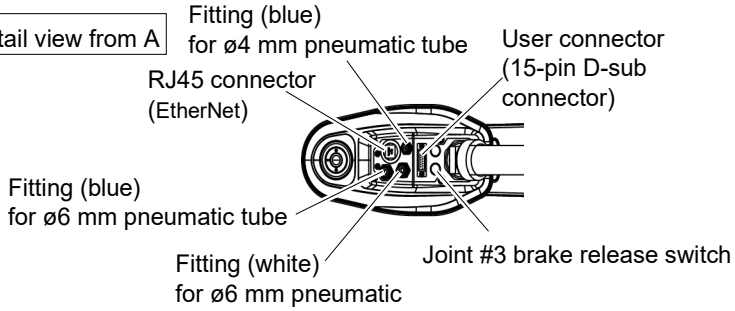
Max. Usable Pneumatic Pressure	Pneumatic Tubes	Outer Diameter × Inner Diameter
0.59 MPa (6 kgf/cm^2 : 86 psi)	2	ø 6 mm × ø 4 mm
	1	ø 4 mm × ø 2.5 mm

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

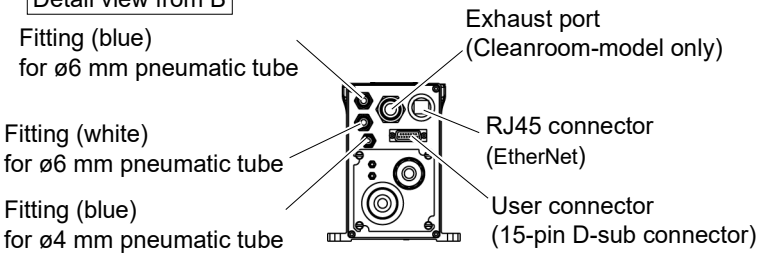
LS3-B



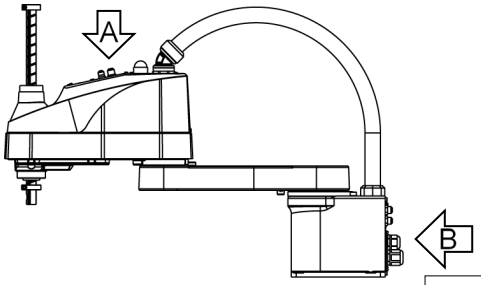
Detail view from A



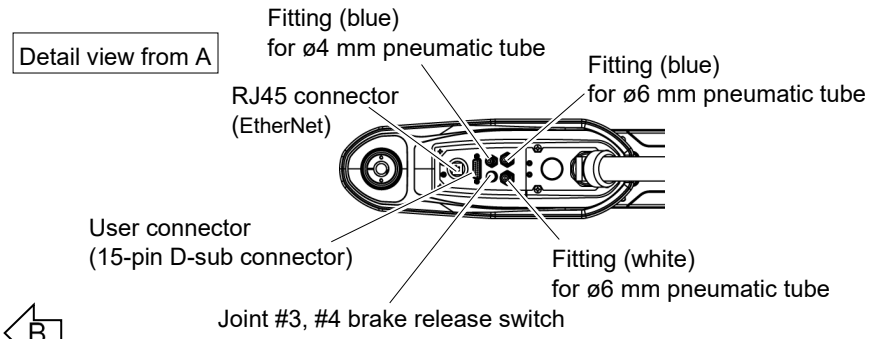
Detail view from B



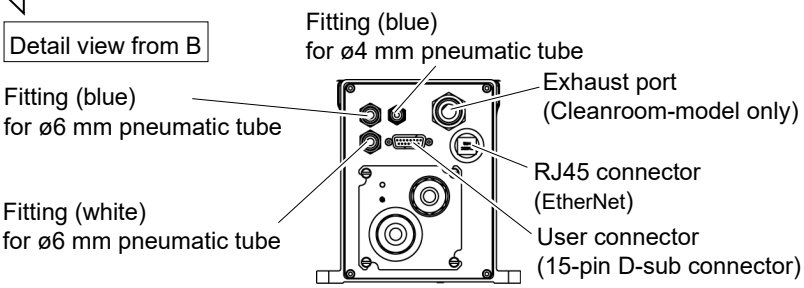
LS6-B



Detail view from A



Detail view from B

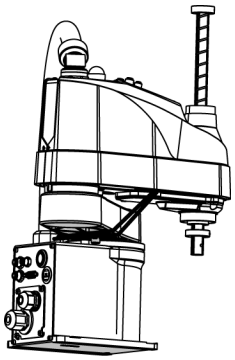


3.8 Relocation and Storage

3.8.1 Precautions for Relocation and Storage

Observe the following when relocating, storing, and transporting the Manipulators.
Transportation and installation of the Manipulators and robotic equipment shall be performed by personnel who has taken robot system training held by us and suppliers and should conform to all national and local codes.

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

CAUTION	■ Before relocating the Manipulator, fold the arm and secure it tightly with a wire tie to prevent hands or fingers from being caught in the Manipulator. ■ When removing the anchor bolts, support the Manipulator to prevent falling. Removing the anchor bolts without support may result in a fall of the Manipulator, and then get hands, fingers, or feet caught. ■ To carry the Manipulator, have two or more people to work on it and secure the Manipulator to the delivery equipment or hold the shaded area (bottom of Arm #1 and the bottom of the base) by hand. When holding the bottom of the base by hand, be very careful not to get hands or fingers caught.  LS3-B401* : approx. 14 kg : 31 lbs. LS6-B502* : approx. 17 kg : 37.5 lbs. LS6-B602* : approx. 17 kg : 37.5 lbs. LS6-B602S-V1 : approx. 18 kg : 39.7 lbs. LS6-B702* : approx. 18 kg : 39.7 lbs. (Figure: LS6-B) ■ Stabilize the Manipulator with your hands when hoisting it. Unstable hoisting is extremely hazardous and may result in fall of the Manipulator.

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

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

Transport and store the Manipulator in the range of Temperature: −20 to +60°C, Humidity: 10 to 90% (no condensation).

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

Do not shock or shake the Manipulator during transport.

3.8.2 Relocation

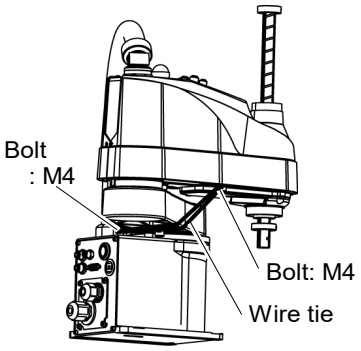
CAUTION	■ Install or relocate the Manipulator with two or more people. The Manipulator weight are as follows. Be careful not to get hands, fingers, or feet caught and/or have equipment damaged by a fall of the Manipulator. LS3-B401* : approx. 14 kg : 31 lbs. LS6-B502* : approx. 17 kg : 37.5 lbs. LS6-B602* : approx. 17 kg : 37.5 lbs. LS6-B602S-V1 : approx. 18 kg : 39.7 lbs. LS6-B702* : approx. 18 kg : 39.7 lbs.

(1) Turn OFF the power on all devices and unplug the cables.

NOTE Remove the mechanical stops if using them to limit the motion range of Joints #1 and #2. For details on the motion range, refer to *5.2 Motion Range Setting by Mechanical Stops*.

(2) Cover the arm with a sheet so that the arm will not be damaged.
Refer to the following figure and fix the arm.

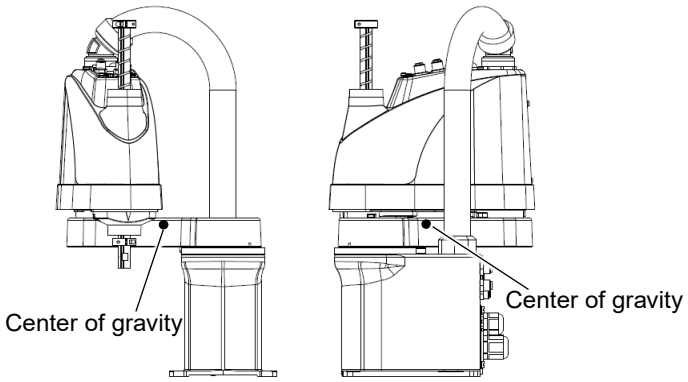
Example of Arm Fixed Posture



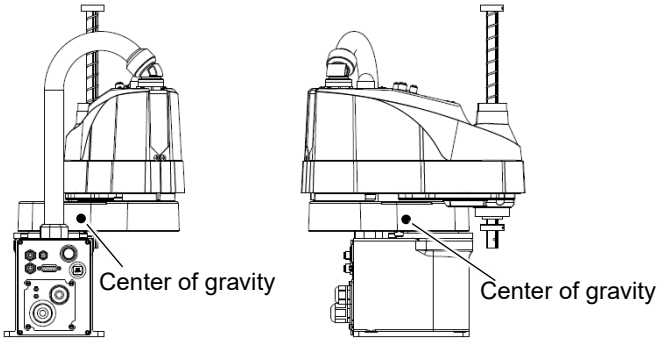
(Figure: LS6-B)

(3) Hold the bottom of Arm #1 by hand to unscrew the anchor bolts.
Then, remove the Manipulator from the base table.

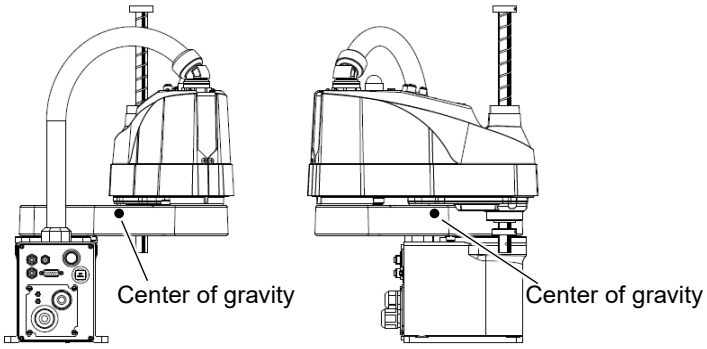
LS3-B401*



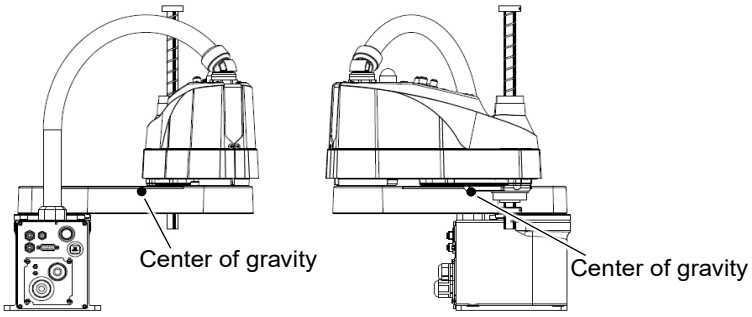
LS6-B502*



LS6-B602*



LS6-B702*



4. Setting of End Effectors

4.1 Attaching an End Effector

Users are responsible for making their own end effector(s). For details of attaching an end effector, refer to "*Hand Function Manual*"

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

Shaft

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

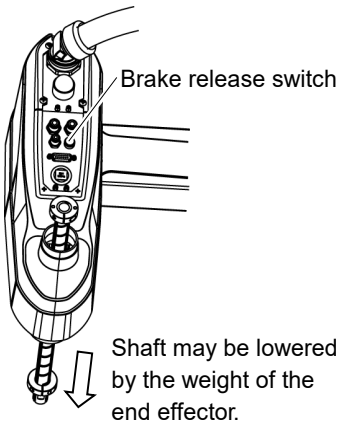
Brake release switch: LS3-B

- Joint #3 cannot be moved up/down by hand because the electromagnetic brake is applied to the joint while power to the robot system is turned OFF.
  This prevents the shaft from colliding with peripheral equipment in the case that the shaft is lowered by the weight of the end effector when the power is disconnected during operation, or when the motor is turned OFF even though the power is turned ON.
  To move Joint #3 up/down while attaching an end effector, turn ON the Controller and move the joint up/down while pressing the brake release switch.

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

Brake release switch: LS6-B

- Joint #3 and #4 cannot be moved up/down and rotated by hand because the electromagnetic brake is applied to the joint while power to the robot system is turned OFF.
  This prevents the shaft from colliding with peripheral equipment in the case that the shaft is lowered by the weight of the end effector when the power is disconnected during operation, or when the motor is turned OFF even though the power is turned ON.
  To move Joint #3 up/down or rotate Joint #4 while attaching an end effector, turn ON the Controller and move the joint up/down or rotate the joint while pressing the brake release switch.
  This button switch is a momentary-type; the brake is released only while the button switch is being pressed



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

Layouts

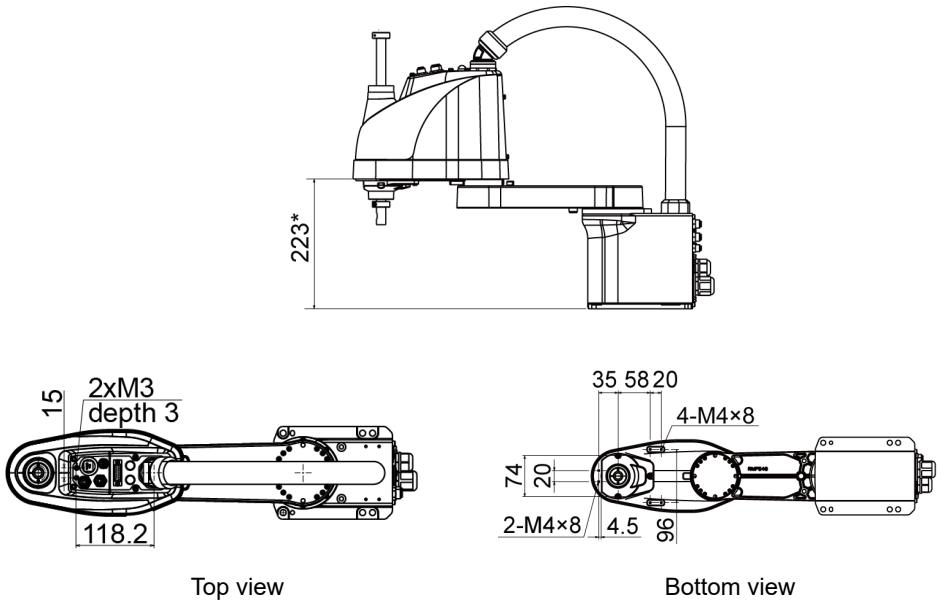
- When you operate the manipulator with an end effector, the end effector may interfere with the Manipulator because of the outer diameter of the end effector, the size of the work piece, or the position of the arms. When designing your system layout, pay attention to the interference area of the end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

4.2 Attaching Cameras and Valves

The Arm #2 has threaded holes as shown in the figure below.
Use M3 screw holes on the top for attaching Ethernet cables, and other equipment.
Use M4 screw holes on the bottom for attaching cameras, valves, and other equipment.

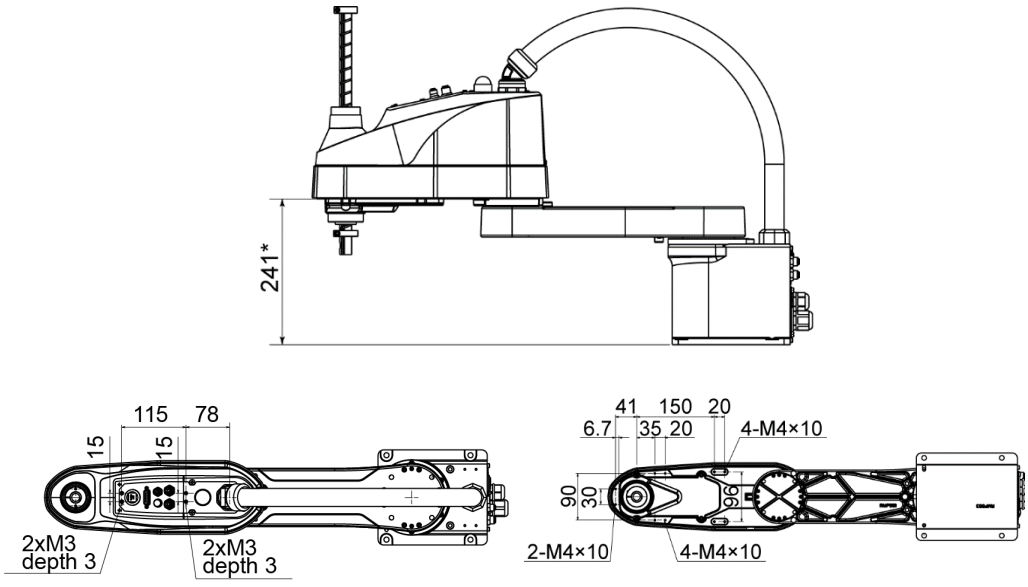
[Unit: mm]

LS3-B



Top view Bottom view

LS6-B



Top view Bottom view

*: From base installation surface

4.3 Weight and Inertia Settings

To ensure optimum Manipulator performance, it is important to make sure that the load (weight of the end effector and work piece) and moment of inertia of the load are within the maximum rating for the Manipulator, and that Joint #4 does not become eccentric.
If the load or moment of inertia exceeds the rating or if the load becomes eccentric, follow the steps below, "*4.3.1Weight Setting"* and "*4.3.2 Inertia Setting"* to set parameters.
Setting parameters makes the PTP motion of the Manipulator optimal, reduces vibration to shorten the operating time, and improves the capacity for larger loads. In addition, it reduces persistent vibration produced when the moment of inertia of the end effector and work piece is larger than the default setting.
You can also set by following "Weight, Inertia, and Eccentricity/offset Measurement Utility". The following manual describes the details.

Epson RC+ User's Guide
6.18.12 Weight, Inertia, and Eccentricity/offset Measurement Utility

4.3.1 Weight Setting

CAUTION	■ The total weight of the end effector and the workpiece must not exceed LS3-B: 3kg, LS6-B: 6 kg. The LS-B series Manipulators are not designed to work with loads exceeding LS3-B: 3kg, LS6-B: 6 kg. Always set the Weight parameters according to the load. Setting a value that is smaller than the actual load may cause errors, excessive shock and insufficient function of the Manipulator. Also, the life cycle of parts will shorten and belt tooth jumping will occur which will lead to potion shift.

The acceptable weight capacity (end effector and workpiece) in LS-B series is

LS3-B: Default rating: 1 kg Maximum: 3 kg
LS6-B: Default rating: 2 kg Maximum: 6 kg

Depends to the load (weight of the end effector and work piece), change the setting of Weight parameter.
After the setting is changed, the maximum acceleration/deceleration speed of the robot system at PTP motion corresponding to the "Weight Parameter" is set automatically.

Load on the Shaft

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

Epson RC+

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

Load on the Arm

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

Equivalent Weight Formula

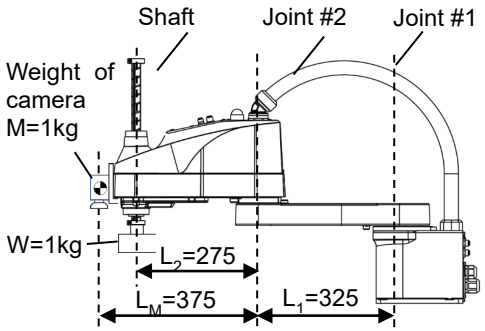
$$W_M = M \times (L_M + L_1)^2 / (L_1 + L_2)^2$$

- 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 [Weight] parameter when a “1 kg” camera is attached to the end of the LS6-B series arm (375 mm away from the rotation center of Joint #2) with a load weight of “1 kg”.

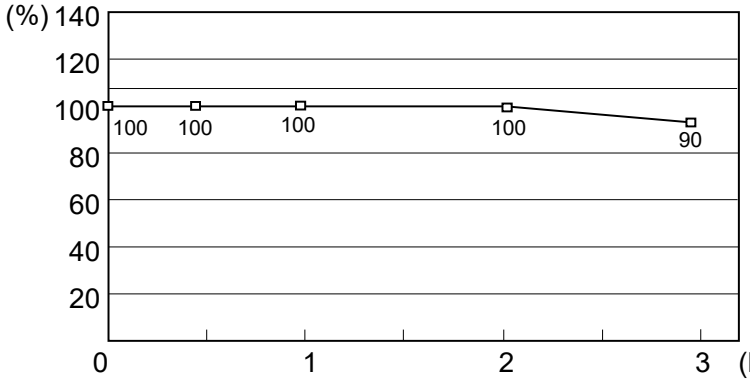
$W=1$
$M=1$
$L_1=325$
$L_2=275$
$L_M=375$
$W_M=1\times(375+325)^2/(325+275)^2=1.36$ (round up)
$W+W_M=1+1.36=2.36$

Enter “2.36” for the Weight Parameter.



Automatic speed setting by Weight

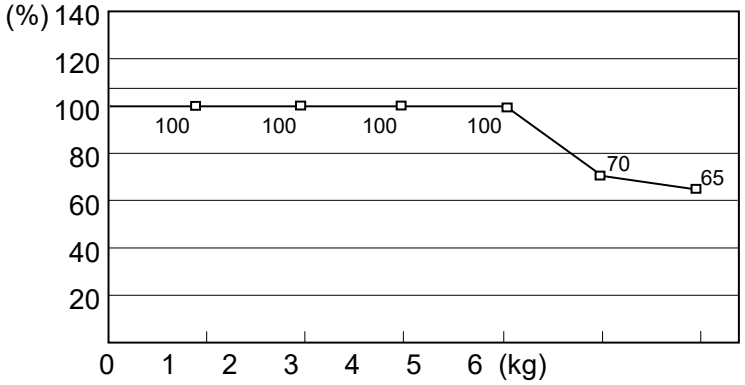
LS3-B



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

End effector weight (kg)	Automatic speed setting by Weight (%)
0	100
0.5	100
1	100
2	100
3	90

LS6-B

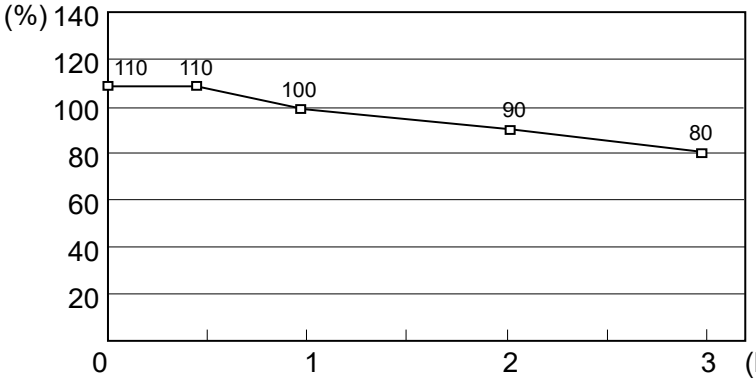


* The percentage in the graph is based on the speed at rated weight (2 kg) as

End effector weight (kg)	Automatic speed setting by Weight (%)
0	100
2	100
3	100
4	100
5	70
6	65

Automatic acceleration/deceleration setting by Weight

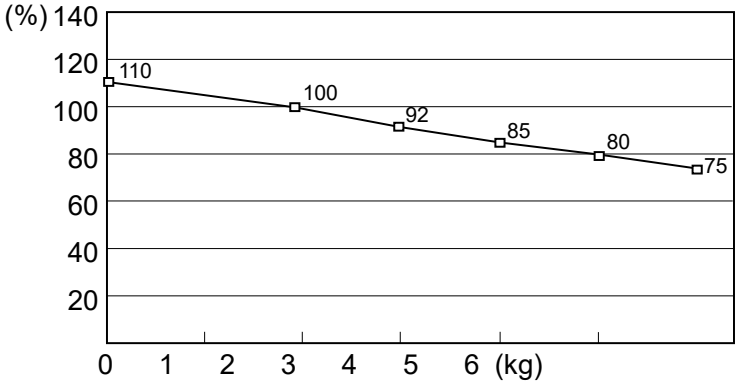
LS3-B



* The percentage in the graph is based on the acceleration/ deceleration at rated weight

End effector weight (kg)	Automatic acceleration/deceleration setting by Weight (%)
0	110
0.5	110
1	100
2	90
3	80

LS6-B



* The percentage in the graph is based on the acceleration/ deceleration at rated weight (2 kg) as 100%.

End effector weight (kg)	Automatic acceleration/deceleration setting by Weight (%)
0	110
2	100
3	92
4	85
5	80
6	75

4.3.2 Inertia Setting

Moment of Inertia and the Inertia Setting

The moment of inertia is defined as “the ratio of the torque applied to a rigid body and its resistance to motion”. This value is typically referred to as “the moment of inertia”, “inertia”, or “GD^2”. When the Manipulator operates with additional objects (such as an end effector) attached to the shaft, the moment of inertia of load must be considered.

CAUTION	■ The moment of inertia of the load (weight of the end effector and workpiece) must be LS3-B: 0.05 kg·m^2, LS6-B: 0.12 kg·m^2 or less. The LS-B series Manipulators are not designed to work with a moment of inertia exceeding LS3-B: 0.05 kg·m^2, LS6-B: 0.12 kg·m^2. Always set the Weight parameters according to the load. Setting a value that is smaller than the actual load may cause errors, excessive shock and insufficient function of the Manipulator. Also, the life cycle of parts is shortened and positional gap due to belt tooth bumping occurs.

The acceptable moment of inertia of load for a LS-B series Manipulator is

LS3-B: Default rating: 0.005 kg·m^2 Maximum: 0.05 kg·m^2

LS6-B: Default rating: 0.01 kg·m^2 Maximum: 0.12 kg·m^2

Depends to the moment of inertia of the load, change the setting for the moment of inertia of the load of the Inertia command. After the setting is changed, the maximum acceleration/deceleration speed of Joint #4 at PTP motion corresponding to the “moment of inertia” value is set automatically.

Moment of inertia of load on the shaft

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

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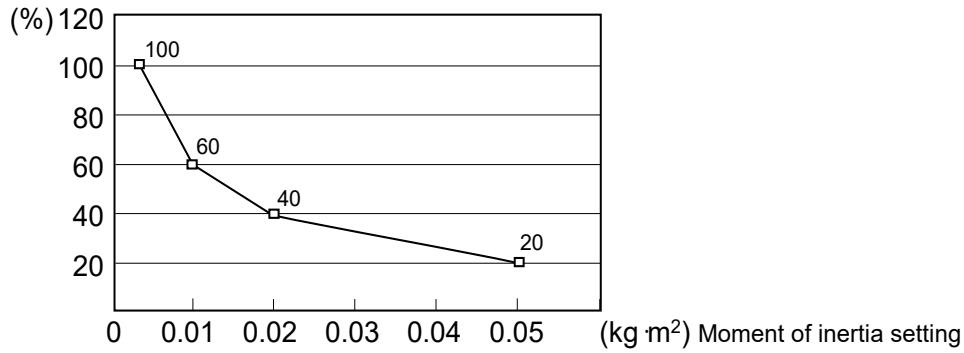
Enter a value into the [Load inertia:] text box on the [Inertia] panel ([Tools]-[Robot Manager]). (You may also execute the Inertia command from the [Command Window].)

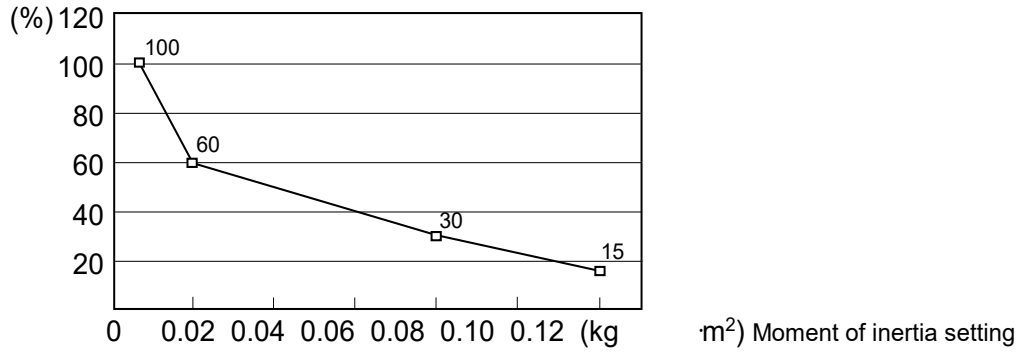
Automatic acceleration/deceleration setting of Joint #4 by Inertia (moment of inertia)

LS3-B



Moment of inertia setting (kg·m^2)	Automatic acceleration/deceleration setting of Joint #4 by Inertia (moment of inertia) (%)
0.005	100
0.01	60
0.02	40
0.05	20

LS6-B



Moment of inertia setting (kg·m^2)	Automatic acceleration/deceleration setting of Joint #4 by Inertia (moment of inertia) (%)
0.01	100
0.02	60
0.08	30
0.12	15

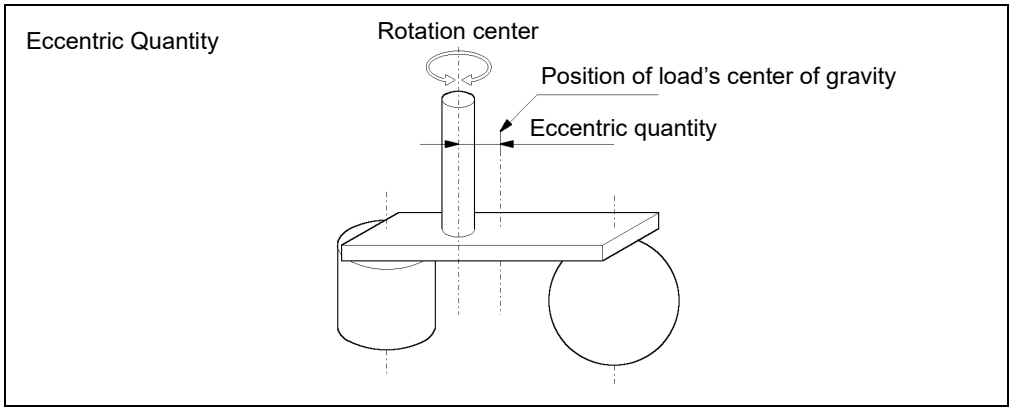
Eccentric Quantity and the Inertia Setting

CAUTION	■ The eccentric quantity of load (weight of the end effector and workpiece) must be LS3-B: 100mm, LS6-B: 150 mm or less. The LS-B series Manipulators are not designed to work with eccentric quantity exceeding LS3-B: 100mm, LS6-B: 150 mm. Always set the Weight parameters according to the load. Setting a value that is smaller than the actual load may cause errors, excessive shock and insufficient function of the Manipulator. Also, the life cycle of parts is shortened and positional gap due to belt tooth bumping occurs.

The acceptable eccentric quantity of load in LS-B series Manipulator:

LS3-B: default rating: 0 mm, maximum: 100 mm
LS6-B: default rating: 0 mm, maximum: 150 mm

Depends to the eccentric quantity of load, change the setting of eccentric quantity parameter of Inertia command. After the setting is changed, the maximum acceleration/deceleration speed of the Manipulator at PTP motion corresponding to the “eccentric quantity” is set automatically.



Eccentric quantity of load on the shaft

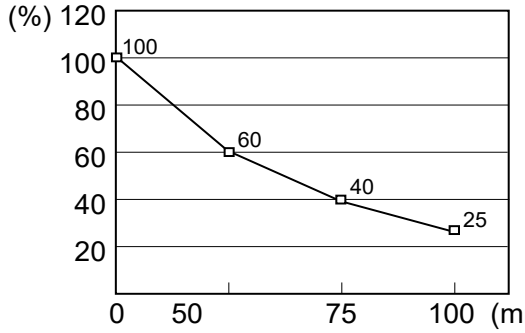
The eccentric quantity of load (weight of the end effector and work piece) on the shaft can be set by “eccentric quantity” parameter of Inertia command.

Epson RC+

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

Automatic acceleration/deceleration setting by Inertia (eccentric quantity)

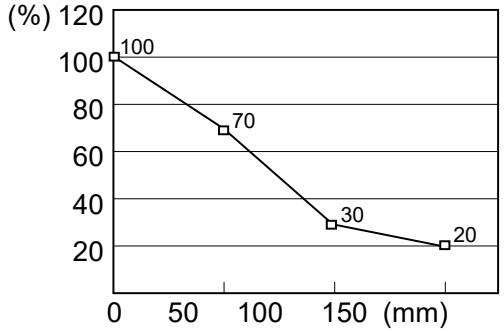
LS3-B



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

Eccentric quantity parameter (mm)	Automatic acceleration/deceleration setting by Inertia (eccentric quantity) (%)
0	100
50	60
75	40
100	25

LS6-B

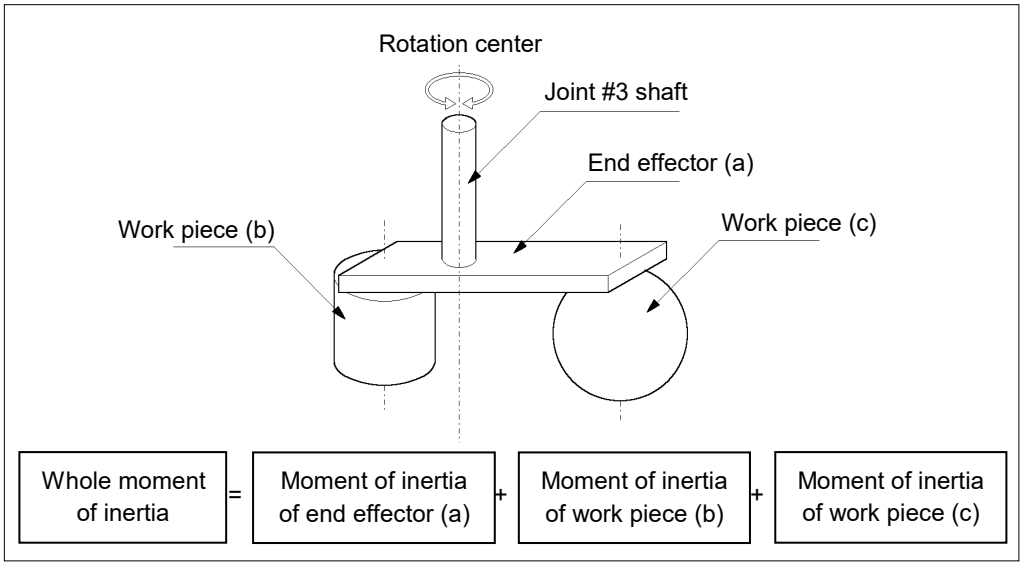


* The percentage in the graph is based on the acceleration / deceleration at rated eccentricity (0 mm) as 100%.

Eccentric quantity parameter (mm)	Automatic acceleration/deceleration setting by Inertia (eccentric quantity) (%)
0	100
50	70
100	30
150	20

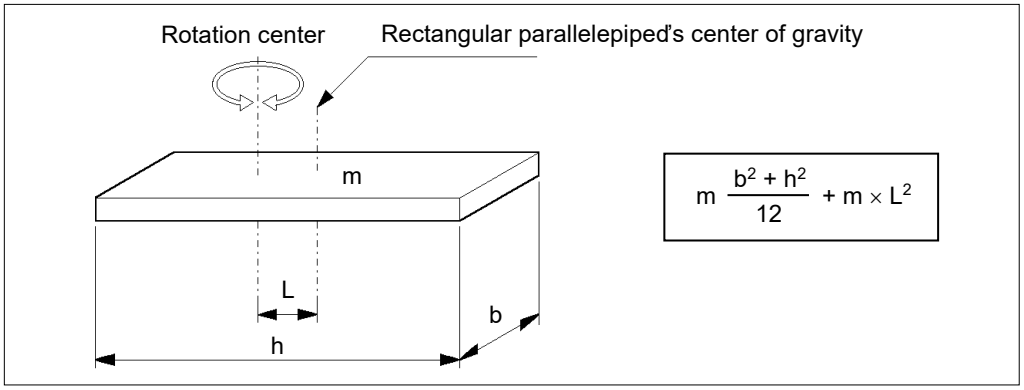
Calculating the Moment of Inertia

Refer to the following examples of formulas to calculate the moment of inertia of load (end effector with work piece). The moment of inertia of the entire load is calculated by the sum of each part (a), (b), and (c).

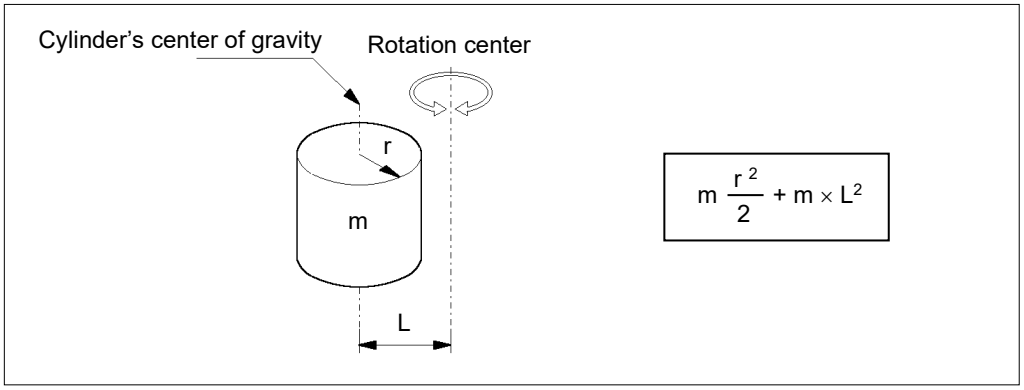


The methods for calculating the moment of inertia for (a), (b), and (c) are shown below. Calculate the total moment of inertia using the basic formulas.

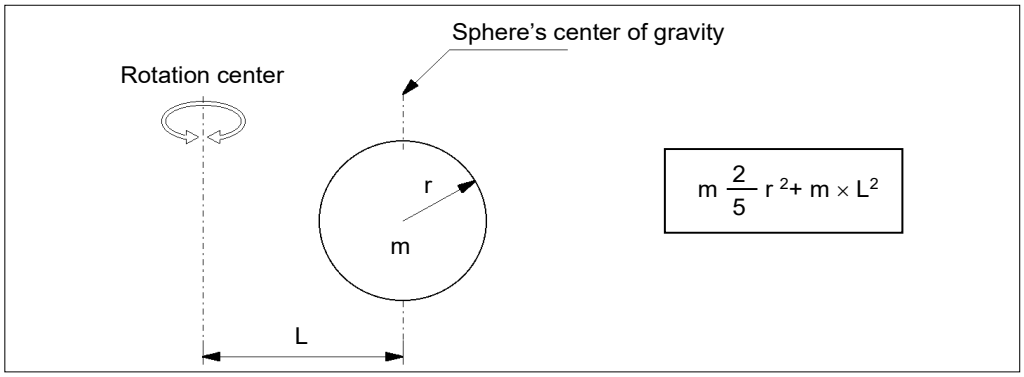
(a) Moment of inertia of a rectangular parallelepiped



(b) Moment of inertia of a cylinder



(c) Moment of inertia of a sphere



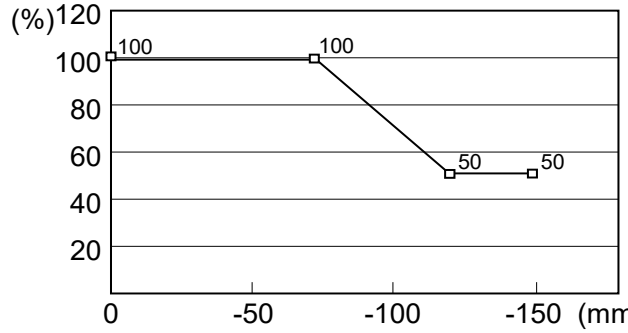
4.4 Precautions for Auto Acceleration/Deceleration of Joint #3

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

When Joint #3 gets below a certain point, then auto acceleration/deceleration is used to reduce acceleration/deceleration. (Refer to the figures below) The higher the position of the shaft is, the faster the motion acceleration/deceleration is. However, it takes more time to move Joint #3 up and down. Adjust the position of Joint #3 for the Manipulator motion after considering the relation between the current position and the destination position. The upper limit of Joint #3 during horizontal motion using Jump command can be set by the LimZ command.

Automatic acceleration/deceleration vs. Joint #3 position

LS3-B



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

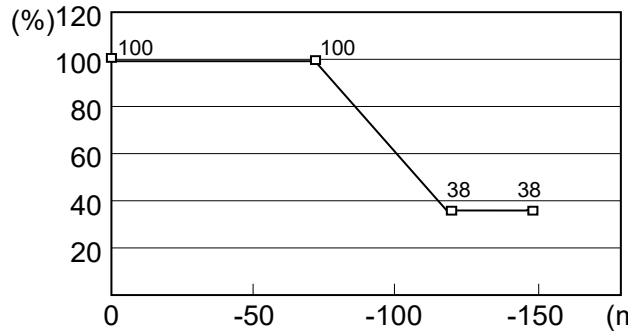
(LS3-B401C: Similarly changes until the shaft height -120mm)

NOTE

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

Shaft height (mm)	Acceleration/Deceleration
0	100
–75	100
–120	50
–150	50

LS3-B401S-V1



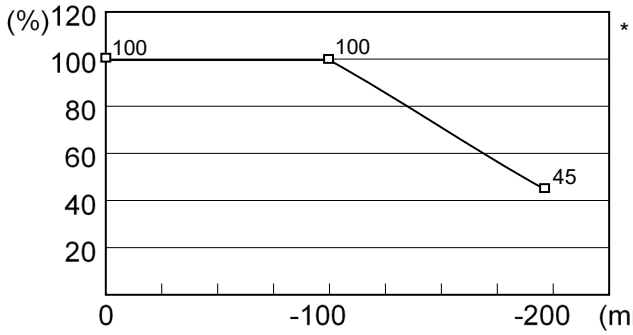
* Figures on the graph (%) are the proportion to the acceleration/deceleration speed at the shaft upper limit position.

NOTE

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

Shaft height (mm)	Acceleration/Deceleration
0	100
–75	100
–120	38
–150	38

LS6-B



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

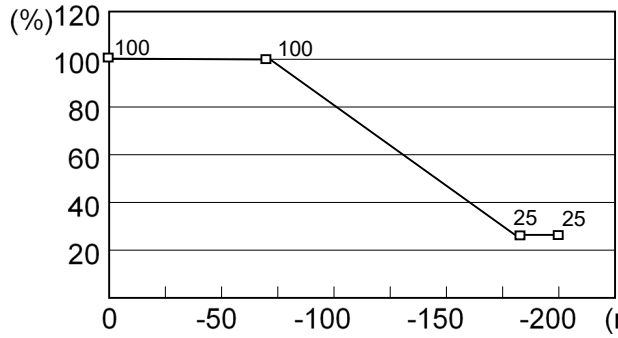
(LS6-B*02C: Similarly changes until the shaft height -170mm.)

NOTE

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

Shaft height (mm)	Acceleration/Deceleration
0	100
−100	100
−200	45

LS6-B602S-V1



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

NOTE

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

Shaft height (mm)	Acceleration/Deceleration
0	100
−70	100
−180	25
−200	25

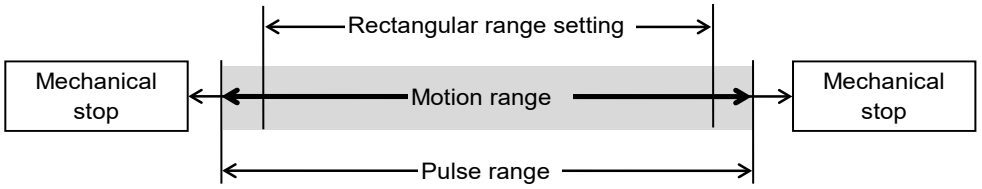
5. Motion Range

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

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

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

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



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

5.1 Motion Range Setting by Pulse Range

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

For the maximum pulse range, refer to the following sections.
The pulse range must be set inside of the mechanical stop range.

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

NOTE

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

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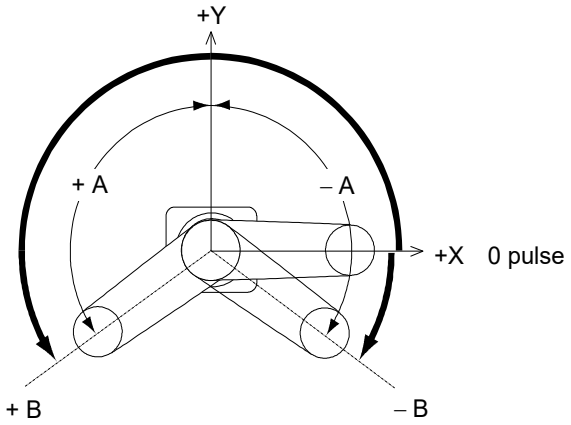
The pulse range can be set on the [Range] panel shown by selecting [Tools]-[Robot Manager]. (You may also execute the Range command from the [Command Window].)

5.1.1 Max. Pulse Range of Joint #1

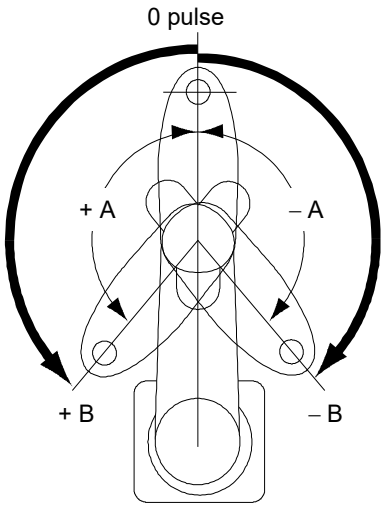
The 0 (zero) pulse position of Joint #1 is the position where Arm #1 faces toward the positive (+) direction on the X-coordinate axis.
When the 0 pulse is a starting point, the counterclockwise pulse value is defined as the positive (+) and the clockwise pulse value is defined as the negative (−).



	A: Max. Motion Range	B: Max. Pulse Range
LS3-B	± 132°	− 95574 ~ 505174 pulse
LS3-B401S-V1		− 152917 ~ 808278 pulse
LS6-B		− 152918 ~ 808278 pulse

5.1.2 Max. Pulse Range of Joint #2

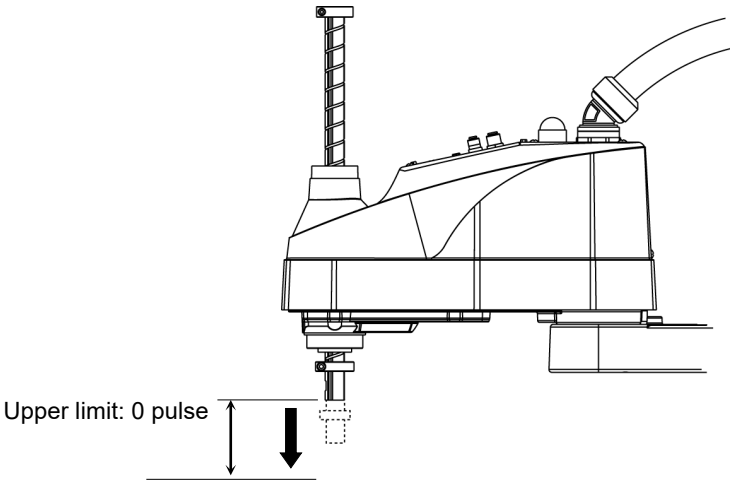
The 0 (zero) pulse position of Joint #2 is the position where Arm #2 is in-line with Arm #1.
With the 0 pulse as a starting point, the counterclockwise pulse value is defined as the positive (+) and the clockwise pulse value is defined as the negative (−).



	A: Max. Motion Range	B: Max. Pulse Range
LS3-B	± 141°	± 320854 pulse
LS6-B	± 150°	± 341334 pulse

5.1.3 Max. Pulse Range of Joint #3

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



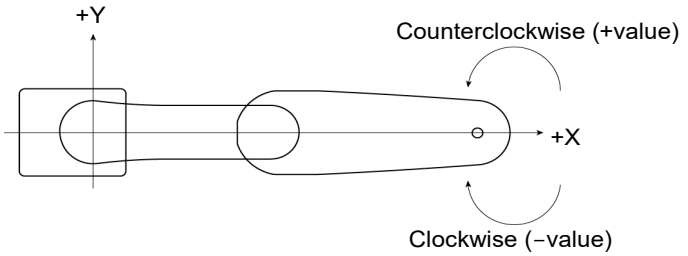
	Joint #3 Stroke	Lower Limit Pulse
LS3-B401S (Standard-model)	150 mm	−187734 pulse
LS3-B401C (Cleanroom-model)	120 mm	−150187 pulse
LS6-B*02S (Standard-model)	200 mm	– 245760 pulse
LS6-B*02C (Cleanroom-model)	170 mm	– 208896 pulse

NOTE

For the Cleanroom-model, the motion range set with the Joint #3 mechanical stop cannot be changed.

5.1.4 Max. Pulse Range of Joint #4

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



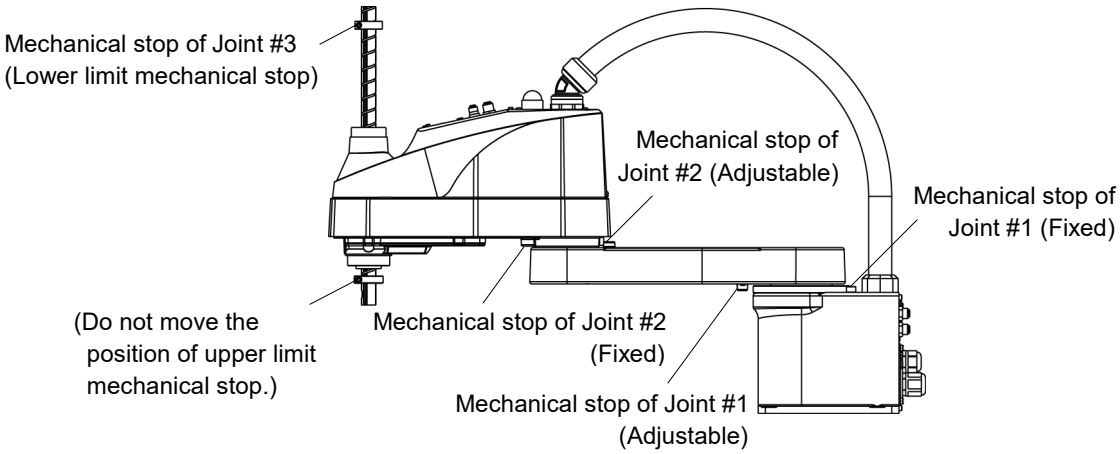
	A: Max. Motion Range	B: Max. Pulse Range
LS3-B	± 360°	0 ± 186778 pulse
LS6-B		0 ± 245760 pulse

5.2 Motion Range Setting by Mechanical Stops

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

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

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

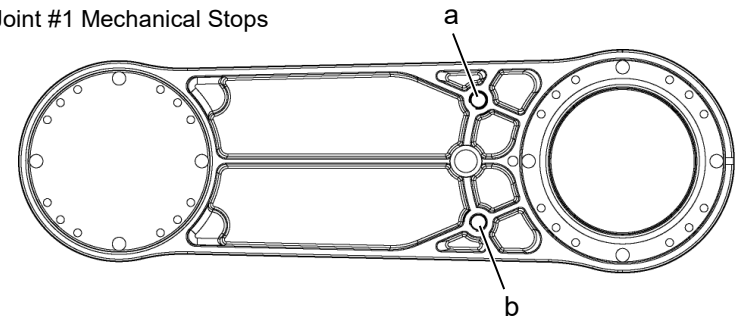


5.2.1 Setting the Mechanical Stops of Joints #1 and #2

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

Install the bolts for the mechanical stop to the following position.

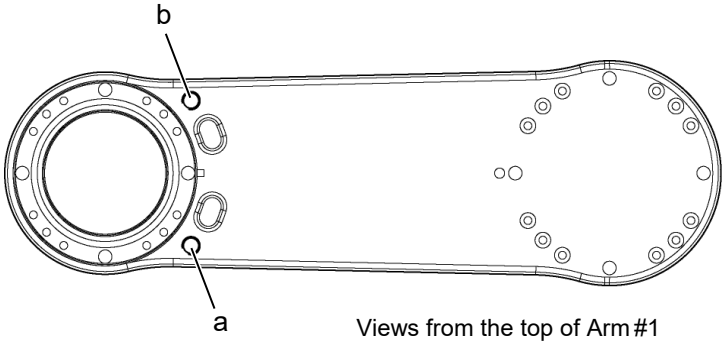
Joint #1 Mechanical Stops



Views from the bottom of Arm #1

		a	b
LS3-B	Setting Angle (°)	110	–110
	Pulse Value (pulse)	455111	□45511
LS3-B401S-V1	Setting Angle (°)	110	–110
	Pulse Value (pulse)	728177	–72818
LS6-B	Setting Angle (°)	115	–115
	Pulse Value (pulse)	746382	–91022

Joint #2 Mechanical Stops



Views from the top of Arm #1

		a	b
LS3-B LS6-B	Setting Angle (°)	125	–125
	Pulse Value (pulse)	284444	–284444

(1) Turn OFF the Controller.

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

Joint	Hexagon socket head cap bolt (fully threaded)	The number of bolts	Recommended tightening torque	Strength
1	M8 × 10	1 bolt / side	12.3 N·m (125 kgf·cm)	ISO898-1 property class 10.9 or 12.9.

(3) Turn ON the Controller.

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

NOTE

Be sure to set the pulse range inside the positions of the mechanical stop range.

Example: LS6-B602S
The angle of Joint #1 is set from −110° to +110°.
The angle of Joint #2 is set from −110° to +110°.

Epson RC+

Execute the following commands from the [Command Window].

```
>JRANGE 1, -72817, 728177     ' Sets the pulse range of Joint #1
>JRANGE 2,-250311, 250311     ' Sets the pulse range of Joint #2
>RANGE                        ' Checks the setting using Range
  -72817, 728177, -250311, 250311, −245760 ,0,
 -245760, 245760
```

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

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

Example: Using LS6-B602S
The angle of Joint #1 is set from −110° to +110°.
The angle of Joint #2 is set from −110° to +110°.

Epson RC+

Execute the following commands from the [Command Window].

```
>MOTOR ON                     'Turns ON the motor
>POWER LOW                    'Enters low-power mode
>SPEED 5                      'Sets at low speeds
>PULSE -72817,0,0,0           'Moves to the min. pulse position of Joint #1
>PULSE 72817,0,0,0            'Moves to the max. pulse position of Joint #1
>PULSE 327680,-250311,0,0     'Moves to the min. pulse position of Joint #2
>PULSE 327680, 250311,0,0     'Moves to the max. pulse position of Joint #2
```

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

In this example, Joint #1 is moved to 0° position where is close to the center of its motion range (pulse value: `327680`*) when checking Joint #2.

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

*: For LS3-B401S-V1 and LS6-B
(For LS3-B401*, pulse value: 204800)

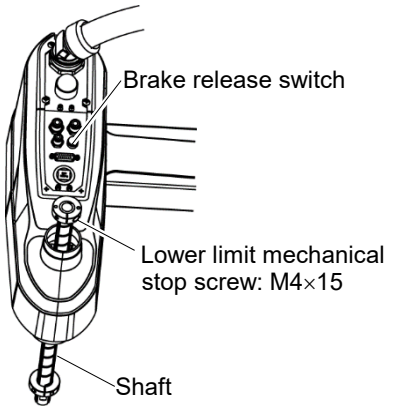
5.2.2 Setting the Mechanical Stop of Joint #3

NOTE This method applies only to the Standard-model manipulator.
For the Cleanroom-model, the motion range set with the Joint #3 mechanical stop cannot be changed.

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

(2) Push up the shaft while pressing the brake release switch.

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



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

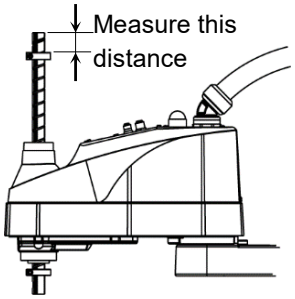
(3) Turn OFF the Controller.

(4) Loosen the lower limit mechanical stop screw (M4×15).

NOTE 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 calibration point of Joint #3 is specified using the stop.

(5) The upper end of the shaft defines the maximum stroke. Move the lower limit mechanical stop down by the length you want to limit the stroke.

For example, when the lower limit mechanical stop is set at “200 mm” stroke, the lower limit Z coordinate value is “□200”. To change the value to “□180”, move the lower limit mechanical stop down “20 mm”. Use calipers to measure the distance when adjusting the mechanical stop.



(6) Firmly tighten the lower limit mechanical stop screw (M4×15).

Recommended tightening torque: 5.4N·m (55 kgf·cm)

(7) Turn ON the Controller.

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

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

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

Lower limit of pulse (pulse)

= lower limit Z coordinate value (mm) / Resolution (mm/pulse)

** For the Joint #3 resolution,
refer to the section *Appendix A: Specifications*.

Epson RC+

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

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

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

NOTE

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

Epson RC+

Execute the following commands from the [Command Window]. Enter the value calculated in Step (9) in X.

```
>MOTOR ON          ' Turns ON the motor
>SPEED 5           ' Sets 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 "0s" with the other pulse values specifying a position where there is
                     no interference even when lowering Joint #3.)
```

5.3 Setting the Cartesian (Rectangular) Range in the XY Coordinate System of the Manipulator

(for Joints #1 and #2)

Use this method to set the upper and lower limits of the X and Y coordinates.

This setting is only enforced by software. Therefore, it does not change the physical range. The maximum physical range is based on the position of the mechanical stops.

Epson RC+

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

5.4 Standard Motion Range

The following “motion range” diagrams show the standard (maximum) specification. When each Joint motor is under servo control, the center of Joint #3’s (shaft’s) lowest point moves in the areas shown in the figure.

“Area limited by mechanical stop” is the area where the center of Joint #3’s lowest point can be moved when each joint motor is not under servo control.

“Mechanical stop” sets the limited motion range so that the center of Joint #3 cannot move beyond the area mechanically.

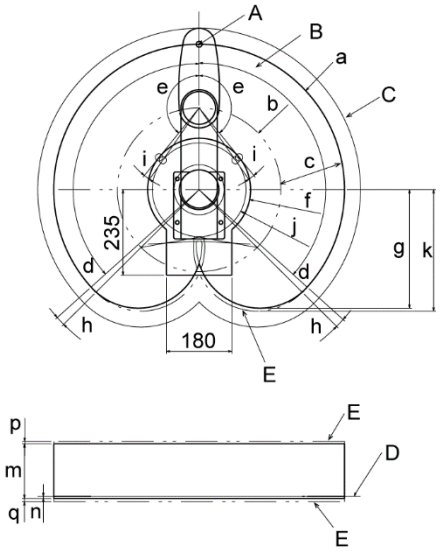
“Maximum space” is the area that contains the farthest reach of the arms. If the maximum radius of the end effector is over 60 mm, add the “Area limited by mechanical stop” and “radius of the end effector”. The total value is specified as the maximum area.

A	Center of Joint #3
B	Motion range
C	Maximum range
D	Base mounting face
E	Area limited by a mechanical stop

			LS3-B401*	LS6-B502*	LS6-B602*	LS6-B702*
a	Arm #1 + Arm #2 length [mm]		400	500	600	700
b	Arm #1 length [mm]		175	225	325	425
c	Arm #2 length [mm]		225	275		
d	Joint #1 motion angle [°]		132	132		
e	Joint #2 motion angle [°]		141	150		
f	(Motion range)		141.6	138.1	162.6	232
g	(Motion range at the rear)		325.5	425.6	492.5	559.4
h	Angle of the Joint #1 mechanical stop [°]		2.8	2.8		
i	Angle of the Joint #2 mechanical stop [°]		4.2	4.2		
j	(Mechanical stop area)		128.8	121.8	142.5	214
k	(Mechanical stop area at the rear)		333.5	433.5	504	574.5
m	(Joint #3 motion range)	Standard	150	200		
		Cleanroom	120	170		
n	(Distance from the base mounting face)	Standard	5.5	51		
		Cleanroom	9.5	53		
p	(Joint #3 mechanical stop area upper end)	Standard	6.5	10		
		Cleanroom	10.5	6		
q	(Joint #3 mechanical stop area lower end)	Standard	6.5	11.8		
		Cleanroom	10.5	9.8		

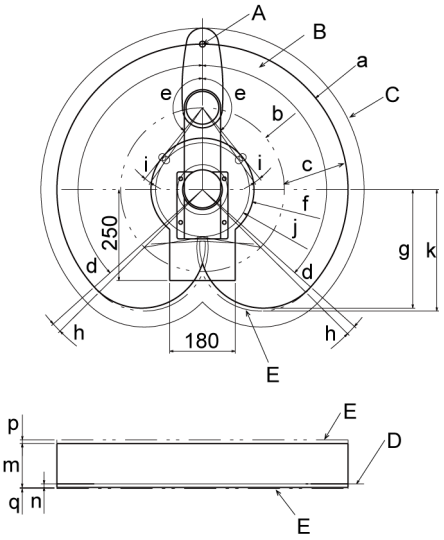
Standard Model

LS3-B401S



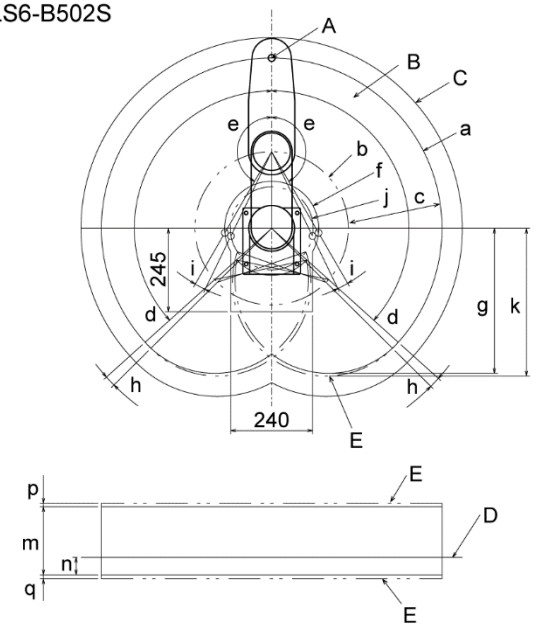
Cleanroom Model

LS3-B401C

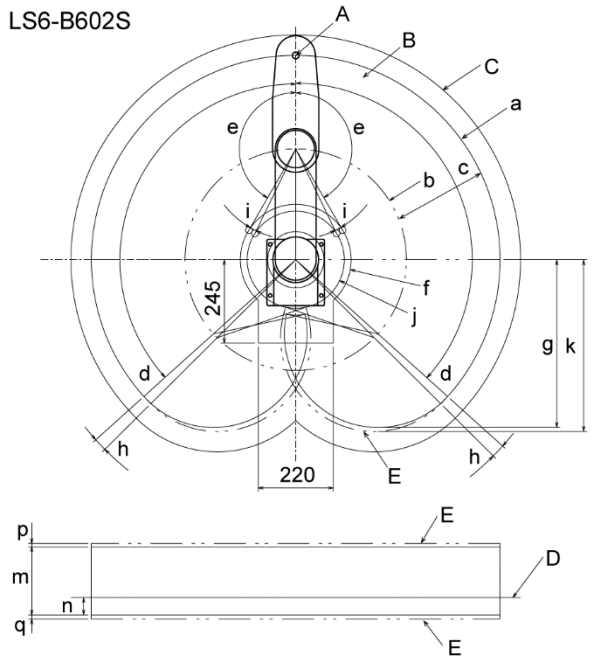


Standard Model LS6-B*02S

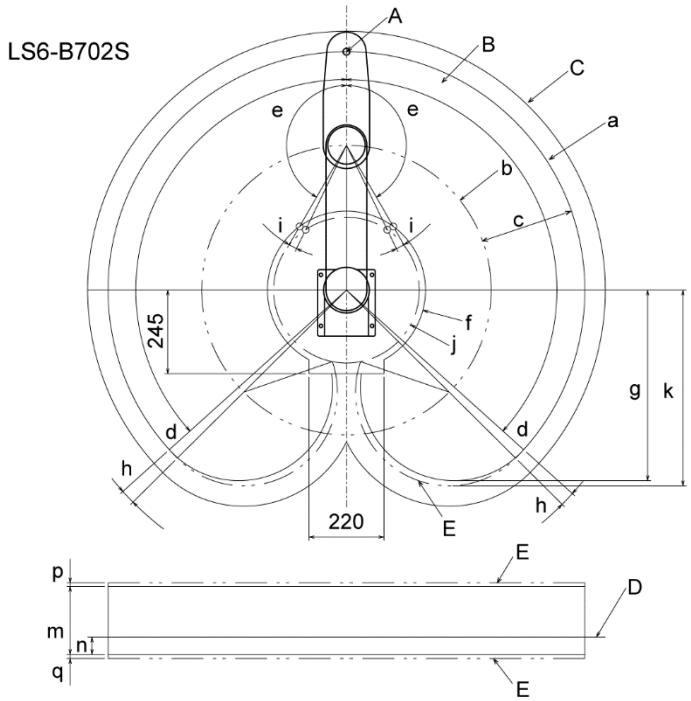
LS6-B502S



LS6-B602S

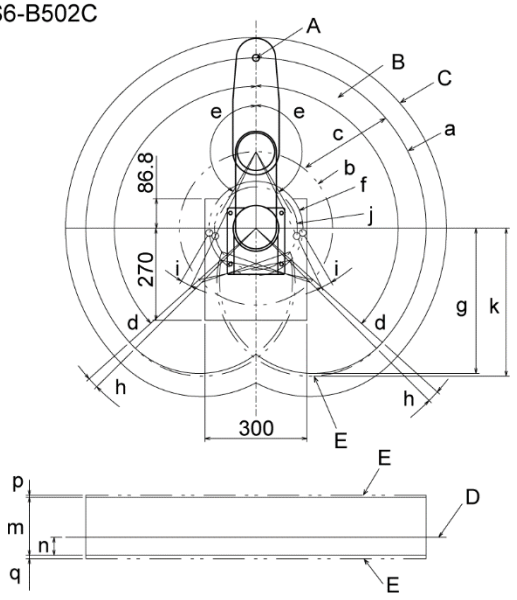


LS6-B702S

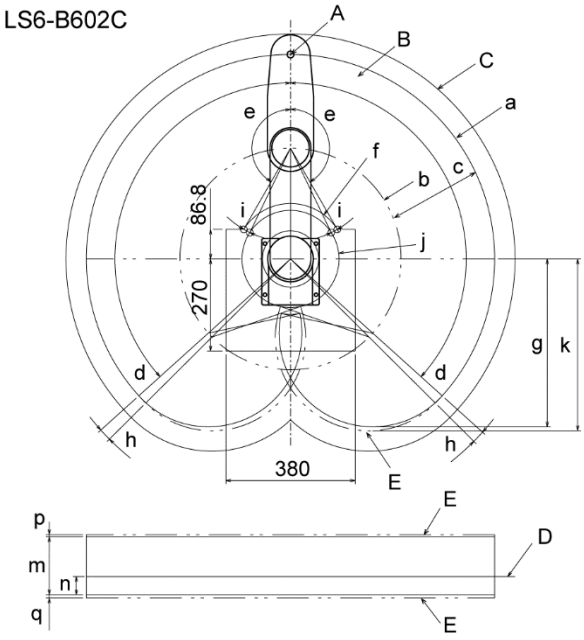


Cleanroom Model LS6-B*02C

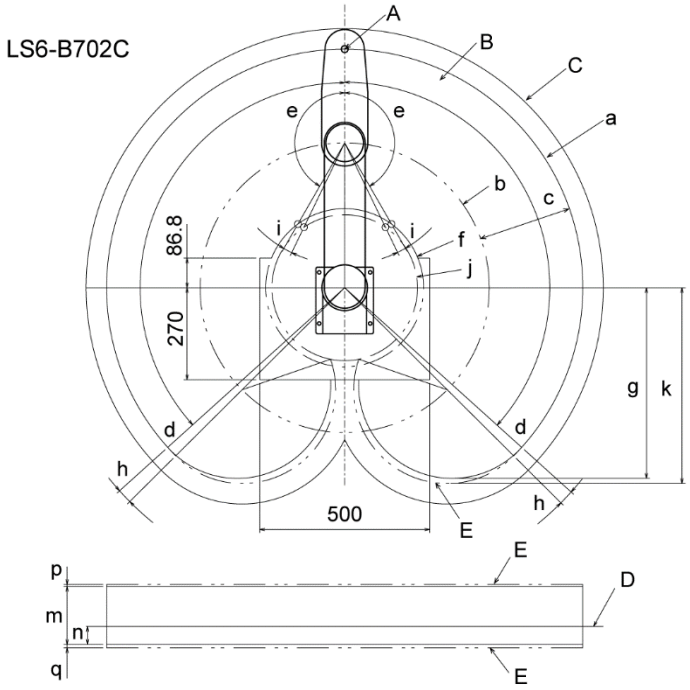
LS6-B502C



LS6-B602C



LS6-B702C



LS10-B Manipulator

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

1. Safety

Unpacking and transportation of the Manipulators and robotic equipment shall be performed by personnel who has taken robot system training held by us and suppliers and should conform to all national and local codes.
Please read this manual and other related manuals before installing the robot system or before connecting cables.
Keep this manual handy for easy access at all times.

1.1 Conventions

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

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

1.2 Design and Installation Safety

This product is intended for transporting and assembling parts in a safely isolated area.
Design and installation of robot system shall be performed by personnel who has taken robot system training held by us and suppliers.
To ensure safety, a safeguard must be installed for the robot system. For details on the safeguard, refer to the *Installation and Design Precautions* in the *Safety* chapter of the *Epson RC+ User's Guide*.

The following items are safety precautions for design personnel:

 WARNING	■ Personnel who design and/or construct the robot system with this product must read the "*Safety Manual"* to understand the safety requirements before designing and/or constructing the robot system. Designing and/or constructing the robot system without understanding the safety requirements is extremely hazardous, may result in serious bodily injury and/or severe equipment damage to the robot system, and may cause serious safety problems. ■ The Manipulator and the Controller must be used within the environmental conditions described in their respective manuals. This product has been designed and manufactured strictly for use in a normal indoor environment. Using the product in an environment that exceeds the specified environmental conditions may not only shorten the life cycle of the product but may also cause serious safety problems. ■ The robot system must be used within the installation requirements described in the manuals. Using the robot system outside of the installation requirements may not only shorten the life cycle of the product but also cause serious safety problems. ■ When designing or installing a robot system, wear at least the following protective gear. Working without protective gear may cause serious safety problems. Work clothes suitable for work Helmet Safety shoes

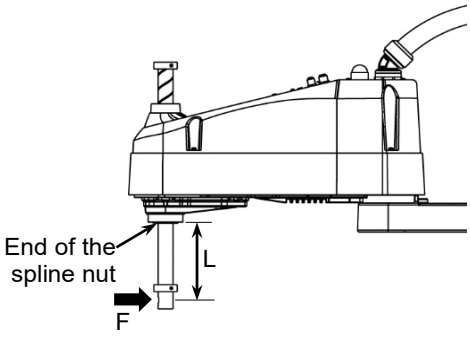
Further precautions for installation are mentioned in the chapter *3. Environments and Installation.* Please read this chapter carefully to understand safe installation procedures before installing the robots and robotic equipment.

1.2.1 Strength of the Ball Screw Spline

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

[Allowable bending moment]
M=50,000 N·mm
[Moment]
M=F·L =100·200 =20,000 N·mm

Example:
If 100 N (10.2kgf) load is applied at 200 mm from the end of the spline nut



1.3 Operation Safety

The following items are safety precautions for qualified Operator personnel:

 WARNING	■ Please carefully read the *Safety Requirements* in the "*Safety Manual"* before operating the robot system. Operating the robot system without understanding the safety requirements is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system. ■ Do not enter the operating area of the Manipulator while the power to the robot system is turned ON. Entering the operating area with the power ON is extremely hazardous and may cause serious safety problems as the Manipulator may move even if it seems to be stopped. ■ Before operating the robot system, make sure that no one is inside the safeguarded area. The robot system can be operated in the mode for teaching even when someone is inside the safeguarded area. The motion of the Manipulator is always in restricted (low speed and low power) status to secure the safety of an operator. However, operating the robot system while someone is inside the safeguarded area is extremely hazardous and may result in serious safety problems in case that the Manipulator moves unexpectedly. ■ Immediately press the Emergency Stop switch whenever the Manipulator moves abnormally while the robot system is operated. Continuing the operation while the Manipulator moves abnormally is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system.

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

CAUTION	■ Whenever possible, only one person should operate the robot system. If it is necessary to operate the robot system with more than one person, ensure that all people involved communicate with each other as to what they are doing and take all necessary safety precautions. ■ Joint #1, #2, and #4: If the joints are operated repeatedly with the operating angle less than 5 degrees, they may get damaged early because the bearings are likely to cause oil film shortage in such situation. To prevent early breakdown, move each joint larger than 50 degrees for about once an hour. Joint #3: If the up-and-down motion of the hand is less than LS10-B: 50 mm, move the joint a half of the maximum stroke for about once an hour. ■ Oscillation (resonance) may occur continuously in low speed Manipulator motion (Speed: approx. 5 to 20%) depending on combination of Arm orientation and end effector load. Oscillation arises from natural oscillation frequency of the Arm and can be controlled by following measures. Changing Manipulator speed Changing the teach points Changing the end effector load

1.4 Emergency Stop

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

Avoid pressing the Emergency Stop switch unnecessarily while the Manipulator is running normally.

- The Manipulator may hit the peripheral equipment.
  When you press the Emergency Stop switch, the operating trajectory until the robot system stops is different from that in normal operation.
- The life of the brakes will be shortened.
  The brakes are locked and the brake friction plate is worn.
  Normal brake life cycle: About 2 years (when the brakes are used 100 times/day)
  However, the rough normal relay life is approximately 20,000 times. If you press the emergency stop switch unnecessarily, the life of the relay will be shortened.
- Impact is applied on the reduction gear unit, and it may result in the short life of the reduction gear unit.

To place the system in emergency mode during normal operation, press the Emergency Stop switch when the Manipulator is not moving. Refer to the Controller manual for instructions on how to wire the Emergency Stop switch circuit.

Do not turn OFF the Controller while the Manipulator is operating.
If you attempt to stop the Manipulator in emergency situations, make sure to stop the Manipulator using the E-STOP of the Controller.

If the Manipulator is stopped by turning OFF the Controller while it is operating, following problems may occur:
Reduction of the life and damage of the reduction gear unit
Position gap at the joints

In addition, if the Controller was forced to be turned OFF by blackouts and the like while the Manipulator is operating, make sure to check the following points after power restoration:
Whether or not the reduction gear is damaged
Whether or not the joints are in their proper positions
If there is a position gap, perform calibration by referring to the *LS-B series Maintenance Manual – LS10-B Manipulator Calibration*.

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

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

To check brake problems, refer to *Regular Inspection 2. LS10-B Manipulator Regular Inspection.*

NOTE
Test pulse cannot be used with the emergency stop input of this model.

Stopping distance in emergency

The operating Manipulator cannot stop immediately after the Emergency Stop switch is pressed. In addition, stopping time and stopping distance vary by following factors:

Hand weight	WEIGHT Setting	ACCEL Setting
Workpiece weight	SPEED Setting	Posture etc.

For stopping time and stopping distance of the Manipulator, refer to "*Appendix B: Stopping Time and Stopping Distance in Emergency*".

1.5 Safeguard

To ensure safe operation, install a safety system using safety doors, light curtains, safety floor mats, etc.

When a closed safeguard is open during robot motion, the safeguard interlock function operates. The robot stops immediately and enters into pause state. Then, all robot motors are turned OFF. The descriptions below explain how the safeguard input works.

Safeguard open : The robot stops immediately, motors are turned OFF, and further operation is impossible until either the safeguard is closed or TEACH or TEST mode is turned ON and the enable circuit is engaged.

Safeguard closed : The robot can automatically operate in unrestricted (high power) state.

Do not open the safeguard unnecessarily while motor is ON. Frequent safeguard inputs affect the life of the relay.

Rough normal relay life: Approximately 20,000 times

For the safeguard, do not use the E-STOP circuit.

For details of wiring instructions, refer to the following manual:

RC90 series Manual - 9. EMERGENCY

For details of Safeguard, refer to the following manual:

RC90 series Manual - 2.7.1 Connection to EMERGENCY Connector

NOTE

Test pulse cannot be used with the safeguard input of this model.

WARNING

- The EMERGENCY connector on the controller has a safeguard input circuit to connect the safety device interlock switch. To protect operators working near the robot, be sure to connect the interlock switch and make sure that it works properly.
- The time to stop the robot and the stopping distance by the safeguard interlock function will change depending on the conditions of use. Be sure to confirm that safety is ensured according to the installation environment of the robot.

Stopping distance when the safeguard is opened

The Manipulator in operation cannot stop immediately after the safeguard is opened. In addition, stopping time and stopping distance vary by following factors:

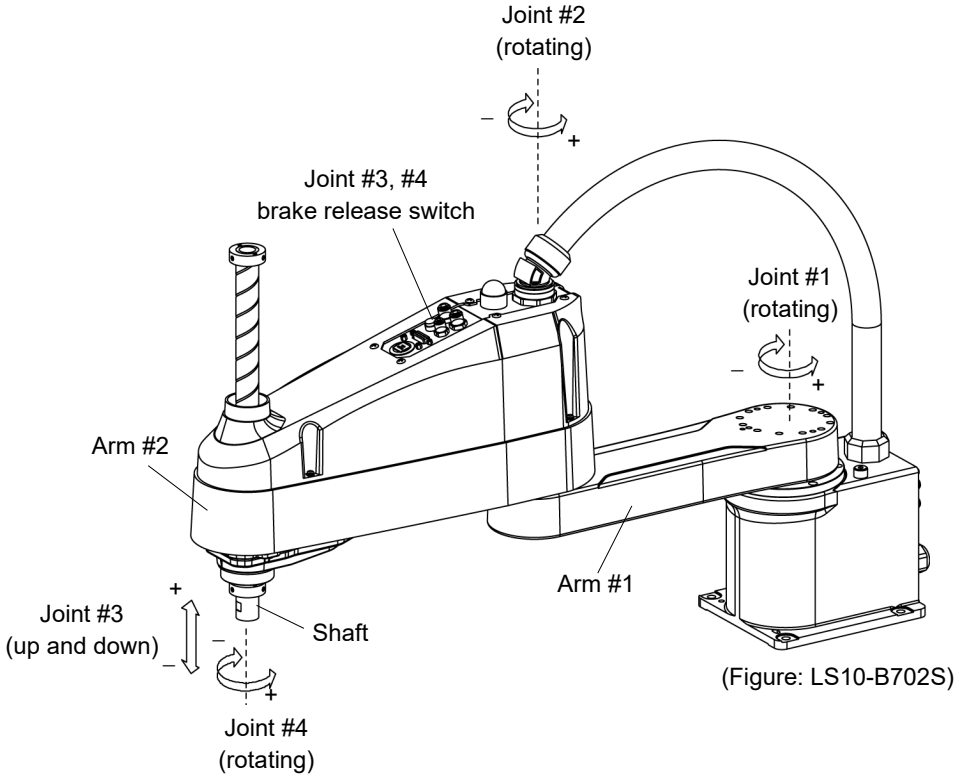
Hand weight	WEIGHT Setting	ACCEL Setting
Workpiece weight	SPEED Setting	Posture etc.

For stopping time and stopping distance of the Manipulator, refer to "*Appendix C: Stopping Time and Stopping Distance When the Safeguard is Opened*".

1.6 Emergency Movement Without Drive Power

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

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



(Figure: LS10-B702S)

NOTE

The brake release switch affects both Joints #3 and #4. When the brake release switch is pressed in emergency mode, the brake for both Joints #3 and #4 are released simultaneously. Be careful of the shaft falling and rotating while the brake release switch is pressed because the shaft may be lowered by the weight of an end effector.

1.7 ACCELS Setting for CP Motions

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.

NOTE

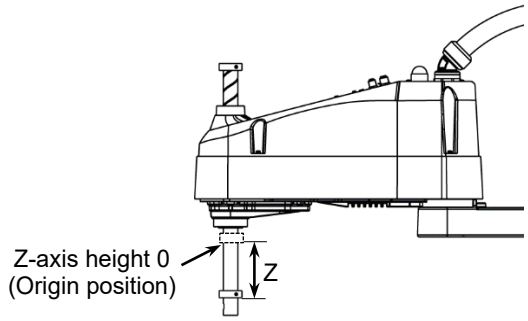
If the ACCELS settings are not properly configured, the following problem occurs.

- Shortened lifespan and damage to the ball screw spline
- Stop with error (Error code: 4002)

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

Maximum ACCELS correction values by Z-axis height and tip load

Z-axis height (mm)	Tip load		
	3kg	6kg	10kg
Z = 0	25000 or less	25000 or less	25000 or less
Z = –100			18000 or less
Z = –200		18000 or less	11000 or less
Z = –300		13000 or less	7500 or less



If the Manipulator is operated in CP motion with the wrong set values, make sure to check the following.

- Whether or not the ball screw spline shaft is deformed or bent

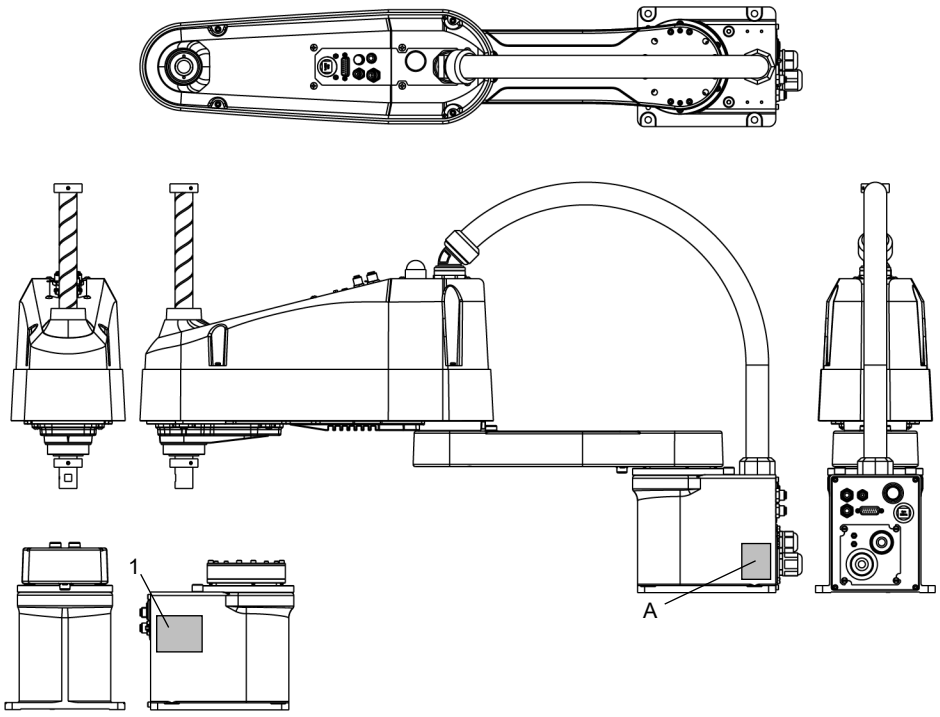
1.8 Warning Labels

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

Location	Warning Label	NOTE
A		Hazardous voltage exists while the Manipulator is ON. To avoid electric shock, do not touch any internal electric parts.

Location	Label	NOTE
1	-	Indicates Product name, Model name, Manipulator's serial No., Local codes information, Specification, Manufacturer, Importer, Date of manufacture, Country of manufacture, etc. For details, refer to the attached label.

LS10-B



1.9 Response for Emergency or Malfunction

1.9.1 Collision

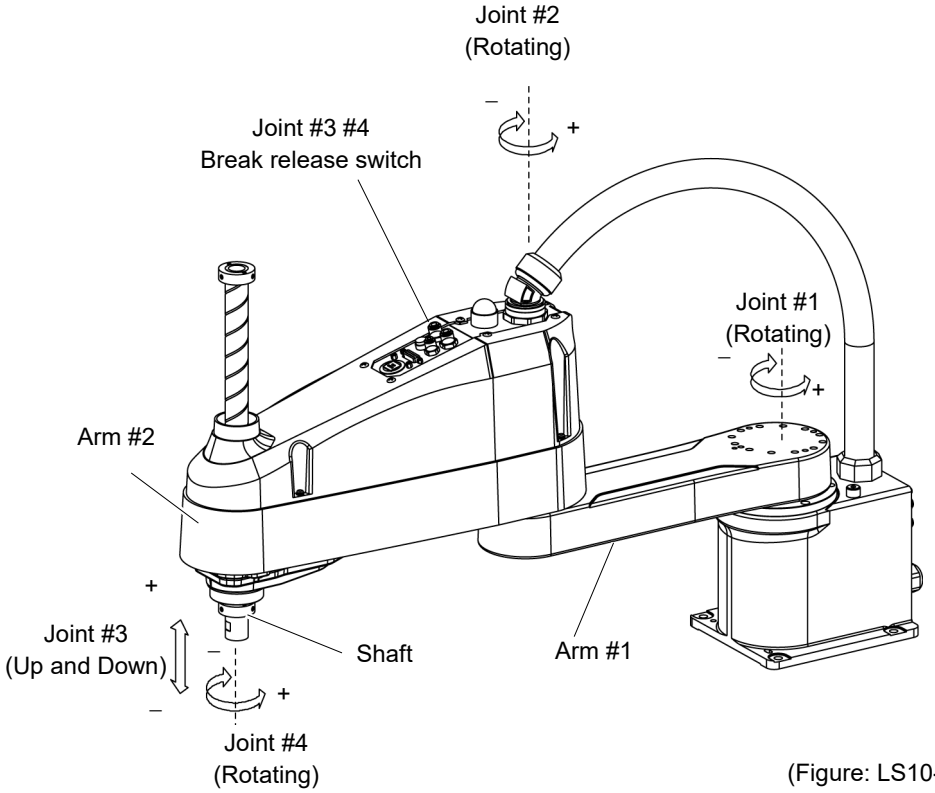
When the Manipulator collides with a mechanical stopper or peripheral device etc., discontinue use and contact the supplier.

1.9.2 Getting body caught in Manipulator

When the operator is caught between the Manipulator and a mechanical part such as a base table, press the emergency stop switch to release the brake on the subject arm, and then move the arm by hand.

Get body caught in the arms:
The break is not working. Move the arms manually.

Get body caught in the shafts:
The break is working. Press the break release switch and move the shafts.

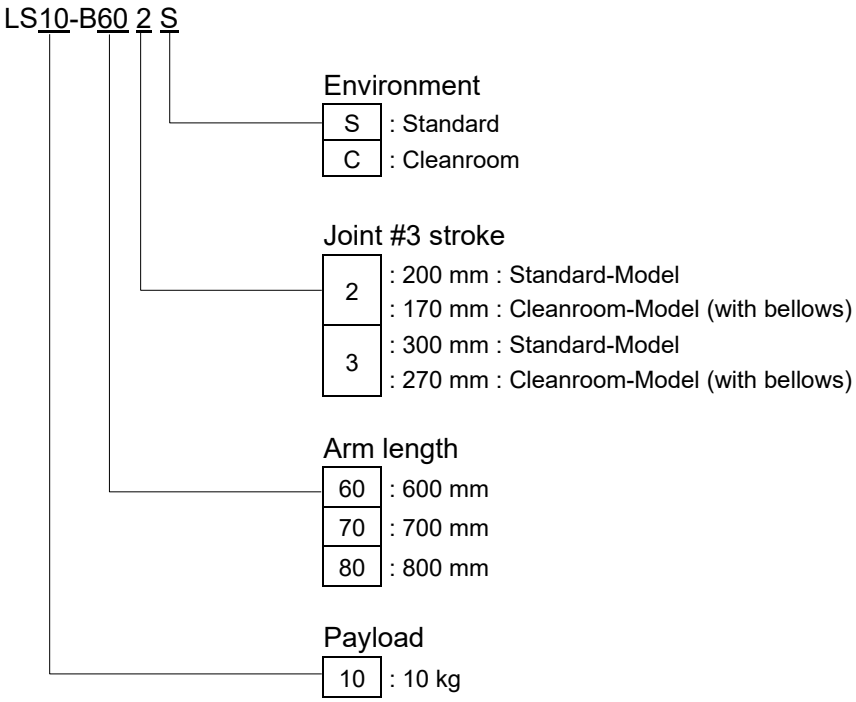


(Figure: LS10-B702S)

CAUTION	■ While pressing the break release switch, not only Joint #3 but also Joint #4 may move due to its own weight. Be careful of the shaft falling or rotating.

2. Specifications

2.1 Model Number



Environment

Cleanroom-model

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

Food grade grease model (LS10-B**3C-FZ)

Food grade grease model have the grease for Z-axis ball screw splines which is usable for foods. Customer is responsible for integrating into food processing machinery and complying with related laws, regulations, and standards.

Food grade grease models are made up of a combination of the following Controller and software.

Manipulator	Controller	Software
LS10-B**3C-FZ	RC90-B	EPSON RC+ 7.0 Ver.7.5.4

Be sure to use the specified grease for food model. For details, refer to *Regular Inspection 2.3 Greasing*.

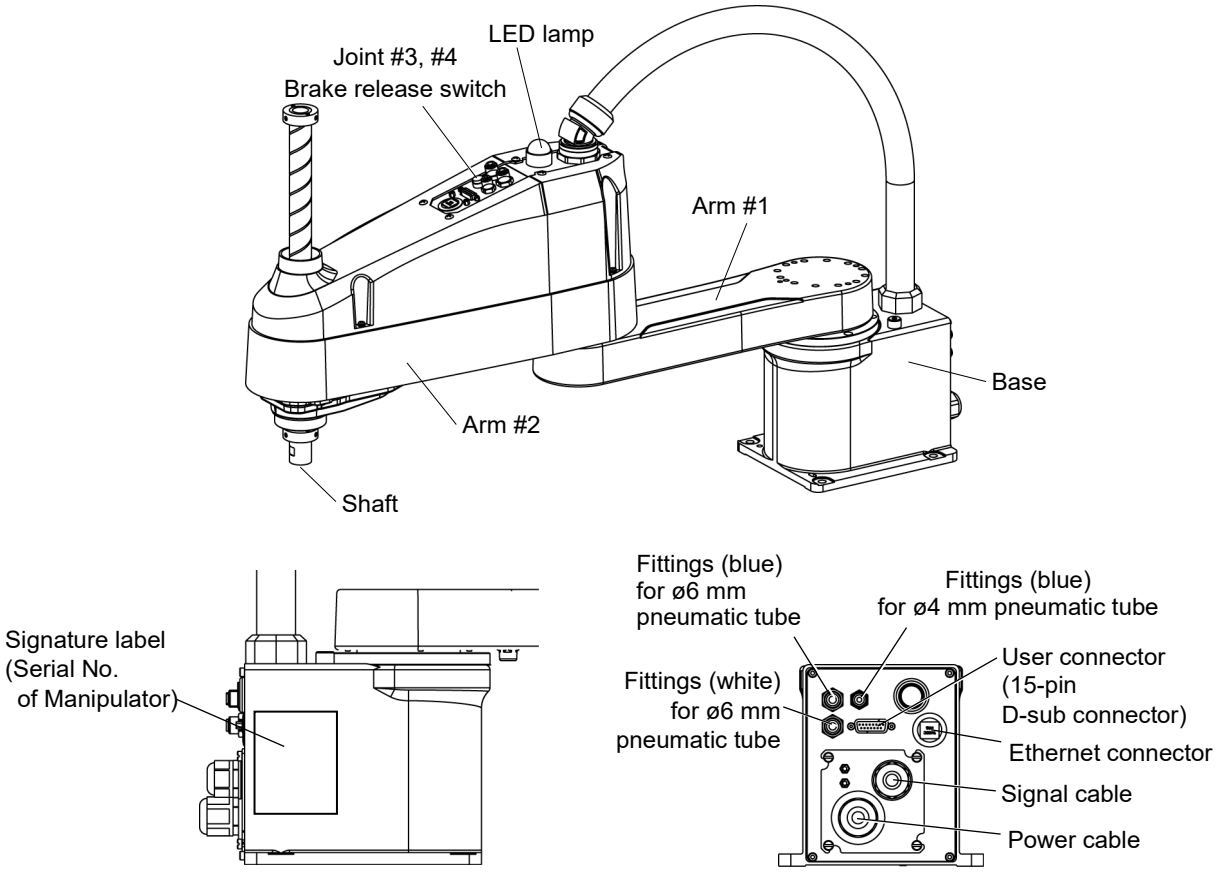
For details on the specifications, refer to *Appendix A: Specifications*.

Models

Payload	Arm length	Environment	Joint #3 stroke	Model Number
10 kg	600 mm	Standard	200 mm	LS10-B602S
			300 mm	LS10-B603S
		Cleanroom	170 mm	LS10-B602C
			270 mm	LS10-B603C
	700 mm	Standard	200 mm	LS10-B702S
			300 mm	LS10-B703S
		Cleanroom	170 mm	LS10-B702C
			270 mm	LS10-B703C
	800 mm	Standard	200 mm	LS10-B802S
			300 mm	LS10-B803S
		Cleanroom	170 mm	LS10-B802C
			270 mm	LS10-B803C

2.2 Part Names and Outer Dimensions

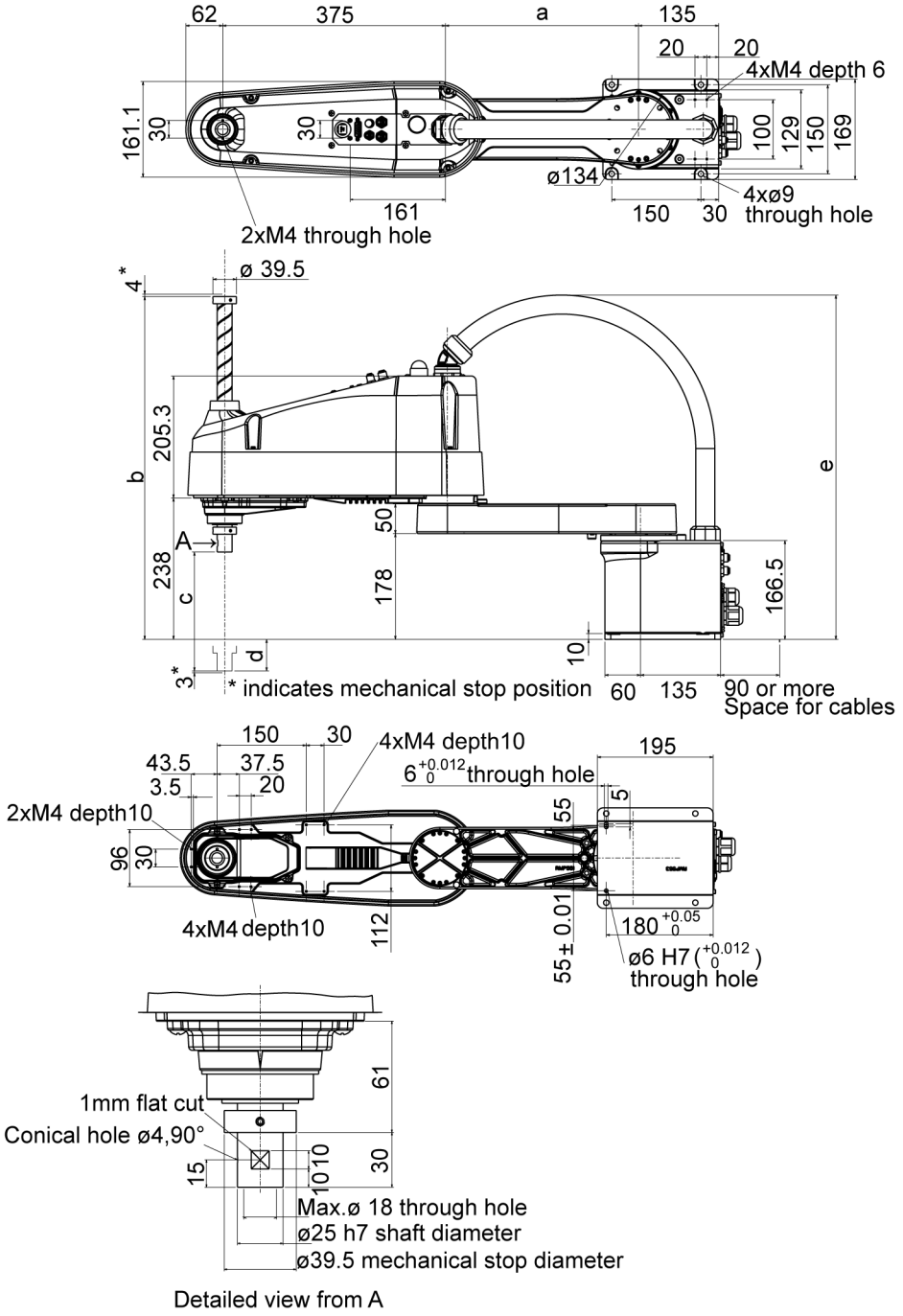
2.2.1 Standard-Model (LS10-B***S)



NOTE

- The brake release switch affects both Joints #3 and #4. When the brake release switch is pressed in emergency mode, the brakes for both Joint #3 and Joint #4 are released simultaneously.
- While the LED lamp is on, current is being applied to the manipulator. Performing any work with the power ON is extremely hazardous and it may result in electric shock and/or improper function of the robot system. Make sure to turn OFF the controller power before the maintenance work.

LS10-B***S (Standard-Model)

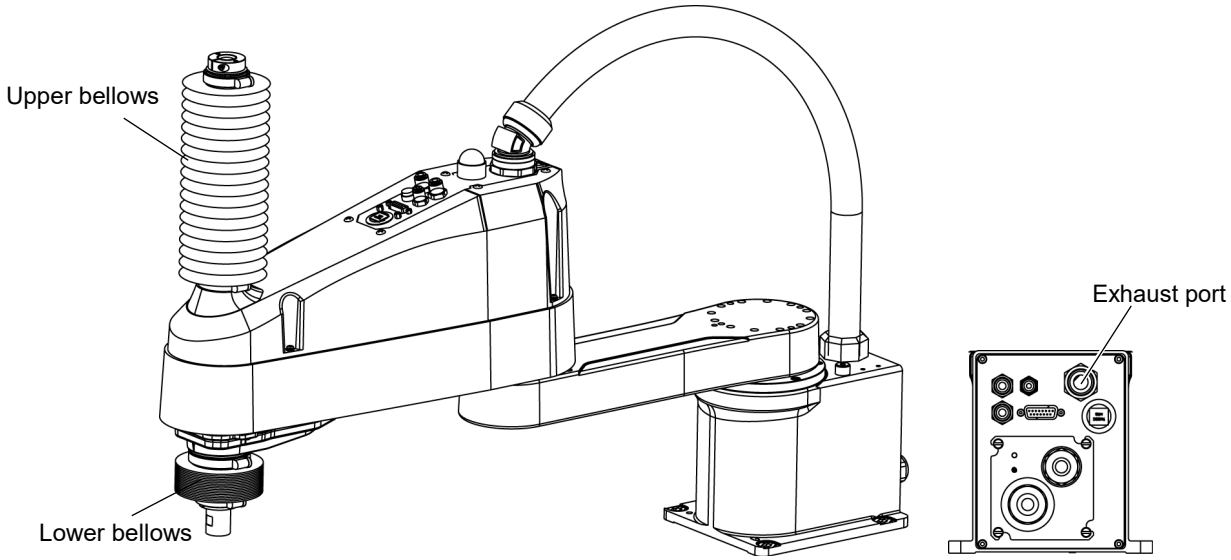


Detailed view from A

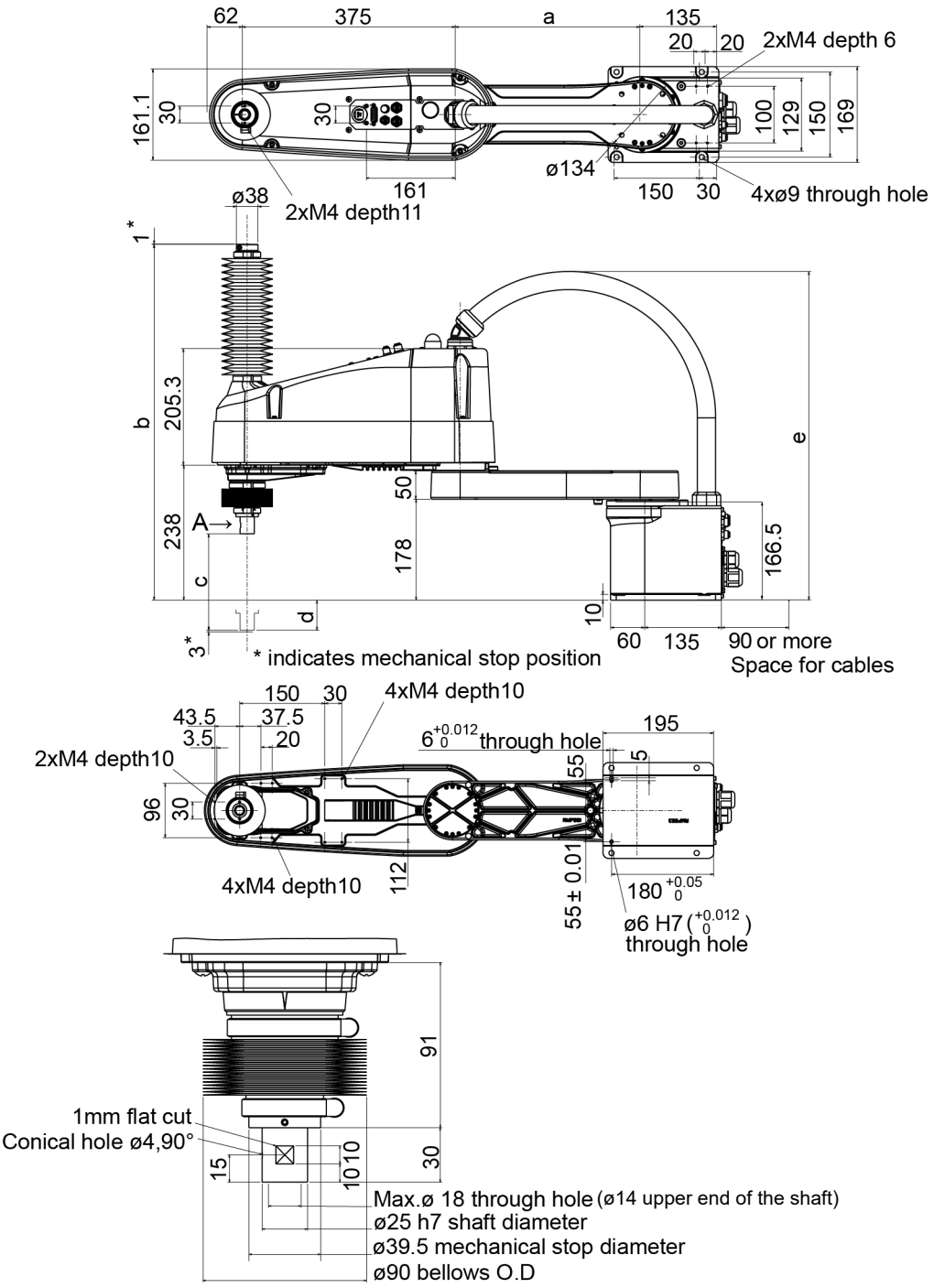
	LS10-B602S	LS10-B702S	LS10-B802S	LS10-B603S	LS10-B703S	LS10-B803S
a	225	325	425	225	325	425
b	577	577	577	677	677	677
c	200	200	200	300	300	300
d	53	53	53	153	153	153
e	565	580	580	565	580	580

2.2.2 Cleanroom-Model (LS10-B***C)

The following figures show the additional parts and specifications for Cleanroom-model when compared with the Standard-model in appearance.



LS10-B***C (Cleanroom-Model)



Detailed view from A

	LS10-B602C	LS10-B702C	LS10-B802C	LS10-B603C	LS10-B703C	LS10-B803C
a	225	325	425	225	325	425
b	627	627	627	727	727	727
c	170	170	170	270	270	270
d	53	53	53	153	153	153
e	565	580	580	565	580	580

2.3 Specifications

For details of each manipulator specifications, refer to *Appendix A: Specifications.*

2.4 How to Set the Model

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

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

NOTE

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

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

The Manipulator model can be set from software.
Refer to the chapter *Robot Configuration* in the *Epson RC+ User's Guide*.

3. Environments and Installation

Designing and installation of the Manipulators and robotic equipment shall be performed by personnel who has taken robot system training held by us and suppliers and should conform to all national and local codes.

3.1 Environmental Conditions

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

Item	Conditions
Ambient temperature *1	5 to 40°C
Ambient relative humidity	10 to 80% (no condensation)
Fast transient burst noise	1 kV or less (Signal wire)
Electrostatic noise	4 kV or less
Altitude	1000 m or lower
Environment	- Install indoors. - Keep away from direct sunlight. - Keep away from dust, oily smoke, salinity, metal powder or other contaminants - Keep away from flammable or corrosive solvents and gases - Keep away from water and oil. - Keep away from shocks or vibrations. - Keep away from sources of electric noise. - Keep away from explosive area - Keep away from a large quantity of radiation

NOTE

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

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

When the product is used in a low temperature environment around the minimum temperature of the product specification, or when the product is suspended for a long time on holidays or at night, a collision detection error may occur due to the large resistance of the drive unit immediately after the start of operation. In such a case, it is recommended to warm up for about 10 minutes.

Special Environmental Conditions

The surface of the Manipulator has general oil resistance. However, if your requirements specify that the Manipulator must withstand certain kinds of oil, please contact the supplier of your region.

Rapid change in temperature and humidity can cause condensation inside the Manipulator.

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

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

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

 CAUTION	■ When cleaning the Manipulator, do not rub it strongly with alcohol or benzene. It may lose luster on the coated face.

3.2 Base Table

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

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

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

	LS10-B
Max. reaction torque on the horizontal plate	550 N·m
Max. horizontal reaction force	3200 N
Max. vertical reaction force	1500 N

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

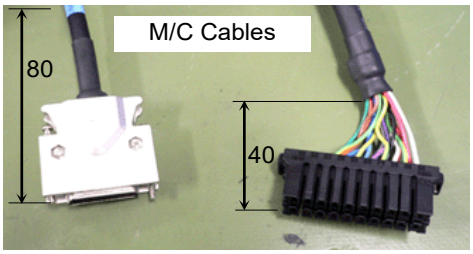
The plate for the Manipulator mounting face should be 20 mm thick or more and made of steel to reduce vibration. The surface roughness of the steel plate should be 25 µm or less.

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

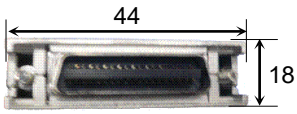
The Manipulator installation surface should have a flatness of 0.5 mm or less and an inclination of 0.5 ° or less. If the flatness of the installation surface is improper, the base may be damaged, or the robot may not fully show its performance.

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

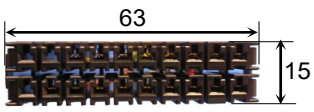
If you are passing cables through the holes on the base table, see the figures below.



(Unit : mm)



Signal Cable Connector



Power Cable Connector

NOTE

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

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

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

3.3 Mounting Dimensions

The maximum space (R) includes the radius of the end effector. If it exceeds 60 mm, define the radius as the distance to the outer edge of maximum space.
If a camera or solenoid valve extends outside of the arm, set the maximum range including the space that they may reach.

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

Space for teaching

Space for maintenance and inspection
(Ensure a space to open the covers and plates for maintenance.)

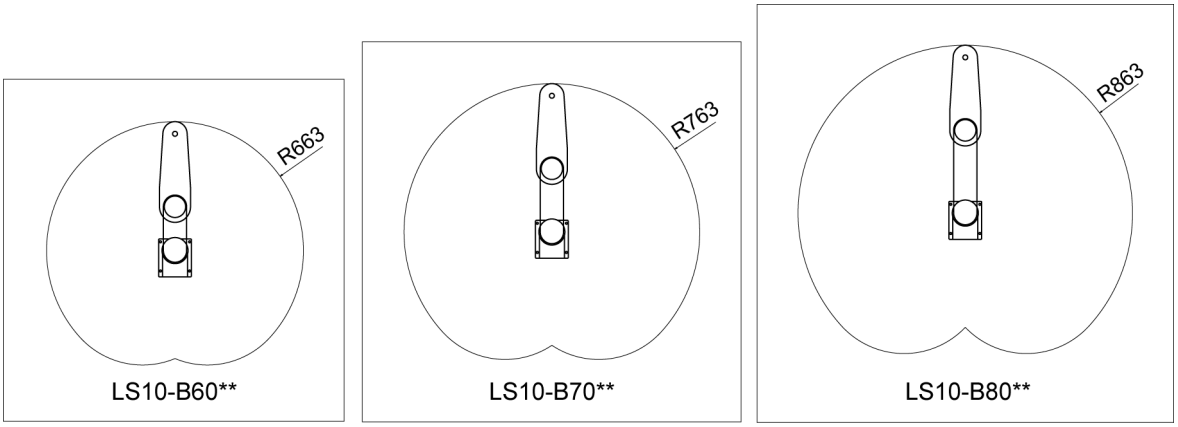
Space for cables

NOTE

When installing the cable, be sure to maintain sufficient distance from obstacles.
For the minimum bend radius of the MC cable, refer to "Appendix A: LS10-B Specifications".

In addition, leave enough space for other cables so that they are not bent forcibly.

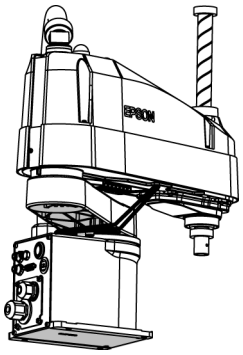
Ensure distance to the safeguard from the maximum motion range is more than 100 mm.



3.4 Unpacking and Transportation

Transportation and installation of the Manipulators and robotic equipment shall be performed by personnel who has taken robot system training held by us and suppliers and should conform to all national and local codes.

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

CAUTION	■ Using a cart or similar equipment, transport the Manipulator in the same manner as it was delivered. ■ After removing the bolts securing the Manipulator to the delivery equipment, the Manipulator can fall. Be careful not to get hands or fingers caught. ■ The arm is secured with a wire tie. Leave the wire tie secured until you finish the installation so as not to get hands or fingers caught. ■ To carry the Manipulator, have two or more people to work on it and secure the Manipulator to the delivery equipment or hold the areas indicated in gray in the figure (bottom of Arm #1 and bottom of the base) by hand. When holding the bottom of the base by hand, be very careful not to get your hands or fingers caught.  LS10-B60** : approx. 23 kg : 50.7 lbs. LS10-B70** : approx. 23 kg : 50.7 lbs. LS10-B80** : approx. 24 kg : 52.9 lbs. ■ Stabilize the Manipulator with your hands when hoisting it. ■ When transporting the Manipulator for a long distance, secure it to the delivery equipment directly so that the Manipulator never falls. If necessary, pack the Manipulator in the same style as it was delivered.

3.5 Installation Procedure

Installation of the Manipulators and robotic equipment shall be performed by personnel who has taken robot system training held by us and suppliers and should conform to all national and local codes.

	■ The robot system must be installed to avoid interference with buildings, structures, utilities, other machines and equipment that may create a trapping hazard or pinch points.
CAUTION	■ Before operating the Manipulator, make sure to remove the bolts (with red tag) that secures the manipulator. Those bolts are not eye bolts for lifting Manipulators. Do not use those bolts for any purpose other than securing the robot arm during transportation. Doing so may damage the Manipulator. ■ Oscillation (resonance) may occur during operation depending on rigidity of the installation table. If the oscillation occurs, improve rigidity of the table or change the speed or acceleration and deceleration settings.

3.5.1 Standard-Model

CAUTION	■ Install the Table Top Mounting Manipulator with two or more people. The Manipulator weights are as follows. Be careful not to get hands, fingers, or feet caught and/or have equipment damaged by a fall of the Manipulator. LS10-B60** : approx. 23 kg :50.7 lbs. LS10-B70** : approx. 23 kg :50.7 lbs. LS10-B80** : approx. 24 kg :52.9 lbs.

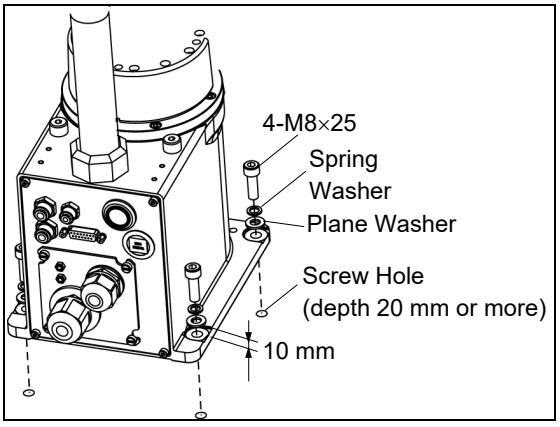
(1) Secure the base to the base table with four bolts.

NOTE

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

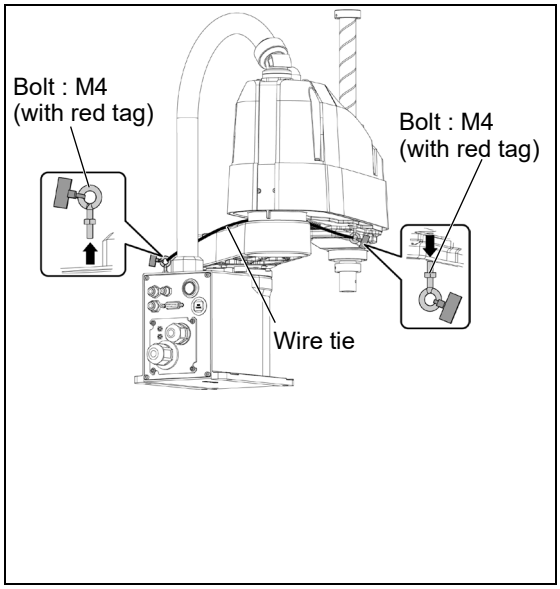
Tightening torque:
32.0 N·m (326 kgf·cm)

Remove the fixing sheet for transportation which is attached to the arm.



(2) Using nippers, cut off the wire tie binding the shaft and arm retaining bracket on the base.

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



NOTE

Make sure to remove the wire tie for protection of mechanical stop.

3.5.2 Cleanroom-Model

(1) Unpack the Manipulator outside of the clean room.

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

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

(4) Transport the Manipulator to the clean room.

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

(6) Connect an exhaust tube to the exhaust port.

3.6 Connecting the Cables

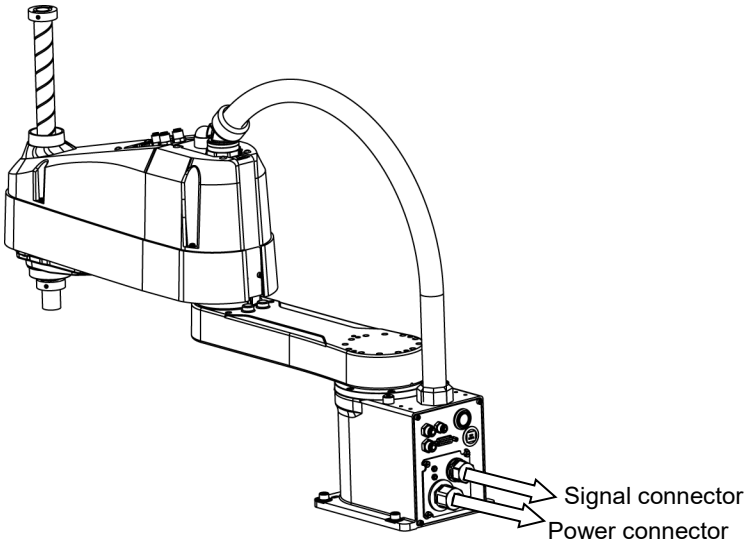
 WARNING	■ To shut off power to the robot system, disconnect the power plug from the power source. Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source. ■ Before performing any replacement procedure, turn OFF the Controller and related equipment, and then disconnect the power plug from the power source. Performing any replacement procedure with the power ON is extremely hazardous and may result in electric shock and/or malfunction of the robot system. ■ Be sure to connect the cables properly. Do not allow unnecessary strain on the cables. (Do not put heavy objects on the cables. Do not bend or pull the cables forcibly.) The unnecessary strain on the cables may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system. ■ Grounding the manipulator is done by connecting with the controller. Ensure that the controller is grounded and the cables are correctly connected. If the ground wire is improperly connected to ground, it may result in the fire or electric shock.

 CAUTION	■ When connecting the Manipulator to the Controller, make sure that the serial numbers on each equipment match. Improper connection between the Manipulator and Controller may not only cause improper function of the robot system but also serious safety problems. The connection method varies with the Controller used. For details on the connection, refer to the *Controller manual*.

When the Manipulator is a Cleanroom-model, be aware of the followings.
For the Manipulator of Cleanroom-model, use it with an exhaust system.
For details, refer to *Appendix A: Specifications.*

Cable Connections

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



NOTE

Connect and disconnect M/C cable

In LS10-B series, you can connect and disconnect the M/C cable to/from the manipulator easily.

For details, refer to*: LS-B series Maintenance Manual- LS10-B Manipulator Replacing M/C Cable.*

3.7 User Wires and Pneumatic Tubes

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

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

Electrical Wires

Rated Voltage	Allowable Current	Wires	Nominal Sectional Area	Note
AC/DC30 V	1 A	15	0.211 mm^2	Twist pair

WARNING	■ Do not apply the current more than 1A to the manipulator.

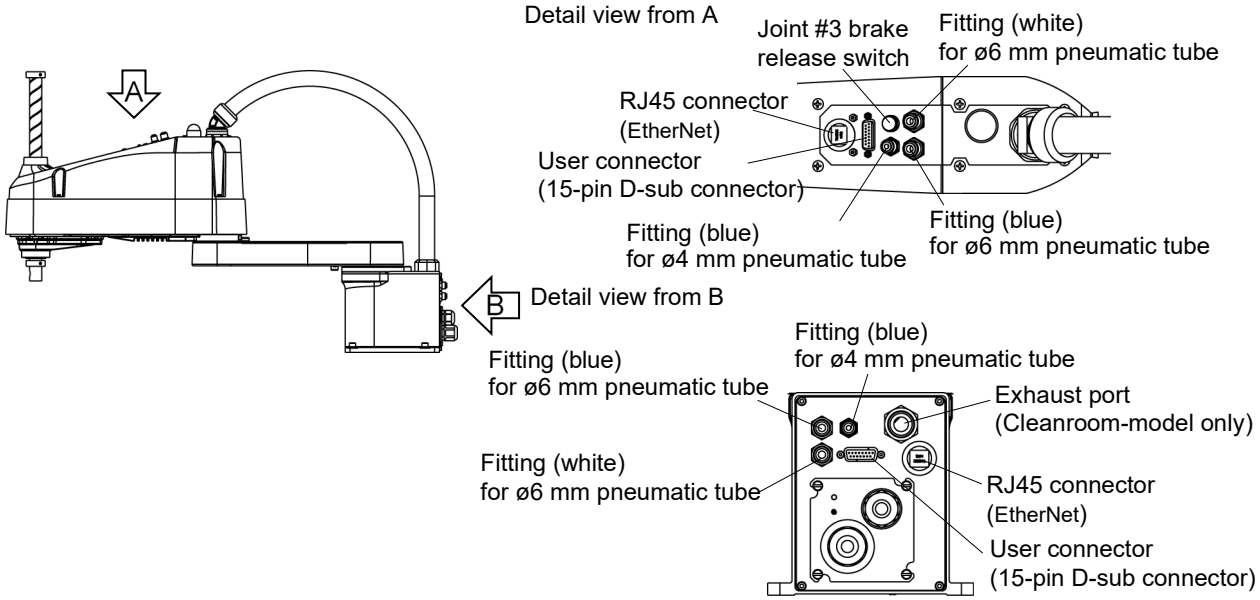
		Mfr.	Standard	
15 pin	Suitable Connector	JAE	DA-15PF-N	(Solder type)
	Clamp Hood	JAE	DA-C8-J10-F2-1R	(Connector setscrew: #4-40 NC)

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

Pneumatic Tubes

Max. Usable Pneumatic Pressure	Pneumatic Tubes	Outer Diameter × Inner Diameter
0.59 MPa (6 kgf/cm^2 : 86 psi)	2	ø 6 mm × ø 4 mm
	1	ø 4 mm × ø 2.5 mm

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

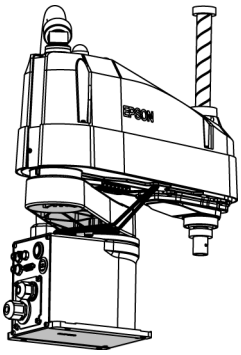


3.8 Relocation and Storage

3.8.1 Precautions for Relocation and Storage

Observe the following when relocating, storing, and transporting the Manipulators.
Transportation and installation of the Manipulators and robotic equipment shall be performed by personnel who has taken robot system training held by us and suppliers and should conform to all national and local codes.

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

CAUTION	■ Before relocating the Manipulator, fold the arm and secure it tightly with a wire tie to prevent hands or fingers from being caught in the Manipulator. ■ When removing the anchor bolts, support the Manipulator to prevent falling. Removing the anchor bolts without support may result in a fall of the Manipulator, and then get hands, fingers, or feet caught. ■ To carry the Manipulator, have two or more people to work on it and secure the Manipulator to the delivery equipment or hold the shaded area (bottom of Arm #1 and the bottom of the base) by hand. When holding the bottom of the base by hand, be very careful not to get hands or fingers caught.  LS10-B60** : approx. 23 kg : 50.7 lbs. LS10-B70** : approx. 23 kg : 50.7 lbs. LS10-B80** : approx. 24 kg : 52.9 lbs. ■ Stabilize the Manipulator with your hands when hoisting it. Unstable hoisting is extremely hazardous and may result in fall of the Manipulator.

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

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

Transport and store the Manipulator in the range of Temperature: −20 to +60 °C, Humidity: 10 to 90% (no condensation).

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

Do not shock or shake the Manipulator during transport.

3.8.2 Relocation

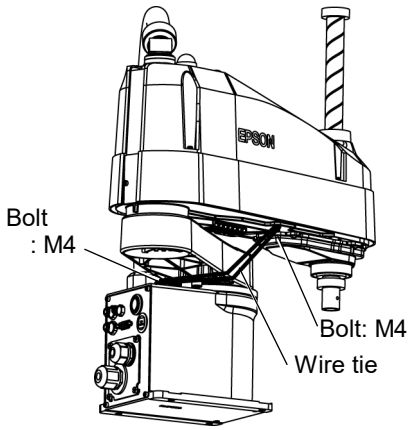
CAUTION	■ Install or relocate the Manipulator with two or more people. The Manipulator weights are as follows. Be careful not to get hands, fingers, or feet caught and/or have equipment damaged by a fall of the Manipulator. LS10-B60** : approx. 23 kg :50.7 lbs. LS10-B70** : approx. 23 kg :50.7 lbs. LS10-B80** : approx. 24 kg :52.9 lbs.

(1) Turn OFF the power on all devices and unplug the cables.

NOTE Remove the mechanical stops if using them to limit the motion range of Joints #1 and #2. For details on the motion range, refer to *5.2 Motion Range Setting by Mechanical Stops*.

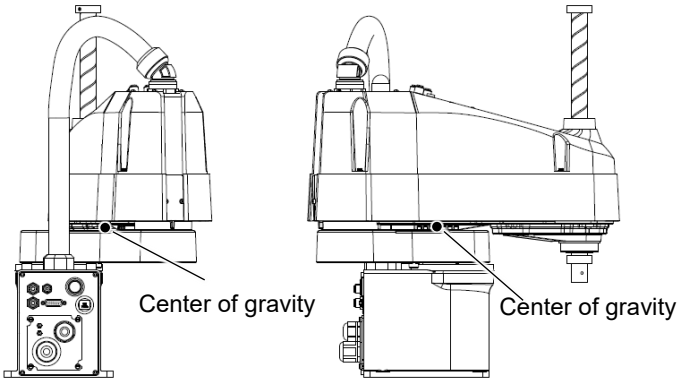
(2) Cover the arm with a sheet so that the arm will not be damaged.
Refer to the following figure and fix the arm.

Example of Arm Fixed Posture

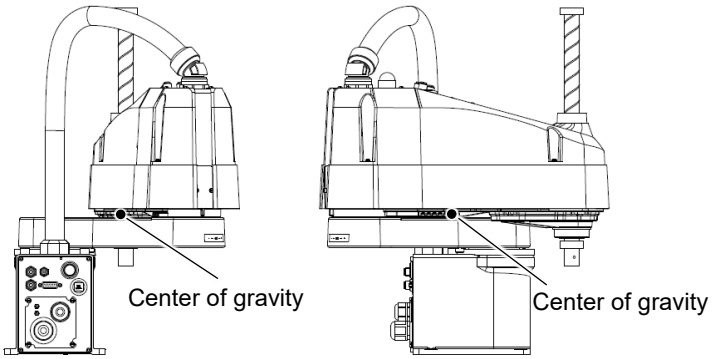


(3) Hold the bottom of Arm #1 by hand to unscrew the anchor bolts.
Then, remove the Manipulator from the base table.

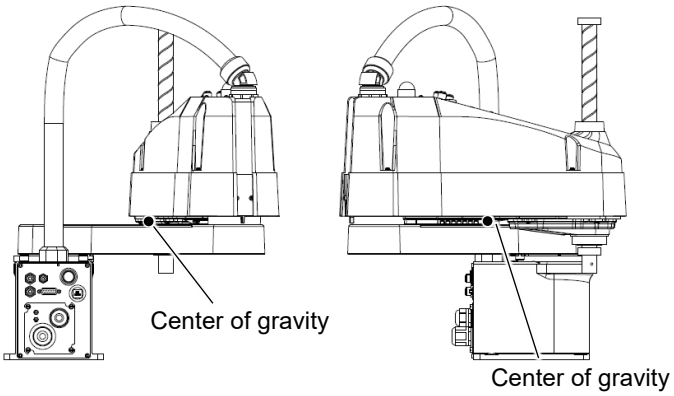
LS10-B60**



LS10-B70**



LS10-B80**



4. Setting of End Effectors

4.1 Attaching an End Effector

Users are responsible for making their own end effector(s). For details of attaching an end effector, refer to "*Hand Function Manual*"

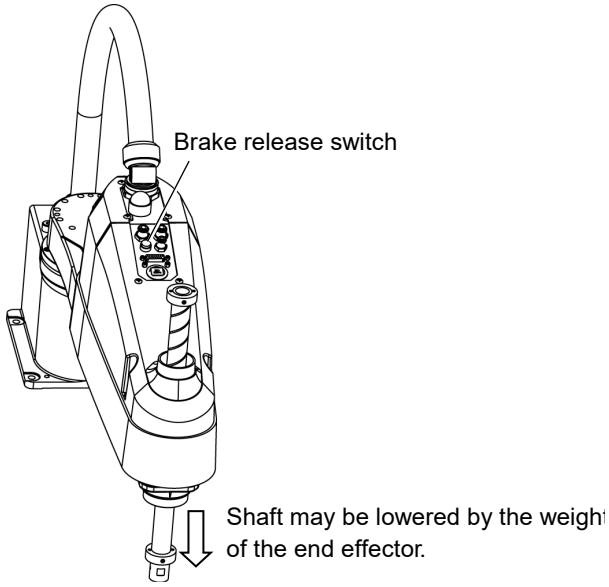
CAUTION	■ If you use an end effector equipped with a gripper or chuck, connect wires and/or pneumatic tubes properly so that the gripper does not release the work piece when the power to the robot system is turned OFF. Improper connection of the wires and/or pneumatic tubes may damage the robot system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

Shaft

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

Brake release switch

- Joint #3 and #4 cannot be moved up/down by hand because the electromagnetic brake is applied to the joint while power to the robot system is turned OFF.
  This prevents the shaft from hitting peripheral equipment in the case that the shaft is lowered by the weight of the end effector when the power is disconnected during operation, or when the motor is turned OFF even though the power is turned ON.
  To move Joint #3 up/down or rotate Joint #4 while attaching an end effector, turn ON the Controller and move the joint up/down or rotate the joint while pressing the brake release switch.
  This button switch is a momentary-type; the brake is released only while the button switch is being pressed
- Be careful of the shaft while the brake release switch is being pressed because the shaft may be lowered by the weight of the end effector.



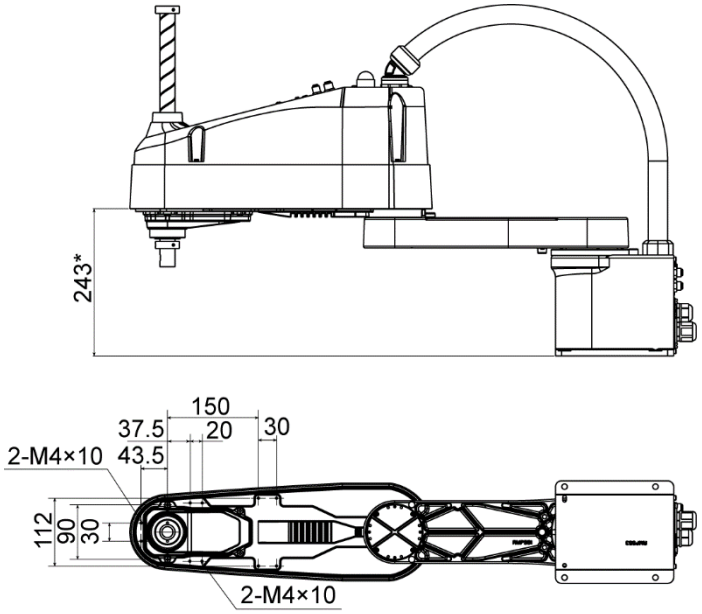
Layouts

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

4.2 Attaching Cameras and Valves

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

[Unit: mm]



*: From base installation surface

4.3 Weight and Inertia Settings

To ensure optimum Manipulator performance, it is important to make sure that the load (weight of the end effector and work piece) and moment of inertia of the load are within the maximum rating for the Manipulator, and that Joint #4 does not become eccentric.
If the load or moment of inertia exceeds the rating or if the load becomes eccentric, follow the steps below, "*4.3.1Weight Setting"* and "*4.3.2 Inertia Setting"* to set parameters.
Setting parameters makes the PTP motion of the Manipulator optimal, reduces vibration to shorten the operating time, and improves the capacity for larger loads. In addition, it reduces persistent vibration produced when the moment of inertia of the end effector and work piece is larger than the default setting.
You can also set by following "Weight, Inertia, and Eccentricity/offset Measurement Utility". The following manual describes the details.

Epson RC+ User's Guide
6.18.12 Weight, Inertia, and Eccentricity/offset Measurement Utility

4.3.1 Weight Setting

CAUTION	■ The total weight of the end effector and the workpiece must not exceed 10 kg. The LS10-B series Manipulators are not designed to work with loads exceeding 10 kg. Always set the Weight parameters according to the load. Setting a value that is smaller than the actual load may cause errors, excessive shock and insufficient function of the Manipulator. Also, the life cycle of parts will shorten and belt tooth jumping will occur which will lead to potion shift.

The acceptable weight capacity (end effector and workpiece) in LS10-B series is
Default rating: 5 kg
Maximum: 10 kg

Depends to the load (weight of the end effector and work piece), change the setting of Weight parameter.
After the setting is changed, the maximum acceleration/deceleration speed of the robot system at PTP motion corresponding to the "Weight Parameter" is set automatically.

Load on the Shaft

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

Epson RC+

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

Load on the Arm

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

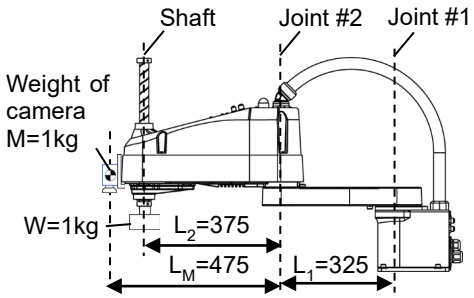
Equivalent Weight Formula

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

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

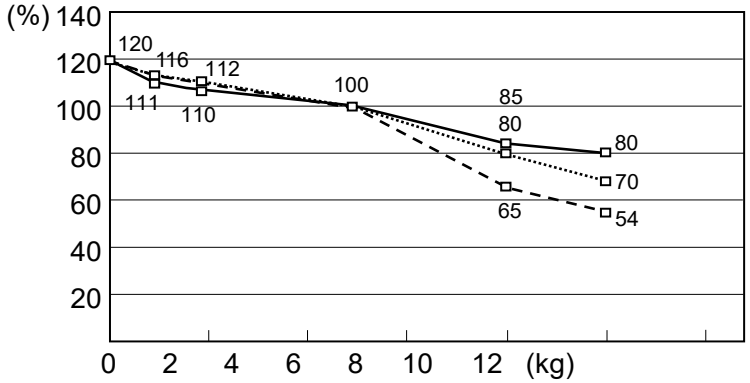
<Example>Calculates [Weight] parameter when a "1 kg" camera is attached to the end of the LS10-B series arm (475 mm away from the rotation center of Joint #2) with a load weight of "1 kg".

W=1
M=1
L_1=325
L_2=375
L_M=475
$W_M=1\times(475+325)^2/(325+375)^2=1.31$ (round up)
$W+W_M=1+1.31=2.31$



Enter "2.31" for the Weight Parameter.

Automatic speed setting by Weight

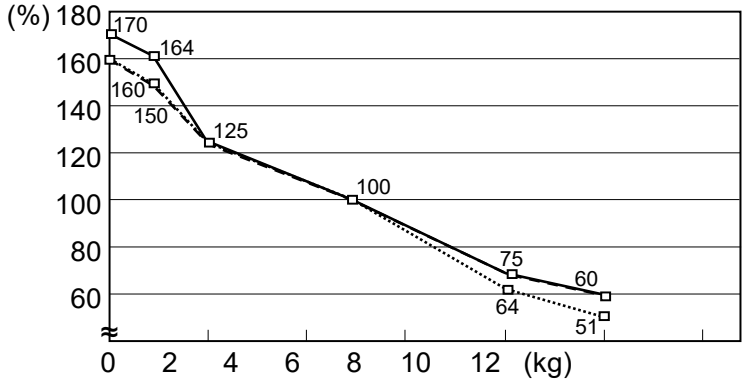


* The percentage in the graph is based on the speed at rated weight (5 kg) as 100%.

LS10-B60**
LS10-B70**
LS10-B80**

End effector weight (kg)	Automatic speed setting by Weight (%)		
	LS10-B60**	LS10-B70**	LS10-B80**
0	120	120	120
1	111	116	116
2	110	112	112
5	100	100	100
8	85	80	65
10	80	70	54

Automatic acceleration/deceleration setting by Weight



* The percentage in the graph is based on the acceleration/ deceleration at rated weight

End effector weight (kg)	Automatic acceleration/deceleration setting by Weight (%)		
	LS10-B60**	LS10-B70**	LS10-B80**
0	170	160	160
1	164	150	150
2	125	125	125
5	100	100	100
8	75	64	75
10	60	51	60

4.3.2 Inertia Setting

Moment of Inertia and the Inertia Setting

The moment of inertia is defined as “the ratio of the torque applied to a rigid body and its resistance to motion”. This value is typically referred to as “the moment of inertia”, “inertia”, or “GD^2”. When the Manipulator operates with additional objects (such as an end effector) attached to the shaft, the moment of inertia of load must be considered.

CAUTION

■ The moment of inertia of the load (weight of the end effector and workpiece) must be 0.30 kg·m^2 or less. The LS10-B series Manipulators are not designed to work with a moment of inertia exceeding 0.30 kg·m^2.
Always set the Weight parameters according to the load. Setting a value that is smaller than the actual load may cause errors, excessive shock and insufficient function of the Manipulator. Also, the life cycle of parts is shortened and positional gap due to belt tooth bumping occurs.

The acceptable moment of inertia of load for a LS10-B series Manipulator is
Default rating: 0.02 kg·m^2
Maximum: 0.30 kg·m^2

Depends to the moment of inertia of the load, change the setting for the moment of inertia of the load of the Inertia command. After the setting is changed, the maximum acceleration/deceleration speed of Joint #4 at PTP motion corresponding to the “moment of inertia” value is set automatically.

Moment of inertia of load on the shaft

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

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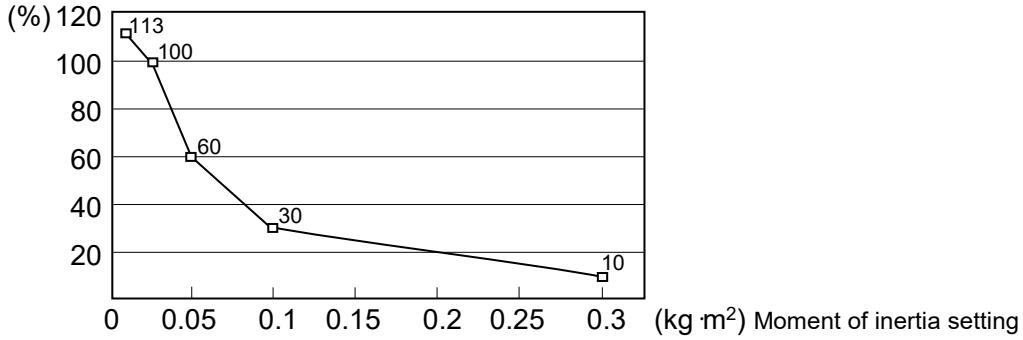
Enter a value into the [Load inertia:] text box on the [Inertia] panel ([Tools]-[Robot Manager]). (You may also execute the Inertia command from the [Command Window].)

Automatic acceleration/deceleration setting of Joint #4 by Inertia (moment of inertia)



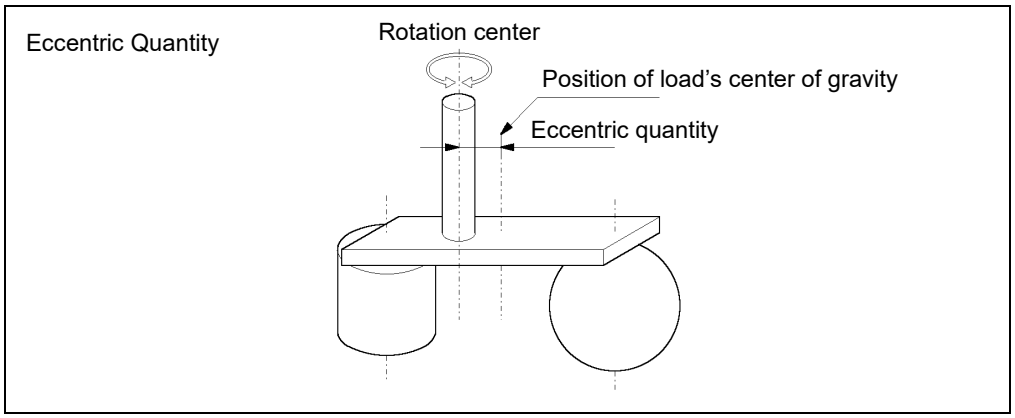
Moment of inertia setting (kg·m^2)	Automatic acceleration/deceleration setting of Joint #4 by Inertia (moment of inertia) (%)
0.01	113
0.02	100
0.05	60
0.1	30
0.3	10

Eccentric Quantity and the Inertia Setting

CAUTION

- The eccentric quantity of load (weight of the end effector and workpiece) must be 200 mm or less. The LS10-B series Manipulators are not designed to work with eccentric quantity exceeding 200 mm.
  Always set the Weight parameters according to the load. Setting a value that is smaller than the actual load may cause errors, excessive shock and insufficient function of the Manipulator. Also, the life cycle of parts is shortened and positional gap due to belt tooth bumping occurs.

The acceptable eccentric quantity of load in LS10-B series is 0 mm at the default rating and 200 mm at the maximum. Depends to the eccentric quantity of load, change the setting of eccentric quantity parameter of Inertia command. After the setting is changed, the maximum acceleration/deceleration speed of the Manipulator at PTP motion corresponding to the "eccentric quantity" is set automatically.



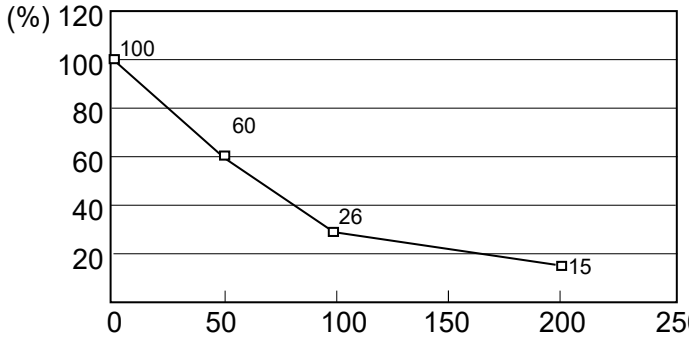
Eccentric quantity of load on the shaft

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

Epson RC+

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

Automatic acceleration/deceleration setting by Inertia (eccentric quantity)

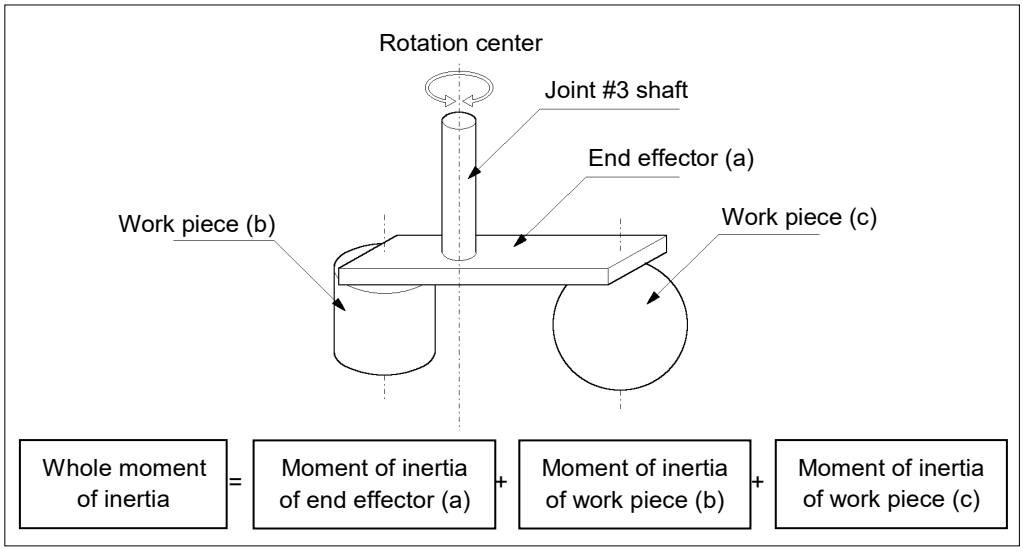


* The percentage in the graph is based on the acceleration / deceleration at rated eccentricity (0 mm) as 100%.

Eccentric quantity parameter (mm)	Automatic acceleration/deceleration setting by Inertia (eccentric quantity) (%)
0	100
50	60
100	26
200	15

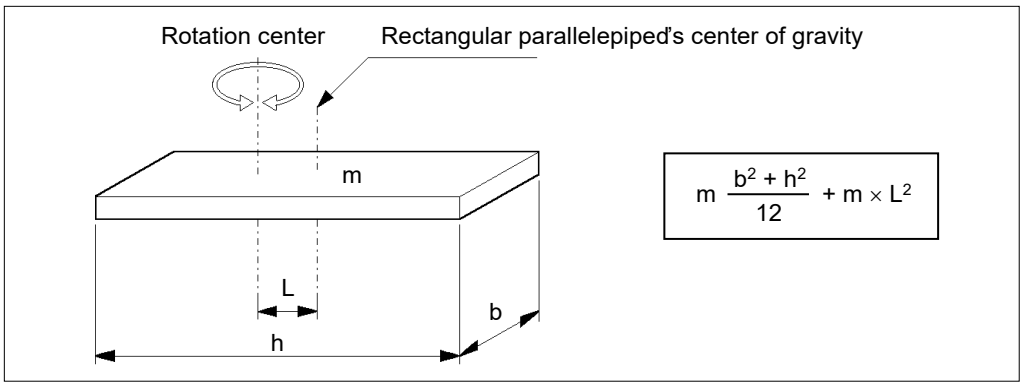
Calculating the Moment of Inertia

Refer to the following examples of formulas to calculate the moment of inertia of load (end effector with work piece). The moment of inertia of the entire load is calculated by the sum of each part (a), (b), and (c).

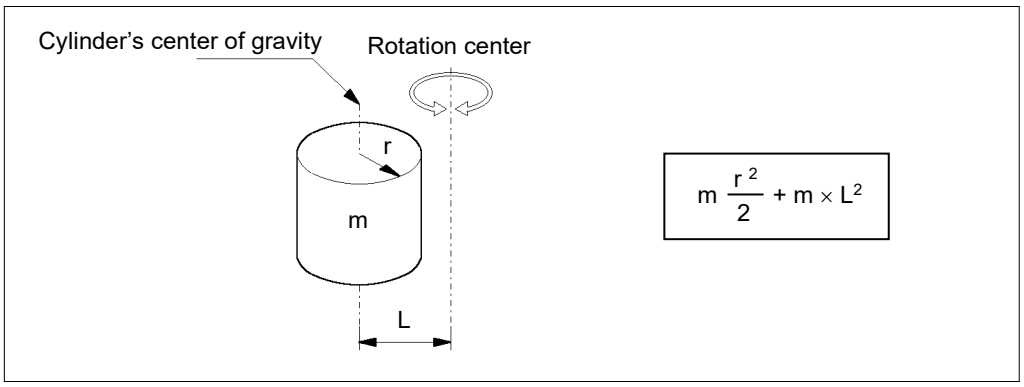


The methods for calculating the moment of inertia for (a), (b), and (c) are shown below. Calculate the total moment of inertia using the basic formulas.

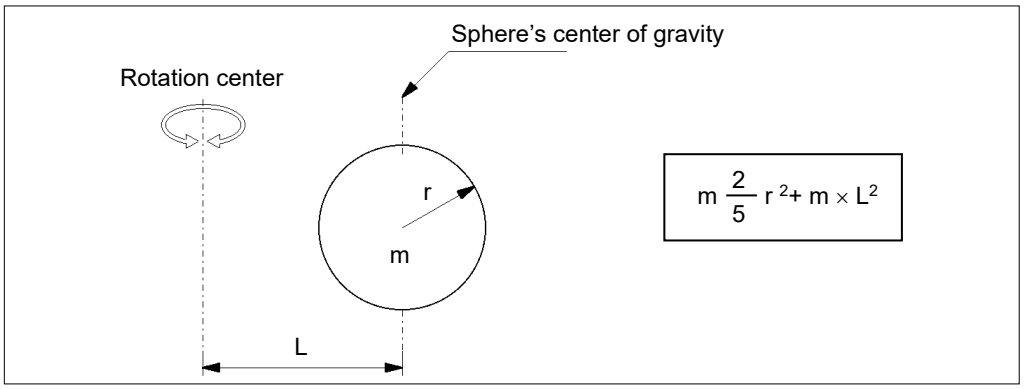
(a) Moment of inertia of a rectangular parallelepiped



(b) Moment of inertia of a cylinder



(c) Moment of inertia of a sphere

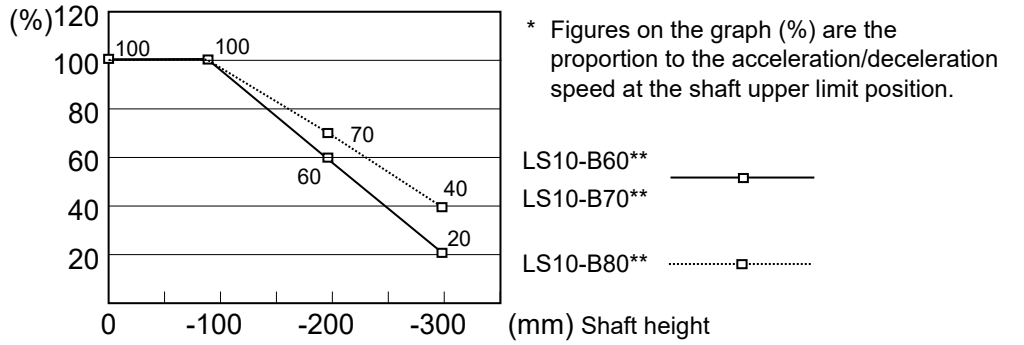


4.4 Precautions for Auto Acceleration/Deceleration of Joint #3

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

When Joint #3 gets below a certain point, then auto acceleration/deceleration is used to reduce acceleration/deceleration. (Refer to the figures below) The higher the position of the shaft is, the faster the motion acceleration/deceleration is. However, it takes more time to move Joint #3 up and down. Adjust the position of Joint #3 for the Manipulator motion after considering the relation between the current position and the destination position. The upper limit of Joint #3 during horizontal motion using Jump command can be set by the LimZ command.

Automatic acceleration/deceleration vs. Joint #3 position



NOTE

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

Shaft height (mm)	Acceleration/Deceleration	
	LS10-B60** LS10-B70**	LS10-B80**
0	100	100
–100	100	100
–200	60	70
–300	20	40

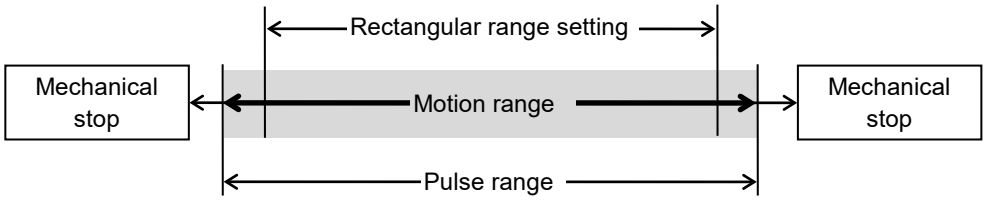
5. Motion Range

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

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

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

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



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

5.1 Motion Range Setting by Pulse Range

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

For the maximum pulse range, refer to the following sections.
The pulse range must be set inside of the mechanical stop range.

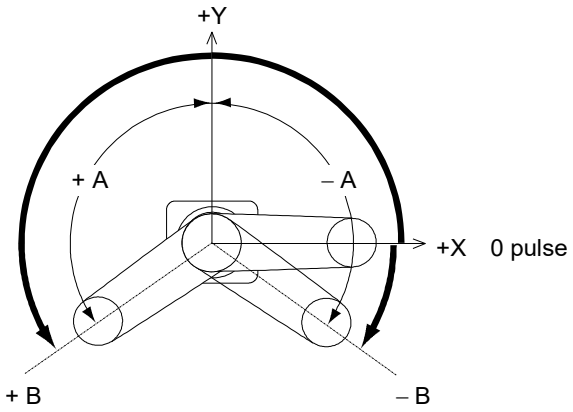
5.1.1 Max. Pulse Range of Joint #1
5.1.2 Max. Pulse Range of Joint #2
5.1.3 Max. Pulse Range of Joint #3
5.1.4 Max. Pulse Range of Joint #4.

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

Epson RC+
The pulse range can be set on the [Range] panel shown by selecting [Tools]-[Robot Manager]. (You may also execute the Range command from the [Command Window].)

5.1.1 Max. Pulse Range of Joint #1

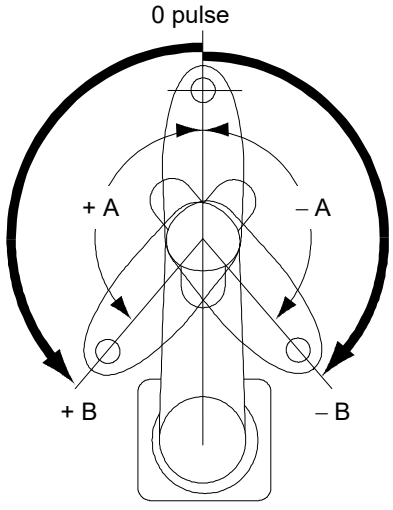
The 0 (zero) pulse position of Joint #1 is the position where Arm #1 faces toward the positive (+) direction on the X-coordinate axis.
When the 0 pulse is a starting point, the counterclockwise pulse value is defined as the positive (+) and the clockwise pulse value is defined as the negative (−).



	A: Max. Motion Range	B: Max. Pulse Range
LS10-B	± 132 °	– 152918~808278 pulse

5.1.2 Max. Pulse Range of Joint #2

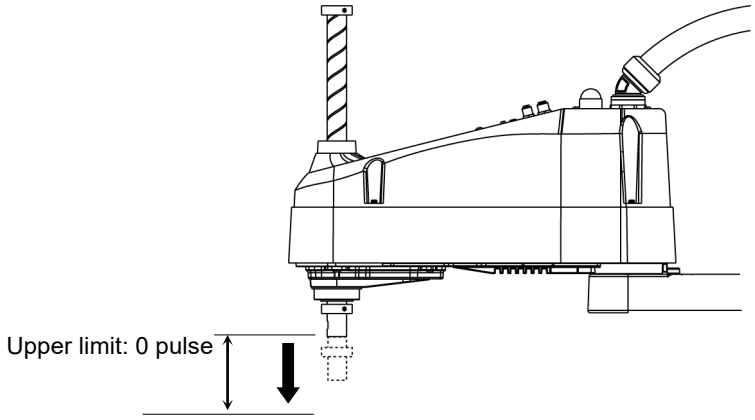
The 0 (zero) pulse position of Joint #2 is the position where Arm #2 is in-line with Arm #1.
With the 0 pulse as a starting point, the counterclockwise pulse value is defined as the positive (+) and the clockwise pulse value is defined as the negative (−).



	A: Max. Motion Range	B: Max. Pulse Range
LS10-B	± 150 °	± 341334 pulse

5.1.3 Max. Pulse Range of Joint #3

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



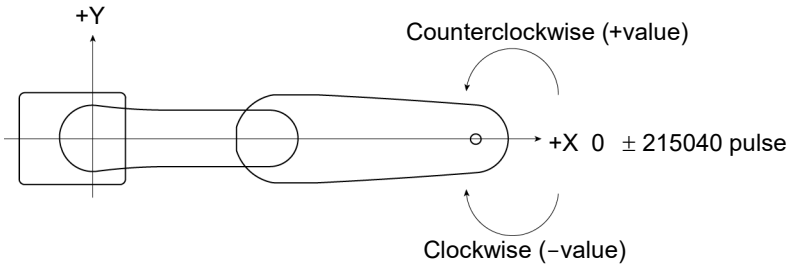
	Joint #3 Stroke	Lower Limit Pulse
LS10-B***S (Standard-model)	200 mm	– 270336 pulse
	300 mm	– 405504 pulse
LS10-B***C (Cleanroom-model)	170 mm	– 229786 pulse
	270 mm	– 364954 pulse

NOTE

For the Cleanroom-model, the motion range set with the Joint #3 mechanical stop cannot be changed.

5.1.4 Max. Pulse Range of Joint #4

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

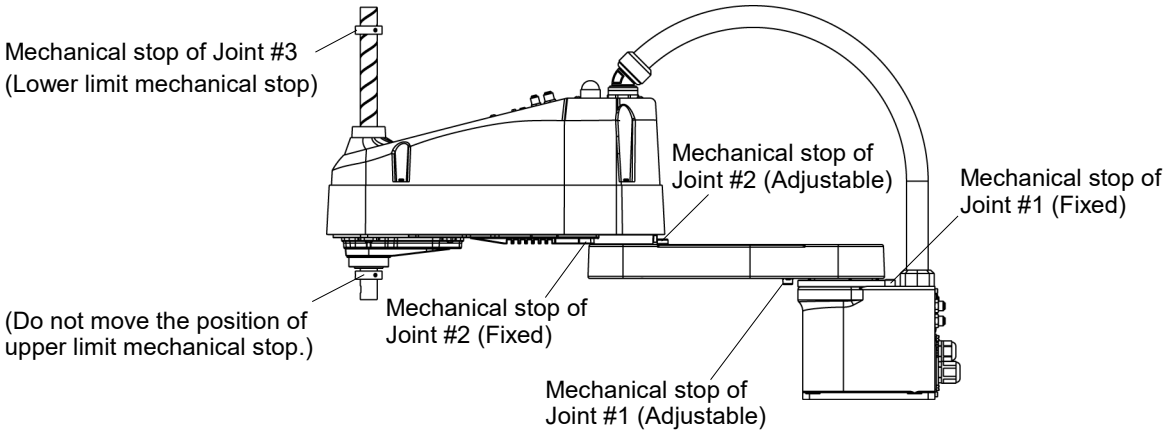


5.2 Motion Range Setting by Mechanical Stops

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

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

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

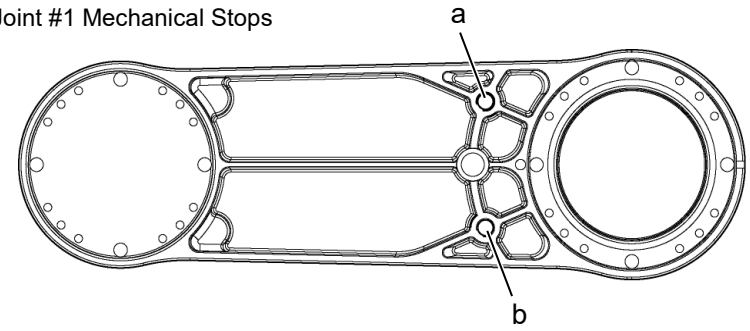


5.2.1 Setting the Mechanical Stops of Joints #1 and #2

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

Install the bolts for the mechanical stop to the following position.

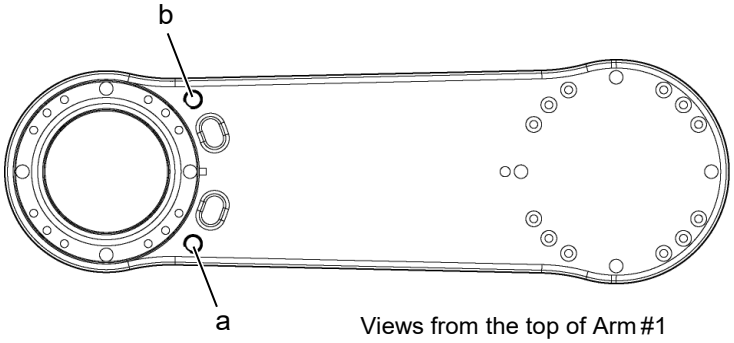
Joint #1 Mechanical Stops



Views from the bottom of Arm #1

		a	b
LS10-B	Setting Angle (°)	115	–115
	Pulse Value (pulse)	746382	–91022

Joint #2 Mechanical Stops



Views from the top of Arm #1

		a	b
LS10-B	Setting Angle (°)	125	–125
	Pulse Value (pulse)	284444	–284444

(1) Turn OFF the Controller.

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

Joint	Hexagon socket head cap bolt (fully threaded)	The number of bolts	Recommended tightening torque	Strength
1	M8 × 10	1 bolt / side	12.3 N·m (125 kgf·cm)	ISO898-1 property class 10.9 or 12.9.

(3) Turn ON the Controller.

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

NOTE

Be sure to set the pulse range inside the positions of the mechanical stop range.

Example: Using LS10-B602S
The angle of Joint #1 is set from −110 ° to +110 °.
The angle of Joint #2 is set from −110 ° to +110 °.

Epson RC+

Execute the following commands from the [Command Window].

```
>JRANGE 1, -72817, 728177      ' Sets the pulse range of Joint #1
>JRANGE 2,-250331, 250331      ' Sets the pulse range of Joint #2
>RANGE                         ' Checks the setting using Range
-72817, 728177, -250311, 250311, -270336, 0,
-215040, 215040
```

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

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

Example: Using LS10-B602S
The angle of Joint #1 is set from −110 ° to +110 °.
The angle of Joint #2 is set from −110 ° to +110 °.

Epson RC+

Execute the following commands from the [Command Window].

```
>MOTOR ON                      'Turns ON the motor
>POWER LOW                     'Enters low-power mode
>SPEED 5                       'Sets at low speeds
>PULSE -72817,0,0,0            'Moves to the min. pulse position of Joint #1
>PULSE 728177,0,0,0            'Moves to the max. pulse position of Joint #1
>PULSE 327680,-250311,0,0      'Moves to the min. pulse position of Joint #2
>PULSE 327680,250311,0,0       'Moves to the max. pulse position of Joint #2
```

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

In this example, Joint #1 is moved to 0 ° position where is close to the center of its motion range (pulse value: `327680`) when checking Joint #2.

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

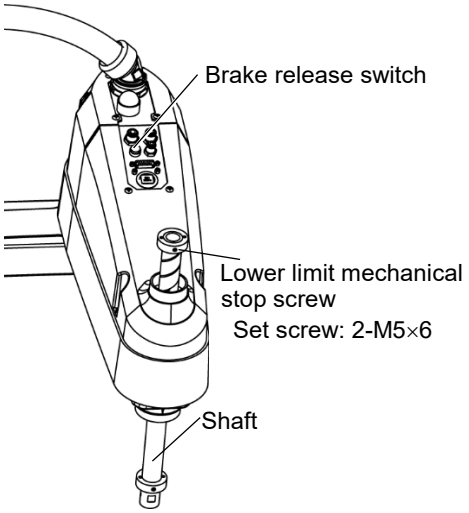
5.2.2 Setting the Mechanical Stop of Joint #3

NOTE This method applies only to the Standard-model manipulator.
For the Cleanroom-model, the motion range set with the Joint #3 mechanical stop cannot be changed.

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

(2) Push up the shaft while pressing the brake release switch.

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



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

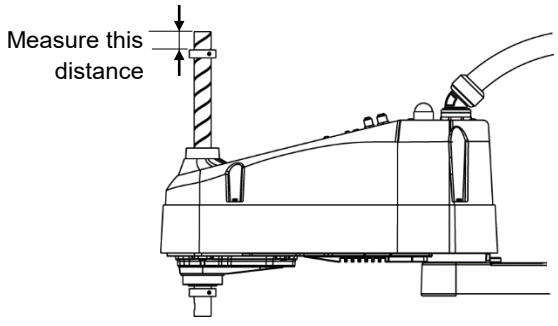
(3) Turn OFF the Controller.

(4) Loosen the lower limit mechanical stop screw (set screws: 2-M5×6).

NOTE 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 calibration point of Joint #3 is specified using the stop.

(5) The upper end of the shaft defines the maximum stroke. Move the lower limit mechanical stop down by the length you want to limit the stroke.

For example, when the lower limit mechanical stop is set at “200 mm” stroke, the lower limit Z coordinate value is “□200”. To change the value to “□180”, move the lower limit mechanical stop down “20 mm”. Use calipers to measure the distance when adjusting the mechanical stop.



(6) Firmly tighten the lower limit mechanical stop screw (set screws: 2-M5×6).

Recommended tightening torque: 3.9 N·m (39.8 kgf·cm)

(7) Turn ON the Controller.

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

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

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

Lower limit of pulse (pulse) = lower limit Z coordinate value (mm) / Resolution (mm/pulse)

** For the Joint #3 resolution,
refer to the section *Appendix A: Specifications*.

Epson RC+

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

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

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

NOTE

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

Epson RC+

Execute the following commands from the [Command Window]. Enter the value calculated in Step (9) in X.

```
>MOTOR ON         ' Turns ON the motor
>SPEED 5          ' Sets 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 "0s" with the other pulse values specifying a position where there is
                    no interference even when lowering Joint #3.)
```

5.3 Setting the Cartesian (Rectangular) Range in the XY Coordinate System of the Manipulator

(for Joints #1 and #2)

Use this method to set the upper and lower limits of the X and Y coordinates.

This setting is only enforced by software. Therefore, it does not change the physical range. The maximum physical range is based on the position of the mechanical stops.

Epson RC+

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

5.4 Standard Motion Range

The following “motion range” diagrams show the standard (maximum) specification. When each Joint motor is under servo control, the center of Joint #3’s (shaft’s) lowest point moves in the areas shown in the figure.

“Area limited by mechanical stop” is the area where the center of Joint #3’s lowest point can be moved when each joint motor is not under servo control.

“Mechanical stop” sets the limited motion range so that the center of Joint #3 cannot move beyond the area mechanically.

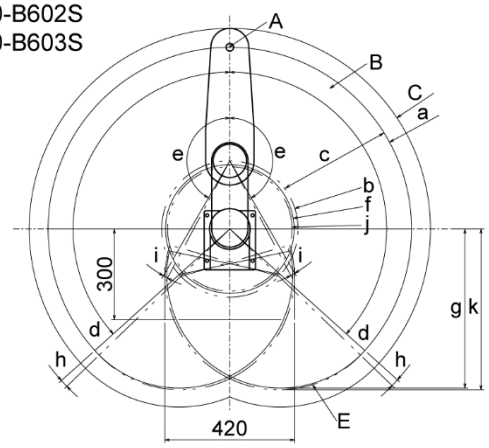
“Maximum space” is the area that contains the farthest reach of the arms. If the maximum radius of the end effector is over 60 mm, add the “Area limited by mechanical stop” and “radius of the end effector”. The total value is specified as the maximum area.

A	Center of Joint #3
B	Motion range
C	Maximum range
D	Base mounting face
E	Area limited by a mechanical stop

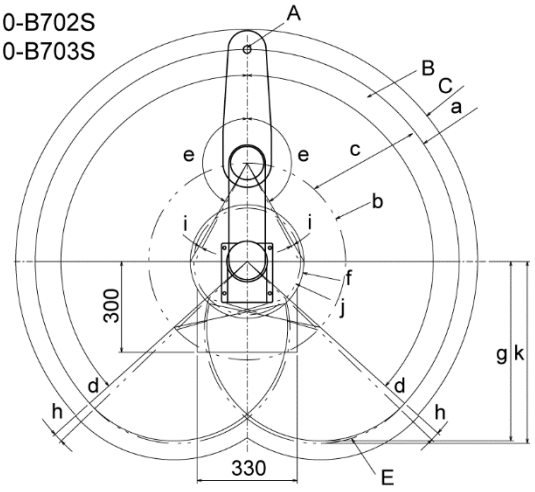
			LS10-B60**	LS10-B70**	LS10-B80**
a	Arm #1 + Arm #2 length [mm]		600	700	800
b	Arm #1 length [mm]		225	325	425
c	Arm #2 length [mm]		375		
d	Joint #1 motion angle [°]		132		
e	Joint #2 motion angle [°]		150		
f	(Motion range)		212	188	213
g	(Motion range at the rear)		526	592	659
h	Angle of the Joint #1 mechanical stop [°]		2.0		
i	Angle of the Joint #2 mechanical stop [°]		2.0		
j	(Mechanical stop area)		206	176	200
k	(Mechanical stop area at the rear)		531	601	670
m	(Joint #3 motion range)	LS10-B**2S	200		
		LS10-B**3S	300		
		LS10-B**2C	170		
		LS10-B**3C	270		
n	(Distance from the base mounting face)	LS10-B**2*	53		
		LS10-B**3*	153		
p	(Joint #3 mechanical stop area upper end)	LS10-B***S	4		
		LS10-B***C	1		
q	(Joint #3 mechanical stop area lower end)		3		

Standard-model LS10-B***S

LS10-B602S
LS10-B603S



LS10-B702S
LS10-B703S



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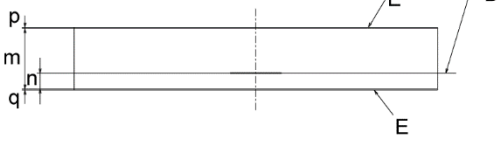

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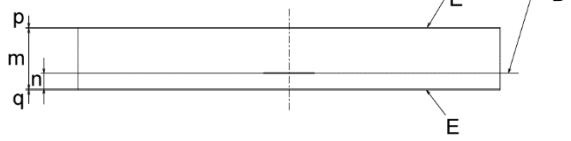

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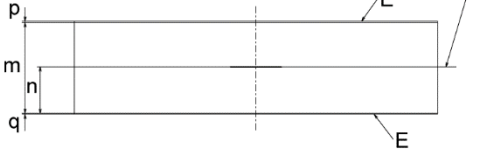

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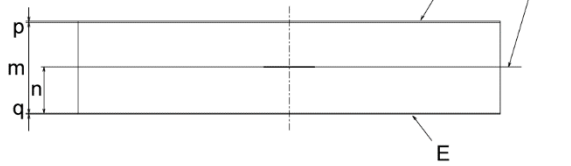
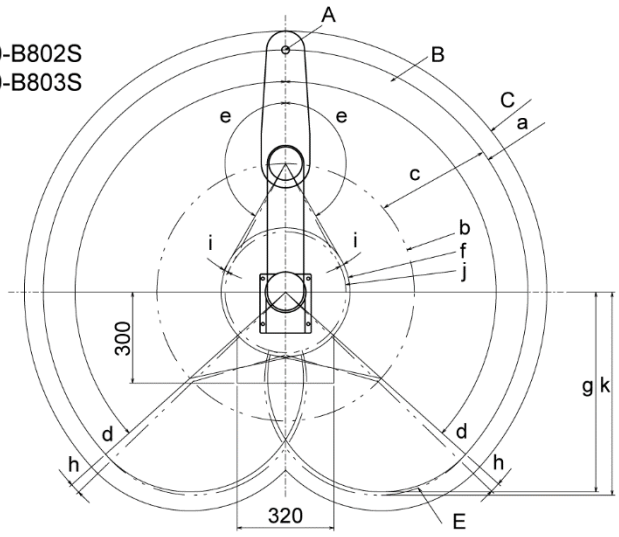


LS10-B802S
LS10-B803S



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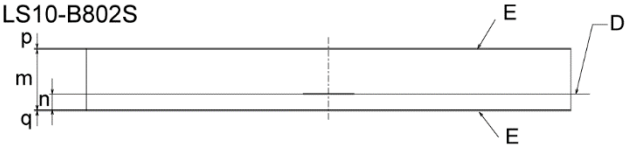

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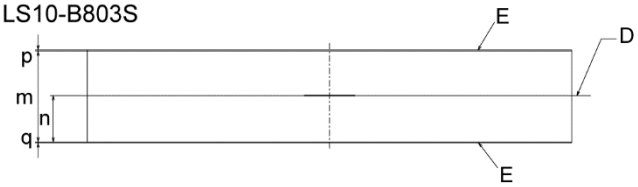
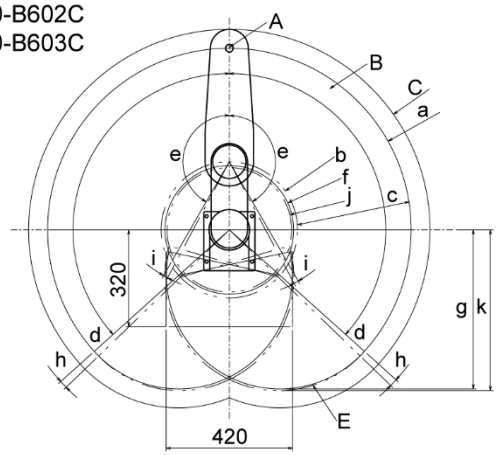
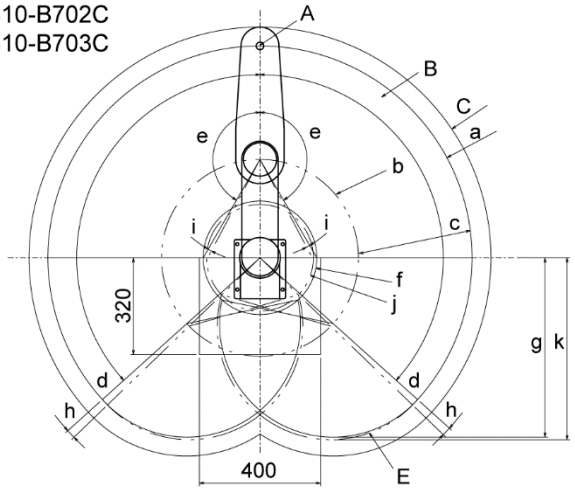


Cleanroom-model LS10-B***C

LS10-B602C
LS10-B603C



LS10-B702C
LS10-B703C



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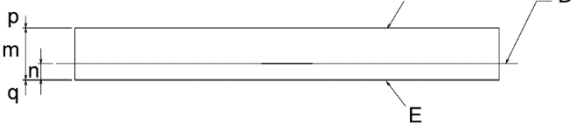

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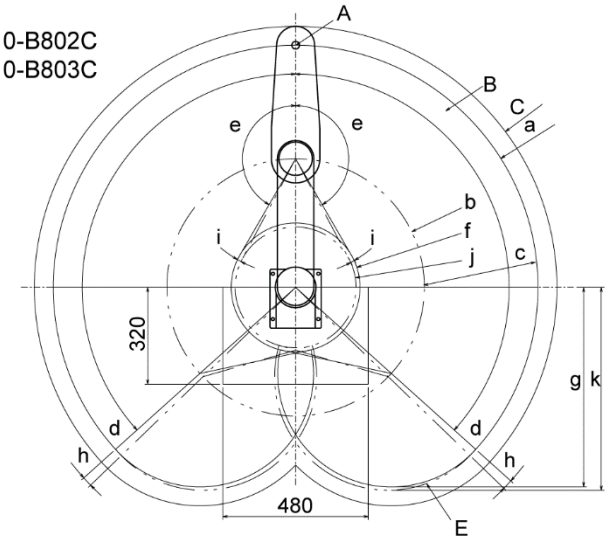

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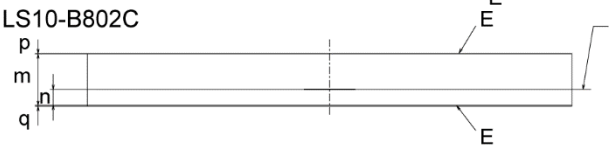

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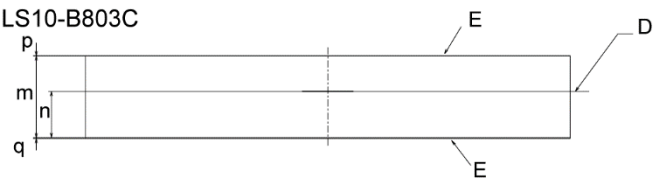


LS20-B Manipulator

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

1. Safety

Unpacking and transportation of the Manipulators and robotic equipment shall be performed by personnel who has taken robot system training held by us and suppliers and should conform to all national and local codes.

Please read this manual and other related manuals before installing the robot system or before connecting cables.

Keep this manual handy for easy access at all times.

1.1 Conventions

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

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

1.2 Design and Installation Safety

This product is intended for transporting and assembling parts in a safely isolated area.
Design and installation of robot system shall be performed by personnel who has taken robot system training held by us and suppliers.
To ensure safety, a safeguard must be installed for the robot system. For details on the safeguard, refer to the *Installation and Design Precautions* in the *Safety* chapter of the *Epson RC+ User's Guide*.

The following items are safety precautions for design personnel:

 WARNING	■ Personnel who design and/or construct the robot system with this product must read the "*Safety Manual*" to understand the safety requirements before designing and/or constructing the robot system. Designing and/or constructing the robot system without understanding the safety requirements is extremely hazardous, may result in serious bodily injury and/or severe equipment damage to the robot system, and may cause serious safety problems. ■ The Manipulator and the Controller must be used within the environmental conditions described in their respective manuals. This product has been designed and manufactured strictly for use in a normal indoor environment. Using the product in an environment that exceeds the specified environmental conditions may not only shorten the life cycle of the product but may also cause serious safety problems. ■ The robot system must be used within the installation requirements described in the manuals. Using the robot system outside of the installation requirements may not only shorten the life cycle of the product but also cause serious safety problems. ■ When designing or installing a robot system, wear at least the following protective gear. Working without protective gear may cause serious safety problems. Work clothes suitable for work Helmet Safety shoes

Further precautions for installation are mentioned in the chapter *3. Environments and Installation.* Please read this chapter carefully to understand safe installation procedures before installing the robots and robotic equipment.

1.2.1 Strength of the Ball Screw Spline

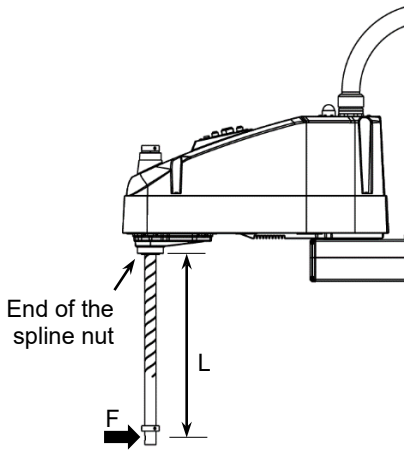
If a load exceeding the allowable value is applied to the ball screw spline, it may not work properly due to deformation or breakage of the shaft.

If the ball screw spline is applied the load exceeding the allowable value, it is necessary to replace the ball screw spline unit.

The allowable loads differ depending on distance where the load is applied to.
For calculating the allowable load, see the calculation formula below.

[Allowable bending moment]
$M=50,000\ N{\cdot}mm$
[Moment]
$M=F{\cdot}L=110{\cdot}400=44,000\ N{\cdot}mm$

Example:
If 110 N(11.2kgf) load is applied
at 400 mm from
the end of the spline nut



1.3 Operation Safety

The following items are safety precautions for qualified Operator personnel:

 WARNING	■ Please carefully read the *Safety Requirements* in the "*Safety Manual"* before operating the robot system. Operating the robot system without understanding the safety requirements is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system. ■ Do not enter the operating area of the Manipulator while the power to the robot system is turned ON. Entering the operating area with the power ON is extremely hazardous and may cause serious safety problems as the Manipulator may move even if it seems to be stopped. ■ Before operating the robot system, make sure that no one is inside the safeguarded area. The robot system can be operated in the mode for teaching even when someone is inside the safeguarded area. The motion of the Manipulator is always in restricted (low speed and low power) status to secure the safety of an operator. However, operating the robot system while someone is inside the safeguarded area is extremely hazardous and may result in serious safety problems in case that the Manipulator moves unexpectedly. ■ Immediately press the Emergency Stop switch whenever the Manipulator moves abnormally while the robot system is operated. Continuing the operation while the Manipulator moves abnormally is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system.

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

CAUTION	■ Whenever possible, only one person should operate the robot system. If it is necessary to operate the robot system with more than one person, ensure that all people involved communicate with each other as to what they are doing and take all necessary safety precautions. ■ Joint #1, #2, and #4: If the joints are operated repeatedly with the operating angle less than 5 degrees, they may get damaged early because the bearings are likely to cause oil film shortage in such situation. To prevent early breakdown, move each joint larger than 50 degrees for about once an hour. Joint #3: If the up-and-down motion of the hand is less than 50 mm, move the joint a half of the maximum stroke for about once an hour. ■ Vibration (resonance) may occur continuously in low speed Manipulator motion (Speed: approx. 5 to 20%) depending on combination of Arm orientation and end effector load. Vibration arises from natural vibration frequency of the Arm and can be controlled by following measures. Changing Manipulator speed Changing the teach points Changing the end effector load

1.4 Emergency Stop

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

Avoid pressing the Emergency Stop switch unnecessarily while the Manipulator is running normally.

- The Manipulator may hit the peripheral equipment.
  When you press the Emergency Stop switch, the operating trajectory until the robot system stops is different from that in normal operation.
- The life of the brakes will be shortened.
  The brakes are locked and the brake friction plate is worn.
  Normal brake life cycle: About 2 years (when the brakes are used 100 times/day)
  However, the rough normal relay life is approximately 20,000 times. If you press the emergency stop switch unnecessarily, the life of the relay will be shortened.
- Impact is applied on the reduction gear unit, and it may result in the short life of the reduction gear unit.

To place the system in emergency mode during normal operation, press the Emergency Stop switch when the Manipulator is not moving. Refer to the Controller manual for instructions on how to wire the Emergency Stop switch circuit.

Do not turn OFF the Controller while the Manipulator is operating.
If you attempt to stop the Manipulator in emergency situations, make sure to stop the Manipulator using the E-STOP of the Controller.

If the Manipulator is stopped by turning OFF the Controller while it is operating, following problems may occur:
Reduction of the life and damage of the reduction gear unit
Position gap at the joints

In addition, if the Controller was forced to be turned OFF by blackouts and the like while the Manipulator is operating, make sure to check the following points after power restoration:
Whether or not the reduction gear is damaged
Whether or not the joints are in their proper positions
If there is a position gap, perform calibration by referring to the *LS-B series Maintenance Manual – LS20-B Manipulator Calibration*.

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

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

To check brake problems, refer to the *Regular Inspection 2. LS20-B Manipulator Regular Inspection.*

NOTE

Test pulse cannot be used with the emergency stop input of this model.

Stopping distance in emergency

The operating Manipulator cannot stop immediately after the Emergency Stop switch is pressed. In addition, stopping time and stopping distance vary by following factors:

Hand weight	WEIGHT Setting	ACCEL Setting
Workpiece weight	SPEED Setting	Posture etc.

For stopping time and stopping distance of the Manipulator, refer to "*Appendix B: Stopping Time and Stopping Distance in Emergency*".

1.5 Safeguard

To ensure safe operation, install a safety system using safety doors, light curtains, safety floor mats, etc.

When a closed safeguard is open during robot motion, the safeguard interlock function operates. The robot stops immediately and enters into pause state. Then, all robot motors are turned OFF. The descriptions below explain how the safeguard input works.

Safeguard open : The robot stops immediately, motors are turned OFF, and further operation is impossible until either the safeguard is closed or TEACH or TEST mode is turned ON and the enable circuit is engaged.

Safeguard closed : The robot can automatically operate in unrestricted (high power) state.

Do not open the safeguard unnecessarily while motor is ON. Frequent safeguard inputs affect the life of the relay.
Rough normal relay life: Approximately 20,000 timesFor the safeguard, do not use the E-STOP circuit.

For details of wiring instructions, refer to the following manual:

RC90 series Manual - 9. EMERGENCY

For details of Safeguard, refer to the following manual:

RC90 series Manual - 2.7.1 Connection to EMERGENCY Connector

NOTE

Test pulse cannot be used with the safeguard input of this model.

WARNING

- The EMERGENCY connector on the controller has a safeguard input circuit to connect the safety device interlock switch. To protect operators working near the robot, be sure to connect the interlock switch and make sure that it works properly.
- The time to stop the robot and the stopping distance by the safeguard interlock function will change depending on the conditions of use. Be sure to confirm that safety is ensured according to the installation environment of the robot.

Stopping distance when the safeguard is opened

The Manipulator in operation cannot stop immediately after the safeguard is opened. In addition, stopping time and stopping distance vary by following factors:

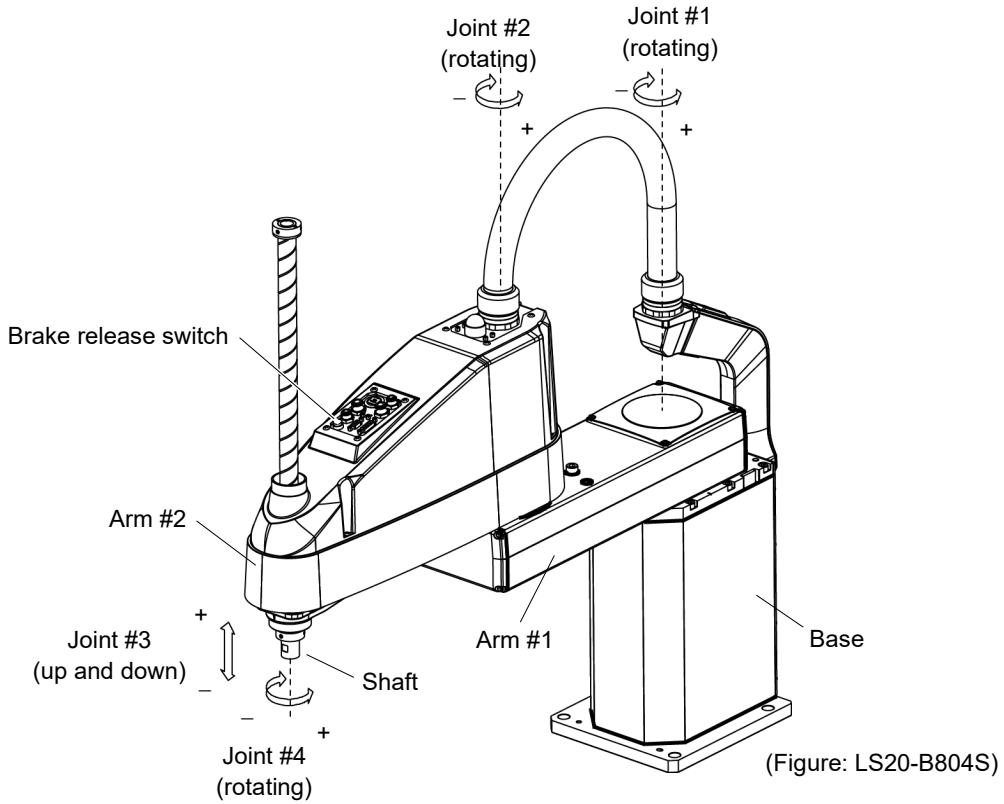
Hand weight	WEIGHT Setting	ACCEL Setting
Workpiece weight	SPEED Setting	Posture etc.

For stopping time and stopping distance of the Manipulator, refer to "*Appendix C: Stopping Time and Stopping Distance When the Safeguard is Opened*".

1.6 Emergency Movement without Drive Power

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

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



(Figure: LS20-B804S)

NOTE

The brake release switch affects both Joints #3 and #4. When the brake release switch is pressed in emergency mode, the brake for both Joints #3 and #4 are released simultaneously. Be careful of the shaft falling and rotating while the brake release switch is pressed because the shaft may be lowered by the weight of an end effector.

1.7 ACCELS Setting for CP Motions

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.

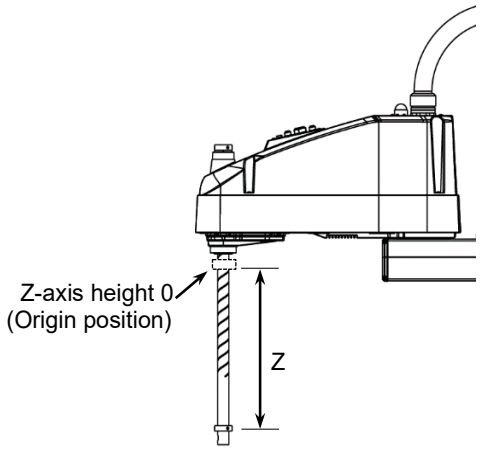
NOTE ☞ If the ACCELS settings are not properly configured, the following problem occurs.

- Shortened lifespan and damage to the ball screw spline
- Stop with error (Error code: 4002)

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

Maximum ACCELS correction values by Z-axis height and tip load

Z-axis height (mm)	Tip load			
	5kg or less	10kg or less	15kg or less	20kg or less
0 > Z >= –100	10000 or less	10000 or less	10000 or less	9000 or less
–100 > Z >= –200			7000 or less	5500 or less
–200 > Z >= –300		7500 or less	5000 or less	3500 or less
–300 > Z >= –420		5500 or less	3500 or less	2500 or less



If the Manipulator is operated in CP motion with the wrong set values, make sure to check the following.

- Whether or not the ball screw spline shaft is deformed or bent

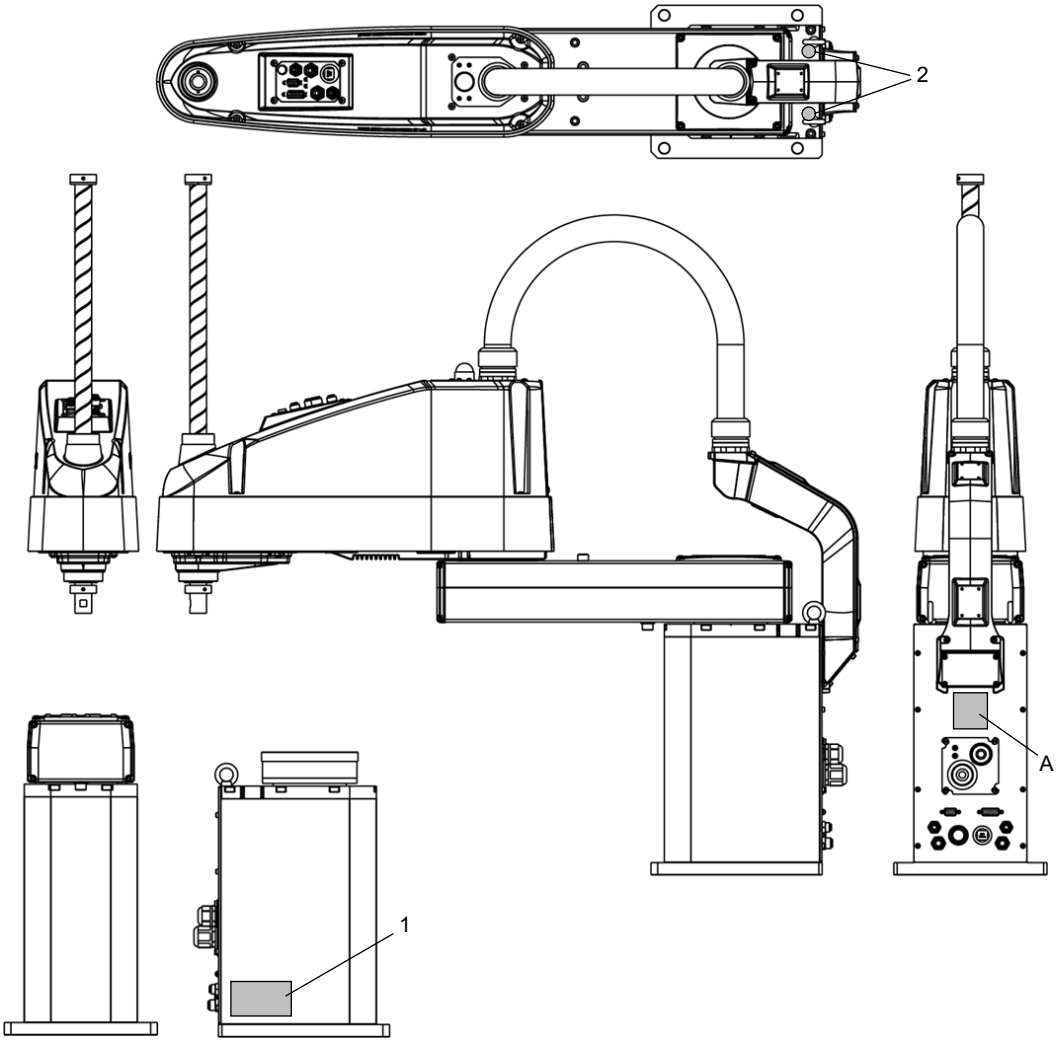
1.8 Warning Labels

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

Location	Warning Label	NOTE
A		Hazardous voltage exists while the Manipulator is ON. To avoid electric shock, do not touch any internal electric parts.

Location	Label	NOTE
1	-	Indicates Product name, Model name, Manipulator's serial No., Local codes information, Specification, Manufacturer, Importer, Date of manufacture, Country of manufacture, etc. For details, refer to the attached label.
2		Indicates position of screw hole for eyebolt mounting

LS20-B



1.9 Response for Emergency or Malfunction

1.9.1 Collision

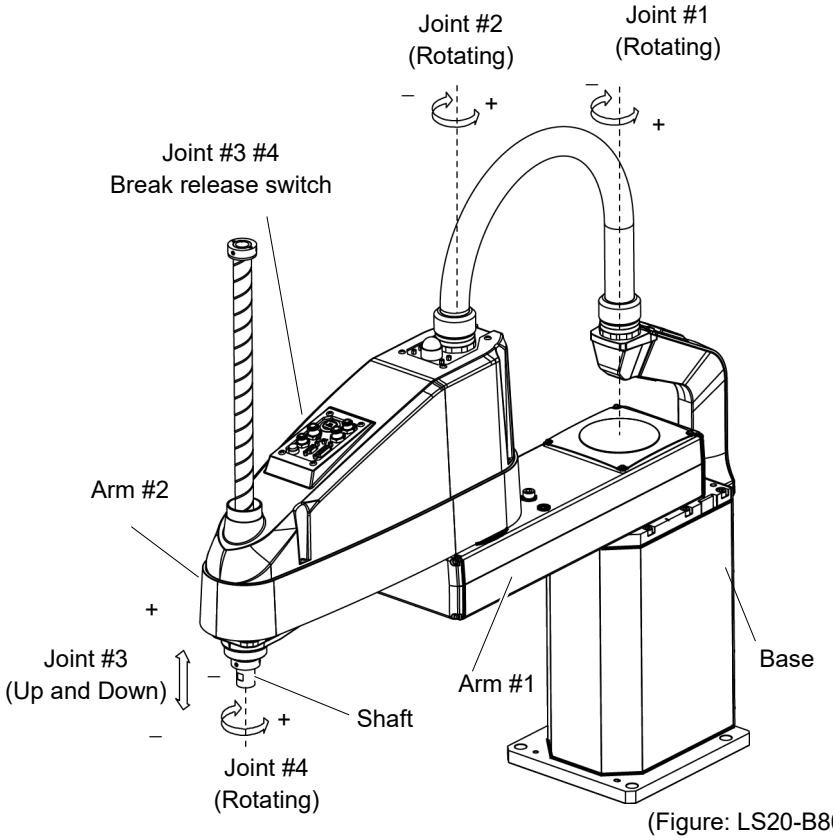
When the Manipulator collides with a mechanical stopper or peripheral device etc., discontinue use and contact the supplier.

1.9.2 Getting body caught in Manipulator

When the operator is caught between the Manipulator and a mechanical part such as a base table, press the emergency stop switch to release the brake on the subject arm, and then move the arm by hand.

Get body caught in the arms:
The break is not working. Move the arms manually.

Get body caught in the shafts:
The break is working. Press the break release switch and move the shafts.

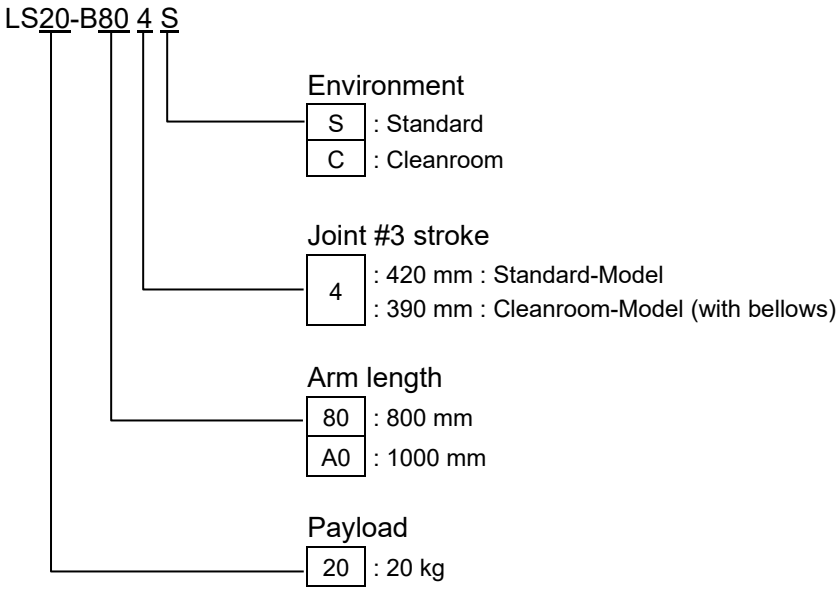


(Figure: LS20-B804S)

CAUTION	■ While pressing the break release switch, not only Joint #3 but also Joint #4 may move due to its own weight. Be careful of the shaft falling or rotating.

2. Specifications

2.1 Model Number



Environment

Cleanroom-model

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

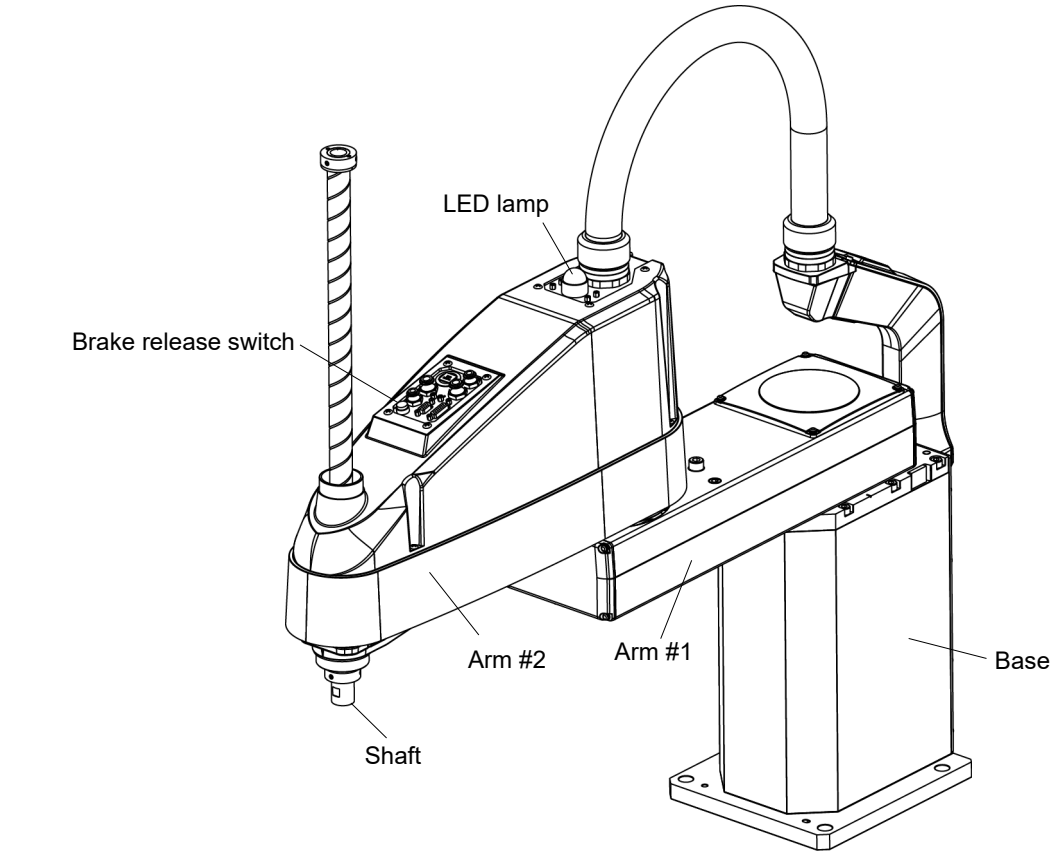
For details on the specifications, refer to *Appendix A: Specifications*.

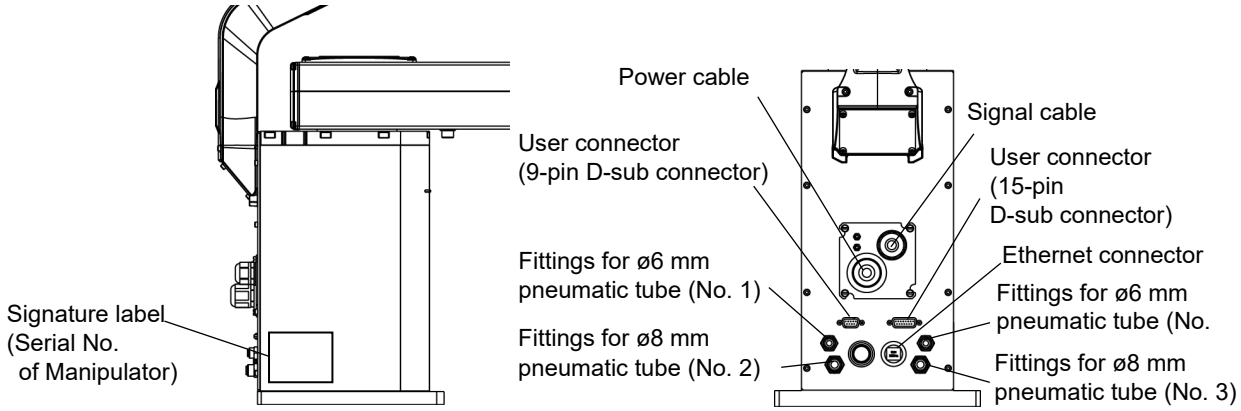
Models

Payload	Arm length	Environment	Joint #3 stroke	Model Number
20 kg	800 mm	Standard	420 mm	LS20-B804S
		Cleanroom	390 mm	LS20-B804C
	1000 mm	Standard	420 mm	LS20-BA04S
		Cleanroom	390 mm	LS20-BA04C

2.2 Part Names and Outer Dimensions

2.2.1 Standard-Model (LS20-B**4S)

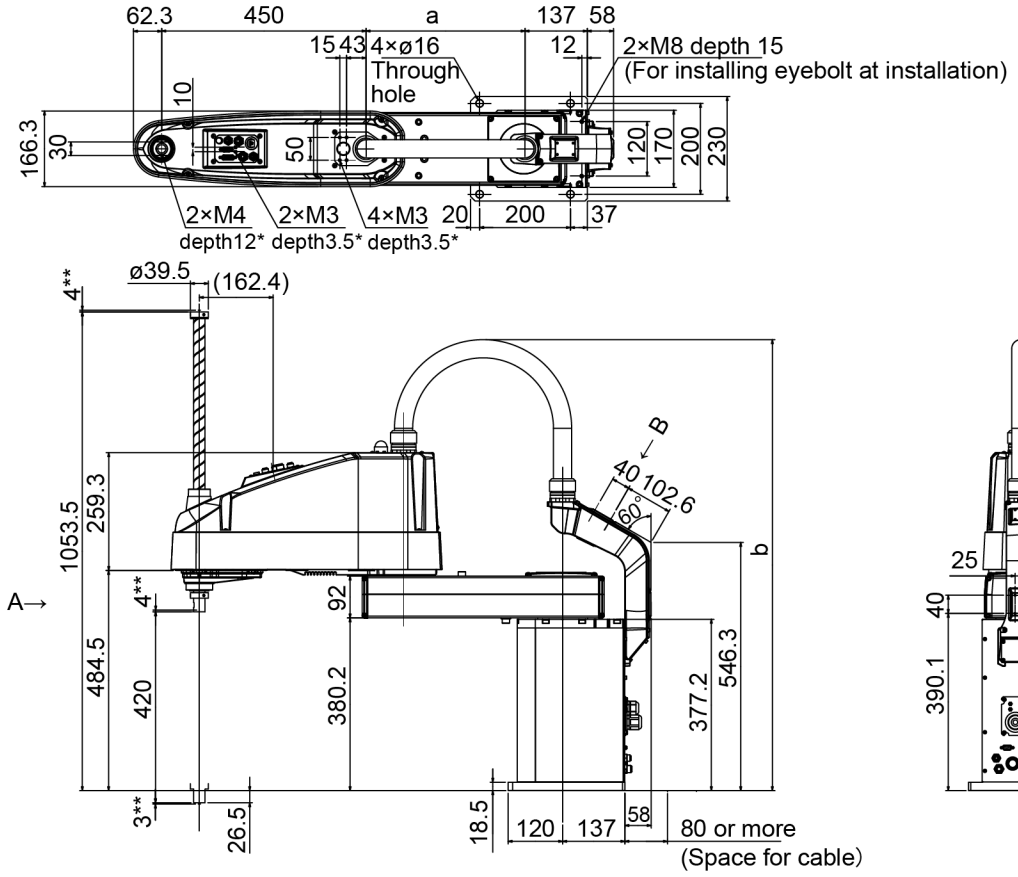


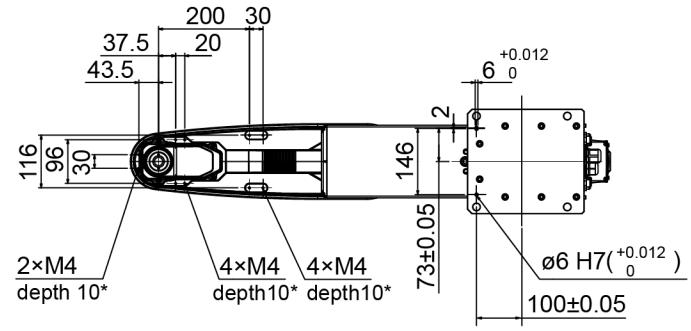


NOTE

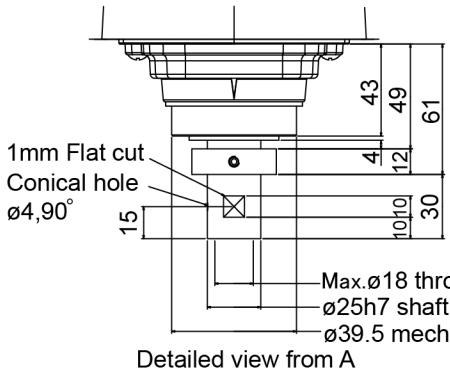
- The brake release switch affects both Joints #3 and #4. When the brake release switch is pressed in emergency mode, the brakes for both Joint #3 and Joint #4 are released simultaneously.
- While the LED lamp is on, current is being applied to the manipulator. Performing any work with the power ON is extremely hazardous and it may result in electric shock and/or improper function of the robot system. Make sure to turn OFF the controller power before the maintenance work.

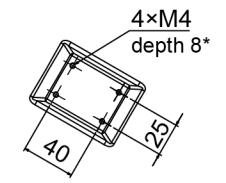
Standard-Model (LS20-B**4S)





	LS20-B804S	LS20-BA04S
a	350	550
b	Max.1000	Max.1100



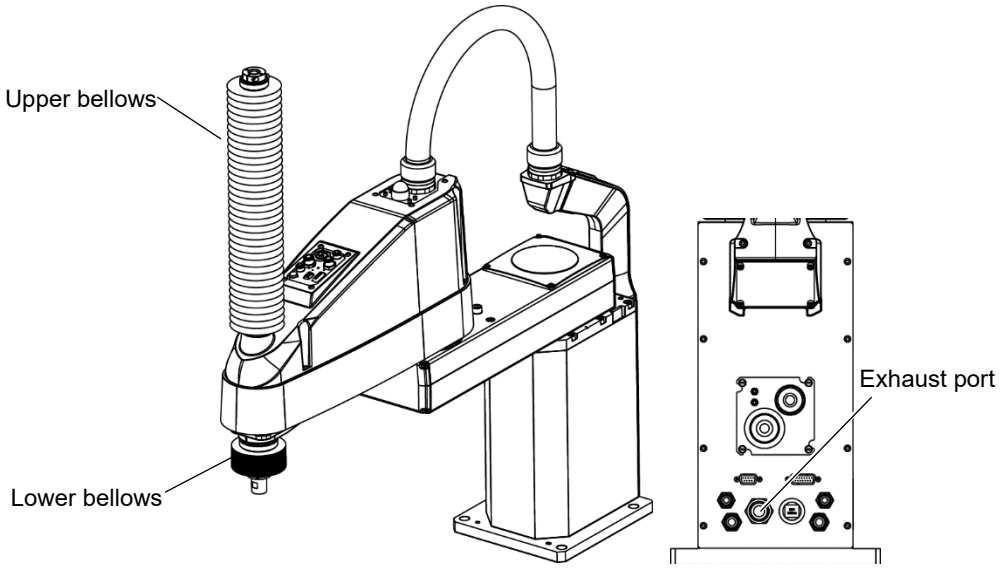


*: User tap

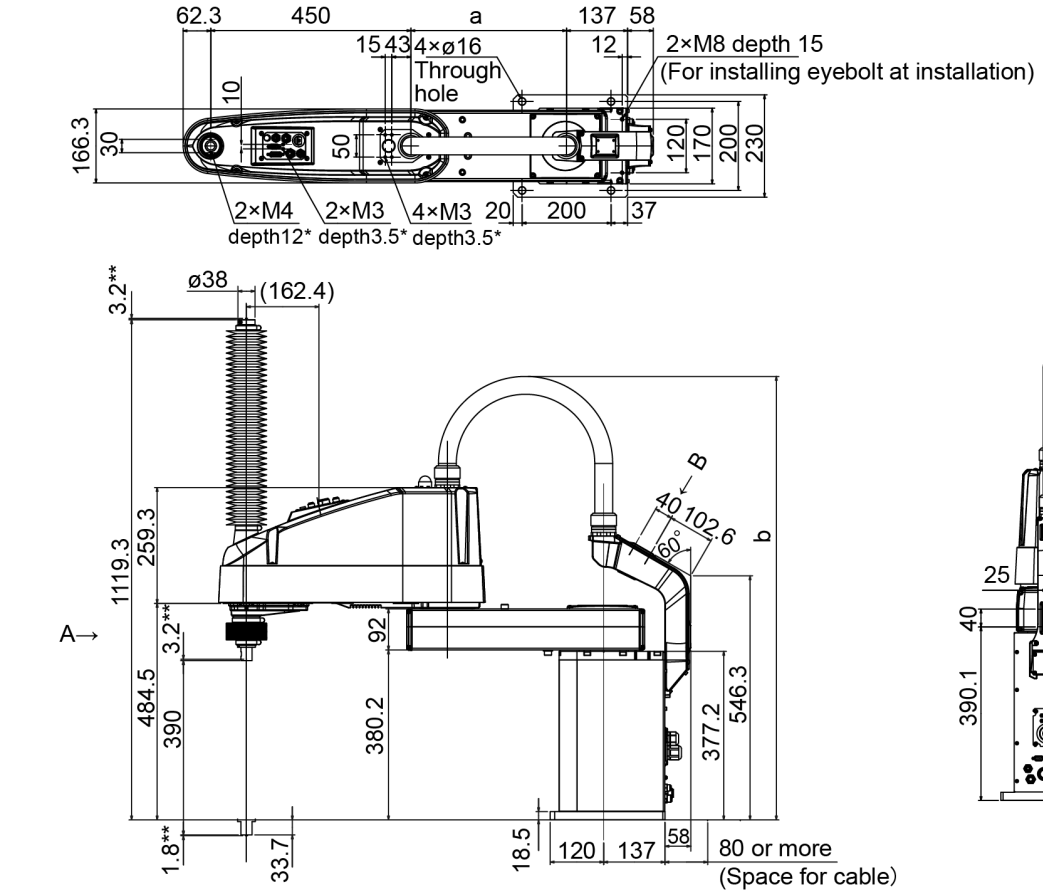
**: Indicates mechanical stop position

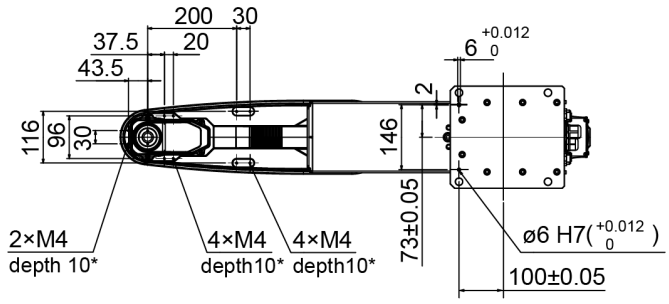
2.2.2 Cleanroom-Model (LS20-B**4C)

The following figures show the additional parts and specifications for Cleanroom-model when compared with the Standard-model in appearance.

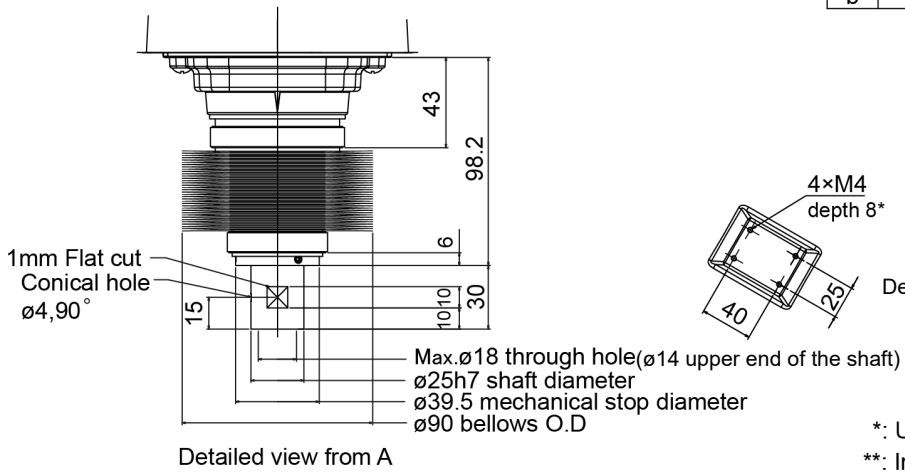


Cleanroom-Model (LS20-B**4C)





	LS20-B804C	LS20-BA04C
a	350	550
b	Max.1000	Max.1100



*: User tap

**: Indicates mechanical stop position

2.3 Specifications

For details of each manipulator specifications, refer to *Appendix A: Specifications.*

2.4 How to Set the Model

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

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

NOTE

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

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

The Manipulator model can be set from software.
Refer to the chapter *Robot Configuration* in *Epson RC+ User's Guide*.

3. Environments and Installation

Designing and installation of the Manipulators and robotic equipment shall be performed by personnel who has taken robot system training held by us and suppliers and should conform to all national and local codes.

3.1 Environmental Conditions

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

Item	Conditions
Ambient temperature *	5 to 40°C
Ambient relative humidity	10 to 80% (no condensation)
Fast transient burst noise	1 kV or less (Signal wire)
Electrostatic noise	4 kV or less
Altitude	1000 m or lower
Environment	- Install indoors. - Keep away from direct sunlight. - Keep away from dust, oily smoke, salinity, metal powder or other contaminants - Keep away from flammable or corrosive solvents and gases - Keep away from water and oil. - Keep away from shocks or vibrations. - Keep away from sources of electric noise. - Keep away from explosive area - Keep away from a large quantity of radiation

NOTE

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

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

When the product is used in a low temperature environment around the minimum temperature of the product specification, or when the product is suspended for a long time on holidays or at night, a collision detection error may occur due to the large resistance of the drive unit immediately after the start of operation. In such a case, it is recommended to warm up for about 10 minutes.

Special Environmental Conditions

The surface of the Manipulator has general oil resistance. However, if your requirements specify that the Manipulator must withstand certain kinds of oil, please contact the supplier of your region.

Rapid change in temperature and humidity can cause condensation inside the Manipulator.

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

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

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

 CAUTION	■ When cleaning the Manipulator, do not rub it strongly with alcohol or benzene. It may lose luster on the coated face.

3.2 Base Table

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

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

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

	LS20-B
Max. reaction torque on the horizontal plate	1000 N·m
Max. horizontal reaction force	7500 N
Max. vertical reaction force	2000 N

The threaded holes required for mounting the Manipulator base are M12. Use mounting bolts with specifications conforming to ISO898-1 property class: 10.9 or 12.9.
For dimensions, refer to *3.3 Mounting Dimensions*.

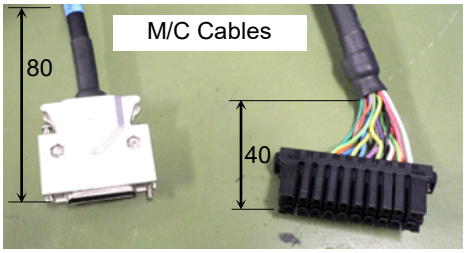
The plate for the Manipulator mounting face should be 20 mm thick or more and made of steel to reduce vibration. The surface roughness of the steel plate should be 25 µm or less.

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

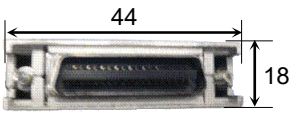
The Manipulator installation surface should have a flatness of 0.5 mm or less and an inclination of 0.5 ° or less. If the flatness of the installation surface is improper, the base may be damaged, or the robot may not fully show its performance.

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

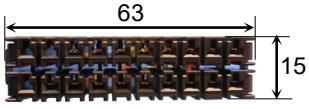
If you are passing cables through the holes on the base table, see the figures below.



(Unit : mm)



Signal Cable Connector



Power Cable Connector

NOTE

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

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

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

3.3 Mounting Dimensions

The maximum space (R) includes the radius of the end effector. If it exceeds 60 mm, define the radius as the distance to the outer edge of maximum space.
If a camera or solenoid valve extends outside of the arm, set the maximum range including the space that they may reach.

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

Space for teaching

Space for maintenance and inspection
(Ensure a space to open the covers and plates for maintenance.)

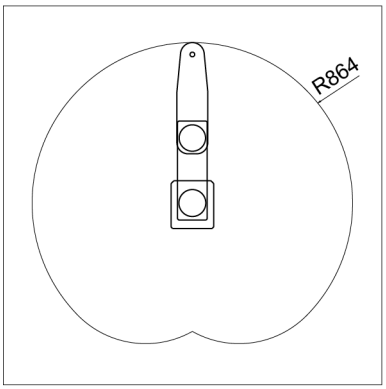
Space for cables

NOTE

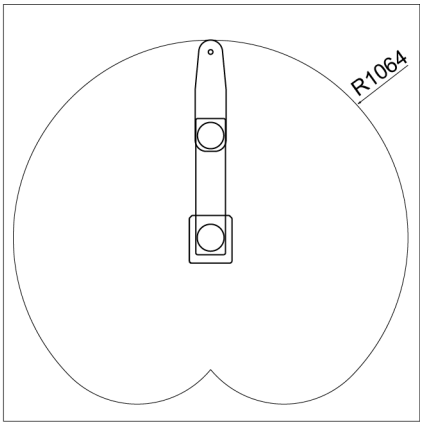
When installing the cable, be sure to maintain sufficient distance from obstacles.
For the minimum bend radius of the MC cable, refer to "Appendix A: LS20-B Specifications".

In addition, leave enough space for other cables so that they are not bent forcibly.

Ensure distance to the safeguard from the maximum motion range is more than 100 mm.



LS20-B804*

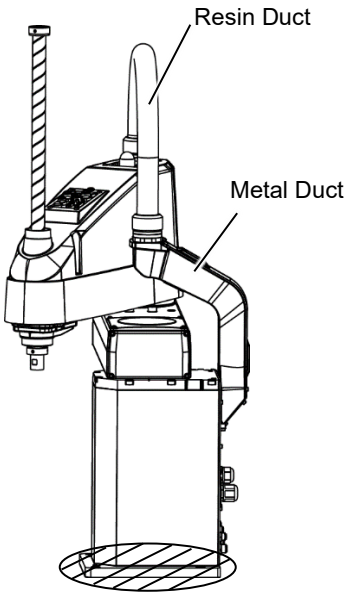


LS20-BA04*

3.4 Unpacking and Transportation

Transportation and installation of the Manipulators and robotic equipment shall be performed by personnel who has taken robot system training held by us and suppliers and should conform to all national and local codes.

WARNING	■ Only authorized personnel should perform sling work and operate a crane and a forklift. When these operations are performed by unauthorized personnel, it is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system. ■ Stabilize the Manipulator with your hands when hoisting it. Unstable hoisting is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system as the fall of the Manipulator.

CAUTION	■ Using a cart or similar equipment, transport the Manipulator in the same manner as it was delivered. ■ After removing the bolts securing the Manipulator to the delivery equipment, the Manipulator can fall. Be careful not to get hands or fingers caught. ■ The arm is secured with a wire tie. Leave the wire tie secured until you finish the installation so as not to get hands or fingers caught. ■ To transport the Manipulator, secure it to the delivery equipment or have at least 2 people to hold it by hand. Also, do not hold the bottom of the base (the shaded area in the figure). Holding the area by hand is extremely hazardous and may cause your hands and fingers caught. LS20-B804*: approx. 48 kg: 105.8 lbs. LS20-BA04*: approx. 51 kg: 112.5 lbs. ■ Do not hold the metal duct and the resin duct when transporting the Manipulator. Doing so may damage them.  (Figure: LS20-B804S)

NOTE When transporting the Manipulator for a long distance, secure it to the delivery equipment directly so that the Manipulator never falls over.
If necessary, pack the Manipulator in the same style as it was delivered.

Transport the Manipulator following the instructions below:

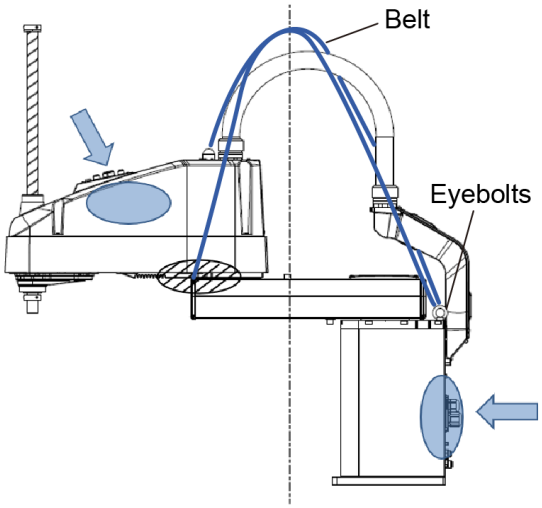
(1) Attach the eyebolts to the upper side of the Base.

(2) Turn the Arm #1 to face the front.

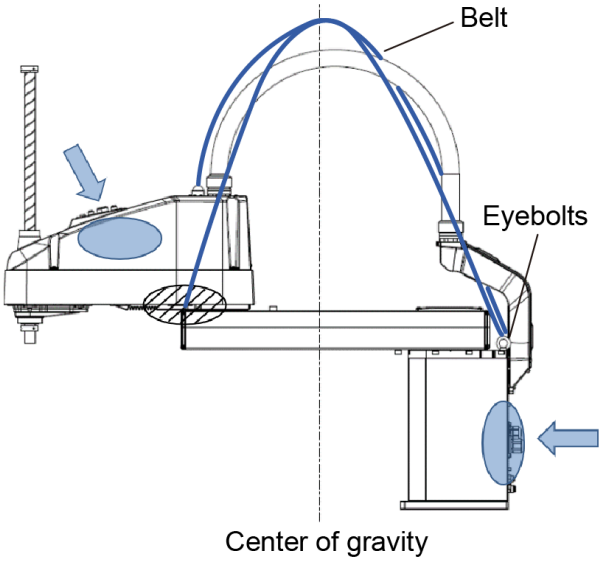
(3) Pass the belts under Arm #2 and the eyebolts.

(4) Hoist the Manipulator slightly so that it does not fall over. Then, remove the bolts securing the Manipulator to the delivery equipment or a pallet.

(5) Hoist the Manipulator attaching the hands at the positions indicated by arrows so that it can keep the balance. Then, move the Manipulator to the base table.



LS20-B804*



LS20-BA04*

3.5 Installation Procedure

Installation of the Manipulators and robotic equipment shall be performed by personnel who has taken robot system training held by us and suppliers and should conform to all national and local codes.

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

3.5.1 Standard-Model

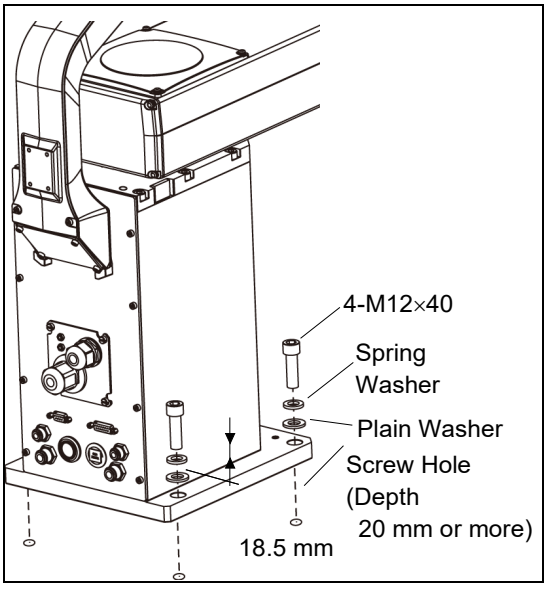
CAUTION	■ Install the Table Top Mounting Manipulator with two or more people. The Manipulator weights are as follows. Be careful not to get hands, fingers, or feet caught and/or have equipment damaged by a fall of the Manipulator. LS20-B804*: approx. 48 kg: 105.8 lbs. LS20-BA04*: approx. 51 kg: 112.5 lbs.

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

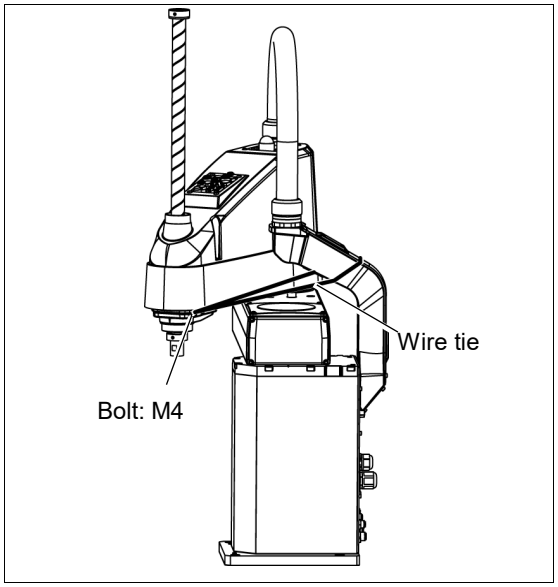
NOTE

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

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



(2) Using nippers, cut off the wire tie binding the arm. Remove the bolt.

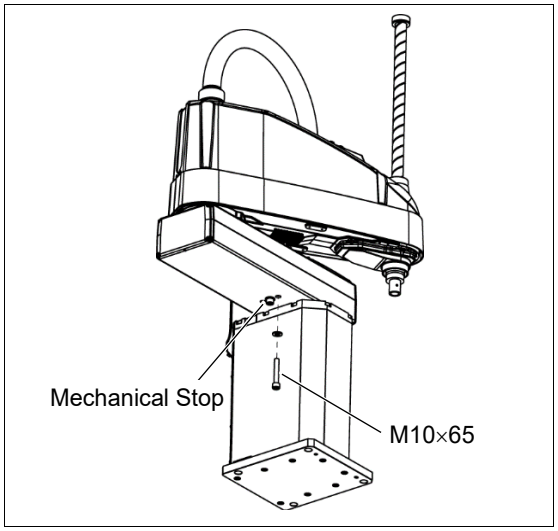


(3) Remove the screw for fixing the arm.

NOTE

The removed screw will be necessary when transporting the Manipulator.
Keep it with the arm lock which is supplied at shipment.
Be careful not to lose the screw.

Do not remove the mechanical stop.



3.5.2 Cleanroom-Model

(1) Unpack the Manipulator outside of the clean room.

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

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

(4) Transport the Manipulator to the cleanroom.

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

(6) Connect an exhaust tube to the exhaust port.

3.6 Connecting the Cables

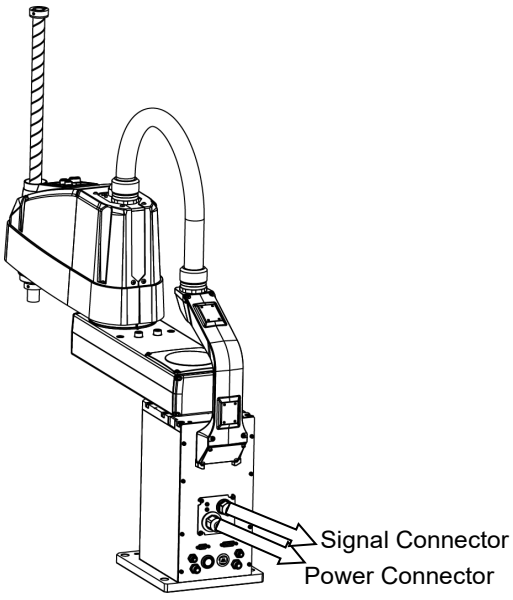
WARNING	■ To shut off power to the robot system, disconnect the power plug from the power source. Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source. ■ Before performing any replacement procedure, turn OFF the Controller and related equipment, and then disconnect the power plug from the power source. Performing any replacement procedure with the power ON is extremely hazardous and may result in electric shock and/or malfunction of the robot system. ■ Be sure to connect the cables properly. Do not allow unnecessary strain on the cables. (Do not put heavy objects on the cables. Do not bend or pull the cables forcibly.) The unnecessary strain on the cables may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system. ■ Grounding the manipulator is done by connecting with the controller. Ensure that the controller is grounded and the cables are correctly connected. If the ground wire is improperly connected to ground, it may result in the fire or electric shock.

CAUTION	■ When connecting the Manipulator to the Controller, make sure that the serial numbers on each equipment match. Improper connection between the Manipulator and Controller may not only cause improper function of the robot system but also serious safety problems. The connection method varies with the Controller used. For details on the connection, refer to the *Controller manual*.

When the Manipulator is a Cleanroom-model, be aware of the followings.
For the Manipulator of Cleanroom-model, use it with an exhaust system.
For details, refer to *Appendix A: Specifications.*

Cable Connections

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



NOTE

Connect and disconnect M/C cable

In LS20-B series, you can connect and disconnect the M/C cable to/from the Manipulator easily.

For details, refer to *LS-B series Maintenance Manual LS20-B Manipulator 4.3 Replacing M/C Cable.*

3.7 User Wires and Pneumatic Tubes

CAUTION

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

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

Electrical Wires

Rated Voltage	Allowable Current	Wires	Nominal Sectional Area	Note
AC/DC30V	1A	15	0.211 mm^2	Twist pair Unshielded
		9		

WARNING

- Do not apply the current more than 1A to the manipulator.

		Mfr.	Standard	
15 pin	Suitable Connector	JAE	DA-15PF-N	(Solder type)
	Clamp Hood		DA-C8-J10-F2-1R	(Connector setscrew : #4-40 NC)
9 pin	Suitable Connector		DE-9PF-N	(Solder type)
	Clamp Hood		DE-C8-J9-F2-1R	(Connector setscrew : #4-40 NC)

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

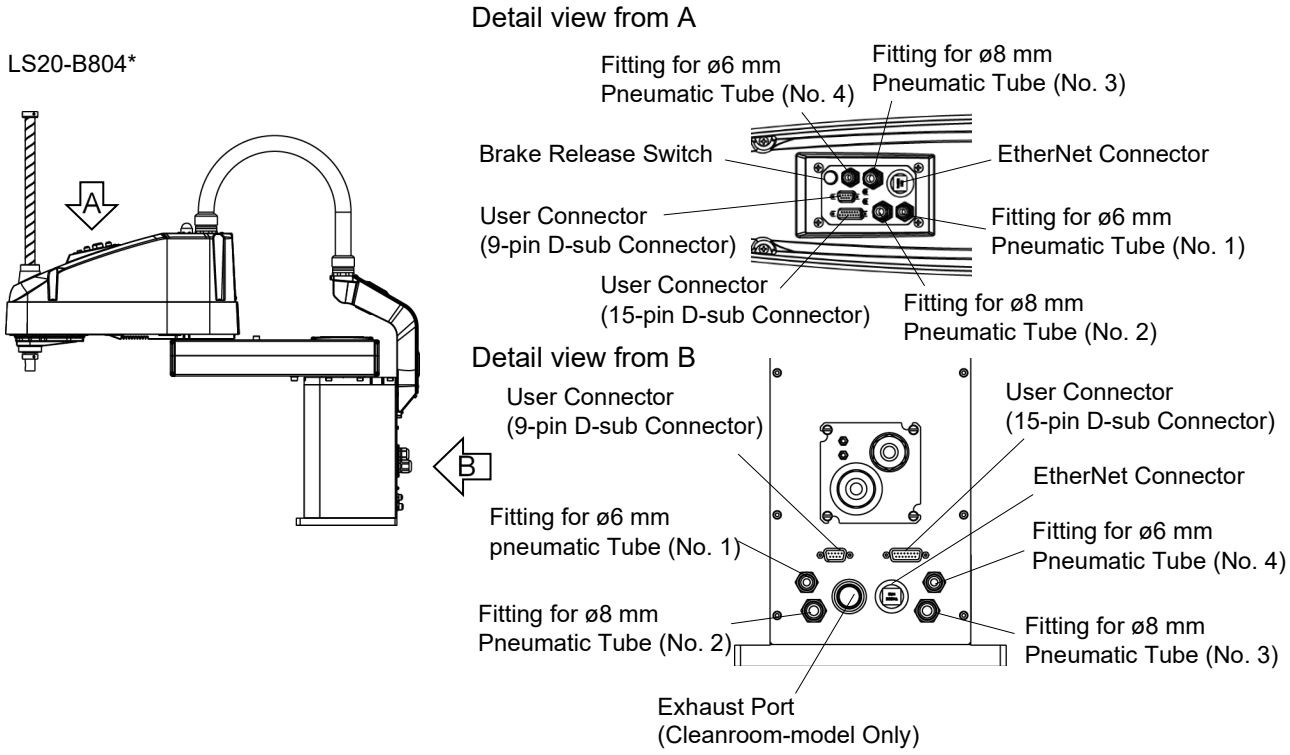
Pneumatic Tubes

Max. Usable Pneumatic Pressure	Pneumatic Tubes	Outer Diameter × Inner Diameter
0.59 MPa (6 kgf/cm^2 : 86 psi)	2	ø6 mm × ø4 mm
	2	ø8 mm × ø5 mm

Fittings for ø6 mm and ø8 mm (outer diameter) pneumatic tubes are supplied on both ends of the pneumatic tubes.

NOTE

All fittings for ø6 mm, ø8 mm pneumatic tubes of LS20-B series manipulators are white. Be sure to check the numbers near the fittings and connect them properly.

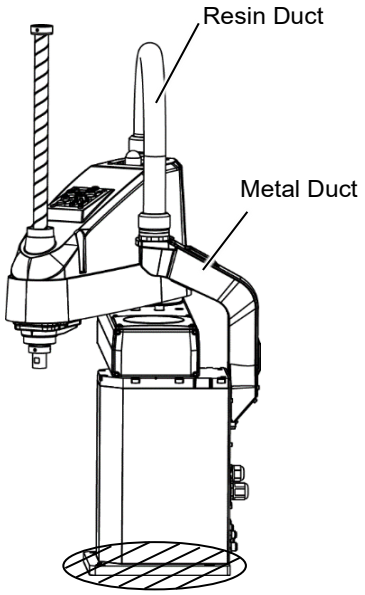


3.8 Relocation and Storage

3.8.1 Precautions for Relocation and Storage

Observe the following when relocating, storing, and transporting the Manipulators.
Transportation and installation of the Manipulators and robotic equipment shall be performed by personnel who has taken robot system training held by us and suppliers and should conform to all national and local codes.

WARNING	■ Only authorized personnel should perform sling work and operate a crane and a forklift. When these operations are performed by unauthorized personnel, it is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system. ■ Stabilize the Manipulator with your hands when hoisting it. Unstable hoisting is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system as the fall of the Manipulator.

CAUTION	■ Before relocating the Manipulator, fold the arm and secure it tightly with a wire tie to prevent hands or fingers from being caught in the Manipulator. ■ When removing the anchor bolts, support the Manipulator to prevent falling. Removing the anchor bolts without support may result in a fall of the Manipulator, and then get hands, fingers, or feet caught. ■ To transport the Manipulator, secure it to the delivery equipment or have at least 2 people to hold it by hand. Also, do not hold the bottom of the base (the shaded area in the figure). Holding the area by hand is extremely hazardous and may cause your hands and fingers caught. LS20-B804*: approx. 48 kg: 105.8 lbs. LS20-BA04*: approx. 51 kg: 112.5 lbs. ■ Do not hold the metal duct and the resin duct when transporting the Manipulator. Doing so may damage them.  (Figure: LS20-B804S)

NOTE

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

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

Transport and store the Manipulator in the range of Temperature: –20 to +60 °C, Humidity: 10 to 90% (no condensation).

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

Do not shock or shake the Manipulator during transport.

3.8.2 Relocation

CAUTION	■ Install or relocate the Manipulator with two or more people. The Manipulator weights are as follows. Be careful not to get hands, fingers, or feet caught and/or have equipment damaged by a fall of the Manipulator. LS20-B804* : approx. 48 kg : 105.8 lbs. LS20-BA04* : approx. 51 kg : 112.5 lbs.

(1) Turn OFF the power on all devices and unplug the cables.

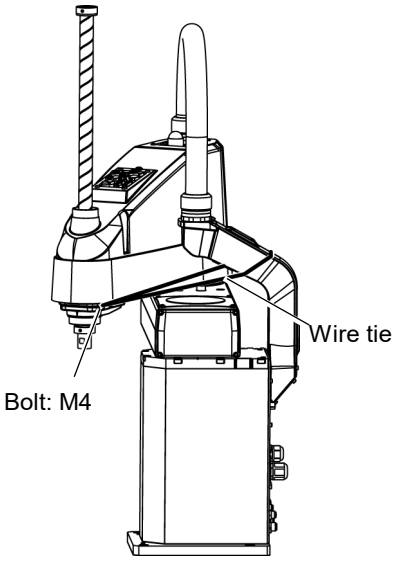
NOTE
Remove the mechanical stops if using them to limit the motion range of Joints #1 and #2. For details on the motion range, refer to *5.2 Motion Range Setting by Mechanical Stops*.

(2) Cover the arm with a sheet so that the arm will not be damaged.
Refer to the following figure and fix the arm.

Cover the arm with a sheet so that the arm will not be damaged. Insert the bolt to the screw hole on the arm and tie the bolt with the metal duct using a string. If fixing the arm using the shaft, fix it with adequate strength not to deform the spline.

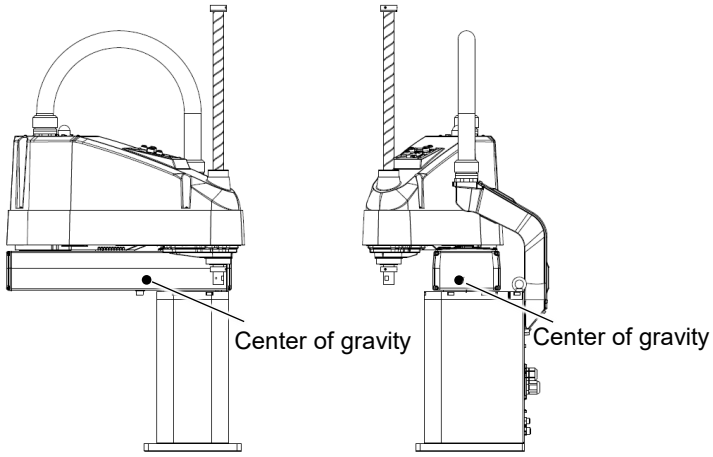
For details on strength of the ball screw spline, refer to *1.2.1 Strength of Ball Screw Spline*.

Example of Arm Fixed Posture

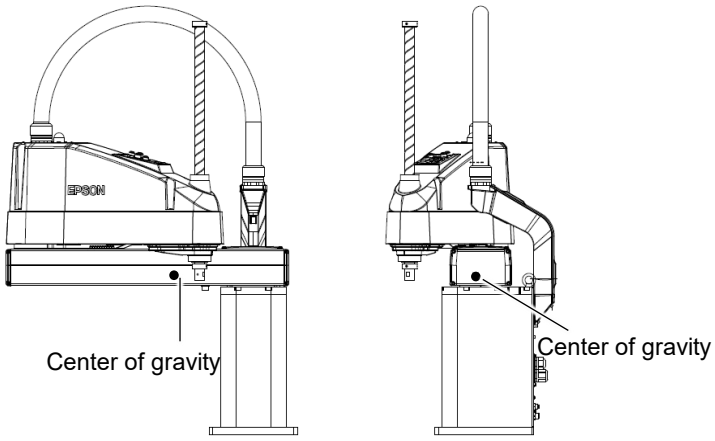


(3) Hold the bottom of Arm #1 by hand to unscrew the anchor bolts.
Then, remove the Manipulator from the base table.

LS20-B804*



LS20-BA04*



4. Setting of End Effectors

4.1 Attaching an End Effector

Users are responsible for making their own end effector(s). For details of attaching an end effector, refer to "*Hand Function Manual*"

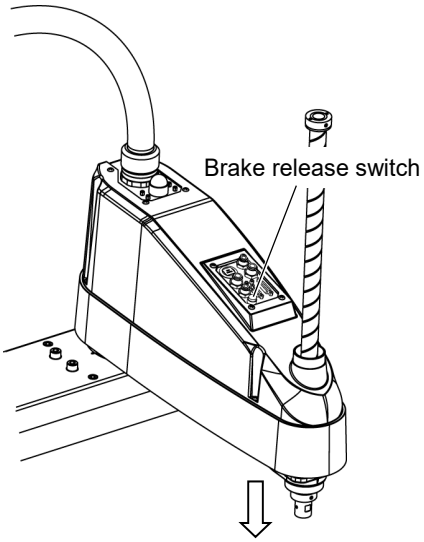
CAUTION	■ If you use an end effector equipped with a gripper or chuck, connect wires and/or pneumatic tubes properly so that the gripper does not release the work piece when the power to the robot system is turned OFF. Improper connection of the wires and/or pneumatic tubes may damage the robot system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

Shaft

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

Brake release switch

- Joint #3 and #4 cannot be moved up/down by hand because the electromagnetic brake is applied to the joint while power to the robot system is turned OFF.
  This prevents the shaft from hitting peripheral equipment in the case that the shaft is lowered by the weight of the end effector when the power is disconnected during operation, or when the motor is turned OFF even though the power is turned ON.
  To move Joint #3 up/down or rotate Joint #4 while attaching an end effector, turn ON the Controller and move the joint up/down or rotate the joint while pressing the brake release switch. This button switch is a momentary-type; the brake is released only while the button switch is being pressed
- Be careful of the shaft while the brake release switch is being pressed because the shaft may be lowered by the weight of the end effector.



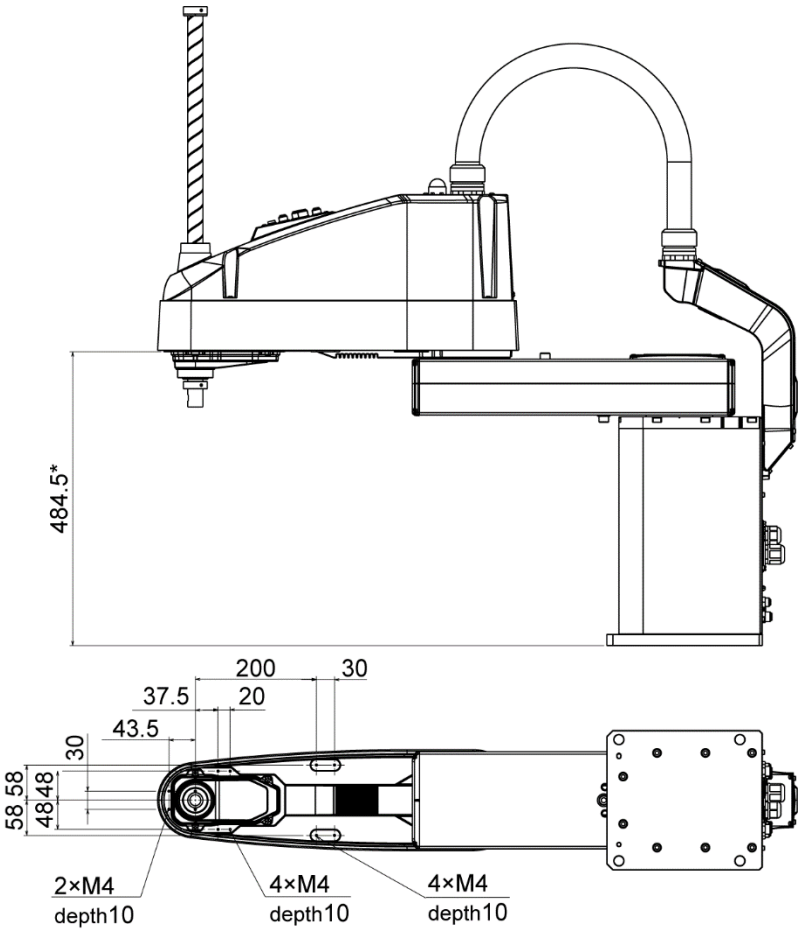
Layouts

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

4.2 Attaching Cameras and Valves

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

[Unit: mm]



*: From base installation surface

4.3 Weight and Inertia Settings

To ensure optimum Manipulator performance, it is important to make sure that the load (weight of the end effector and work piece) and moment of inertia of the load are within the maximum rating for the Manipulator, and that Joint #4 does not become eccentric.
If the load or moment of inertia exceeds the rating or if the load becomes eccentric, follow the steps below, "*4.3.1 Weight Setting"* and "*4.3.2 Inertia Setting"* to set parameters.
Setting parameters makes the PTP motion of the Manipulator optimal, reduces vibration to shorten the operating time, and improves the capacity for larger loads. In addition, it reduces persistent vibration produced when the moment of inertia of the end effector and work piece is larger than the default setting.
You can also set by following "Weight, Inertia, and Eccentricity/offset Measurement Utility". The following manual describes the details.

Epson RC+ User's Guide
6.18.12 Weight, Inertia, and Eccentricity/offset Measurement Utility

4.3.1 Weight Setting

CAUTION	■ The total weight of the end effector and the workpiece must not exceed 20 kg. The LS20-B series Manipulators are not designed to work with loads exceeding 20 kg. Always set the Weight parameters according to the load. Setting a value that is smaller than the actual load may cause errors, excessive shock and insufficient function of the Manipulator. Also, the life cycle of parts will shorten and belt tooth jumping will occur which will lead to potion shift.

The acceptable weight capacity (end effector and workpiece) in LS20-B series is
Default rating: 10 kg
Maximum: 20 kg

Depends to the load (weight of the end effector and work piece), change the setting of Weight parameter.
After the setting is changed, the maximum acceleration/deceleration speed of the robot system at PTP motion corresponding to the "Weight Parameter" is set automatically.

Load on the Shaft

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

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

Load on the Arm

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

Equivalent Weight Formula

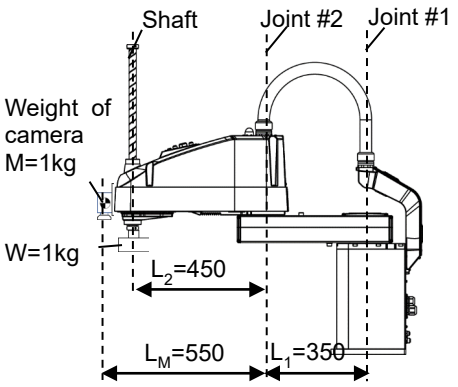
$$W_M = M \times (L_M + L_1)^2 / (L_1 + L_2)^2$$

- 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

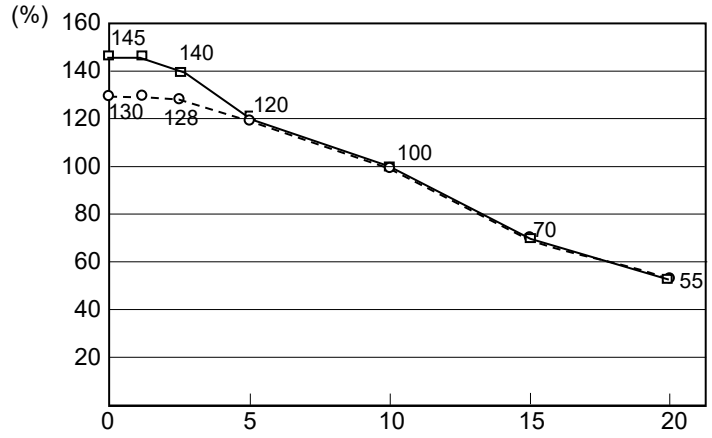
<Example>Calculates [Weight] parameter when a "1 kg" camera is attached to the end of the LS20-B series arm (550 mm away from the rotation center of Joint #2) with a load weight of "1 kg".

W=1
M=1
L_1=350
L_2=450
L_M=550
$W_M = 1 \times (550+350)^2/(350+450)^2 = 1.27$ (round up)
$W + W_M = 1 + 1.27 = 2.27$

Enter "2.27" for the Weight Parameter.



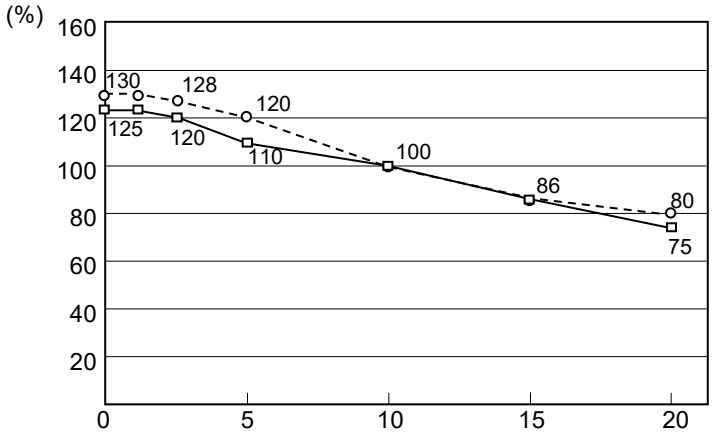
Automatic speed setting by Weight



* The percentage in the graph is based on the acceleration/ deceleration at rated weight (10 kg)

End effector weight (kg)	Automatic speed setting by Weight (%)	
	LS20-B804*	LS20-BA04*
0	130	145
1	130	145
2	128	140
5	120	120
10	100	100
15	70	70
20	55	55

Automatic acceleration/deceleration setting by Weight



* The percentage in the graph is based on the acceleration/ deceleration at rated weight (10 kg) as 100%.

End effector weight (kg)	Automatic acceleration/deceleration setting by Weight (%)	
	LS20-B804*	LS20-BA04*
0	130	125
1	130	125
2	128	120
5	120	110
10	100	100
15	86	86
20	80	75

4.3.2 Inertia Setting

Moment of Inertia and the Inertia Setting

The moment of inertia is defined as “the ratio of the torque applied to a rigid body and its resistance to motion”. This value is typically referred to as “the moment of inertia”, “inertia”, or “GD^2”. When the Manipulator operates with additional objects (such as an end effector) attached to the shaft, the moment of inertia of load must be considered.

CAUTION	■ The moment of inertia of the load (weight of the end effector and workpiece) must be 1.0 kg·m^2 or less. The LS20-B series Manipulators are not designed to work with a moment of inertia exceeding 1.0 kg·m^2. Always set the Weight parameters according to the load. Setting a value that is smaller than the actual load may cause errors, excessive shock and insufficient function of the Manipulator. Also, the life cycle of parts is shortened and positional gap due to belt tooth bumping occurs.

The acceptable moment of inertia of load for a LS20-B series Manipulator is

Default rating: 0.05 kg·m^2

Maximum: 1.00 kg·m^2

Depends to the moment of inertia of the load, change the setting for the moment of inertia of the load of the Inertia command. After the setting is changed, the maximum acceleration/deceleration speed of Joint #4 at PTP motion corresponding to the “moment of inertia” value is set automatically.

Moment of inertia of load on the shaft

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

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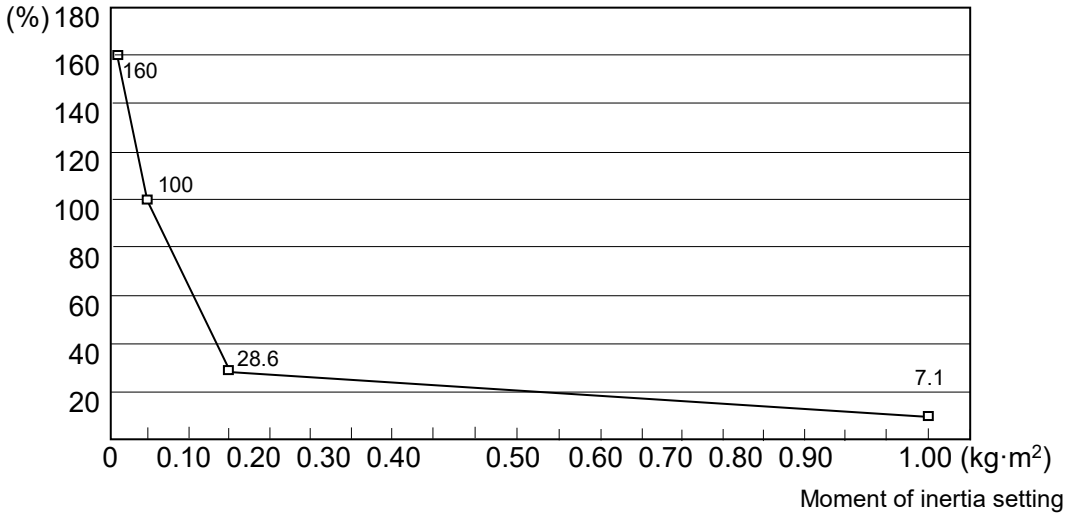
Enter a value into the [Load inertia:] text box on the [Inertia] panel ([Tools]-[Robot Manager]). (You may also execute the Inertia command from the [Command Window].)

Automatic acceleration/deceleration setting of Joint #4 by Inertia (moment of inertia)

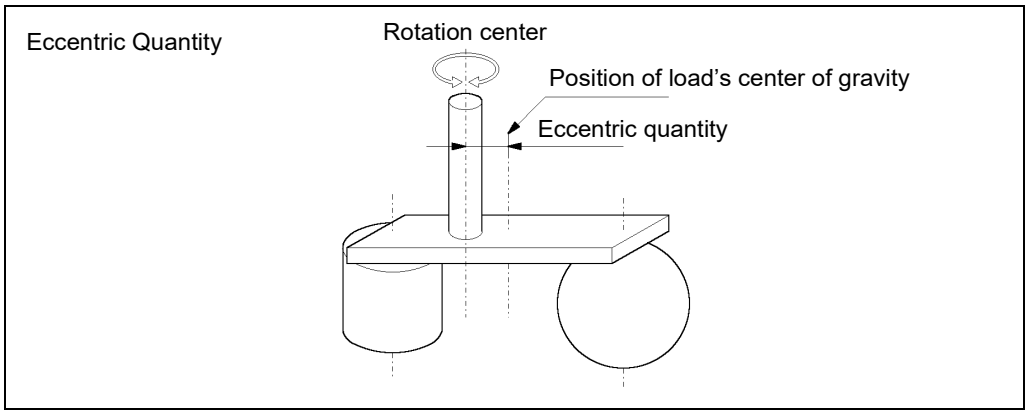


Moment of inertia setting (kg·m^2)	Automatic acceleration/deceleration setting of Joint #4 by Inertia (moment of inertia) (%)
0.01	160
0.05	100
0.15	28.6
1.00	7.1

Eccentric Quantity and the Inertia Setting

CAUTION	■ The eccentric quantity of load (weight of the end effector and workpiece) must be 200 mm or less. The LS20-B series Manipulators are not designed to work with eccentric quantity exceeding 200 mm. Always set the Weight parameters according to the load. Setting a value that is smaller than the actual load may cause errors, excessive shock and insufficient function of the Manipulator. Also, the life cycle of parts is shortened and positional gap due to belt tooth bumping occurs.

The acceptable eccentric quantity of load in LS20-B series is 0 mm at the default rating and 200 mm at the maximum. Depends to the eccentric quantity of load, change the setting of eccentric quantity parameter of Inertia command. After the setting is changed, the maximum acceleration/deceleration speed of the Manipulator at PTP motion corresponding to the "eccentric quantity" is set automatically.



Eccentric quantity of load on the shaft

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

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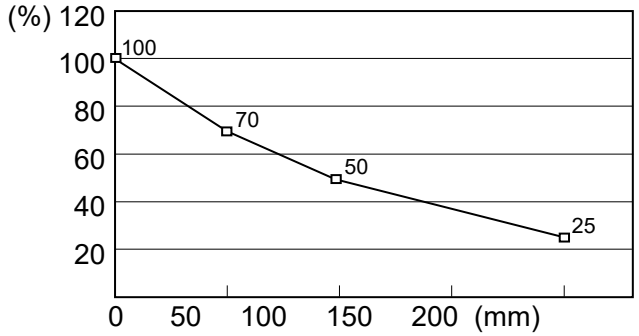
Enter a value into the [Eccentricity:] text box on the [Inertia] panel ([Tools]-[Robot Manager]). (You may also execute the Inertia command from the [Command Window].)

Automatic acceleration/deceleration setting by Inertia (eccentric quantity)

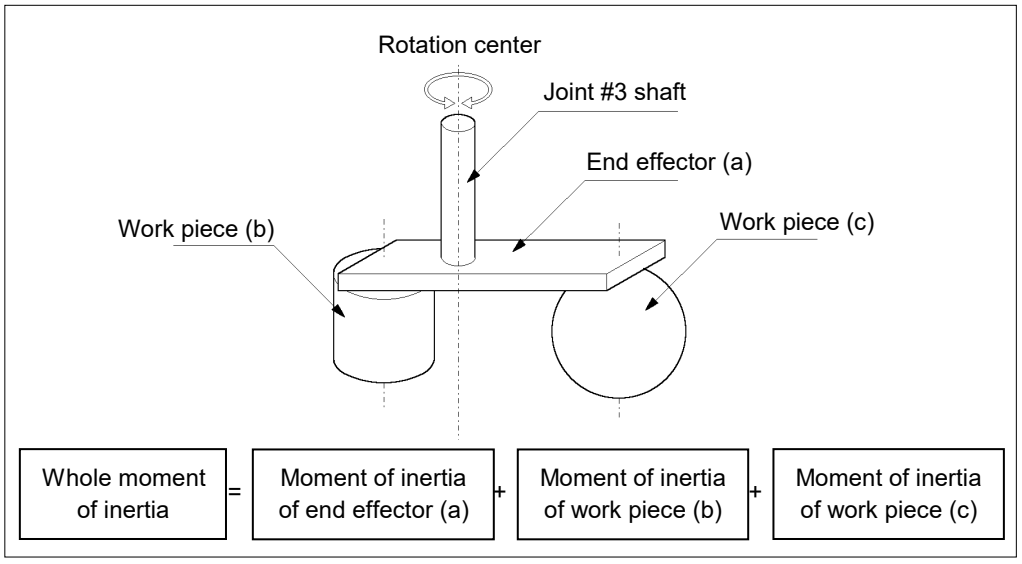


* The percentage in the graph is based on the acceleration / deceleration at rated eccentricity (0 mm) as 100%.

Eccentric quantity parameter (mm)	Automatic acceleration/deceleration setting by Inertia (eccentric quantity) (%)
0	100
50	70
100	50
200	25

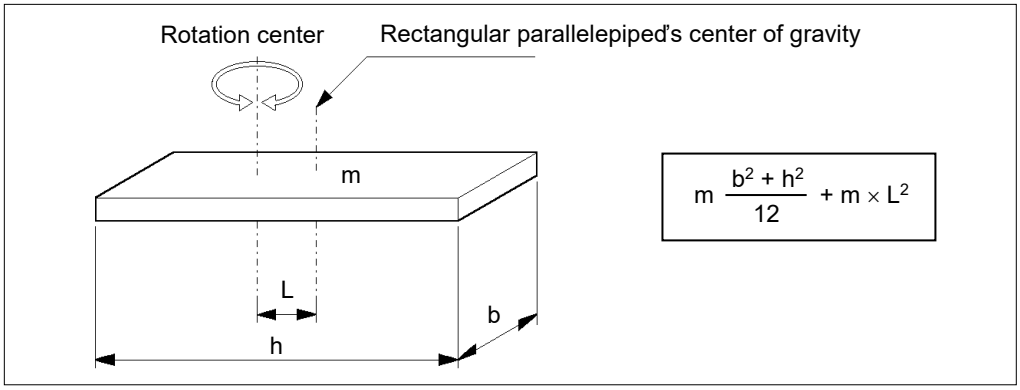
Calculating the Moment of Inertia

Refer to the following examples of formulas to calculate the moment of inertia of load (end effector with work piece). The moment of inertia of the entire load is calculated by the sum of each part (a), (b), and (c).

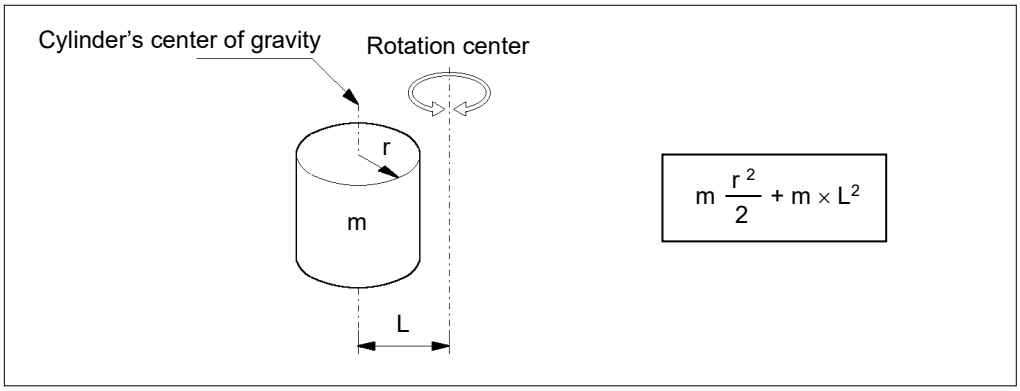


The methods for calculating the moment of inertia for (a), (b), and (c) are shown below. Calculate the total moment of inertia using the basic formulas.

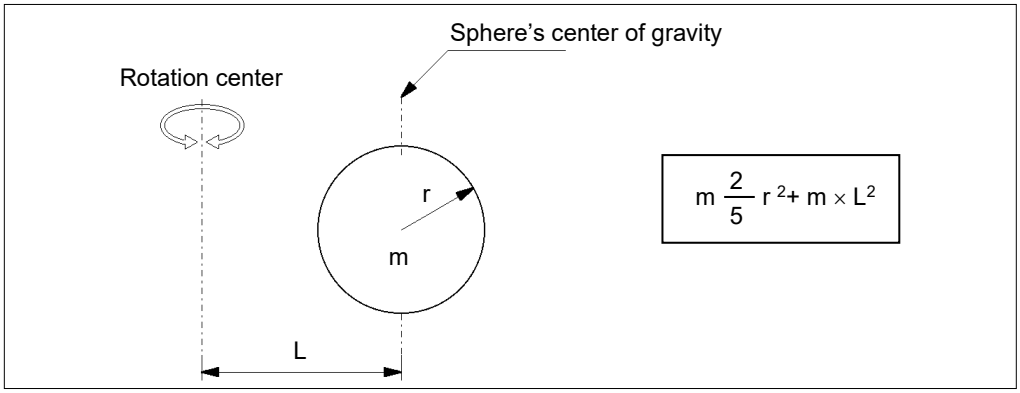
(a) Moment of inertia of a rectangular parallelepiped



(b) Moment of inertia of a cylinder



(c) Moment of inertia of a sphere

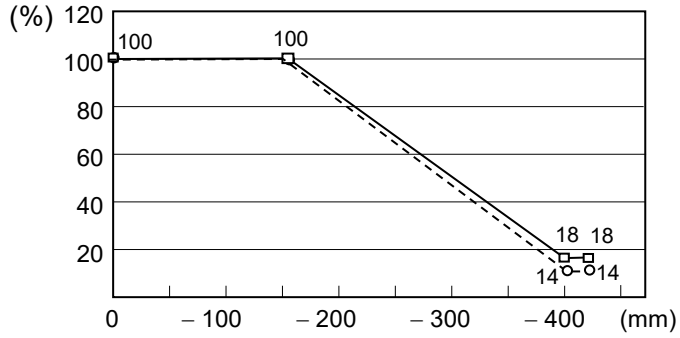


4.4 Precautions for Auto Acceleration/Deceleration of Joint #3

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

When Joint #3 gets below a certain point, then auto acceleration/deceleration is used to reduce acceleration/deceleration. (Refer to the figures below) The higher the position of the shaft is, the faster the motion acceleration/deceleration is. However, it takes more time to move Joint #3 up and down. Adjust the position of Joint #3 for the Manipulator motion after considering the relation between the current position and the destination position. The upper limit of Joint #3 during horizontal motion using Jump command can be set by the LimZ command.

Automatic acceleration/deceleration vs. Joint #3 position



NOTE

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

Shaft height (mm)	Acceleration/Deceleration	
	LS20-B804*	LS20-BA04*
0	100	100
–150	100	100
–400	14	18
–420	14	18

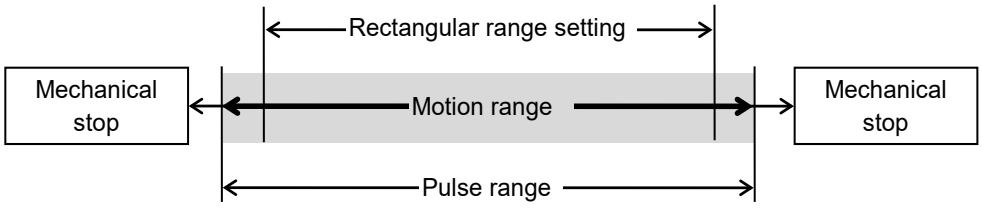
5. Motion Range

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

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

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

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



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

5.1 Motion Range Setting by Pulse Range

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

For the maximum pulse range, refer to the following sections.
The pulse range must be set inside of the mechanical stop range.

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

NOTE

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

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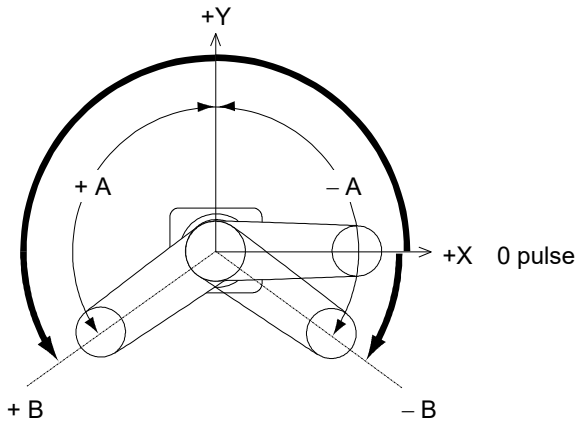
The pulse range can be set on the [Range] panel shown by selecting [Tools]-[Robot Manager]. (You may also execute the Range command from the [Command Window].)

5.1.1 Max. Pulse Range of Joint #1

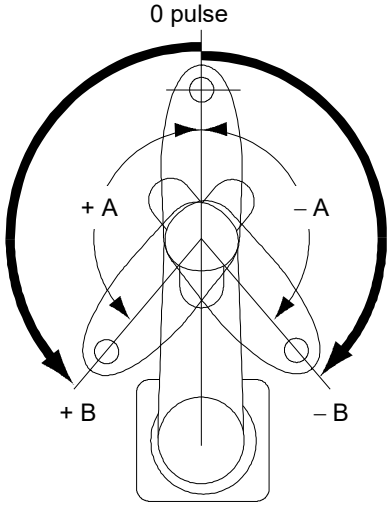
The 0 (zero) pulse position of Joint #1 is the position where Arm #1 faces toward the positive (+) direction on the X-coordinate axis.
When the 0 pulse is a starting point, the counterclockwise pulse value is defined as the positive (+) and the clockwise pulse value is defined as the negative (−).



A: Max. Motion Range	B: Max. Pulse Range
±132°	− 152918 ~ 808278 pulse

5.1.2 Max. Pulse Range of Joint #2

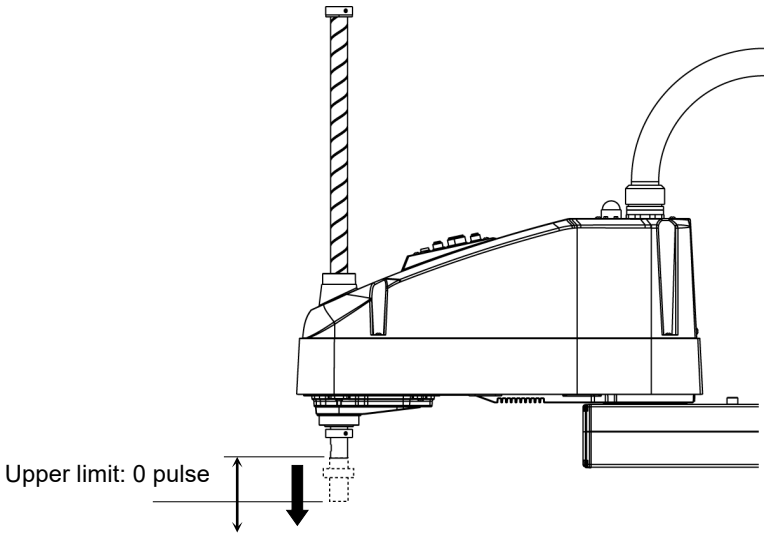
The 0 (zero) pulse position of Joint #2 is the position where Arm #2 is in-line with Arm #1.
With the 0 pulse as a starting point, the counterclockwise pulse value is defined as the positive (+) and the clockwise pulse value is defined as the negative (−).



A: Max. Motion Range	B: Max. Pulse Range
± 152°	± 345885 pulse

5.1.3 Max. Pulse Range of Joint #3

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

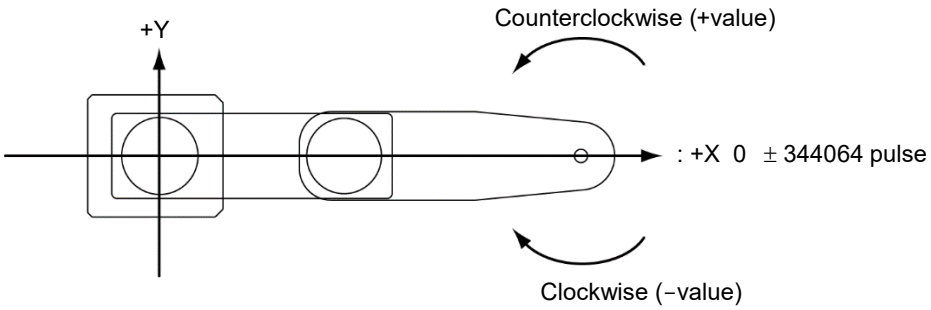


		Joint #3 Stroke	Lower Limit Pulse
LS20-B804S	Standard-model	420 mm	–283853 pulse
LS20-BA04S			
LS20-B804C	Cleanroom-model	390 mm	–263578 pulse
LS20-BA04C			

NOTE For the Cleanroom-model, the motion range set with the Joint #3 mechanical stop cannot be changed.

5.1.4 Max. Pulse Range of Joint #4

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

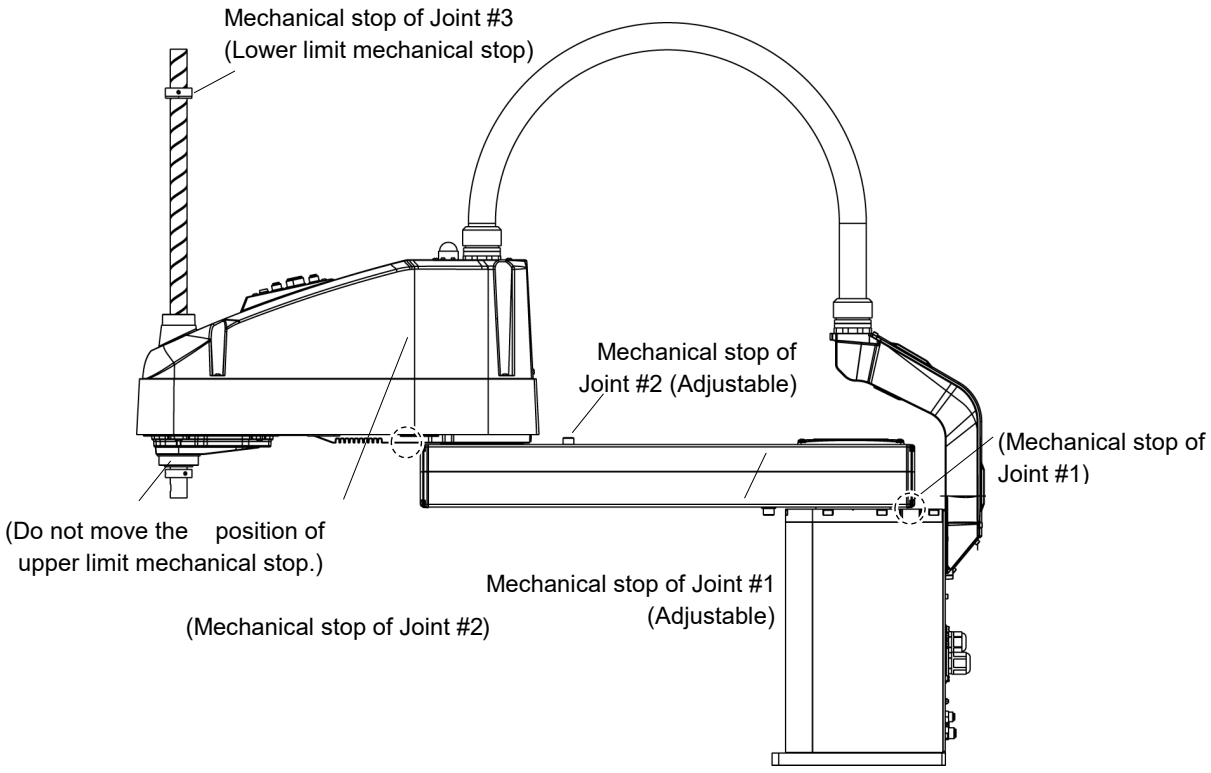


5.2 Motion Range Setting by Mechanical Stops

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

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

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

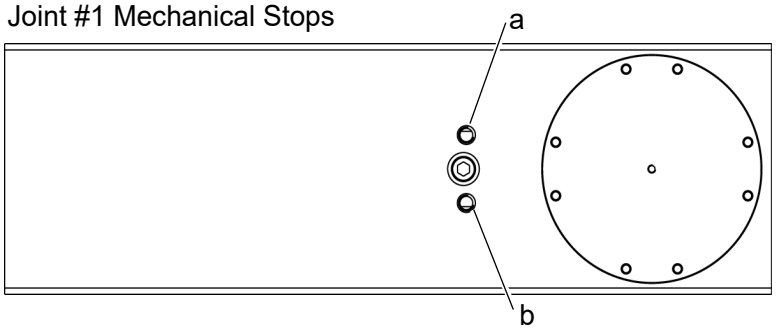


5.2.1 Setting the Mechanical Stops of Joints #1 and #2

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

Install the bolts for the mechanical stop to the following position.

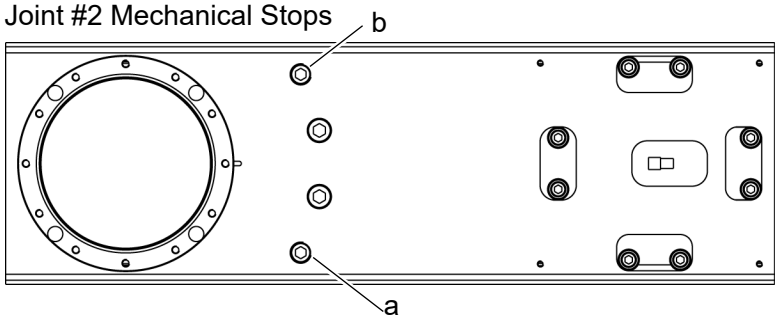
Joint #1 Mechanical Stops



Views from the bottom of Arm #1

	a	b
Setting Angle (°)	122	–122
Pulse Value (pulse)	771868	–116508

Joint #2 Mechanical Stops



Views from the top of Arm #1

	a	b
Setting Angle (°)	135	–135
Pulse Value (pulse)	307200	–307200

(1) Turn OFF the Controller.

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

Joint	Hexagon socket head cap bolt (fully threaded)	The number of bolts	Recommended tightening torque	Strength
1	M8 × 10	1 bolt / side	13.0 N·m (132.7 kgf·cm)	ISO898-1 property class 10.9 or 12.9.
2	M10 × 50			

(3) Turn ON the Controller.

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

NOTE

Be sure to set the pulse range inside the positions of the mechanical stop range.

Example: Using LS20-B804S
The angle of Joint #1 is set from −110 to +110°.
The angle of Joint #2 is set from −120 to +120°.

Epson RC+

Execute the following commands from the [Command Window].

```
>JRANGE 1, -72817, 728177     ' Sets the pulse range of Joint #1
>JRANGE 2, -273066, 273066    ' Sets the pulse range of Joint #2
>RANGE                        ' Checks the setting using Range
 -72817, 728177, -273066, 273066, -283853, 0,
 -344064, 344064
```

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

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

Example: Using LS20-B804S
The angle of Joint #1 is set from −110 to +110°.
The angle of Joint #2 is set from −120 to +120°.

Epson RC+

Execute the following commands from the [Command Window].

```
>MOTOR ON                     'Turns ON the motor
>POWER LOW                    'Enters low-power mode
>SPEED 5                      'Sets at low speeds
>PULSE -72817,0,0,0           'Moves to the min. pulse position of Joint #1
>PULSE 728177,0,0,0           'Moves to the max. pulse position of Joint #1
>PULSE 327680,-273066,0,0     'Moves to the min. pulse position of Joint #2
>PULSE 327680,273066,0,0      'Moves to the max. pulse position of Joint #2
```

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

In this example, Joint #1 is moved to 0° position where is close to the center of its motion range (pulse value: 327680) when checking Joint #2.

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

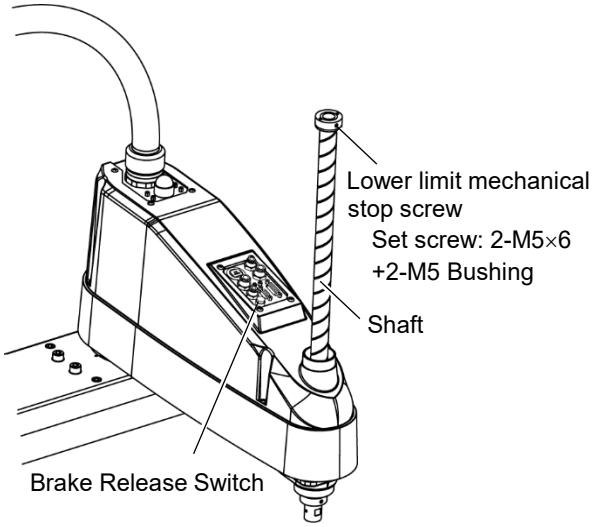
5.2.2 Setting the Mechanical Stop of Joint #3

NOTE
This method applies only to the Standard-model (LS20-B**4S) manipulator.
For the Cleanroom-model (LS20-B**4C), the motion range set with the Joint #3 mechanical stop cannot be changed.

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

(2) Push up the shaft while pressing the brake release switch.

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



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

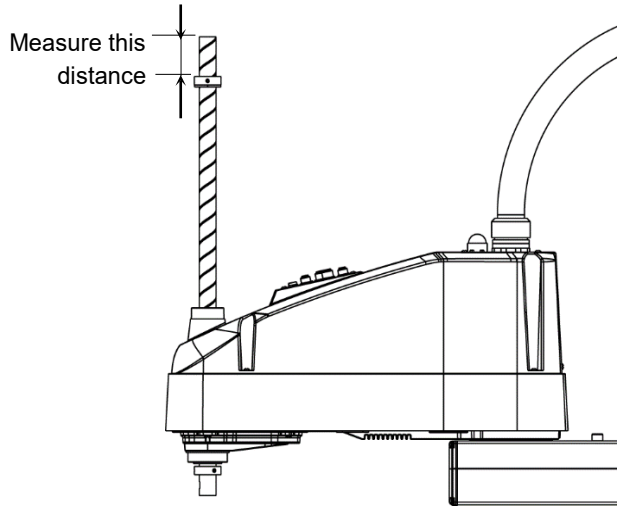
(3) Turn OFF the Controller.

(4) Loosen the lower limit mechanical stop screw (set screws: 2-M5×6).

NOTE
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 calibration point of Joint #3 is specified using the stop.

(5) The upper end of the shaft defines the maximum stroke. Move the lower limit mechanical stop down by the length you want to limit the stroke.

For example, when the lower limit mechanical stop is set at “420 mm” stroke, the lower limit Z coordinate value is “–420”. To change the value to “−100”, move the lower limit mechanical stop down “320 mm”. Use calipers to measure the distance when adjusting the mechanical stop.



(6) Firmly tighten the lower limit mechanical stop screw (set screws: 2-M5×6).

Recommended tightening torque: 3.9 N·m (39.8 kgf·cm)

(7) Turn ON the Controller.

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

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

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

Lower limit of pulse (pulse) = lower limit Z coordinate value (mm) / Resolution (mm/pulse)

** For the Joint #3 resolution,
refer to the section *Appendix A: Specifications*.

Epson RC+

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

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

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

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

Epson RC+

Execute the following commands from the [Command Window]. Enter the value calculated in Step (9) in X.

```
>MOTOR ON          ' Turns ON the motor
>SPEED 5           ' Sets 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 "0s" with the other pulse values specifying a position where there is
                     no interference even when lowering Joint #3.)
```

5.3 Setting the Cartesian (Rectangular) Range in the XY Coordinate System of the Manipulator (for Joints #1 and #2)

Use this method to set the upper and lower limits of the X and Y coordinates.

This setting is only enforced by software. Therefore, it does not change the physical range. The maximum physical range is based on the position of the mechanical stops.

Epson RC+

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

5.4 Standard Motion Range

The following “motion range” diagrams show the standard (maximum) specification. When each Joint motor is under servo control, the center of Joint #3’s (shaft’s) lowest point moves in the areas shown in the figure.

“Area limited by mechanical stop” is the area where the center of Joint #3’s lowest point can be moved when each joint motor is not under servo control.

“Mechanical stop” sets the limited motion range so that the center of Joint #3 cannot move beyond the area mechanically.

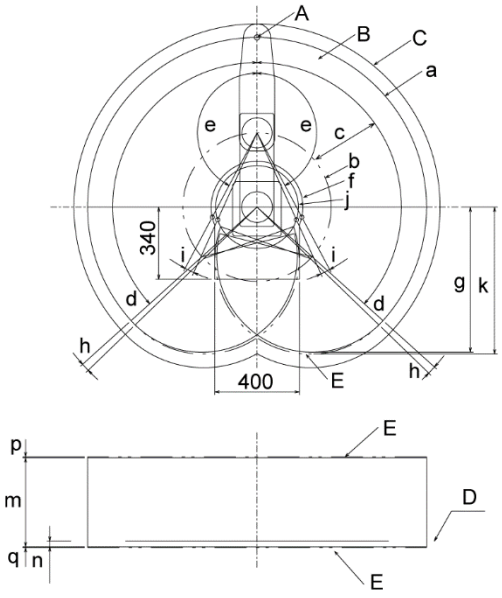
“Maximum space” is the area that contains the farthest reach of the arms. If the maximum radius of the end effector is over 60 mm, add the “Area limited by mechanical stop” and “radius of the end effector”. The total value is specified as the maximum area.

A	Center of Joint #3
B	Motion range
C	Maximum range
D	Base mounting face
E	Area limited by a mechanical stop

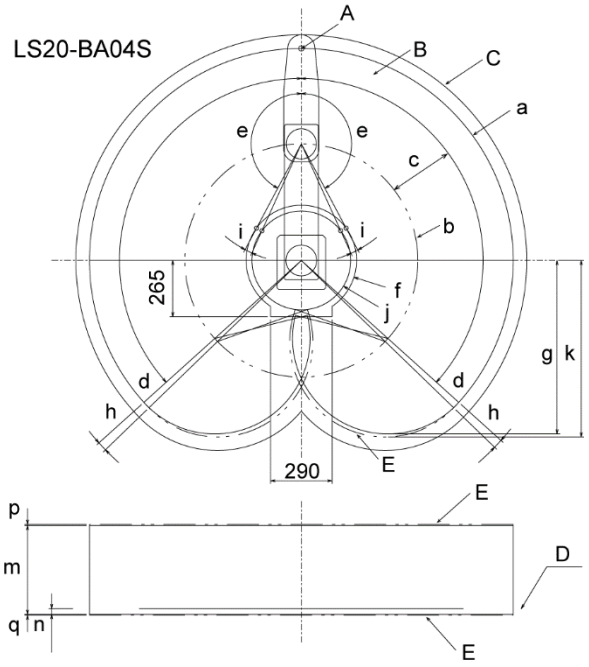
			LS20-B804*	LS20-BA04*
a	Arm #1 + Arm #2 length [mm]		800	1000
b	Arm #1 length [mm]		350	550
c	Arm #2 length [mm]		450	
d	Joint #1 motion angle [°]		132	
e	Joint #2 motion angle [°]		152	
f	(Motion range)		216.5	260.7
g	(Motion range at the rear)		684.2	818
h	Angle of the Joint #1 mechanical stop [°]		2.0	
i	Angle of the Joint #2 mechanical stop [°]		3.6	
j	(Mechanical stop area)		195.3	232.8
k	(Mechanical stop area at the rear)		693.1	832.1
m	(Joint #3 motion range)	LS20-B***S	420	
		LS20-B***C	390	
n	(Distance from the base mounting face)	LS20-B***S	26.5	
		LS20-B***C	33.7	
p	(Joint #3 mechanical stop area upper end)	LS20-B***S	4	
		LS20-B***C	3.2	
q	(Joint #3 mechanical stop area lower end)	LS20-B***S	3	
		LS20-B***C	1.8	

Standard-model

LS20-B804S

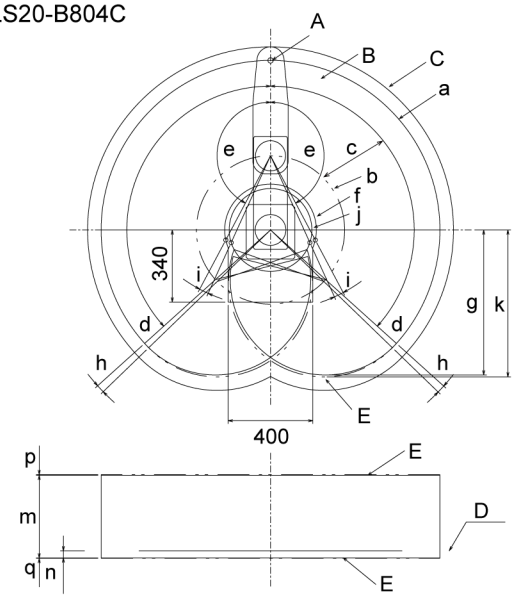


LS20-BA04S

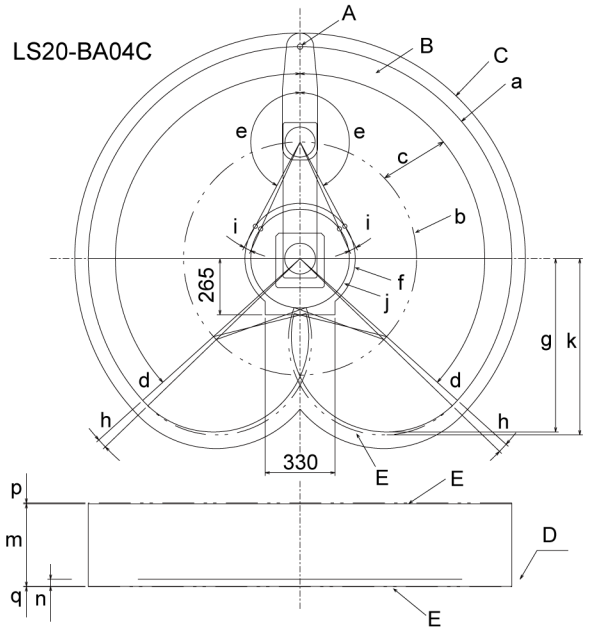


Cleanroom-model

LS20-B804C



LS20-BA04C



Regular Inspection

Performing inspection properly is essential to prevent trouble and ensure safety.
This volume describes the inspection schedule and contents.
Inspect according to the schedule.

1. Regular Inspection for LS3-B LS6-B Manipulator

This chapter describes maintenance inspection procedures. Performing maintenance inspection properly is essential to prevent trouble and ensure safety.
Be sure to perform the maintenance inspections in accordance with the schedule.

1.1 Inspection

1.1.1 Schedule for Inspection

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

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

h = hour

1.1.2 Inspection Point

Inspection Item

Inspection Point	Inspection Place	Daily	Monthly	Quarterly	Biannual	Annual
Check looseness or backlash of bolts/screws.	End effector mounting bolts	√	√	√	√	√
	Manipulator mounting bolts	√	√	√	√	√
Check looseness of connectors.	External connectors on Manipulator (on the connector plates etc.)	√	√	√	√	√
Visually check for external defects. Clean up if necessary.	External appearance of Manipulator	√	√	√	√	√
	External cables		√	√	√	√
Check for bends or improper location. Repair or place it properly if necessary.	Safeguard etc.	√	√	√	√	√
Check the brake operation	LS3-B: Break for arm #3 LS6-B: Break for arm #3 to #4	√	√	√	√	√
Check whether unusual sound or vibration occurs.	Whole	√	√	√	√	√

Inspection Method

Inspection Point	Inspection Method
Check looseness or backlash of bolts/screws.	Use a hexagonal wrench to check that the end effector mounting bolts and the Manipulator mounting bolts are not loose. When the bolts are loose, refer to *"1.4 Tightening Hexagon Socket Head Bolts*" and tighten them to the proper torque.
Check looseness of connectors.	Check that connectors are not loose. When the connectors are loose, reattach it not to come off.
Visually check for external defects. Clean up if necessary.	Check the appearance of the Manipulator and clean up if necessary. Check the appearance of the cable, and if it is scratched, check that there is no cable disconnection.
Check for bends or improper location. Repair or place it properly if necessary.	Check that the safeguard, etc. are located properly. If the location is improper, place it properly.
Check the brake operation	Check that the shaft does not fall when in MOTOR OFF. If the shaft falls when in MOTOR OFF and the brake is not released, contact the supplier. Also, if the break is not released even operated release the break, contact the supplier.
Check whether unusual sound or vibration occurs.	Check that there is no unusual sound or vibration when operating. If there is something wrong, contact the supplier.

1.2 Overhaul (Parts Replacement)

Overhaul (replacement) shall be performed by personnel who has taken a proper training.
For details, refer to "*Safety Manual Training*".
For details of overhaul, refer to *Maintenance Manual.*

1.3 Greasing

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

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

	Greasing part	Greasing Interval	Grease	How to grease
Joint #1, Joint #2	Reduction gear units	Overhaul timing	-	Greasing shall be performed by personnel who has taken a proper training. For details, refer to the G series Manipulator Maintenance Manual.
Joint #3	Ball screw spline unit	At 100 km of operation (50 km for first greasing)	AFB	*Greasing the Ball Screw Spline Unit* *(See below)*

Joint #3 Ball screw spline unit

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

Normal grease

Discolored grease

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

NOTE

For EPSON RC+ 7.0 Ver. 7.2.x or later (firmware Ver.7.2.x.x or later), the recommended replacement time for the grease on the ball screw spline unit can be checked in the [Maintenance] dialog box of Epson RC+.
For details, refer to the following manual.
Robot Controller RC90 series "Maintenance Manual 6. Alarm"

Greasing the Ball Screw Spline Unit

	Name	Quantity	NOTE
Grease	For Ball Screw Spline Unit (AFB grease)	Proper quantity	
Tools	Wiping cloth	1	For wiping grease (Spline shaft)
	Cross-point screwdriver	1	

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

(1) Turn ON the Controller.

(2) Move the shaft to its lower limit in one of the following methods.

- Move the shaft to its lower limit manually while pressing the brake release switch.
- Move the shaft to its lower limit from Epson RC+ [Tools]-[Robot Manager]-[Jog & Teach].

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

LS3-B: The brake release switch affects only Joint #3. When the brake release switch is pressed, the brake for Joint #3 is released. Be careful of the shaft falling and rotating while the brake release switch is being pressed because the shaft may be lowered by the weight of the end effector.

LS6-B: The brake release switch affects both Joints #3 and #4. When the brake release switch is pressed in emergency mode, the brakes for both Joints #3 and #4 are released. Be careful of the shaft falling and rotating while the brake release switch is being pressed because the shaft may be lowered by the weight of the end effector.

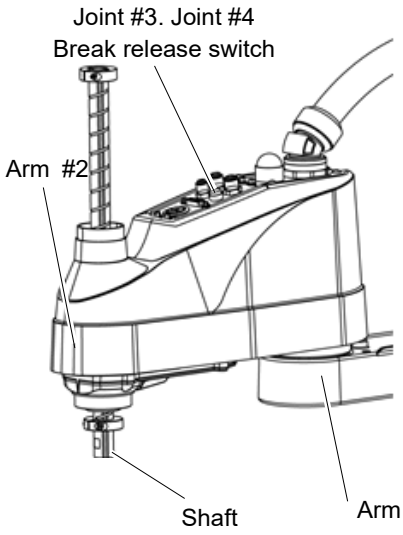
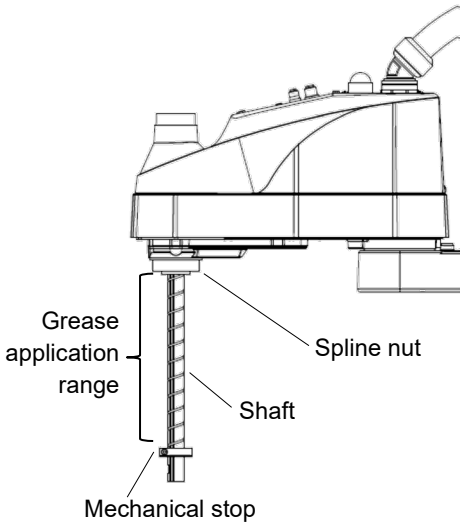


Figure: LS6-B

(3) Turn OFF the Controller.

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

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



(Figure: LS6-B)

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


Grease application example

(6) Turn ON the Controller.

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

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

(9) Turn OFF the controller.

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

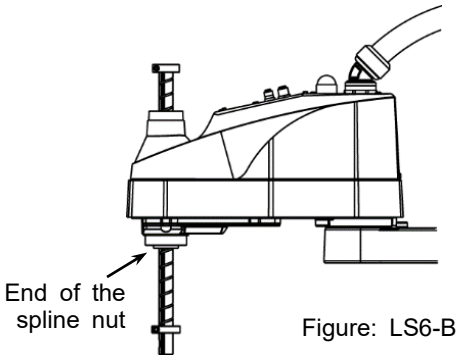


Figure: LS6-B

1.4 Tightening Hexagon Socket Head Bolts

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

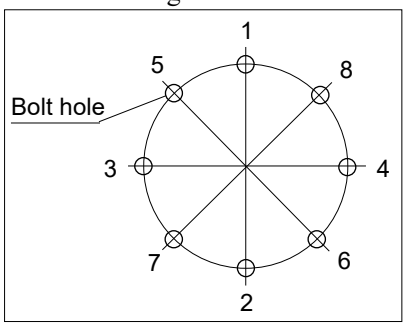
When it is required to refasten the bolts in some procedures in this manual (except special cases as noted), use a torque wrench so that the bolts are fastened with appropriate tightening torque as shown below.

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

See below for the set screw.

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

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



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

2. Regular Inspection for LS10-B Manipulator

This chapter describes maintenance inspection procedures. Performing maintenance inspection properly is essential to prevent trouble and ensure safety.
Be sure to perform the maintenance inspections in accordance with the schedule.

2.1 Inspection

2.1.1 Schedule for Inspection

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

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

2.1.2 Inspection Point

Inspection Item

Inspection Point	Inspection Place	Daily	Monthly	Quarterly	Biannual	Annual
Check looseness or backlash of bolts/screws.	End effector mounting bolts	√	√	√	√	√
	Manipulator mounting bolts	√	√	√	√	√
Check looseness of connectors.	External connectors on Manipulator (on the connector plates etc.)	√	√	√	√	√
Visually check for external defects. Clean up if necessary.	External appearance of Manipulator	√	√	√	√	√
	External cables		√	√	√	√
Check for bends or improper location. Repair or place it properly if necessary.	Safeguard etc.	√	√	√	√	√
Check the brake operation	Brake for arm #3 to #4	√	√	√	√	√
Check whether unusual sound or vibration occurs.	Whole	√	√	√	√	√

Inspection Method

Inspection Point	Inspection Method
Check looseness or backlash of bolts/screws.	Use a hexagonal wrench to check that the end effector mounting bolts and the Manipulator mounting bolts are not loose. When the bolts are loose, refer to "*2.4 Tightening Hexagon Socket Head Bolts*" and tighten them to the proper torque.
Check looseness of connectors.	Check that connectors are not loose. When the connectors are loose, reattach it not to come off.
Visually check for external defects. Clean up if necessary.	Check the appearance of the Manipulator and clean up if necessary. Check the appearance of the cable, and if it is scratched, check that there is no cable disconnection.
Check for bends or improper location. Repair or place it properly if necessary.	Check that the safeguard, etc. are located properly. If the location is improper, place it properly.
Check the brake operation	Check that the shaft does not fall when in MOTOR OFF. If the shaft when in MOTOR OFF and the brake is not released, contact the supplier. Also, if the break is not released even operated release the break, contact the supplier.
Check whether unusual sound or vibration occurs.	Check that there is no unusual sound or vibration when operating. If there is something wrong, contact the supplier.

2.2 Overhaul (Parts Replacement)

Overhaul (replacement) shall be performed by personnel who has taken a proper training.
For details, refer to "*Safety Manual Training*".
For details of overhaul, refer to *Maintenance Manual.*

2.3 Greasing

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

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

	Greasing part	Greasing Interval	Grease	How to grease
Joint #1, Joint #2	Reduction gear units	Overhaul timing	-	Greasing shall be performed by personnel who has taken a proper training. For details, refer to the G series Manipulator Maintenance Manual.
Joint #3	Ball screw spline unit	At 100 km of operation (50 km for first greasing)	AFB*	*Greasing the Ball Screw Spline Unit*

* Grease for food grade grease is L700 or UH1 14-151.

Joint #3 Ball screw spline unit

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


Normal grease


Discolored grease

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

NOTE
For EPSON RC+ 7.0 Ver. 7.2.x or later (firmware Ver.7.2.x.x or later), the recommended replacement time for the grease on the ball screw spline unit can be checked in the [Maintenance] dialog box of Epson RC+.
For details, refer to the following manual.
Robot Controller RC90 series "Maintenance Manual 6. Alarm"

Greasing the Ball Screw Spline Unit

	Name	Quantity	NOTE
Grease	For Ball Screw Spline Unit (AFB grease)	Proper quantity	-
	For Ball Screw Spline Unit (L700/UH1 14-151 grease)	Proper quantity	L700 and UH1 14-151 grease is exclusively for food grade grease.
Tools	Wiping cloth	1	For wiping grease (Spline shaft)
	Cross-point screwdriver	1	-

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

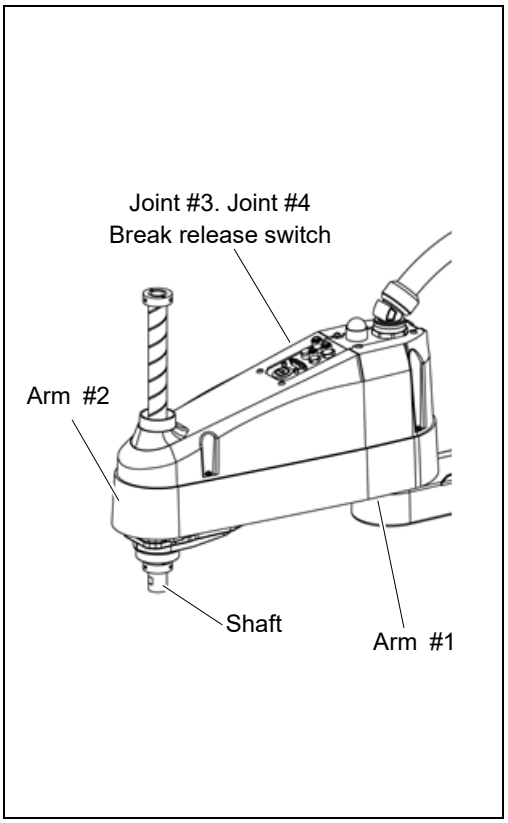
(1) Turn ON the Controller.

(2) Move the shaft to its lower limit in one of the following methods.

- Move the shaft to its lower limit manually while pressing the brake release switch.
- Move the shaft to its lower limit from Epson RC+ [Tools]-[Robot Manager]-[Jog & Teach].

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

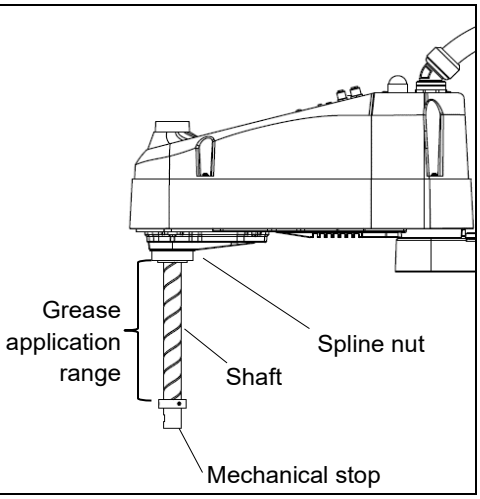
The brake release switch affects both Joints #3 and #4. When the brake release switch is pressed, the brakes for both Joints #3 and #4 are released simultaneously.
Be careful of the shaft falling and rotating while the brake release switch is being pressed because the shaft may be lowered by the weight of the end effector.



(3) Turn OFF the Controller.

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

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



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


Grease application example

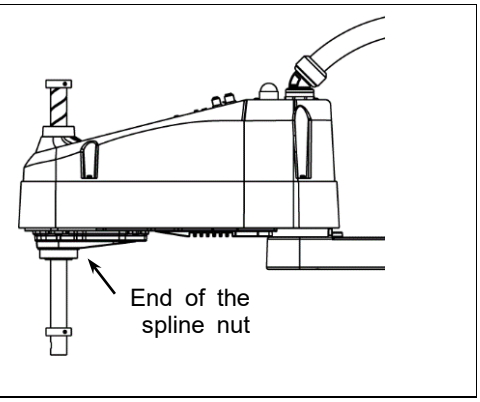
(6) Turn ON the Controller.

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

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

(9) Turn OFF the controller.

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



2.4 Tightening Hexagon Socket Head Bolts

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

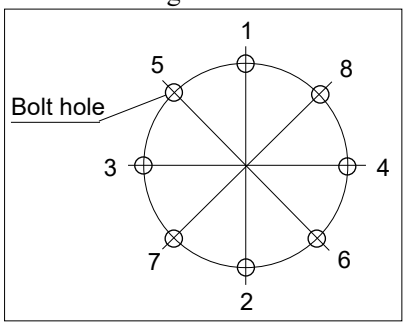
When it is required to refasten the bolts in some procedures in this manual (except special cases as noted), use a torque wrench so that the bolts are fastened with appropriate tightening torque as shown below.

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

See below for the set screw.

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

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



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

3. Regular Inspection for LS20-B Manipulator

This chapter describes maintenance inspection procedures. Performing maintenance inspection properly is essential to prevent trouble and ensure safety.
Be sure to perform the maintenance inspections in accordance with the schedule.

3.1 Inspection

3.1.1 Schedule for Inspection

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

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

3.1.2 Inspection Point

Inspection Item

Inspection Point	Inspection Place	Daily	Monthly	Quarterly	Biannual	Annual
Check looseness or backlash of bolts/screws.	End effector mounting bolts	√	√	√	√	√
	Manipulator mounting bolts	√	√	√	√	√
Check looseness of connectors.	External connectors on Manipulator (on the connector plates etc.)	√	√	√	√	√
Visually check for external defects. Clean up if necessary.	External appearance of Manipulator	√	√	√	√	√
	External cables		√	√	√	√
Check for bends or improper location. Repair or place it properly if necessary.	Safeguard etc.	√	√	√	√	√
Check the brake operation	Brake for arm #3 to #4	√	√	√	√	√
Check whether unusual sound or vibration occurs.	Whole	√	√	√	√	√

Inspection Method

Inspection Point	Inspection Method
Check looseness or backlash of bolts/screws.	Use a hexagonal wrench to check that the end effector mounting bolts and the Manipulator mounting bolts are not loose. When the bolts are loose, refer to "*3.4 Tightening Hexagon Socket Head Bolts*" and tighten them to the proper torque.
Check looseness of connectors.	Check that connectors are not loose. When the connectors are loose, reattach it not to come off.
Visually check for external defects. Clean up if necessary.	Check the appearance of the Manipulator and clean up if necessary. Check the appearance of the cable, and if it is scratched, check that there is no cable disconnection.
Check for bends or improper location. Repair or place it properly if necessary.	Check that the safeguard, etc. are located properly. If the location is improper, place it properly.
Check the brake operation	Check that the shaft does not fall when in MOTOR OFF. If the shaft falls when in MOTOR OFF and the brake is not released, contact the supplier. Also, if the break is not released even operated release the break, contact the supplier.
Check whether unusual sound or vibration occurs.	Check that there is no unusual sound or vibration when operating. If there is something wrong, contact the supplier.

3.2 Overhaul (Parts Replacement)

Overhaul (replacement) shall be performed by personnel who has taken a proper training.
For details, refer to "*Safety Manual Training*".
For details of overhaul, refer to *Maintenance Manual.*

3.3 Greasing

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

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

	Greasing part	Greasing Interval	Grease	How to grease
Joint #1, Joint #2	Reduction gear units	Overhaul timing	-	Greasing shall be performed by personnel who has taken a proper training. For details, refer to the G series Manipulator Maintenance Manual.
Joint #3	Ball screw spline unit	At 100 km of operation (50 km for first greasing)	AFB	*Greasing the Ball Screw Spline Unit*

Joint #3 Ball screw spline unit

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

Normal grease

Discolored grease

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

NOTE ☞ For EPSON RC+ 7.0 Ver. 7.2.x or later (firmware Ver.7.2.x.x or later), the recommended replacement time for the grease on the ball screw spline unit can be checked in the [Maintenance] dialog box of Epson RC+.
For details, refer to the following manual.
Robot Controller RC90 series "Maintenance Manual 6. Alarm"

Greasing the Ball Screw Spline Unit

	Name	Quantity	NOTE
Grease	For Ball Screw Spline Unit (AFB grease)	Proper quantity	
Tools	Wiping cloth	1	For wiping grease (Spline shaft)
	Cross-point screwdriver	1	

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

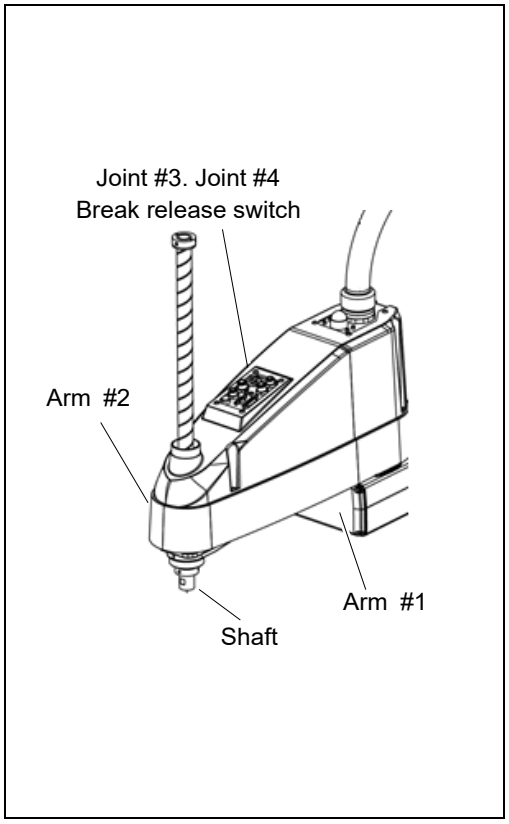
(1) Turn ON the Controller.

(2) Move the shaft to its lower limit in one of the following methods.

- Move the shaft to its lower limit manually while pressing the brake release switch.
- Move the shaft to its lower limit from Epson RC+ [Tools]-[Robot Manager]-[Jog & Teach].

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

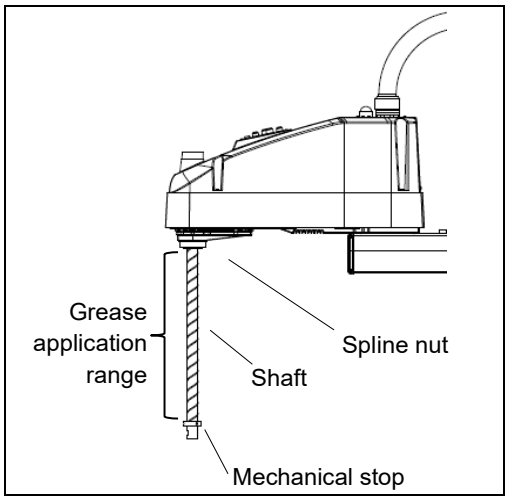
The brake release switch affects both Joints #3 and #4. When the brake release switch is pressed, the brakes for both Joints #3 and #4 are released simultaneously.
Be careful of the shaft falling and rotating while the brake release switch is being pressed because the shaft may be lowered by the weight of the end effector.



(3) Turn OFF the Controller.

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

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



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

Grease application example

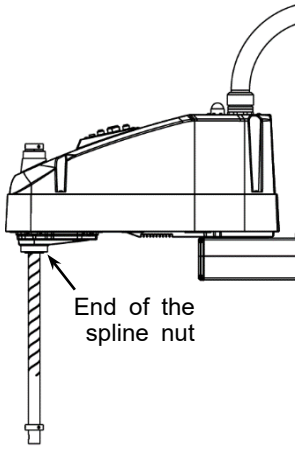
(6) Turn ON the Controller.

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

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

(9) Turn OFF the controller.

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



3.4 Tightening Hexagon Socket Head Bolts

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

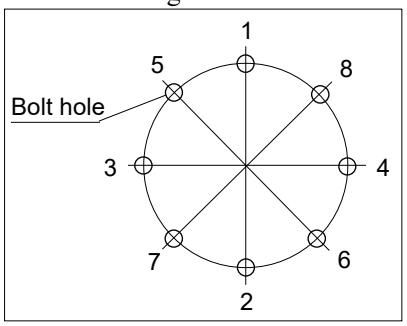
When it is required to refasten the bolts in some procedures in this manual (except special cases as noted), use a torque wrench so that the bolts are fastened with appropriate tightening torque as shown below.

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

See below for the set screw.

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

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



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

Appendix

This volume describes the specifications table for each model and detailed data of stopping time and stopping distance.

Appendix A: Specifications

LS3-B Specifications

Item			LS3-B401*	LS3-B401S-V1
Arm length		Arm #1+#2	400 mm	
		Arm #1	225 mm	
		Arm #2	175 mm	
Max. operating speed *1		Joints #1+#2	7200 mm/s	5340 mm/s
		Joint #3	1100 mm/s	
		Joint #4	2600°/s	
Repeatability		Joints #1+#2	± 0.01 mm	
		Joint #3	± 0.01 mm	
		Joint #4	± 0.01°	
Payload (Load)		Rated	1 kg	
		Max.	3 kg	
Joint #4 allowable moment of inertia *2		Rated	0.005 kg·m^2	
		Max.	0.05 kg·m^2	
Resolution		Joint #1 (°/pulse)	0.000439	0.000275
		Joint #2 (°/pulse)	0.000439	
		Joint #3 (°/pulse)	0.000799	
		Joint #4 (°/pulse)	0.001927	
Shaft diameter		Outer diameter	ø 16 mm	
		Inner diameter	ø 11 mm	
Mounting hole			120 × 120 mm 135 × 120 mm (Free choice of either hole.)	
			4-M8	
Weight (cables not included)			14 kg (31 lbs.)	
Driving method		All joints	AC servo motor	
Motor rated capacity		Joint #1	200 W	
		Joint #2	100 W	
		Joint #3	100 W	
		Joint #4	100 W	
Option		Installation environment	Cleanroom *3	Standard model only
Joint #3 down force			100 N	
Installed wire for customer use			15 (15 pin: D-sub) Equivalent to 8 pin (RJ45) Cat.5e	
Installed pneumatic tube for customer use			2 pneumatic tubes (ø6 mm) : 0.59 MPa (6 kgf/cm^2 : 86 psi)	
			1 pneumatic tube (ø4 mm) : 0.59 MPa (6 kgf/cm^2 : 86 psi)	
Environmental requirements *4		Ambient Temp.	5 to 40 °C	
		Ambient relative humidity	10 to 80% (no condensation)	
Noise level *5			L_{Aeq} = 70 dB (A) or under	
Applicable Controller			RC90-B	
MC cable	Cable weight (cable only)	For fixing and signal (common to all lengths)	0.06 kg/m	
		For fixing and power (common to all lengths)	0.21 kg/m	
		For movable and signal (common to all lengths)	0.15 kg/m	

Item			LS3-B401*	LS3-B401S-V1
		For movable and power (common to all lengths)	0.22 kg/m	
	Cable outer diameter	For fixing and signal (common to all lengths)	ø6.2 mm (typ)	
		For fixing and power (common to all lengths)	ø12.0 mm (typ)	
		For movable and signal (common to all lengths)	ø10.4 mm (typ)	
		For movable and power (common to all lengths)	ø12.8 mm (typ)	
	Minimum bending radius *6	For fixing and signal (common to all lengths)	38 mm	
		For fixing and power (common to all lengths)	73 mm	
		For movable and signal (common to all lengths)	100 mm	
		For movable and power (common to all lengths)	100 mm	
Assignable Value ( ) Default values		Speed	1 ~ (4) ~ 100	1 ~ (5) ~ 100
		Accel *7	1 ~ (10) ~ 120	
		SpeedS	0.1 ~ (50) ~ 2000	
		AccelS	0.1 ~ (200) ~ 25000	
		Fine	0 ~ (1250) ~ 65535	
		Weight	0 ~ (1) ~ 3	

Item		LS3-B401S	LS3-B401S-V1	LS3-B401C
Max. motion range	Joint #1	± 132°		
	Joint #2	± 141°		
	Joint #3	150 mm		120 mm
	Joint #4	± 360°		
Max. pulse range	Joint #1	− 95574 ~ 505174	− 152917 ~ 808278	− 95574 ~ 505174
	Joint #2	± 320854		
	Joint #3	−187734 ~ 0		−150187 ~ 0
	Joint #4	± 186778		

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

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

*3: The exhaust system in the Cleanroom-model Manipulator draws air from the base interior and arm cover interior together.
A crack or other opening in the base unit can cause loss of negative air pressure in the outer part of the arm, which can cause increased dust emission.

Cleanliness level : Class ISO 4 (ISO14644-1)

Exhaust System : Exhaust port diameter : Inner diameter: ø12 mm

Exhaust tube : Polyurethane tube
Outer diameter: ø12 mm (Inner diameter: ø8 mm)
Recommended exhaust flow rate : approx. 1000 cm^3/s (Normal)

*4: When the product is used in a low temperature environment around the minimum temperature of the product specification, or when the product is suspended for a long time on holidays or at night, a collision detection error may occur due to the large resistance of the drive unit immediately after the start of operation. In such a case, it is recommended to warm up for about 10 minutes.

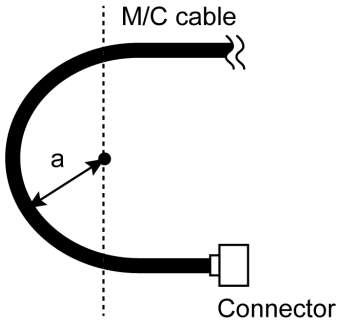
*5: Conditions of Manipulator during measurement as follows:

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

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

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

- Install the cable not to apply a load to the connector.
- Bend the cable at the minimum bending radius of the movable part or more. The bending radius (a) and dimensions are shown in the figure below.



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

LS6-B Specifications

Item			LS6-B502*	LS6-B602*	LS6-B702*	LS6-B602S-V1
Arm length		Arm #1+#2	500 mm	600 mm	700 mm	600 mm
		Arm #1	225 mm	325 mm	425 mm	325 mm
		Arm #2	275 mm			
Max. operating speed *1		Joints #1+#2	7120 mm/s	7850 mm/s	8590 mm/s	7850 mm/s
		Joint #3	1100 mm/s			
		Joint #4	2000°/s			
Repeatability		Joints #1+#2	± 0.02 mm			
		Joint #3	± 0.01 mm			
		Joint #4	± 0.01°			
Payload (Load)		Rated	2 kg			
		Max.	6 kg			
Joint #4 allowable moment of inertia *2		Rated	0.01 kg·m^2			
		Max.	0.12 kg·m^2			
Resolution		Joint #1 (°/pulse)	0.000275			
		Joint #2 (°/pulse)	0.000439			
		Joint #3 (°/pulse)	0.000814			
		Joint #4 (°/pulse)	0.001465			
Shaft diameter		Outer diameter	ø 20 mm			
		Inner diameter	ø 14 mm			
Mounting hole			150 × 150 mm			
			4-M8			
Weight (cables not included)			17 kg (37.5lbs.)		18 kg (39.7lbs.)	
Driving method		All joints	AC servo motor			
Motor rated capacity		Joint #1	200 W			520W
		Joint #2	200 W			520W
		Joint #3	100 W			150W
		Joint #4	100 W			100 W
Option	Installation environment		Cleanroom *3			Standard model only
Joint #3 down force			100 N			
Installed wire for customer use			15 (15 pin: D-sub) Equivalent to 8 pin (RJ45) Cat.5e			
Installed pneumatic tube for customer use			2 pneumatic tubes (ø6 mm) : 0.59 MPa (6 kgf/cm^2 : 86 psi)			
			1 pneumatic tube (ø4 mm) : 0.59 MPa (6 kgf/cm^2 : 86 psi)			
Environmental requirements *4		Ambient Temp.	5 to 40 °C			
		Ambient relative humidity	10 to 80% (no condensation)			
Noise level *5			L_{Aeq} = 70 dB (A) or under			
Applicable Controller			RC90-B			
MC cable	Cable weight (cable only)	For fixing and signal (common to all lengths)	0.06 kg/m			
		For fixing and power (common to all lengths)	0.21 kg/m			
		For movable and signal (common to all lengths)	0.15 kg/m			
		For movable and power (common to all lengths)	0.22 kg/m			
	Cable outer diameter	For fixing and signal (common to all lengths)	ø6.2 mm (typ)			

Item			LS6-B502*	LS6-B602*	LS6-B702*	LS6-B602S-V1
		For fixing and power (common to all lengths)	ø12.0 mm (typ)			
		For movable and signal (common to all lengths)	ø10.4 mm (typ)			
		For movable and power (common to all lengths)	ø12.8 mm (typ)			
	Minimum bending radius *6	For fixing and signal (common to all lengths)	38 mm			
		For fixing and power (common to all lengths)	73 mm			
		For movable and signal (common to all lengths)	100 mm			
		For movable and power (common to all lengths)	100 mm			
Assignable Value ( ) Default values		Speed	1 ~ (5) ~ 100			
		Accel *7	1 ~ (10) ~ 120			
		SpeedS	0.1 ~ (50) ~ 2000			
		AccelS	0.1 ~ (200) ~ 25000			
		Fine	0 ~ (1250) ~ 65535			
		Weight	0 ~ (2) ~ 6			

Item		LS6-B*02S	LS6-B*02C
Max. motion range	Joint #1	± 132°	
	Joint #2	± 150°	
	Joint #3	200 mm	170 mm
	Joint #4	± 360°	
Max.pulse range	Joint #1	– 152918 ~ 808278	
	Joint #2	± 341334	
	Joint #3	–245760 ~ 0	– 208896 ~ 0
	Joint #4	± 245760	

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

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

*3: The *exhaust system in the Cleanroom-model Manipulator draws air from the base interior and arm cover in*terior together.
A crack or other opening in the base unit can cause loss of negative air pressure in the outer part of the arm, which can cause increased dust emission.

Cleanliness level : Class ISO 4 (ISO14644-1)

Exhaust System : Exhaust port diameter : Inner diameter: ø12 mm

Exhaust tube : Polyurethane tube
Outer diameter: ø12 mm (Inner diameter: ø8 mm)
Recommended exhaust flow rate : approx. 1000 cm^3/s (Normal)

*4: When the product is used in a low temperature environment around the minimum temperature of the product specification, or when the product is suspended for a long time on holidays or at night, a collision detection error may occur due to the large resistance of the drive unit immediately after the start of operation. In such

a case, it is recommended to warm up for about 10 minutes.

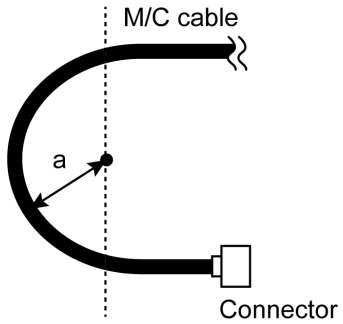
*5: Conditions of Manipulator during measurement as follows:

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

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

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

- Install the cable not to apply a load to the connector.
- Bend the cable at the minimum bending radius of the movable part or more. The bending radius (a) and dimensions are shown in the figure below.



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

LS10-B Specifications

Item			LS10-B60**	LS10-B70**	LS10-B80**
Arm length		Arm #1+#2	600 mm	700 mm	800 mm
		Arm #1	225 mm	325 mm	425 mm
		Arm #2	375 mm		
Max. operating speed *1		Joints #1+#2	9100 mm/s	9800 mm/s	10500 mm/s
		Joint #3	1100 mm/s		
		Joint #4	2700 °/s		
Repeatability		Joints #1+#2	± 0.02 mm		± 0.025 mm
		Joint #3	± 0.01 mm		
		Joint #4	± 0.01 °		
Payload (Load)		Rated	5 kg		
		Max.	10 kg		
Joint #4 allowable moment of inertia *2		Rated	0.02 kg·m^2		
		Max.	0.3 kg·m^2		
Resolution		Joint #1	0.000275 °/pulse		
		Joint #2	0.000439 °/pulse		
		Joint #3	0.000740 mm/pulse		
		Joint #4	0.001674 °/pulse		
Shaft diameter		Outer diameter	ø 25 mm		
		Inner diameter	ø 18 mm		
Mounting hole			150 × 150 mm		
			4-M8		
Weight (cables not included)			23 kg (50.7lbs.)	23 kg (50.7lbs.))	24 kg (52.9lbs.)
Driving method		All joints	AC servo motor		
Motor rated capacity		Joint #1	520 W		
		Joint #2	520 W		
		Joint #3	200 W		
		Joint #4	150 W		
Option	Installation environment		Cleanroom *3		
Joint #3 down force			200 N		
Installed wire for customer use			15 (15 pin: D-sub) Equivalent to 8 pin (RJ45) Cat.5e		
Installed pneumatic tube for customer use			2 pneumatic tubes (ø6 mm) : 0.59 MPa (6 kgf/cm^2 : 86 psi)		
			1 pneumatic tube (ø4 mm) : 0.59 MPa (6 kgf/cm^2 : 86 psi)		
Environmental requirements *4	Ambient Temp.		5 to 40 °C		
	Ambient relative humidity		10 to 80% (no condensation)		
Noise level *5			L_{Aeq} = 70 dB (A) or under		
Applicable Controller			RC90-B		
MC cable	Cable weight (cable only)	For fixing and signal (common to all lengths)	0.06 kg/m		
		For fixing and power (common to all lengths)	0.21 kg/m		
		For movable and signal (common to all lengths)	0.15 kg/m		
		For movable and power (common to all lengths)	0.22 kg/m		
	Cable outer diameter	For fixing and signal (common to all lengths)	ø6.2 mm (typ)		
		For fixing and power (common to all lengths)	ø12.0 mm (typ)		

Item			LS10-B60**	LS10-B70**	LS10-B80**
		For movable and signal (common to all lengths)	ø10.4 mm (typ)		
		For movable and power (common to all lengths)	ø12.8 mm (typ)		
	Minimum bending radius *6	For fixing and signal (common to all lengths)	38 mm		
		For fixing and power (common to all lengths)	73 mm		
		For movable and signal (common to all lengths)	100 mm		
		For movable and power (common to all lengths)	100 mm		
Assignable Value ( ) Default values		Speed	1 ~ (4) ~ 100		
		Accel *7	1 ~ (10) ~ 120		
		SpeedS	0.1 ~ (50) ~ 2000		
		AccelS	0.1 ~ (200) ~ 25000		
		Fine	0 ~ (1250) ~ 65535		
		Weight	0 ~ (5) ~ 10		
Operation mode			Standard mode (default), Low-oscillation mode *8		

Item		LS10-B**2S	LS10-B**2C	LS10-B**3S	LS10-B**3C
Max. motion range	Joint #1	± 132 °			
	Joint #2	± 150 °			
	Joint #3	200 mm	170 mm	300 mm	270 mm
	Joint #4	± 360 °			
Max. pulse range	Joint #1	– 152918 ~ 808278			
	Joint #2	± 341334			
	Joint #3	– 270336 ~ 0	– 229786 ~ 0	– 405504 ~ 0	– 364954 ~ 0
	Joint #4	± 215040			

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

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

*3: The exhaust system in the Cleanroom-model Manipulator draws air from the base interior and arm cover interior together.
A crack or other opening in the base unit can cause loss of negative air pressure in the outer part of the arm, which can cause increased dust emission.

Cleanliness level : Class ISO 4 (ISO14644-1)

Exhaust System : Exhaust port diameter : Inner diameter: ø12 mm

Exhaust tube : Polyurethane tube
Outer diameter: ø12 mm (Inner diameter:ø8 mm)
Recommended exhaust flow rate : approx. 1000 cm^3/s (Normal)

*4: When the product is used in a low temperature environment around the minimum temperature of the product specification, or when the product is suspended for a long time on holidays or at night, a collision detection error may occur due to the large resistance of the drive unit immediately after the start of operation. In such a case, it is recommended to warm up for about 10 minutes.

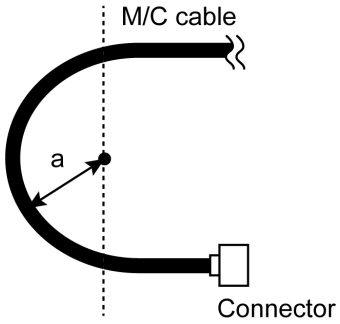
*5: Conditions of Manipulator during measurement as follows:

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

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

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

- Install the cable not to apply a load to the connector.
- Bend the cable at the minimum bending radius of the movable part or more. The bending radius (a) and dimensions are shown in the figure below.



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

*8: PerformMode command allows you to switch operation mode. For details, refer to the SPEL+ Language Reference.

Be careful following for the Low-oscillation mode.

1. An error occurs with the following conditions. Use with standard mode.
   - Auxiliary arm is active
   - Path motion is active
   - VRT option is active
   - Jump3 motion
   - Analog IO function is activated
   - Conveyor tracking is executed
   - Eccentricity is bigger than 150mm
2. Vibration may get bigger with the following conditions.
   - Weight setting is different from actual weight (end effector or work piece weight)
3. Performance does not change between Standard mode and Low-oscillation mode with the following conditions
   - Move, BMove, TMove, CVMove, Arc, Arc3,Jump3CP motion executed
   - Operated with the torque control
4. Consider using VRT option with following conditions
   - Eccentric Quantity is large and vibrates (As a guide, end effector or work piece is 100 mm or more.)
   - Base table vibrates
   - End effector or work piece vibrates

LS20-B Specifications

Item			LS20-B804*	LS20-BA04*
Arm length		Arms #1+#2	800 mm	1000 mm
		Arm #1	350 mm	550 mm
		Arm #2	450 mm	
Max. operating speed *1		Joints #1+#2	9940 mm/s	11250 mm/s
		Joint #3	2300 mm/s	
		Joint #4	1400°/s	
Repeatability		Joints #1+#2	± 0.025 mm	
		Joint #3	± 0.01 mm	
		Joint #4	± 0.01°	
Payload (Load)		Rated	10 kg	
		Max.	20 kg	
Joint #4 allowable moment of inertia *2		Rated	0.05 kg·m^2	
		Max.	1.00 kg·m^2	
Resolution		Joint #1	0.000275°/pulse	
		Joint #2	0.000439°/pulse	
		Joint #3	0.00148 mm/pulse	
		Joint #4	0.001046°/pulse	
Shaft diameter		Outer diameter	ø 25 mm	
		Inner diameter	ø 18 mm Upper end of the shaft for C*: ø14 mm	
Mounting hole			200 × 200 mm	
			4 × ø16	
Weight (cables not included)			48 kg: 105.8 lbs.	51 kg: 112.5 lbs.
Driving method		All joints	AC servo motor	
Motor rated capacity		Joint #1	750 W	
		Joint #2	520 W	
		Joint #3	520 W	
		Joint #4	150 W	
Option		Installation environment	Cleanroom *3	
Joint #3 down force			250 N	
Installed wire for customer use			15 pin: D-sub, 9 pin: D-sub Equivalent to 8 pin (RJ45) Cat.5e	
Installed pneumatic tube for customer use			2 pneumatic tubes (ø8 mm): 0.59 MPa (6 kgf/cm^2: 86 psi)	
			2 pneumatic tubes (ø6 mm): 0.59 MPa (6 kgf/cm^2: 86 psi)	
Environmental requirements *4		Ambient Temp.	5 to 40 °C	
		Ambient relative humidity	10 ~ 80 % (no condensation)	
Noise level *5			L_{Aeq} = 70 dB (A) or under	
Applicable Controller			RC90-B	
MC cable	Cable weight (cable only)	For fixing and signal (common to all lengths)	0.06 kg/m	
		For fixing and power (common to all lengths)	0.21 kg/m	
		For movable and signal (common to all lengths)	0.15 kg/m	
		For movable and power (common to all lengths)	0.22 kg/m	
	Cable outer diameter	For fixing and signal (common to all lengths)	ø6.2 mm (typ)	

Item			LS20-B804*	LS20-BA04*
		For fixing and power (common to all lengths)	ø12.0 mm (typ)	
		For movable and signal (common to all lengths)	ø10.4 mm (typ)	
		For movable and power (common to all lengths)	ø12.8 mm (typ)	
	Minimum bending radius *6	For fixing and signal (common to all lengths)	38 mm	
		For fixing and power (common to all lengths)	73 mm	
		For movable and signal (common to all lengths)	100 mm	
		For movable and power (common to all lengths)	100 mm	
Assignable Value ( ) Default values		Speed	1 ~ (3) ~ 100	
		Accel *7	1 ~ (10) ~ 120	
		SpeedS	0.1 ~ (50) ~ 2000	
		AccelS	0.1 ~ (200) ~ 10000	
		Fine	0 ~ (1250) ~ 65535	
		Weight	0 ~ (10) ~ 20	

Item		LS20-B804S	LS20-BA04S	LS20-B804C	LS20-BA04C
Max. motion range	Joint #1	± 132°			
	Joint #2	± 152°			
	Joint #3	420 mm		390 mm	
	Joint #4	± 360°			
Max. pulse range	Joint #1	– 152918 ~ 808278			
	Joint #2	± 345885			
	Joint #3	–283853 ~ 0		–263578 ~ 0	
	Joint #4	± 344064			

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

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

*3: The exhaust system in the Cleanroom-model Manipulator draws air from the base interior and arm cover interior together. A crack or other opening in the base unit can cause loss of negative air pressure in the outer part of the arm, which can cause increased dust emission.

Cleanliness level : Class ISO 4 (ISO14644-1)

Exhaust System : Exhaust port diameter : Inner diameter: ø12 mm

Exhaust tube : Polyurethane tube
Outer diameter: ø12 mm (Inner diameter: ø8 mm)
Recommended exhaust flow rate : approx. 1000 cm^3/s (Normal)

*4: When the product is used in a low temperature environment around the minimum temperature of the product specification, or when the product is suspended for a long time on holidays or at night, a collision detection error may occur due to the large resistance of the drive unit immediately after the start of operation. In such a case, it is recommended to warm up for about 10 minutes.

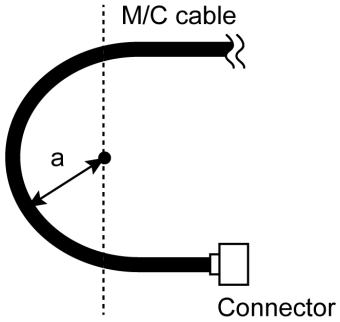
*5: Conditions of Manipulator during measurement as follows:

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

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

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

- Install the cable not to apply a load to the connector.
- Bend the cable at the minimum bending radius of the movable part or more. The bending radius (a) and dimensions are shown in the figure below.

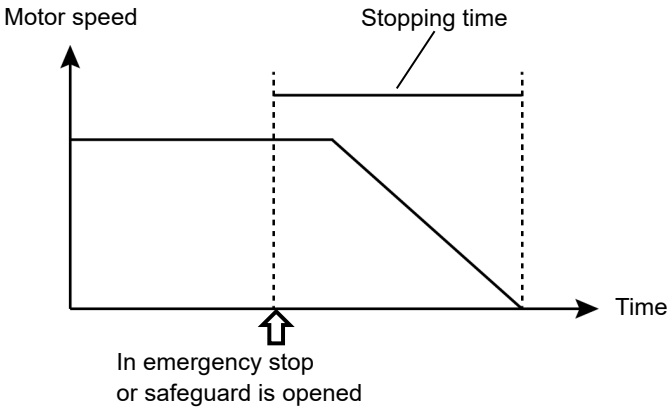


*7: In general use, Accel setting 100 is the optimum setting that maintains the balance of acceleration and vibration when positioning. Although values larger than 100 can be set to Accel, it is recommended to minimize the use of large values to necessary motions since operating the manipulator continuously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

Appendix B: Stopping time and Stopping distance in Emergency

The stopping time and stopping distance in emergency stop are shown in a graph for each model.

The stopping time is “Stopping time” in the figure below. Be sure to confirm that safety is ensured according to the installation environment and operation of the robot.



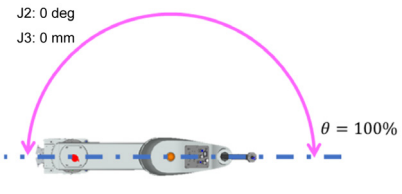
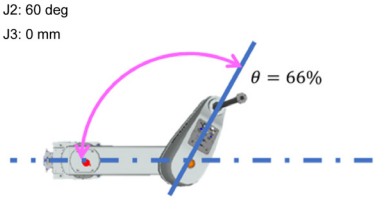
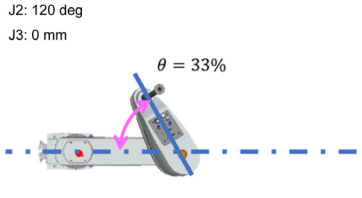
Condition:

The stopping time and stopping distance vary depending on the parameters (setting value) set for the robot. In this chapter, the time and distance are shown with 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 : 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	ɵ = 100%	ɵ = 66%	ɵ = 33%
J1			

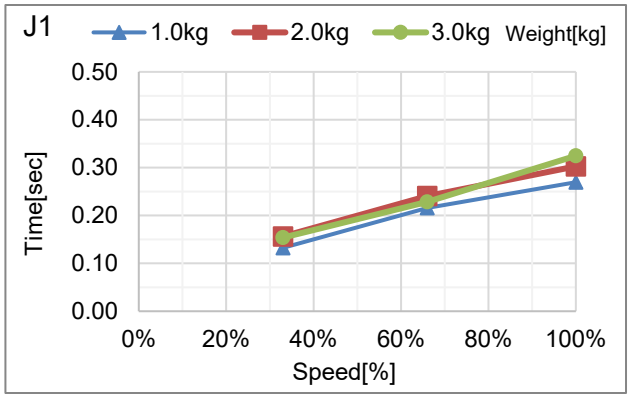
Description of legend:

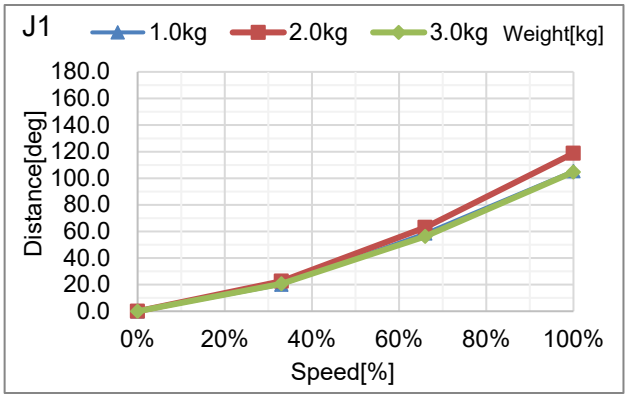
The graph is shown for each Weight value (at 100%, approx. 66%, and approx. 33% of the maximum payload, and at the rated payload).

Horizontal axis	: Arm speed (Speed value)
Vertical axis	: Stopping time and stopping distance in each arm speed
Time [sec]	: Stopping time
Distance [deg]	: Stopping distance of J1 and J2
Distance [mm]	: Stopping distance of J3

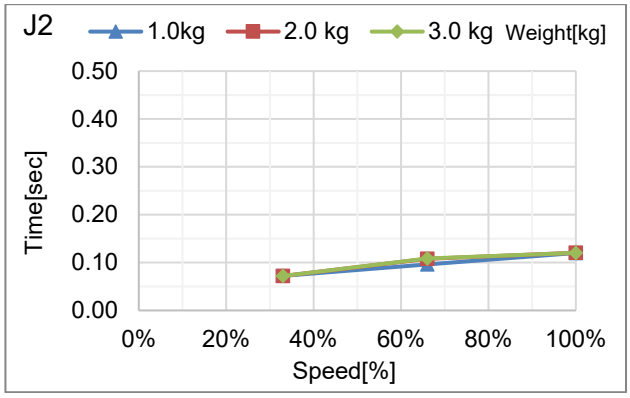
LS3-B Stopping time and Stopping distance in Emergency

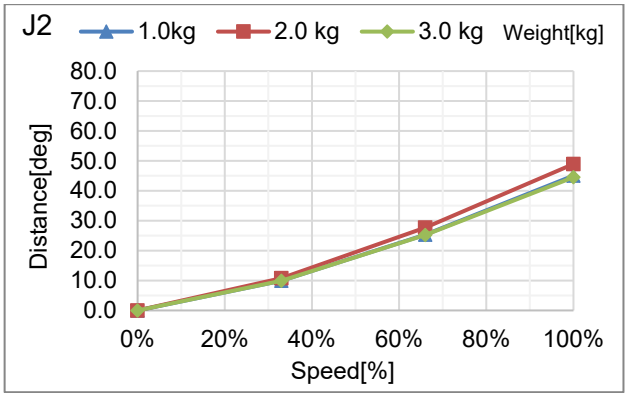
LS3-B401*: J1



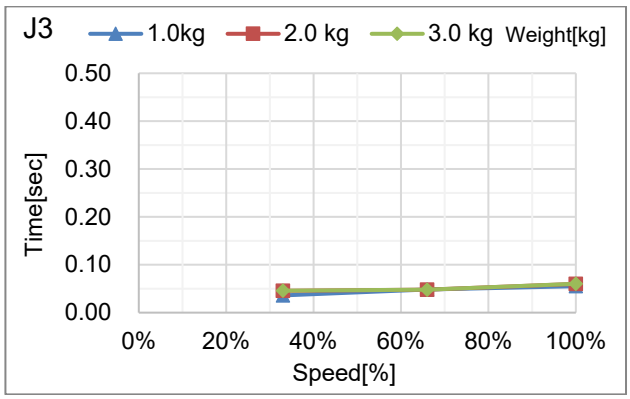


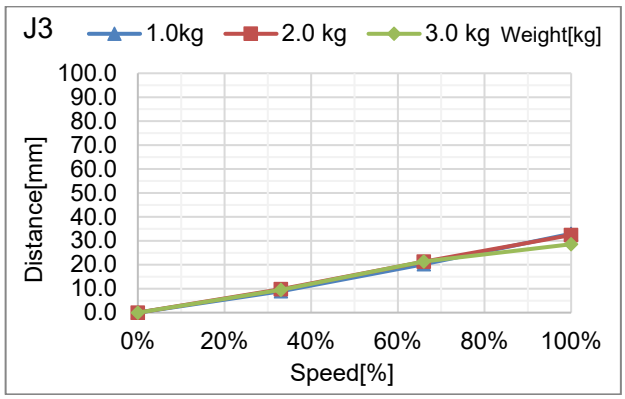
LS3-B401*: J2



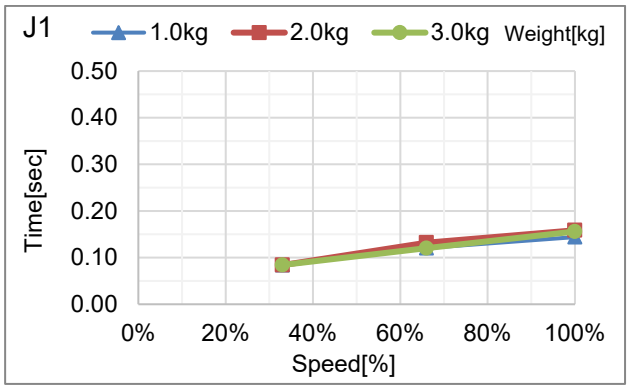


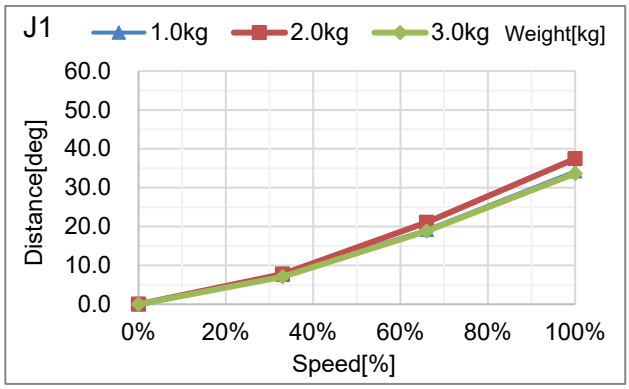
LS3-B401*: J3



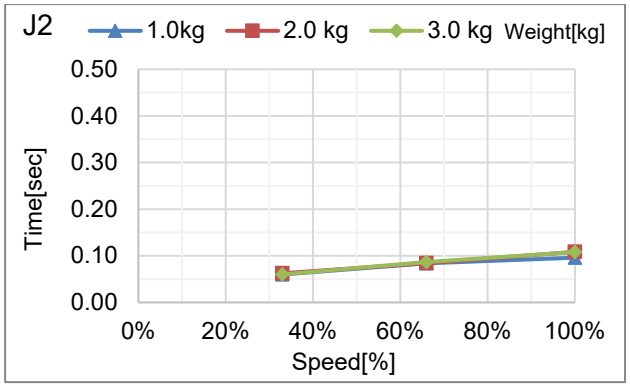


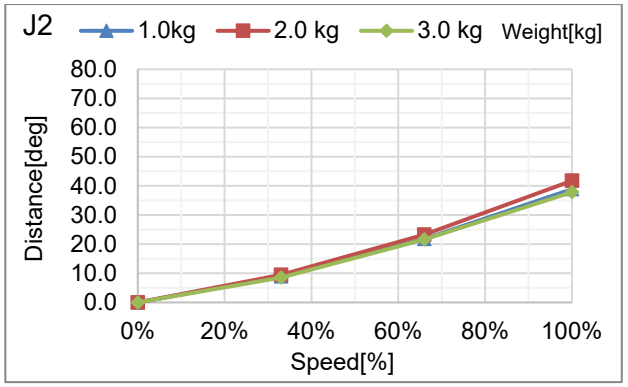
LS3-B401S-V1: J1



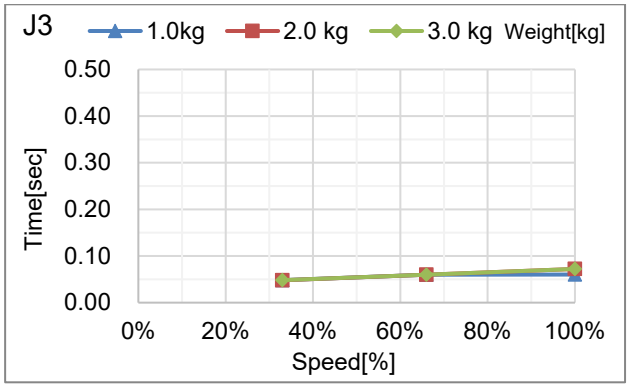


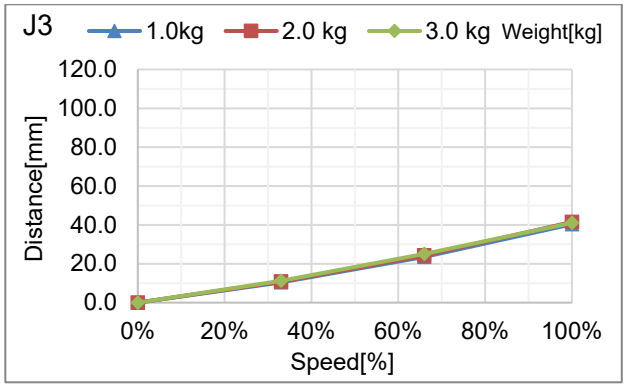
LS3-B401S-V1: J2





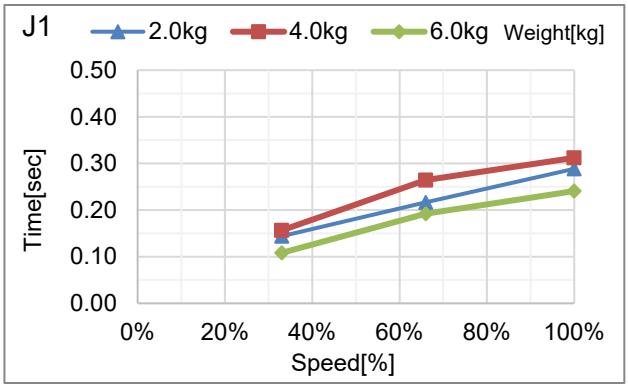
LS3-B401S-V1: J3

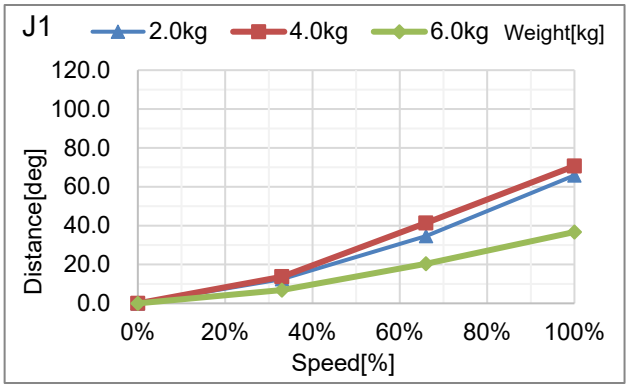




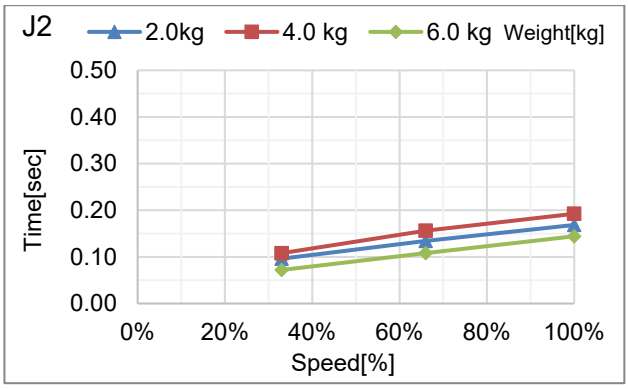
LS6-B Stopping time and Stopping distance in Emergency

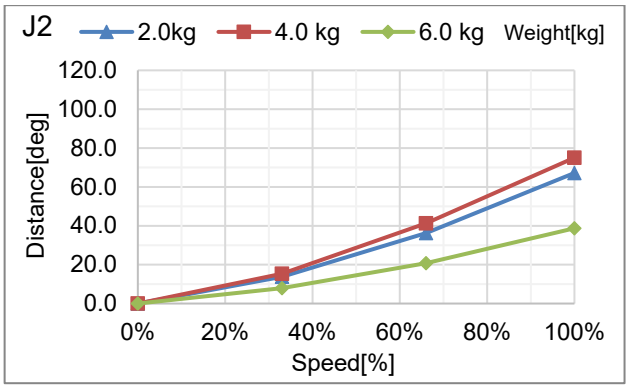
LS6-B502*: J1



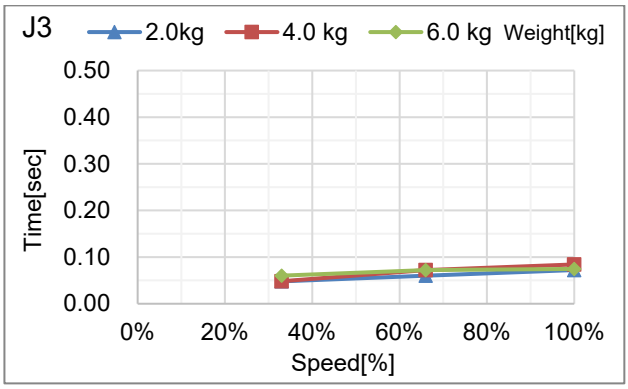


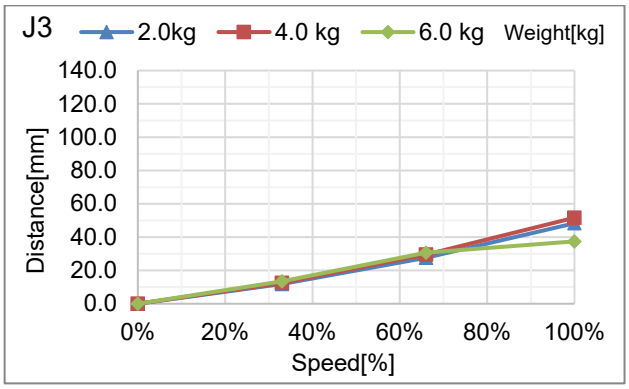
LS6-B502*: J2



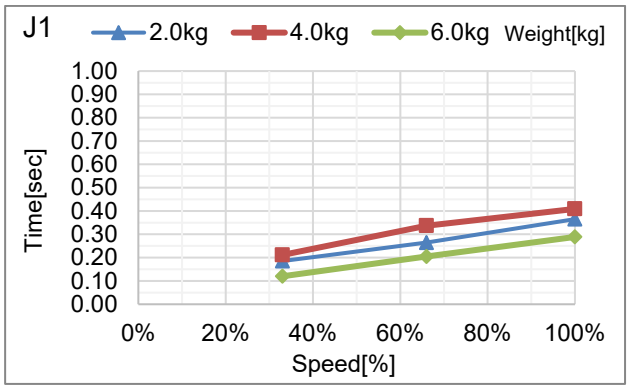


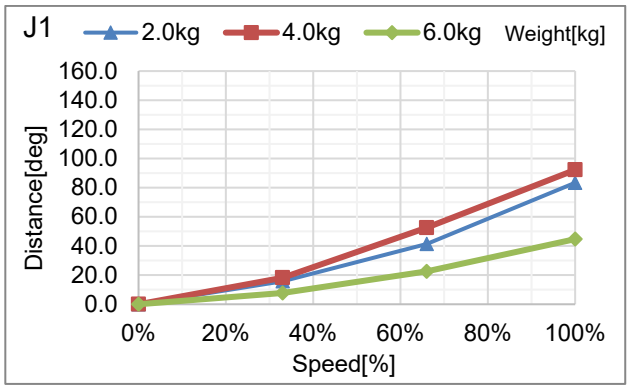
LS6-B502*: J3



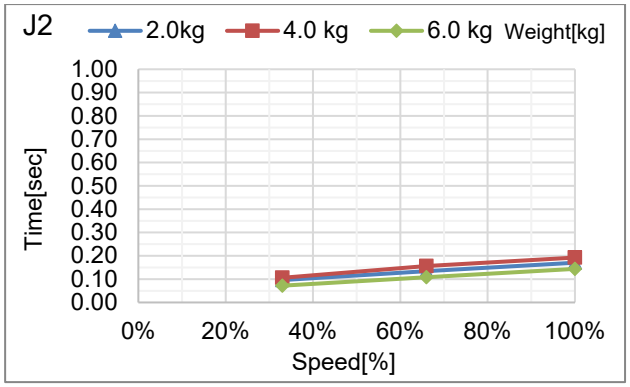


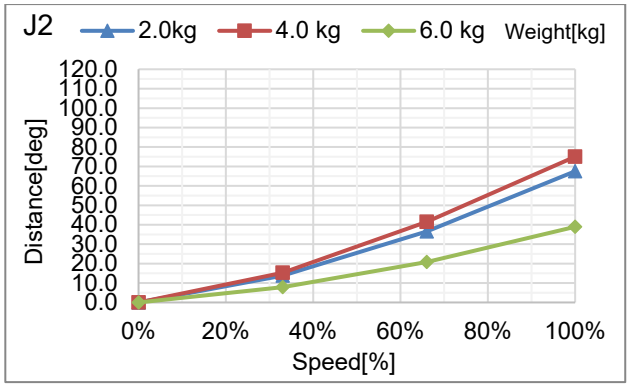
LS6-B602*: J1



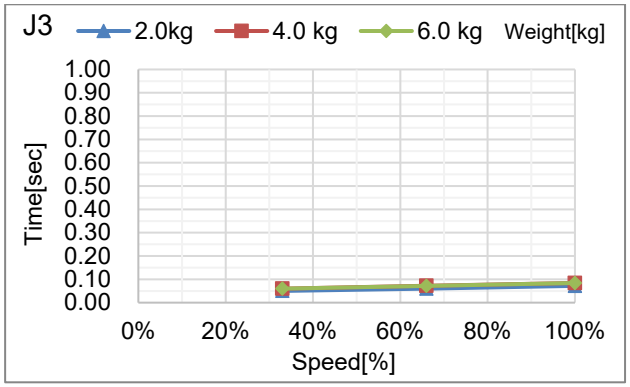


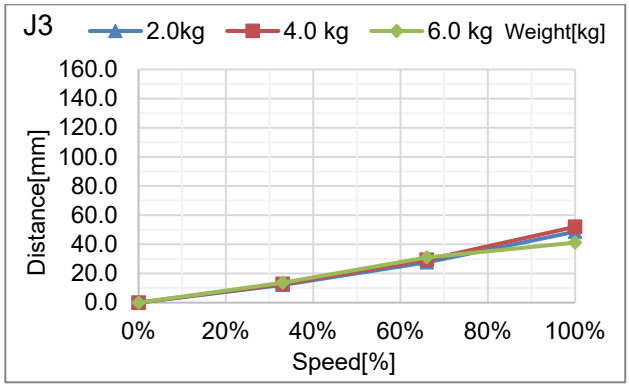
LS6-B602*: J2



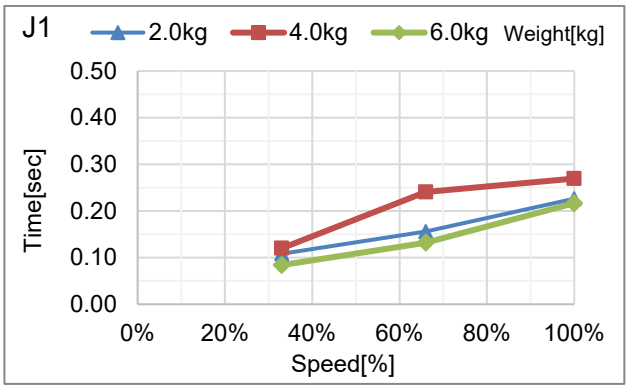


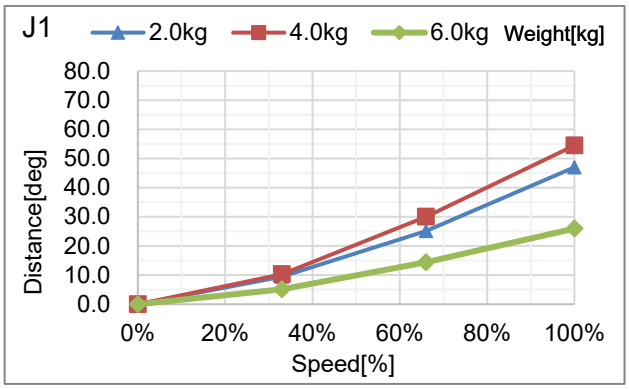
LS6-B602*: J3



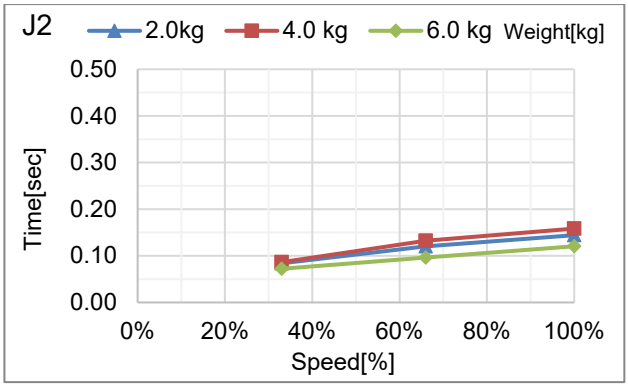


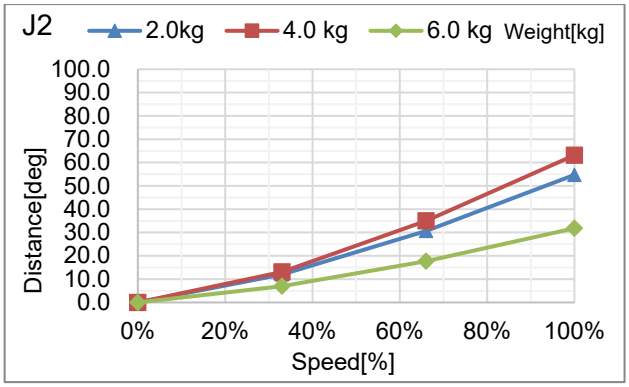
LS6-B602S-V1: J1



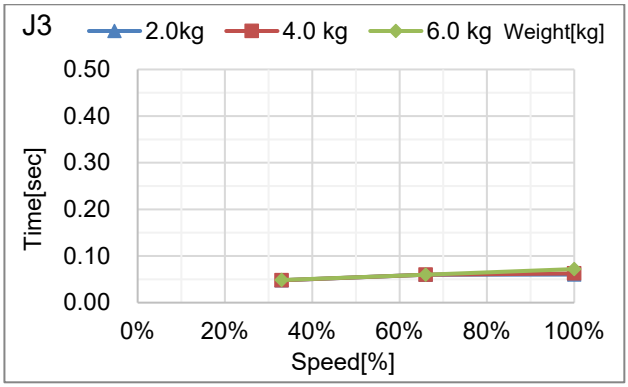


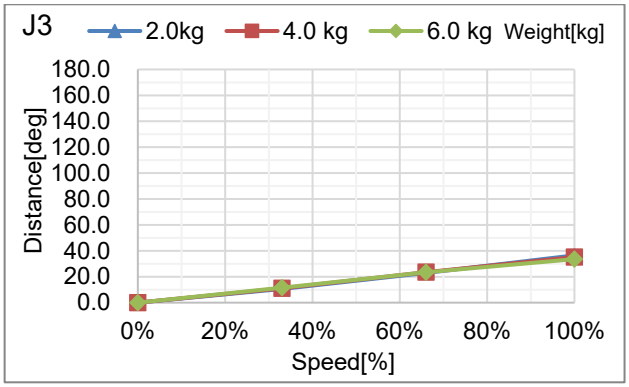
LS6-B602S-V1: J2



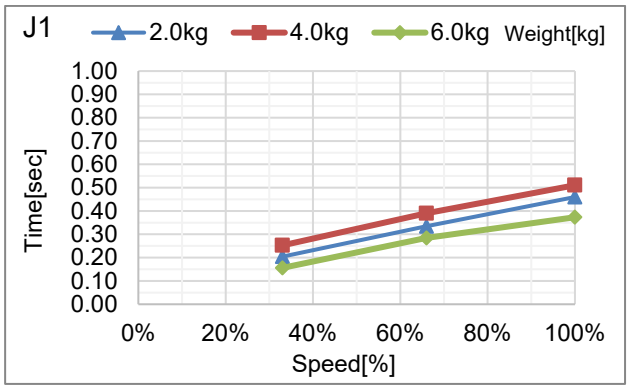


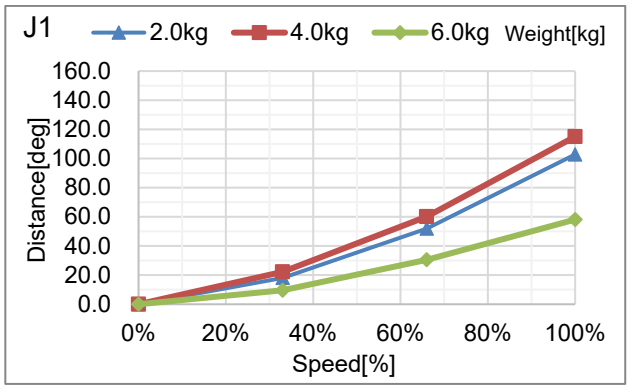
LS6-B602S-V1: J3



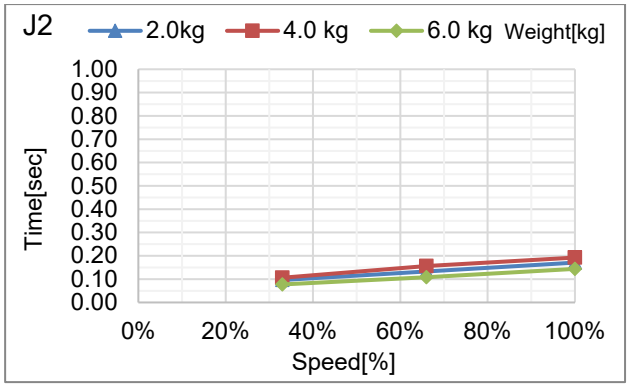


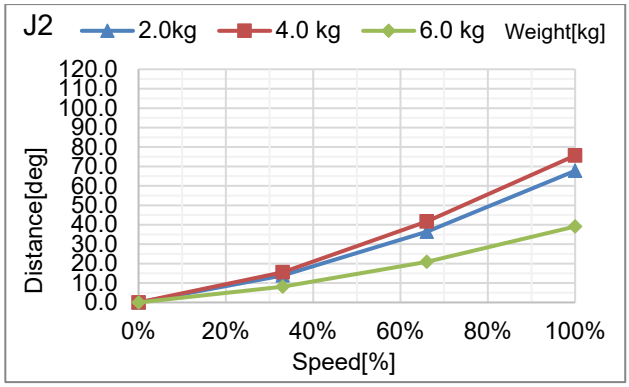
LS6-B702*: J1



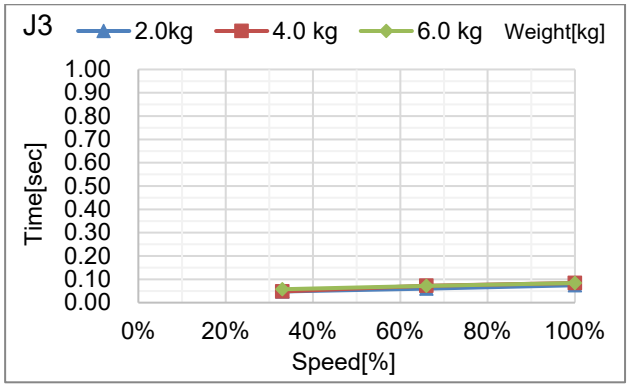


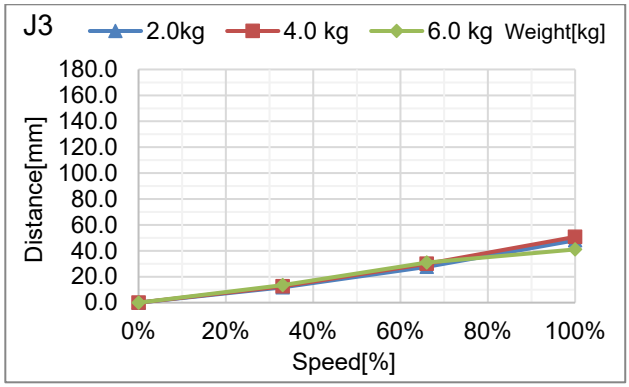
LS6-B702*: J2





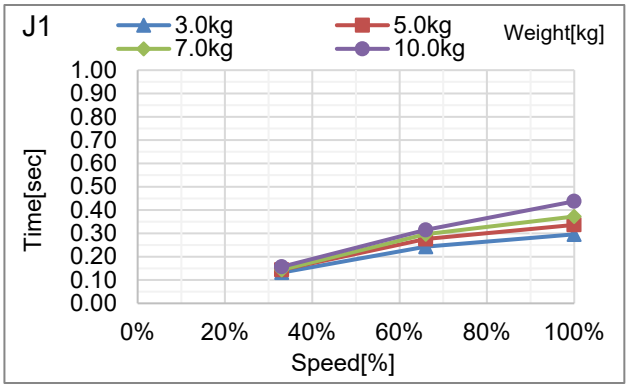
LS6-B702*: J3

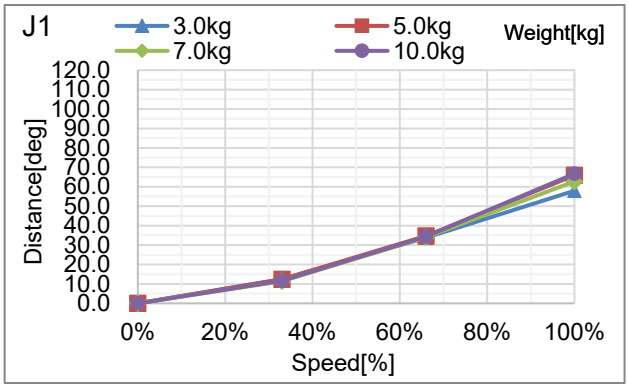




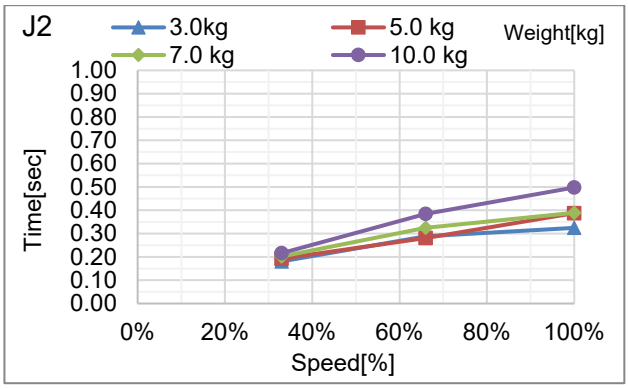
LS10-B Stopping time and Stopping distance in Emergency

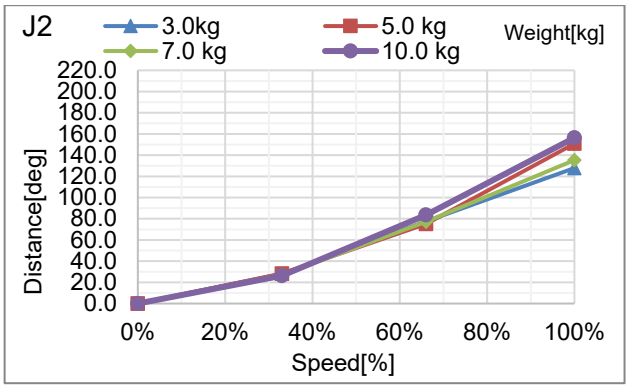
LS10-B60**: J1



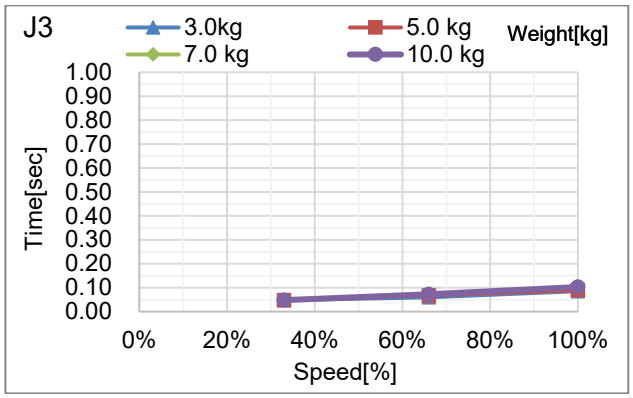


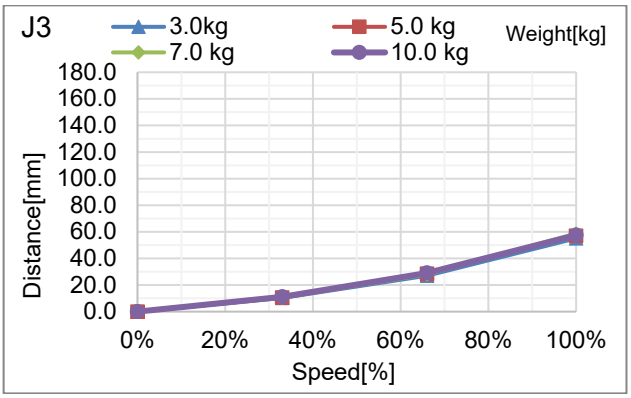
LS10-B60**: J2



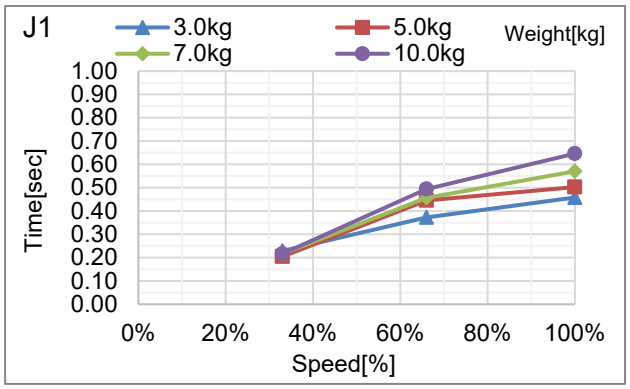


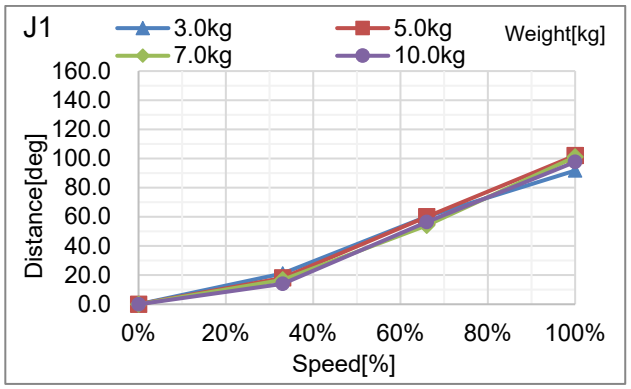
LS10-B60**: J3





LS10-B70**: J1





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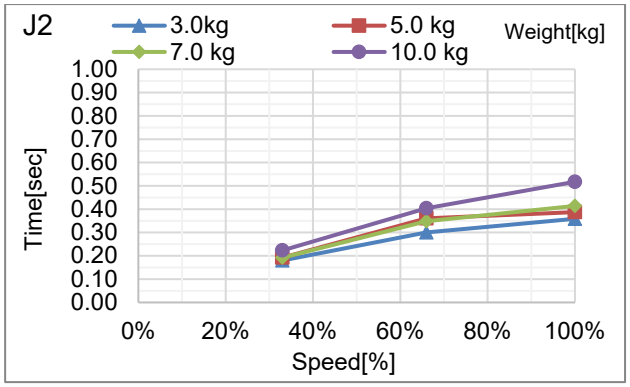
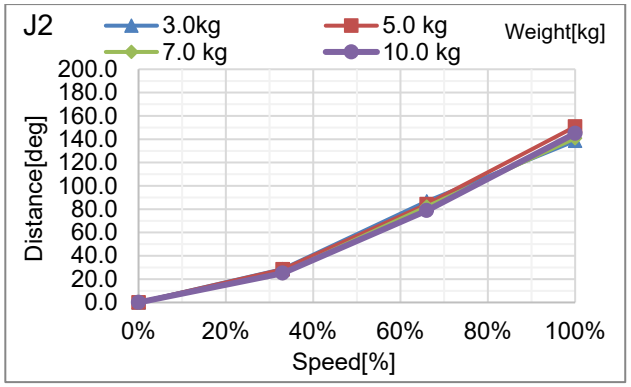
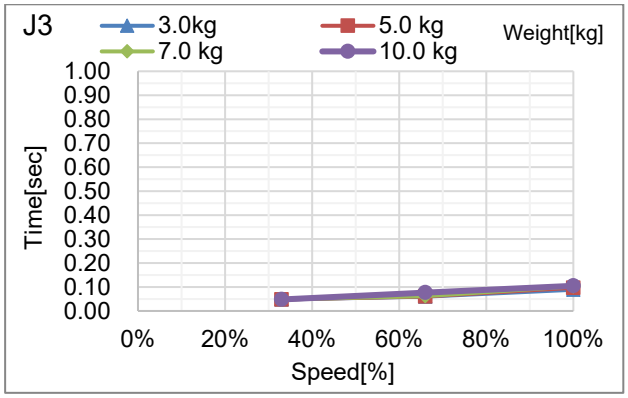
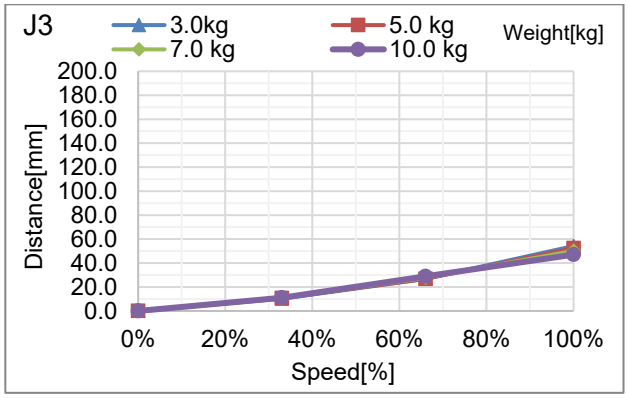


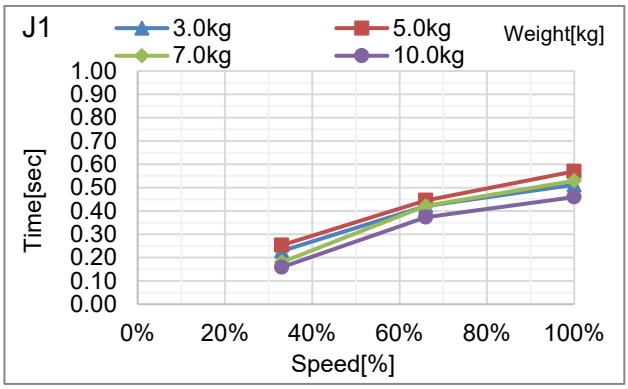


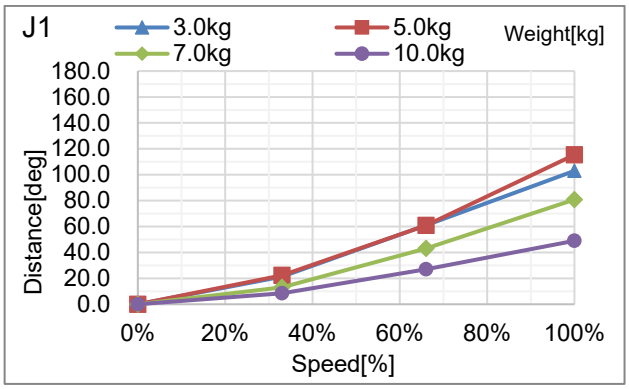
LS10-B70**: J3





LS10-B80**: J1





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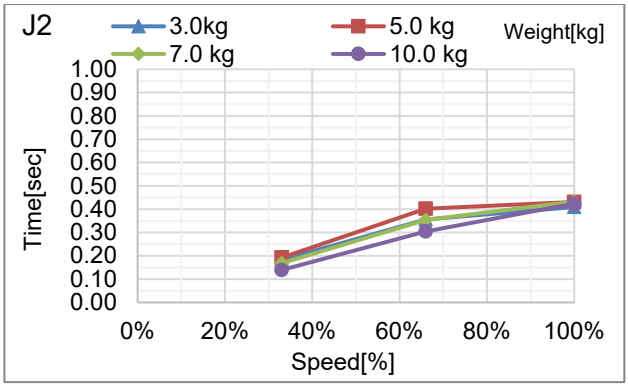
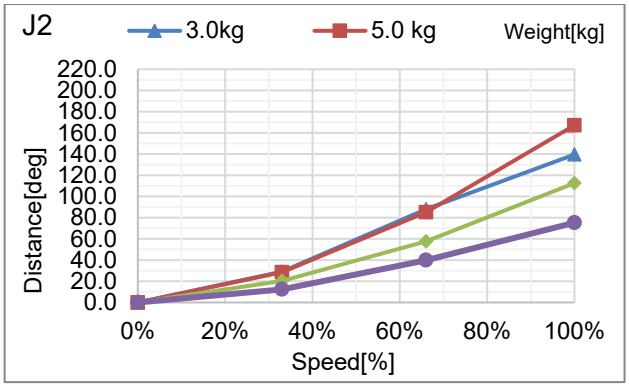
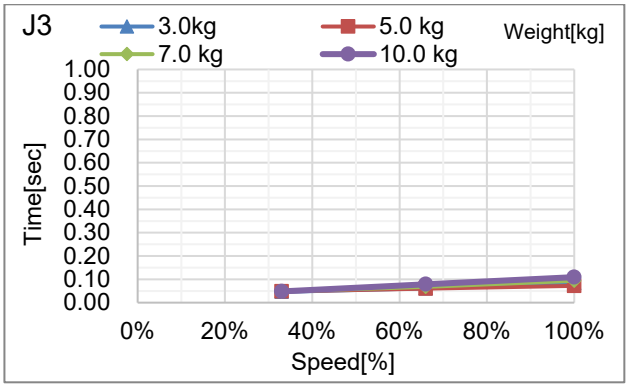
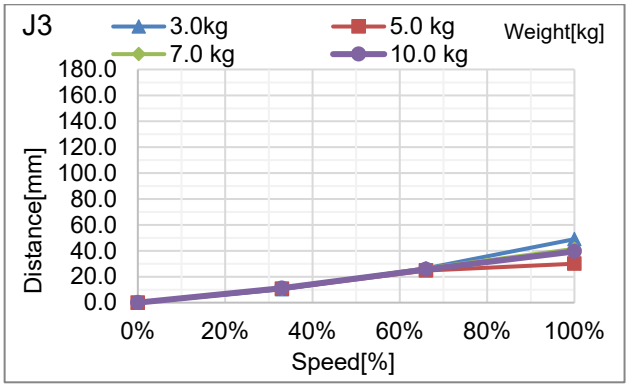




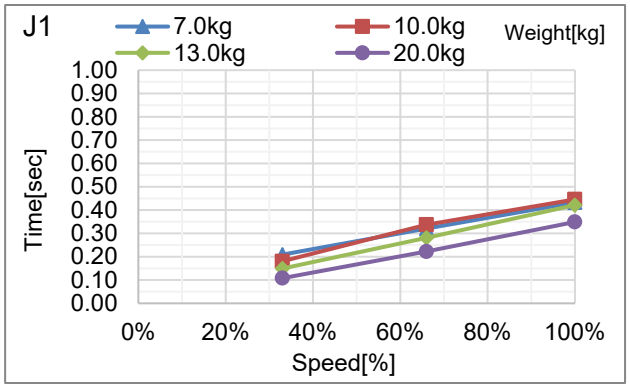
LS10-B80**: J3

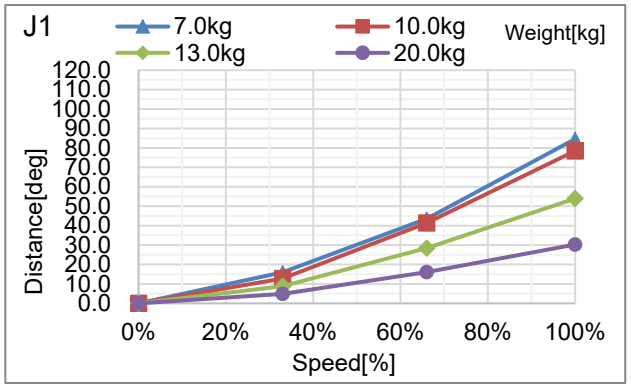




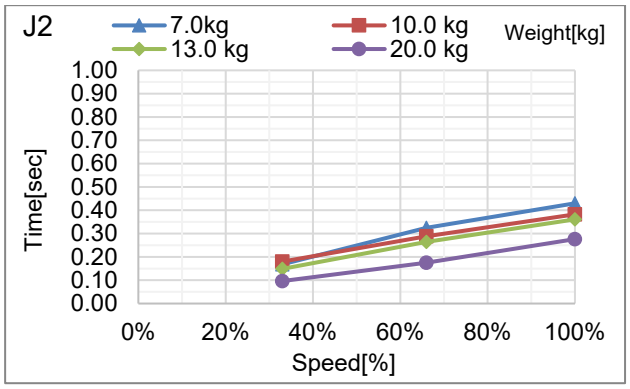
LS20-B Stopping time and Stopping distance in Emergency

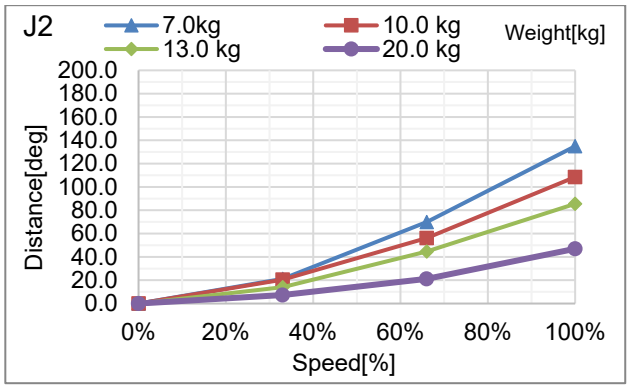
LS20-B804*: J1



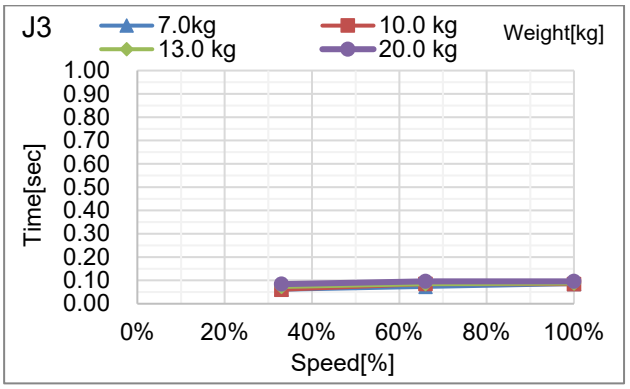


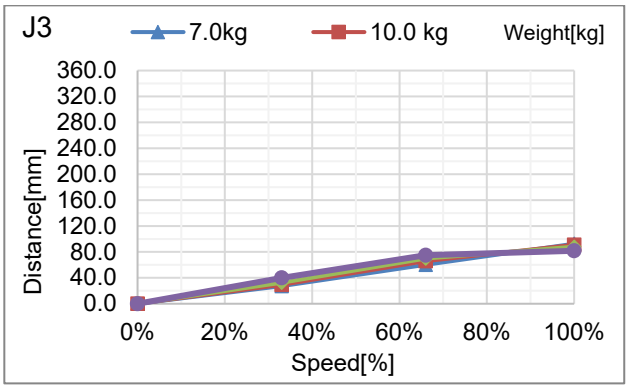
LS20-B804*: J2



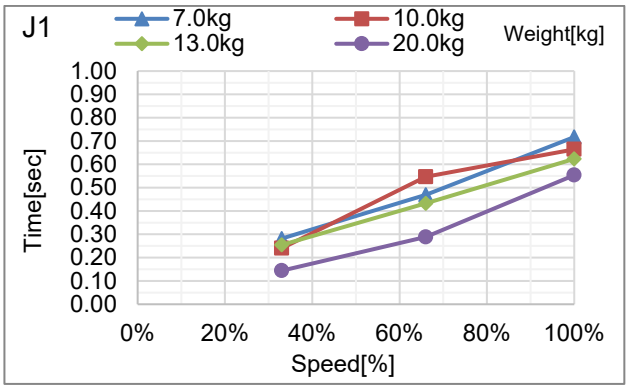


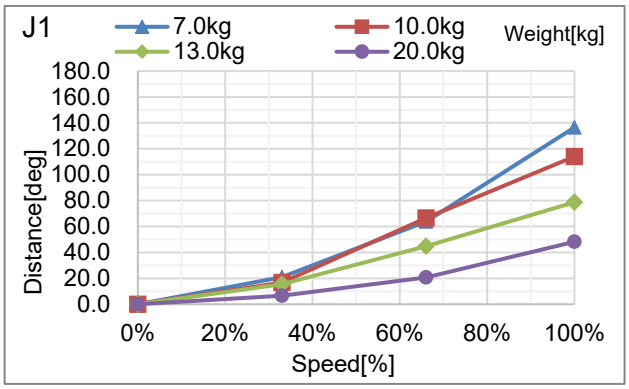
LS20-B804*: J3



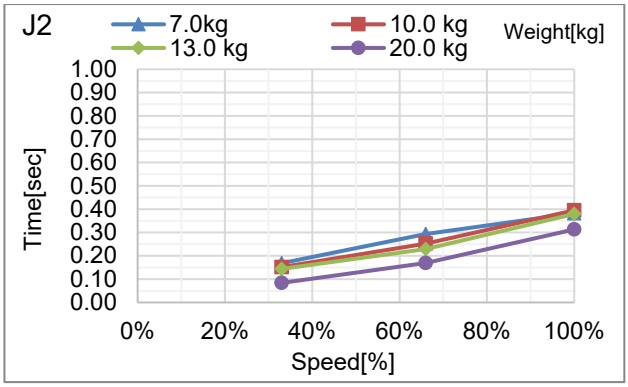


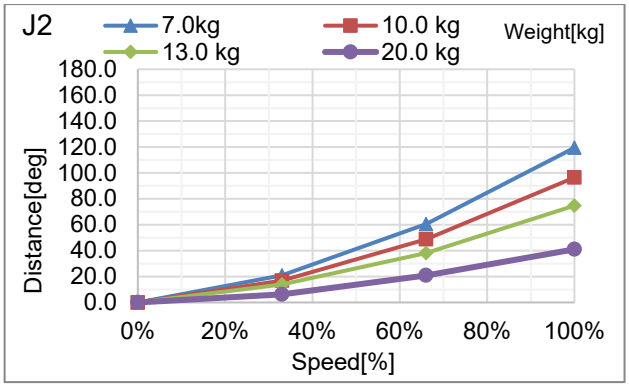
LS20-BA04*: J1



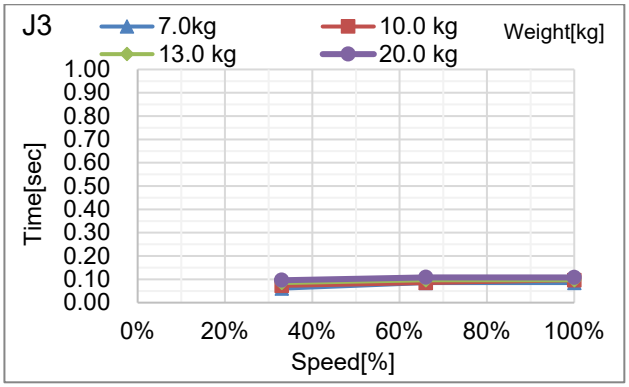


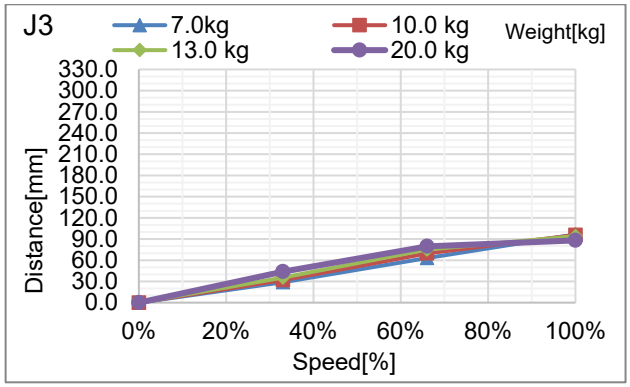
LS20-BA04*: J2





LS20-BA04*: J3





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.

NOTE

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.
"LS3-B LS6-B,LS10-B, LS20-B Manipulator - 4.3 Weight and Inertia Settings"
"LS3-B LS6-B,LS10-B, LS20-B Manipulator - 4.4 Precautions for Auto Acceleration/Deceleration of Joint #3 "

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.

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
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.

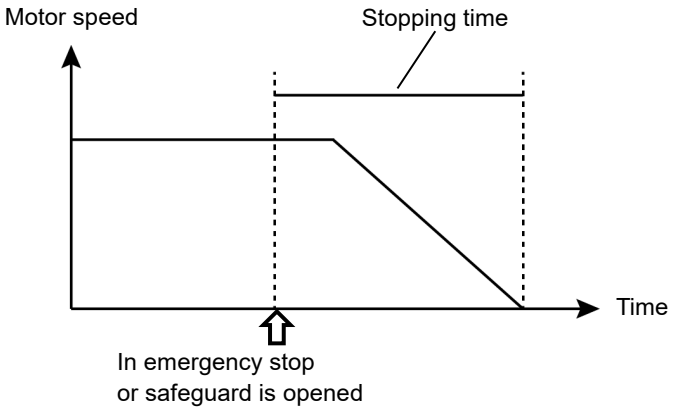
For more information, refer to the following manual.

"Epson RC+ SPEL+ Language Reference"

Appendix C: Stopping time and Stopping distance When Safeguard Is Opened

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

The stopping time is “Stopping time” in the figure below. Be sure to confirm that safety is ensured according to the installation environment and operation of the robot.



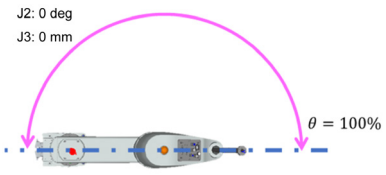
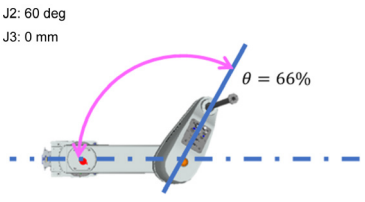
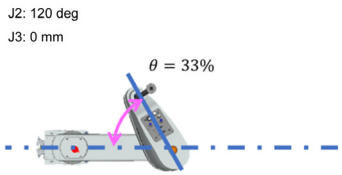
Condition:

The stopping time and stopping distance vary depending on the parameters (setting value) set for the robot. In this chapter, the time and distance are shown with 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 ：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	ɵ = 100%	ɵ = 66%	ɵ = 33%
J1			

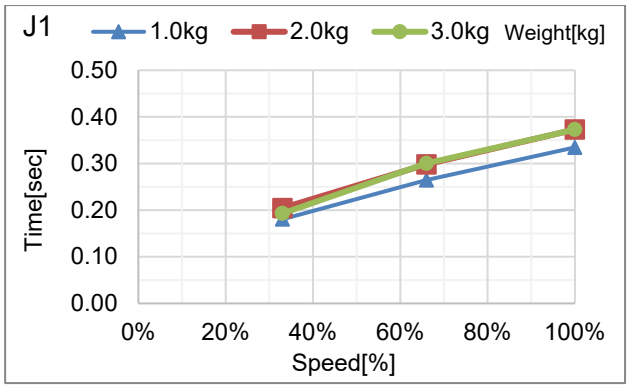
Description of legend:

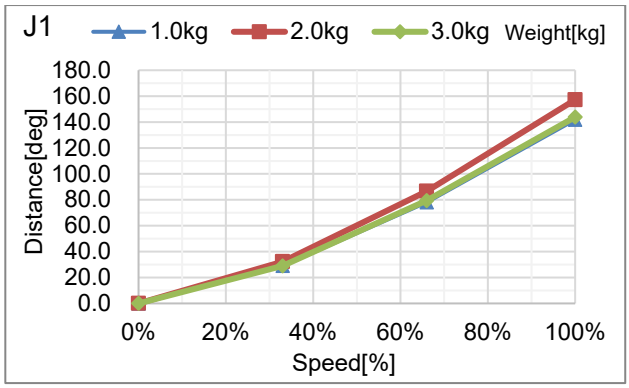
The graph is shown for each Weight value (at 100%, approx. 66%, and approx. 33% of the maximum payload, and at the rated payload).

Horizontal axis	: Arm speed (Speed value)
Vertical axis	: Stopping time and stopping distance in each arm speed
Time [sec]	: Stopping time
Distance [deg]	: Stopping distance of J1 and J2
Distance [mm]	: Stopping distance of J3

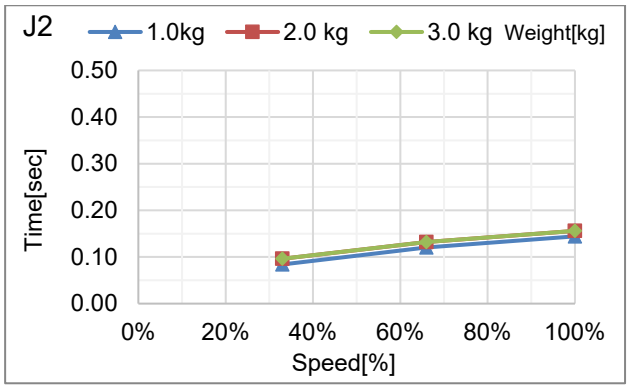
LS3-B Stopping time and Stopping distance When Safeguard Is Opened

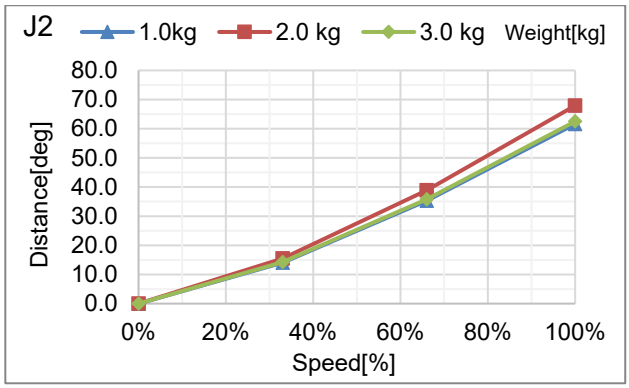
LS3-B401*: J1



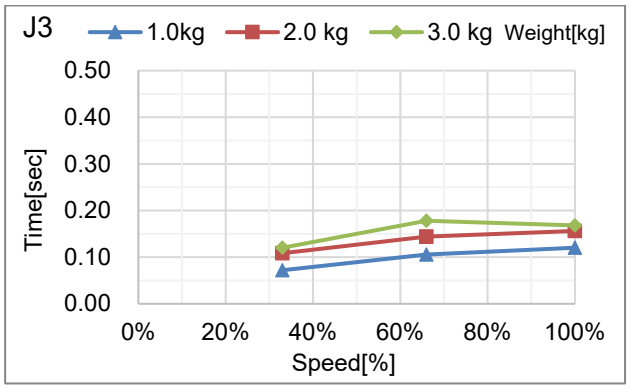


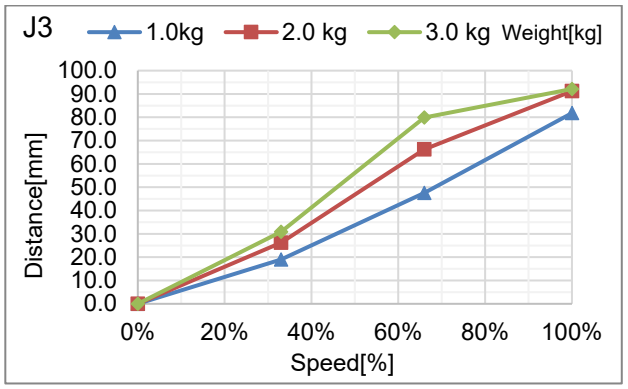
LS3-B401*: J2



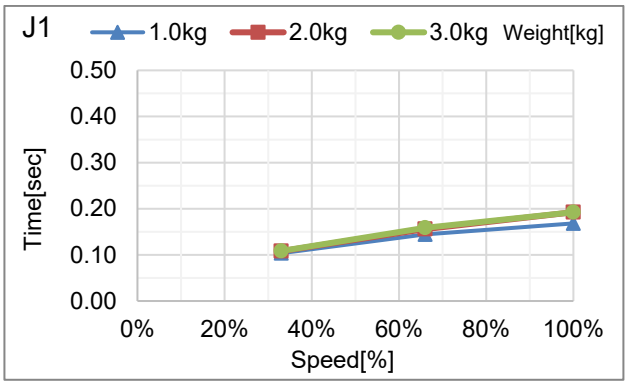


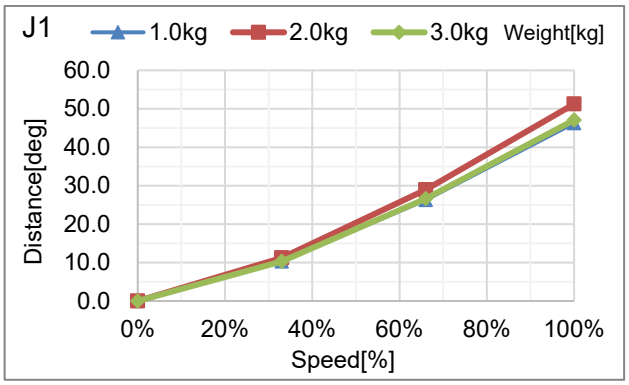
LS3-B401*: J3



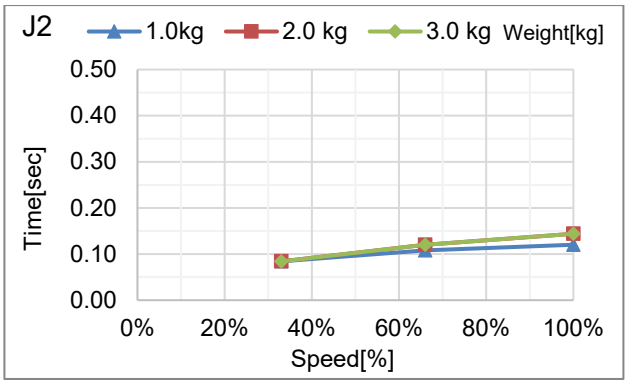


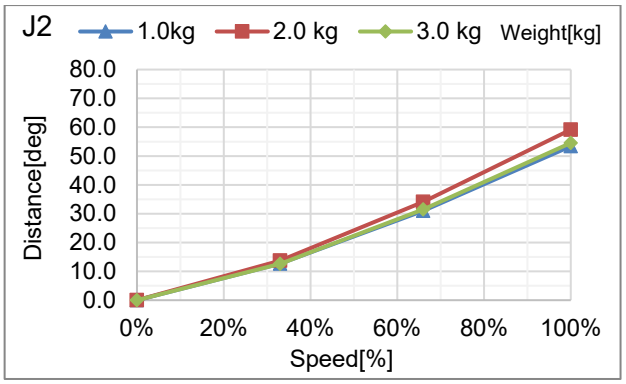
LS3-B401S-V1: J1



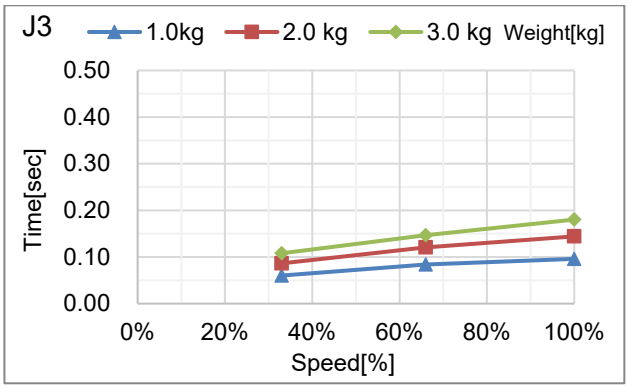


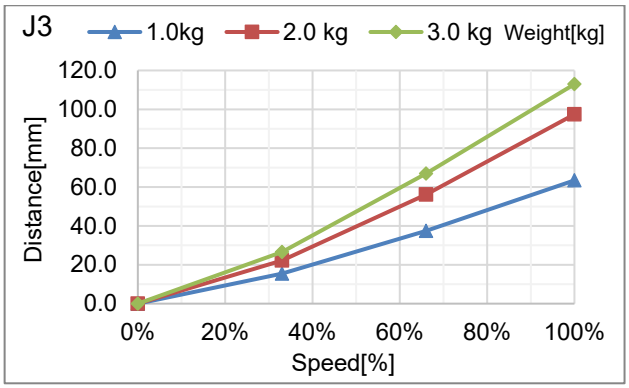
LS3-B401S-V1: J2





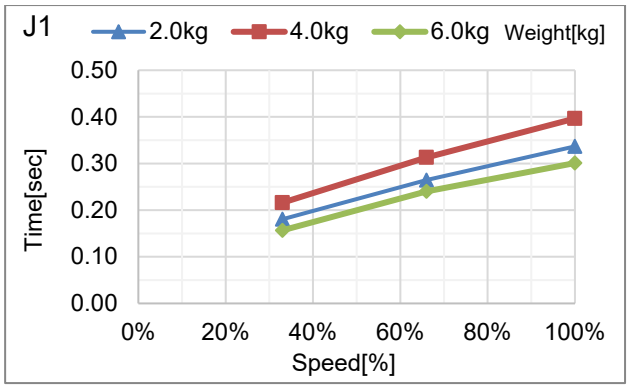
LS3-B401S-V1: J3

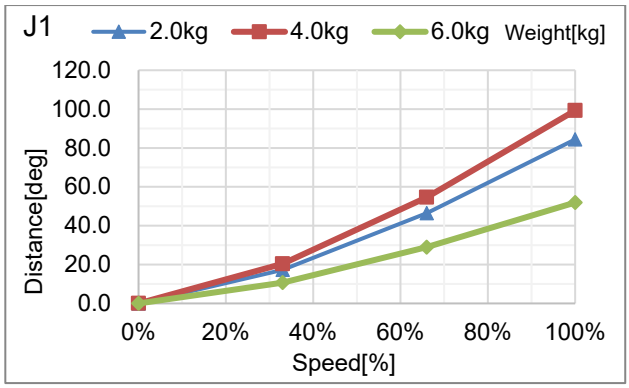




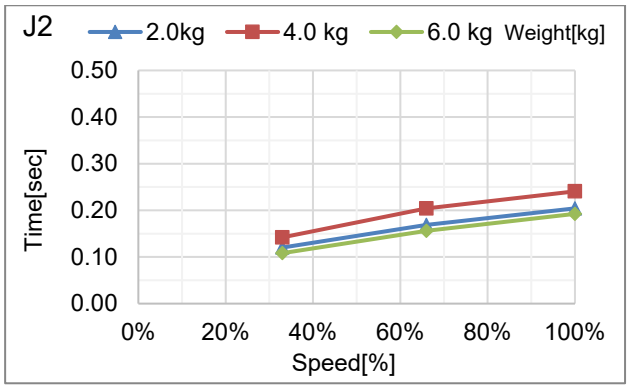
LS6-B Stopping time and Stopping distance When Safeguard Is Opened

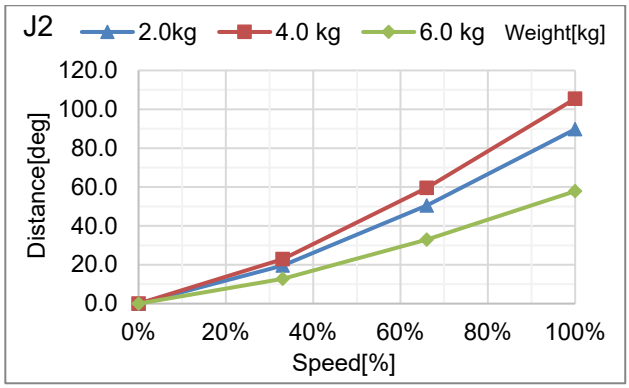
LS6-B502*: J1



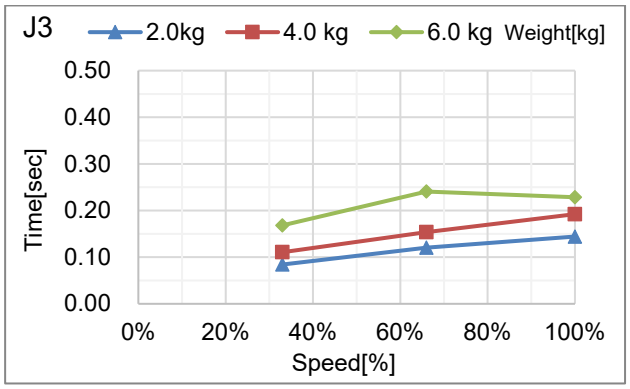


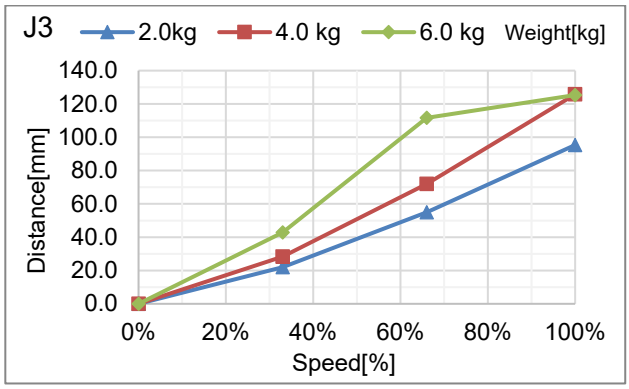
LS6-B502*: J2



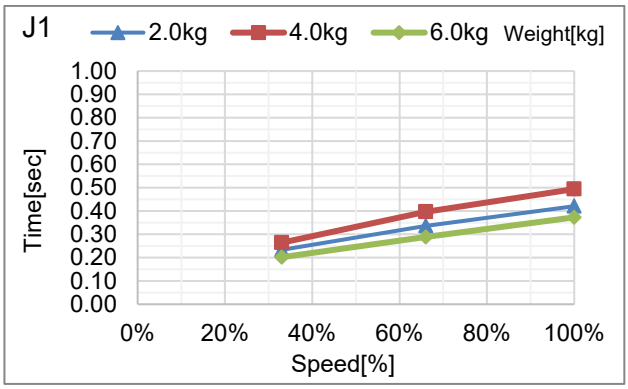


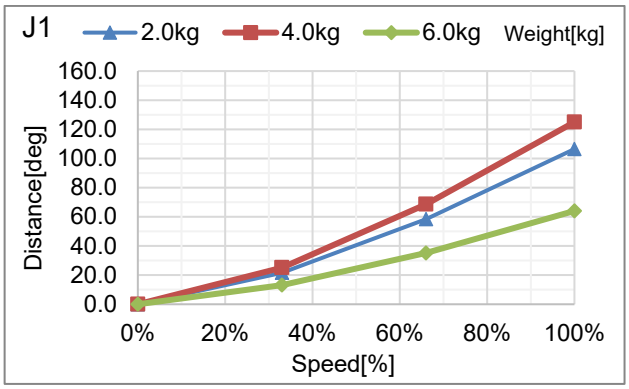
LS6-B502*: J3



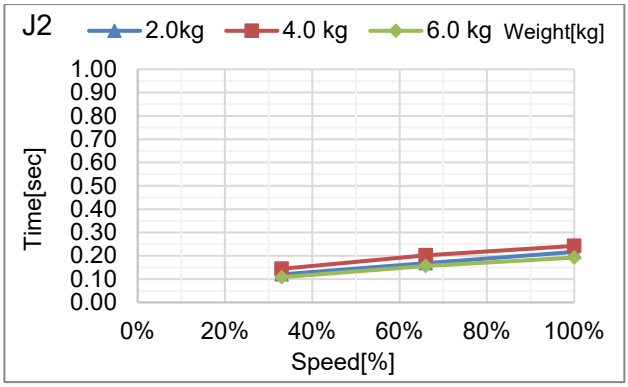


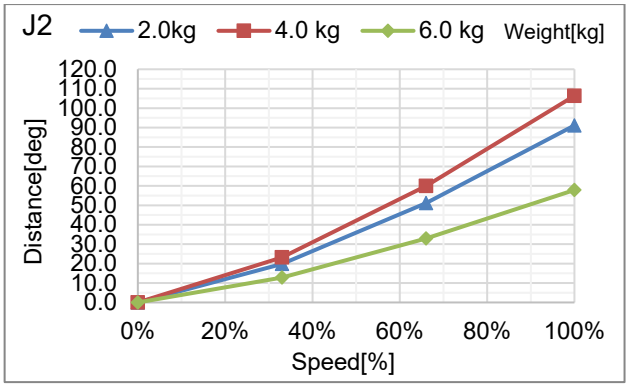
LS6-B602*: J1



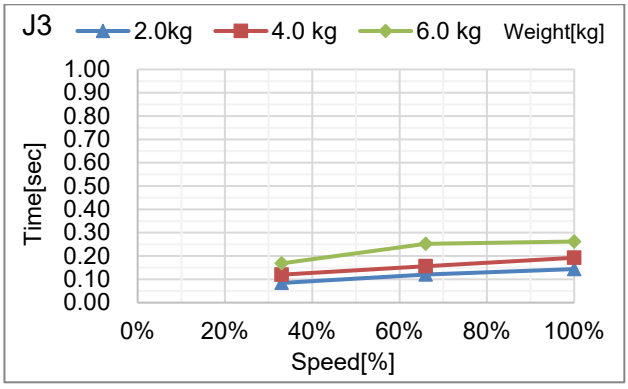


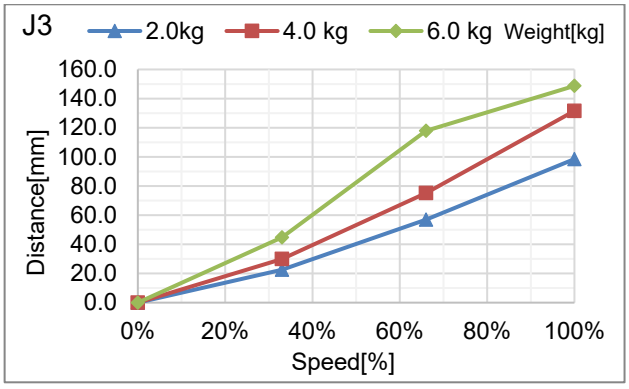
LS6-B602*: J2



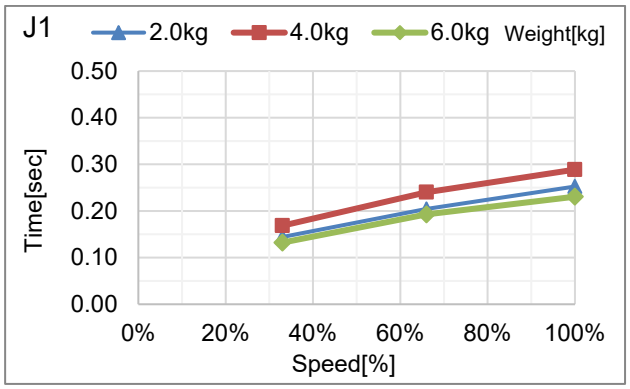


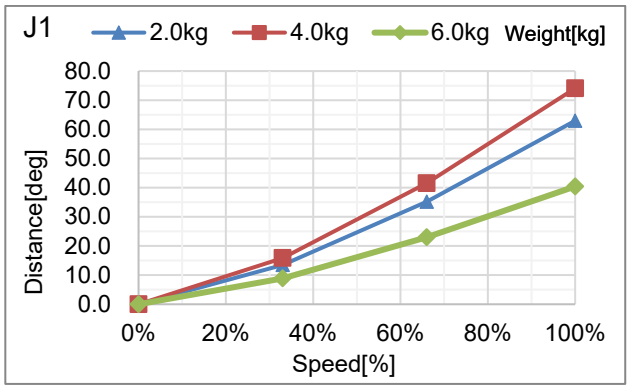
LS6-B602*: J3



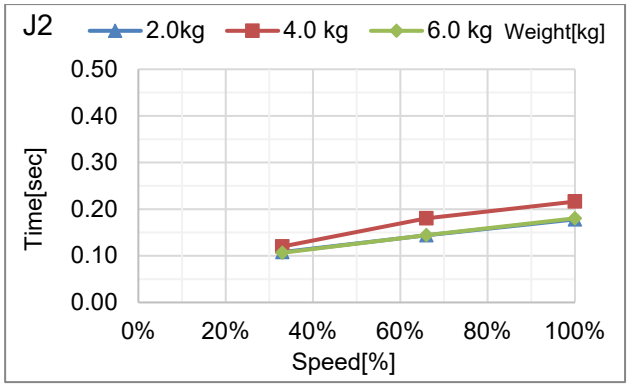


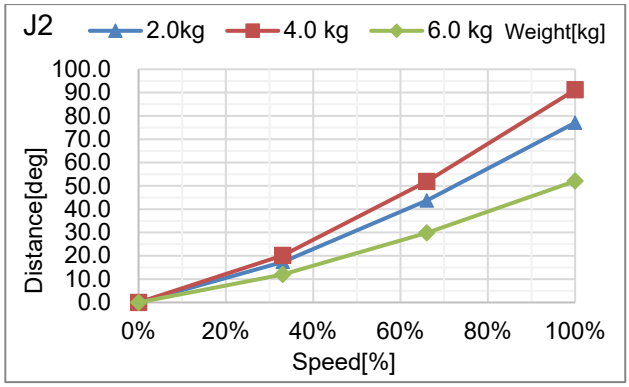
LS6-B602S-V1: J1



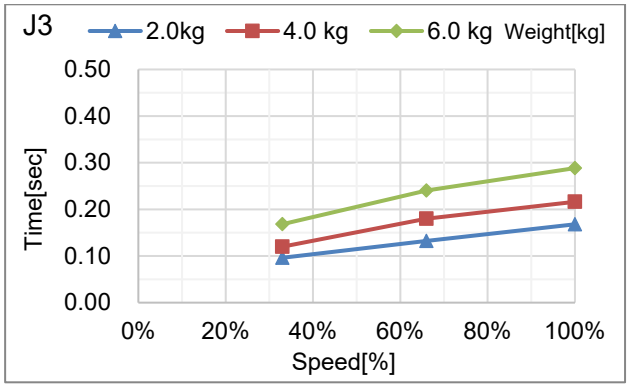


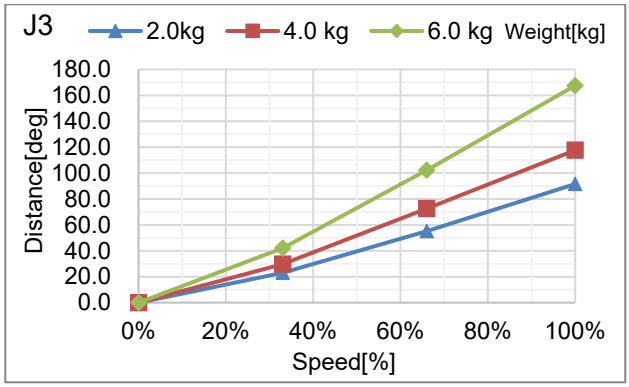
LS6-B602S-V1: J2



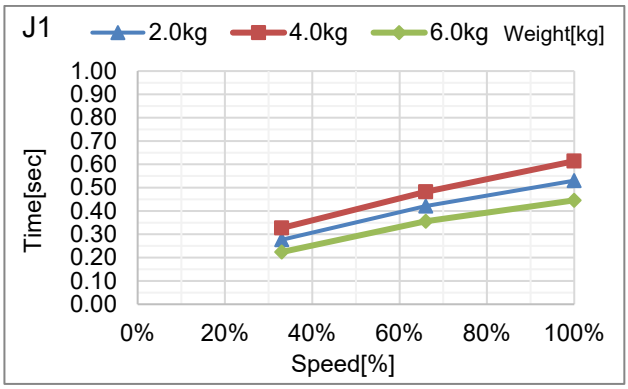


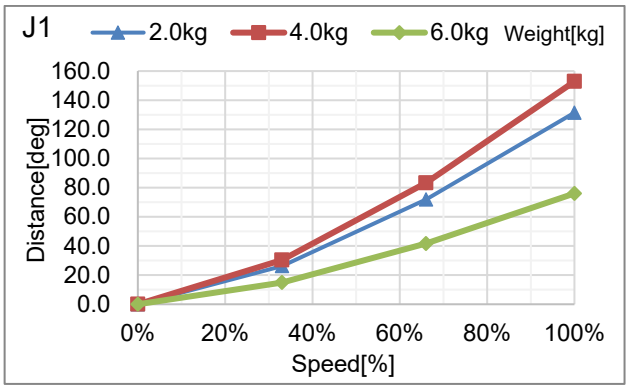
LS6-B602S-V1: J3



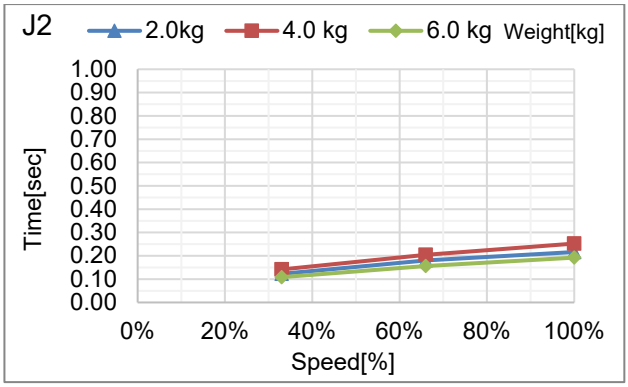


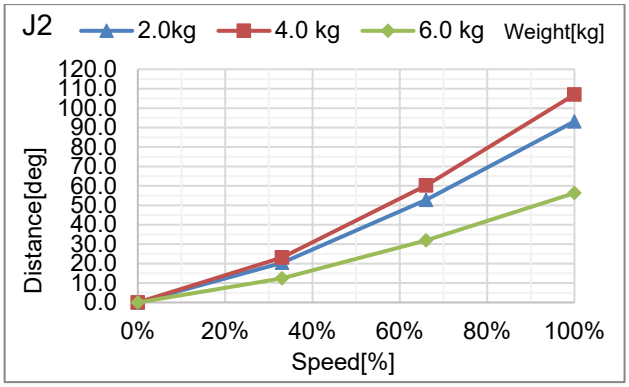
LS6-B702*: J1



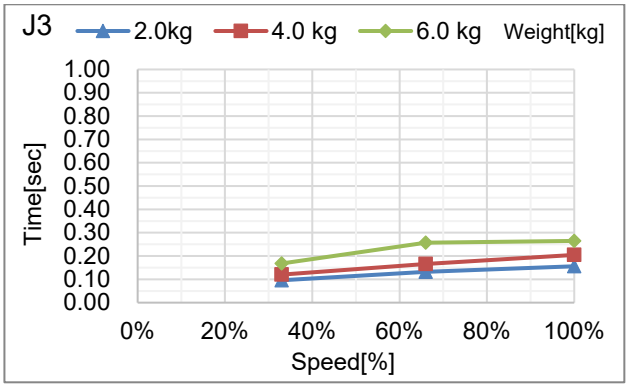


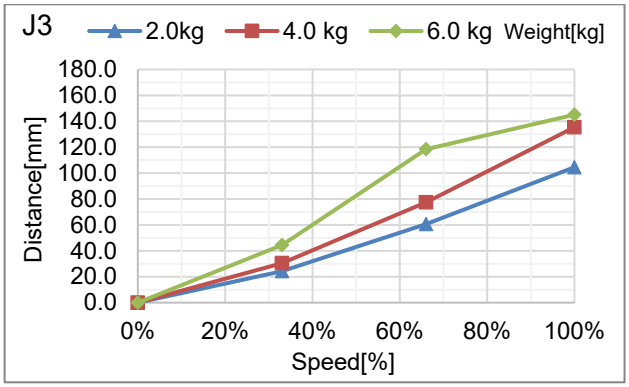
LS6-B702*: J2





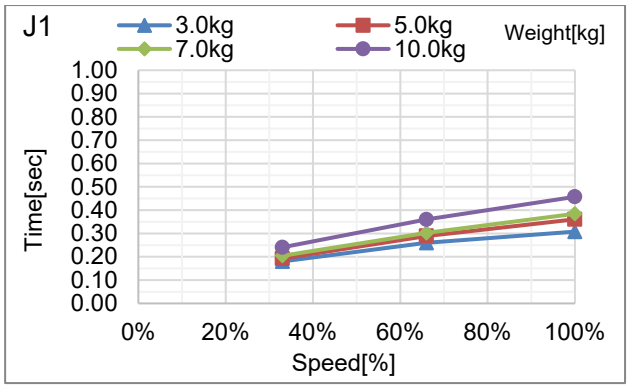
LS6-B702*: J3

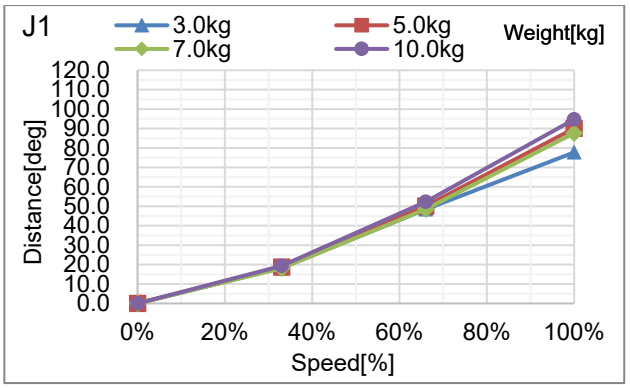




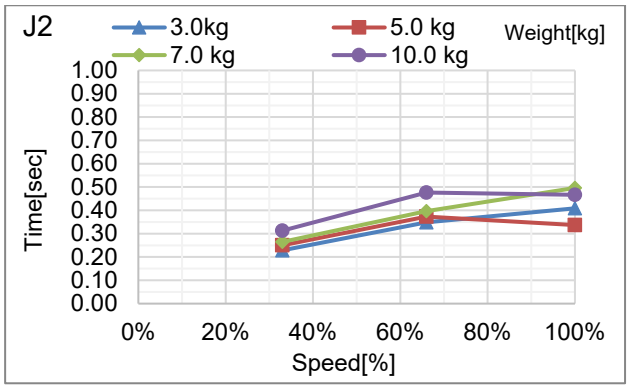
LS10-B Stopping time and Stopping distance When Safeguard Is Opened

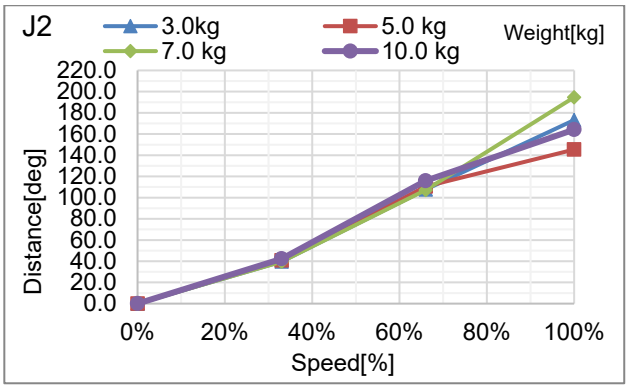
LS10-B60**: J1



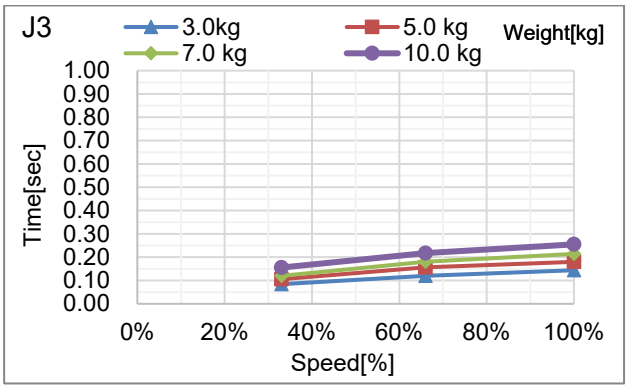


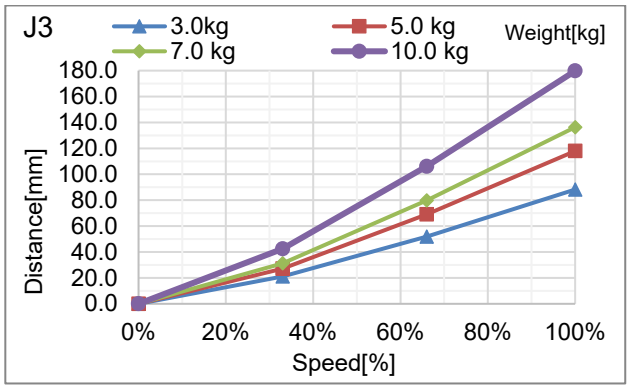
LS10-B60**: J2



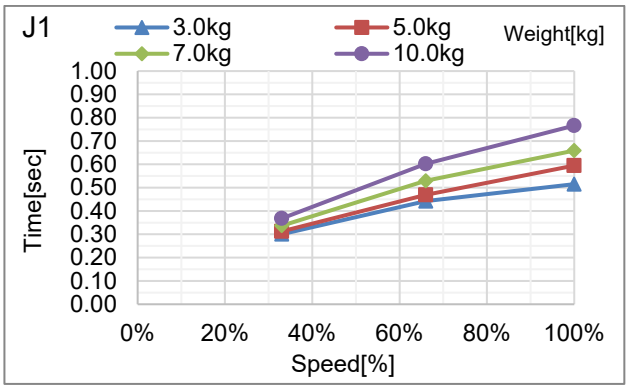


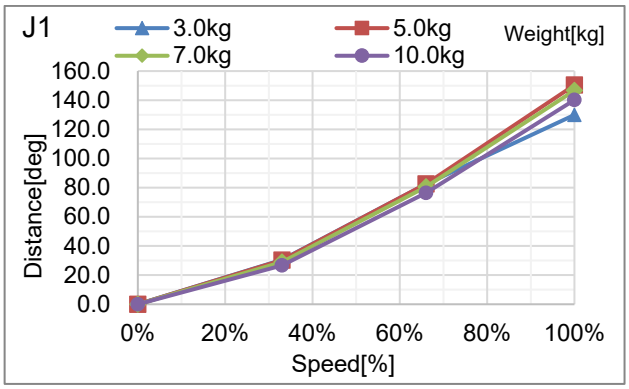
LS10-B60**: J3



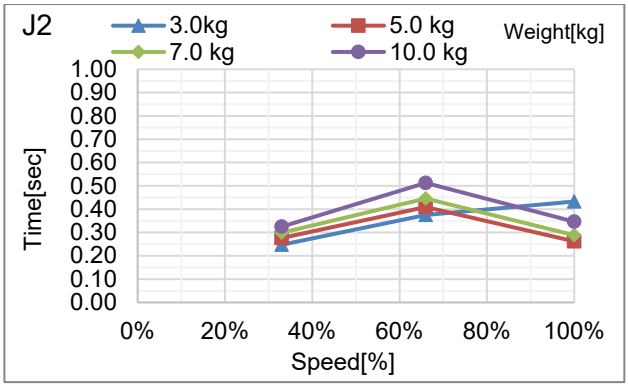


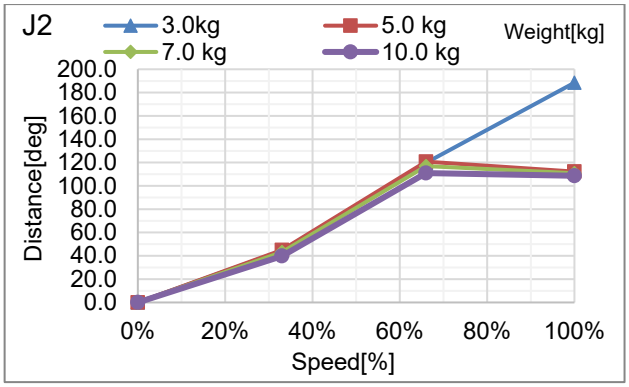
LS10-B70**: J1



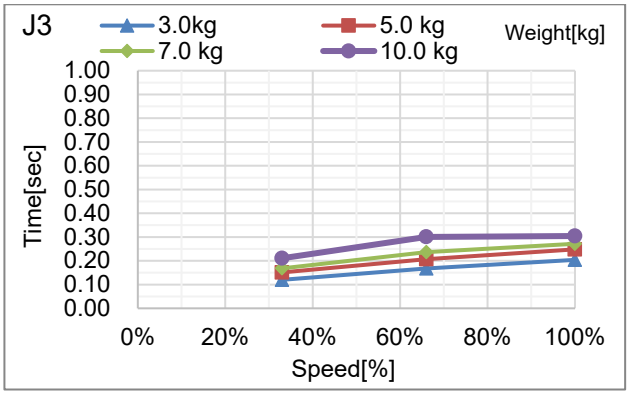


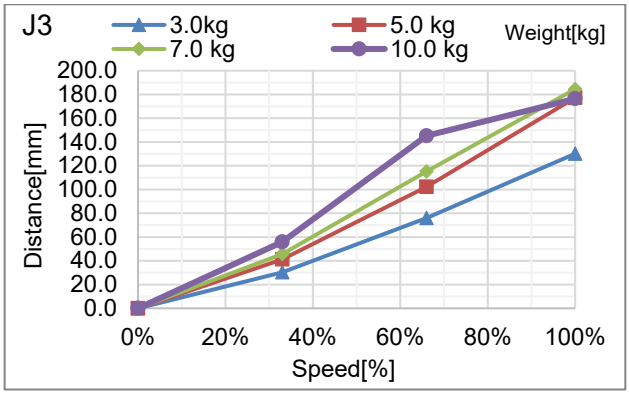
LS10-B70**: J2



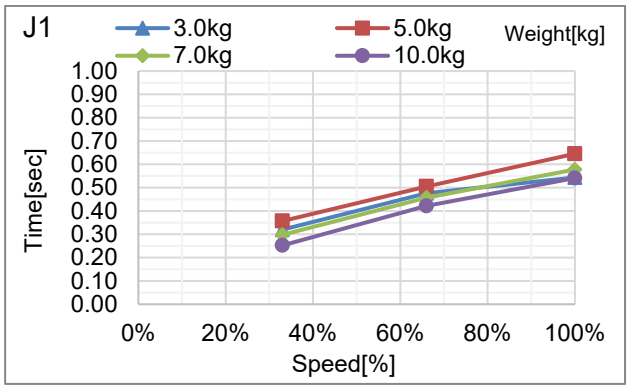


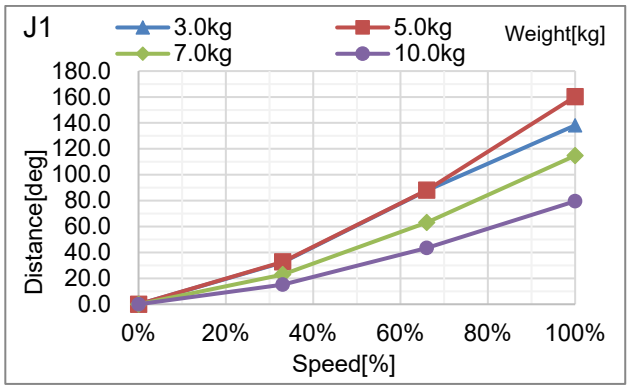
LS10-B70**: J3



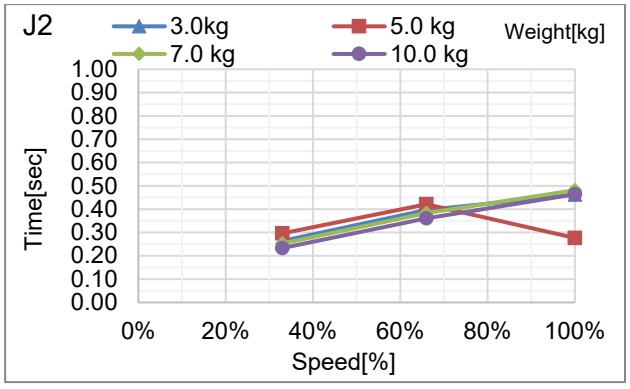


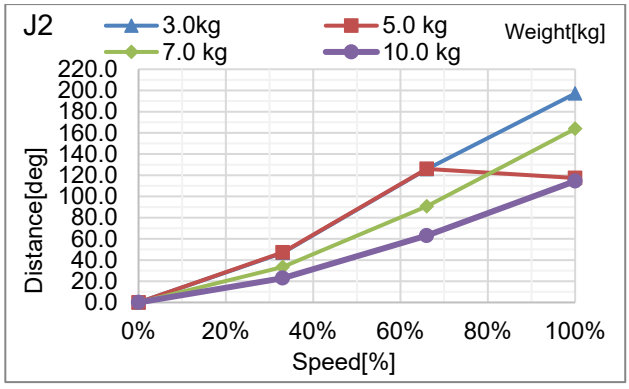
LS10-B80**: J1



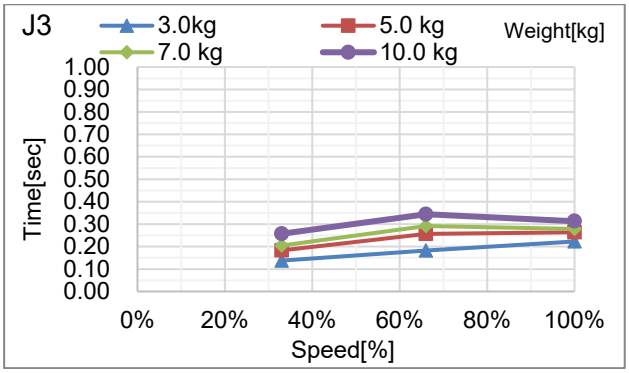


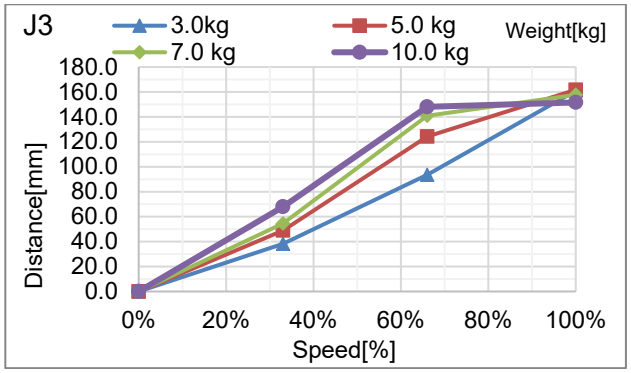
LS10-B80**: J2





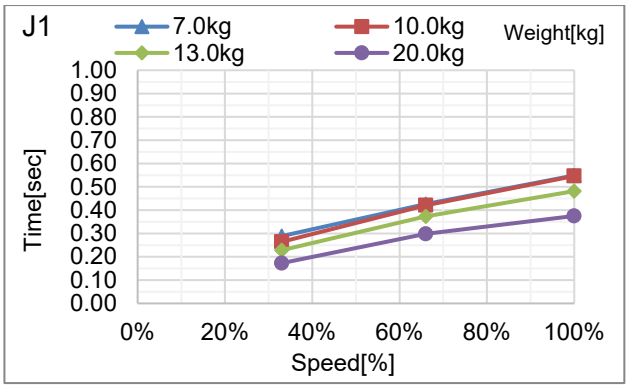
LS10-B80**: J3

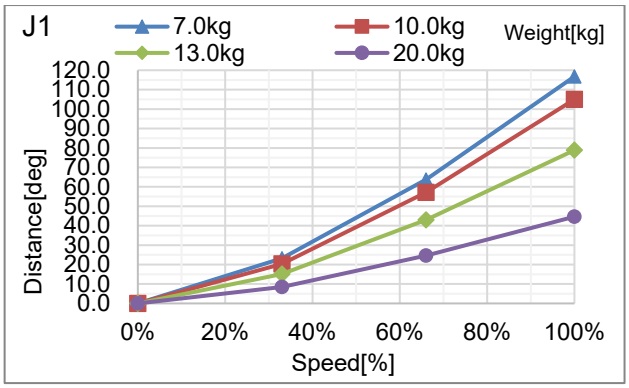




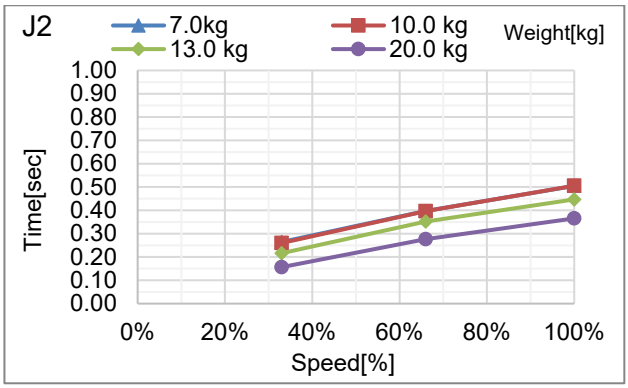
LS20-B Stopping time and Stopping distance When Safeguard Is Opened

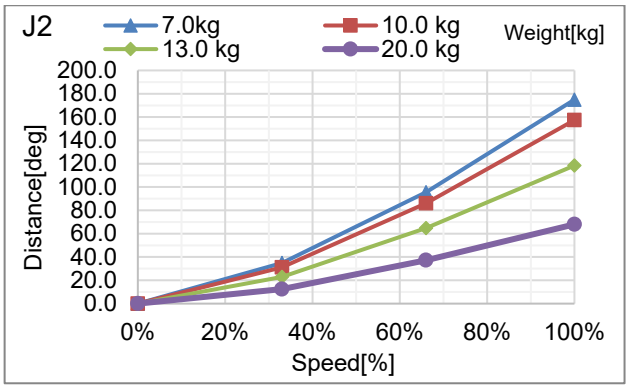
LS20-B804*: J1



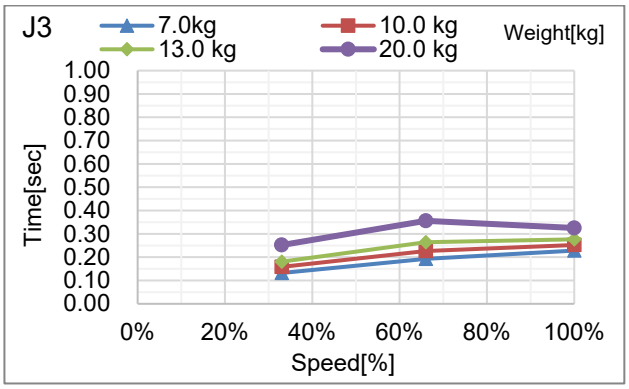


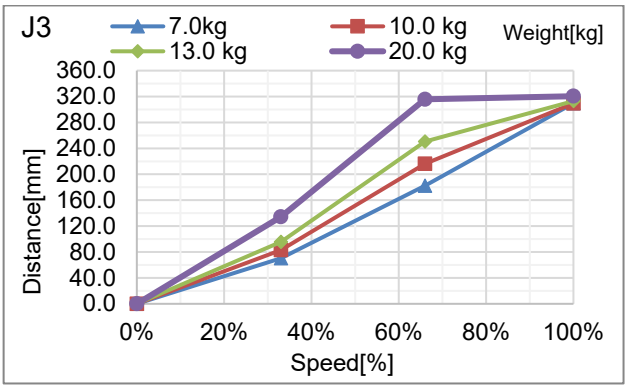
LS20-B804*: J2



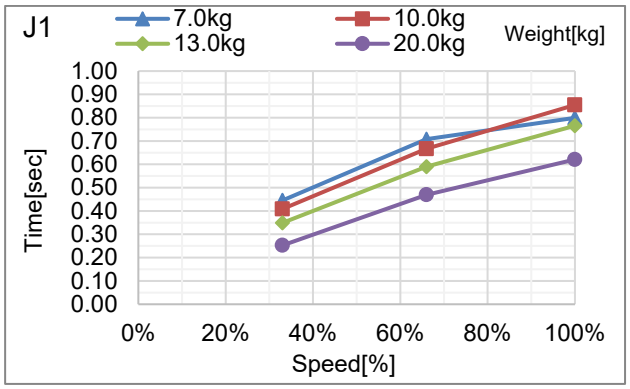


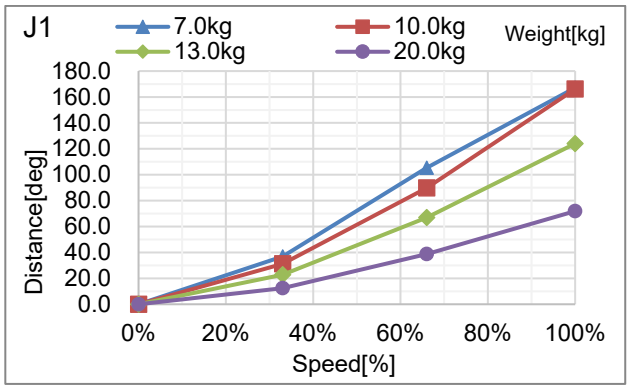
LS20-B804*: J3



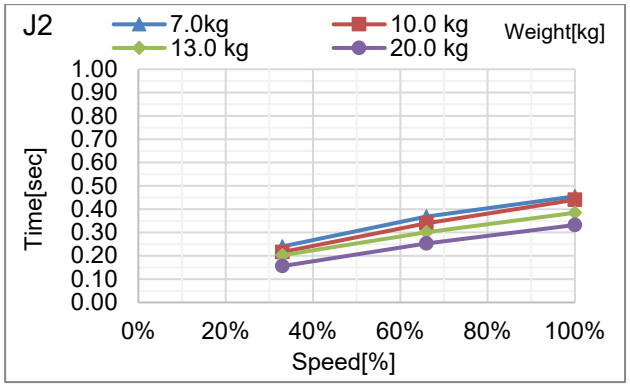


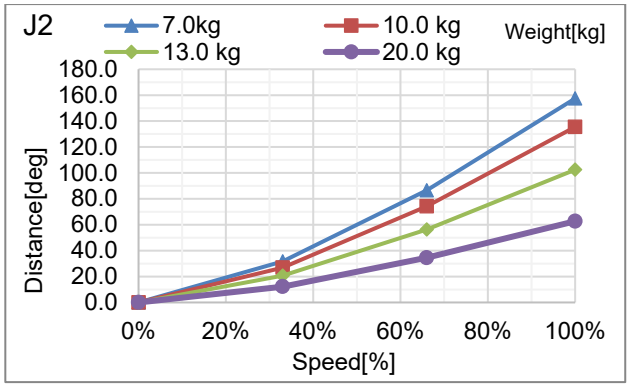
LS20-BA04*: J1





LS20-BA04*: J2





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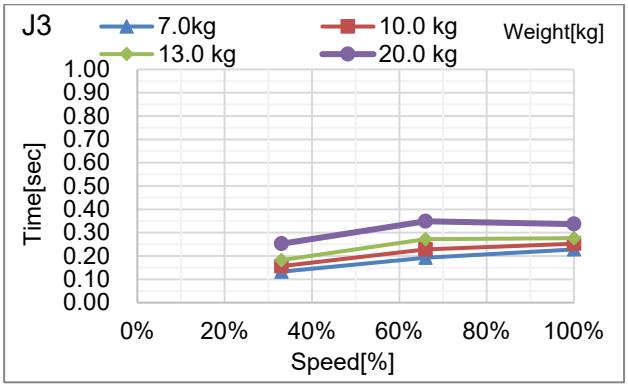

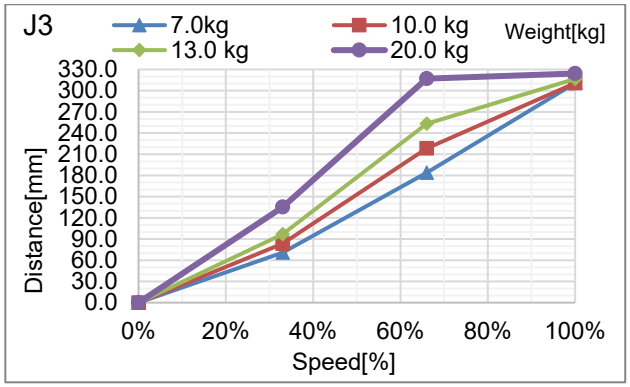

Supplementary Information regarding the Stopping Time and Stopping Distance when the Safeguard is Open

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.

NOTE

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.
"LS3-B LS6-B,LS10-B, LS20-B Manipulator - 4.3 Weight and Inertia Settings"
"LS3-B LS6-B,LS10-B, LS20-B Manipulator - 4.4 Precautions for Auto Acceleration/Deceleration of Joint #3 "

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/safeguard 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.

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
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"