EPSON

EPSON ProSix

C4 series

C4 Manipulator

Rev.1

EM12YR2415F

EPSON ProSix

C4 series

C4 Manipulator

Rev. 1

FOREWORD

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

WARRANTY

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

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

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

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

Warnings, Cautions, Usage:

1. If the robot or associated equipment is used outside of the usage conditions and product specifications described in the manuals, this warranty is void.
2. If you do not follow the WARNINGS and CAUTIONS in this manual, we cannot be responsible for any malfunction or accident, even if the result is injury or death.
3. We cannot foresee all possible dangers and consequences. Therefore, this manual cannot warn the user of all possible hazards.

TRADEMARKS

Microsoft, Windows, and Windows logo are either registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries. Other brand and product names are trademarks or registered trademarks of the respective holders.

NOTICE

No part of this manual may be copied or reproduced without authorization.
The contents of this manual are subject to change without notice.
Please notify us if you should find any errors in this manual or if you have any comments regarding its contents.

INQUIRIES

Contact the following service center for robot repairs, inspections or adjustments.
If service center information is not indicated below, please contact the supplier office for your region.

Please prepare the following items before you contact us.

- Your controller model and its serial number
- Your manipulator model and its serial number
- Software and its version in your robot system
- A description of the problem

SERVICE CENTER

MANUFACTURER

SEIKO EPSON CORPORATION
Toyoshina Plant
Factory Automation Systems Dept.
6925 Toyoshina Tazawa,
Azumino-shi, Nagano, 399-8285
JAPAN
TEL : +81-(0)263-72-1530
FAX : +81-(0)263-72-1495

SUPPLIERS

North & South America **EPSON AMERICA, INC.**
Factory Automation/Robotics
18300 Central Avenue
Carson, CA 90746
USA
TEL : +1-562-290-5900
FAX : +1-562-290-5999
E-MAIL : info@robots.epson.com

Europe **EPSON DEUTSCHLAND GmbH**
Factory Automation Division
Otto-Hahn-Str.4
D-40670 Meerbusch
Germany
TEL : +49-(0)-2159-538-1391
FAX : +49-(0)-2159-538-3170
E-MAIL : robot.infos@epson.de

China **EPSON China Co., Ltd**
Factory Automation Division
7F, Jinbao Building No. 89 Jinbao Street
Dongcheng District, Beijing,
China, 100005
TEL : +86-(0)-10-8522-1199
FAX : +86-(0)-10-8522-1120

Taiwan **EPSON Taiwan Technology & Trading Ltd.**
Factory Automation Division
14F, No.7, Song Ren Road, Taipei 110
Taiwan, ROC
TEL : +886-(0)-2-8786-6688
FAX : +886-(0)-2-8786-6677

Southeast Asia India	**Epson Singapore Pte Ltd.** Factory Automation System 1 HarbourFrontPlace, #03-02 HarbourFront Tower one, Singapore 098633 TEL : +65-(0)-6586-5696 FAX : +65-(0)-6271-3182
Korea	**EPSON Korea Co, Ltd.** Marketing Team (Robot Business) 11F Milim Tower, 825-22 Yeoksam-dong, Gangnam-gu, Seoul, 135-934 Korea TEL : +82-(0)-2-3420-6692 FAX : +82-(0)-2-558-4271
Japan	**EPSON SALES JAPAN CORPORATION** Factory Automation Systems Department Nishi-Shinjuku Mitsui Bldg.6-24-1 Nishishinjuku. Shinjuku-ku. Tokyo. 160-8324 JAPAN TEL : +81-(0)3-5321-4161

For Customers in the European Union

The crossed out wheeled bin label that can be found on your product indicates that this product and incorporated batteries should not be disposed of via the normal household waste stream. To prevent possible harm to the environment or human health please separate this product and its batteries from other waste streams to ensure that it can be recycled in an environmentally sound manner. For more details on available collection facilities please contact your local government office or the retailer where you purchased this product. Use of the chemical symbols Pb, Cd or Hg indicates if these metals are used in the battery.

This information only applies to customers in the European Union, according to DIRECTIVE 2006/66/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL OF 6 September 2006 on batteries and accumulators and waste batteries and accumulators and repealing Directive 91/157/EEC and legislation transposing and implementing it into the various national legal systems.
For other countries, please contact your local government to investigate the possibility of recycling your product.

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

Before Reading This Manual

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

Structure of Control System

C4 Manipulators can be used with the following combinations of Controllers and software.

Controller : RC700

Software : EPSON RC+ 7.0

Setting by Software

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

Turning ON/OFF Controller

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

Photos and Illustrations Used in This Manual

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

Setup & Operation

Setup & Operation

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

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

1.1 Conventions

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

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

1.2 Design and Installation Safety

Only trained personnel should design and install the robot system. Trained personnel are defined as those who have taken robot system training and maintenance training classes held by the manufacturer, dealers, or local representative companies, or those who understand the manuals thoroughly and have the same knowledge and skill level as those who have completed the training courses.
To ensure safety, a safeguard must be installed for the robot system. For details on the safeguard, refer to the *Installation and Design Precautions* in the *Safety* chapter of the EPSON RC+ User's Guide.

The following items are safety precautions for design personnel:

 WARNING	■ Personnel who design and/or construct the robot system with this product must read the *Safety* chapter in the EPSON RC+ User's Guide. Designing and/or constructing the robot system without understanding the safety requirements is extremely hazardous, and may result in serious bodily injury and/or severe equipment damage to the robot system.

 WARNING	■ 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 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 of the product but also cause serious safety problems.

Further precautions for installation are described in the chapter *Setup & Operation 3. Environment and Installation*. Please read this chapter carefully to understand safe installation procedures before installing the robots and robotic equipment.

1.3 Operation Safety

The following items are safety precautions for qualified Operator personnel:

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

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

1.4 Emergency Stop

If the Manipulator moves abnormally during operation, immediately press the Emergency Stop switch. The motor power will be turned OFF, and the arm motion by inertia will be stopped with the electromagnetic brake and dynamic brake.

However, avoid pressing the Emergency Stop switch unnecessarily while the Manipulator is running normally. Otherwise, the Manipulator may hit the peripheral equipment since the operating trajectory until the robot system stops is different from that in normal operation.
To place the robot system in emergency mode during normal operation, press the Emergency Stop switch while the Manipulator is not moving.
Refer to the Controller manual for instructions on how to wire the Emergency Stop switch circuit.

Do not press the Emergency Stop switch unnecessarily while the Manipulator is operating. Pressing the switch during the operation makes the brakes work. This will shorten the life of the brakes due to the worn friction plates.
Normal brake life cycle: About 2 years (when the brakes are used 100 times/day)

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

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

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

EPSON RC+ User's Guide *2. Safety - Installation and Design Precautions - Safeguard System*

Safety and Installation *2.6 Connection to EMERGENCY Connector*

To check brake problems, refer to the following manuals.

Manipulator Manual Maintenance *2.2.2 Inspection While the Power is ON (Manipulator is operating)*

Safety and Installation *5.2 Inspection Point - Inspection While the Power is ON (Manipulator is operating)*

Free running distance in emergency

The Manipulator in operation cannot stop immediately after the Emergency Stop switch is pressed. However, time, angle, and distance of the free running vary by following factors:

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

Approximate time and distance of the free running are as follow:

Conditions of Measurement

	C4, C4L
ACCEL Setting	100
SPEED Setting	100
Load [kg]	4
WEIGHT Setting	4

Manipulator		C4	C4L
Robot controller		RC700	
Free running time [sec.]	Arm #1	0.4	0.3
	Arm #2	0.4	0.4
	Arm #3	0.4	0.5
	Arm #4	0.3	
	Arm #5	0.4	
	Arm #6	0.3	
Free running angle [deg.]	Arm #1	85	60
	Arm #2	60	65
	Arm #3	55	55
	Arm #4	40	
	Arm #5	40	
	Arm #6	25	

1.5 How to Move Arms with the Electromagnetic Brake

There are two methods to release the electromagnetic brake. Follow either method to release the electromagnetic brake and move the arms manually.

1.5.1 Moving the arm using the brake release unit

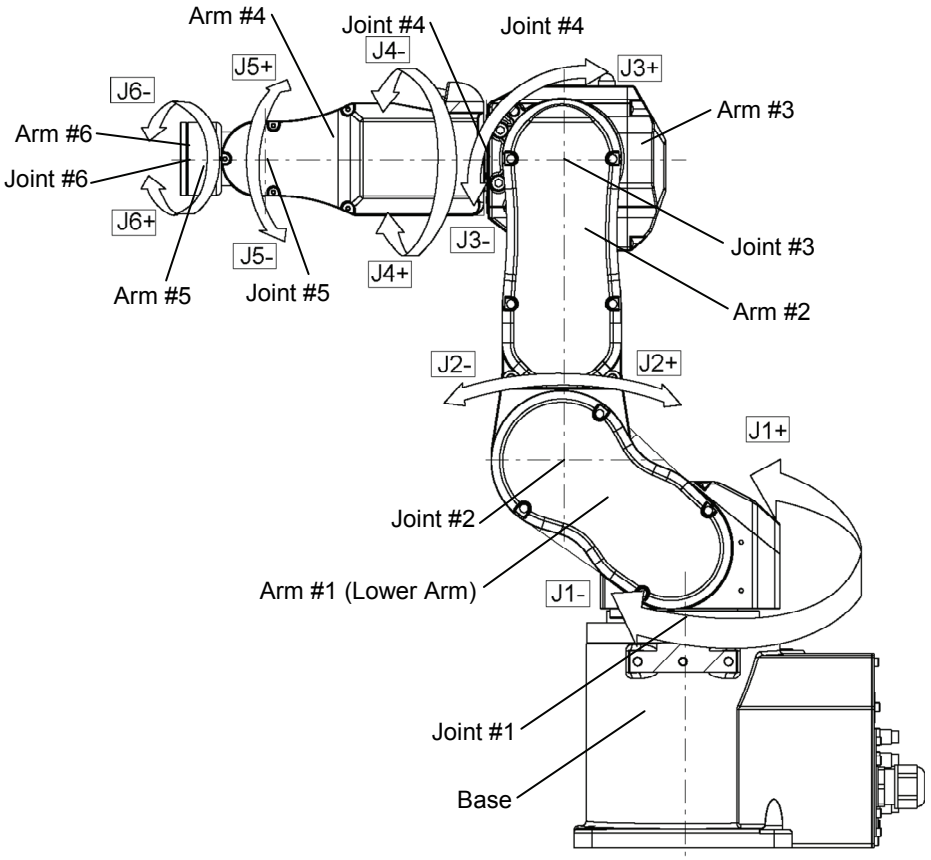
Follow the method when you just unpack the delivered boxes or when the Controller does not start up yet.

1.5.2 Moving the arm using the software

Follow the method when you can use the software.

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

Arm Motion



1.5.1 Moving the Arm using the brake release unit

The C4 series has the Brake Release Unit as an option.
For details, refer to *Setup & Option: 6 Options*.

1.5.2 Moving the Arm using the software

CAUTION

- Normally, release the brake of joints one by one. Take extra care if you need to release the brakes of two or more joints simultaneously. Releasing the brakes of two or more joints simultaneously may cause hands and fingers to be caught and/or equipment damage to or malfunction of the Manipulator as the arms of the Manipulator may move in unexpected directions.
- Be careful of the arm falling when releasing the brake.
  While the brake is being released, the Manipulator's arm falls by its own weight. The arm falling may cause hands and fingers to be caught and/or may cause equipment damage to or malfunction of the Manipulator.
- Before releasing the brake, be sure to keep the Emergency Stop switch handy so that you can immediately press the Emergency Stop switch. Otherwise, you cannot immediately stop the arm falling due to an erroneous operation. The arm falling may cause equipment damage to and/or malfunction of the Manipulator.

EPSON RC+

After releasing the Emergency Stop switch, execute the following command in [Command Window].

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

Execute the following command to turn on the brake again.

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

1.6 Precaution for Operation in Low Power Status

In the low power status, the Manipulator operates at low speed and low torque. However, comparatively high torque as shown in the table below may be generated to support the Manipulator's own weight.
Carefully operate the Manipulator since it may get your hands or fingers caught during operation. The Manipulator may also collide with peripheral equipment and cause equipment damage to or malfunction of the Manipulator.

Maximum Joint Torque in Low Power Status [Unit: N·m]

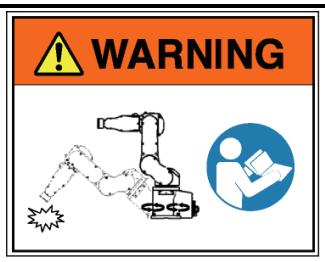
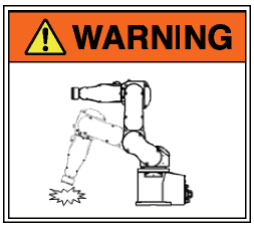
Joint	#1	#2	#3	#4	#5	#6
Joint Torque	116.24	193.74	59.31	12.45	11.41	6.88

CAUTION

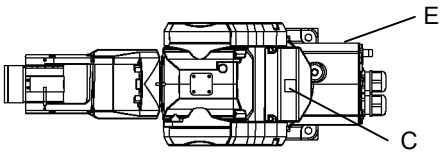
- Carefully operate the Manipulator in the low power status. A comparatively high joint torque may be generated. It may cause your hands and fingers caught and/or cause equipment damage to or malfunction of the Manipulator as it may collide with peripheral equipment.

1.7 Manipulator Labels

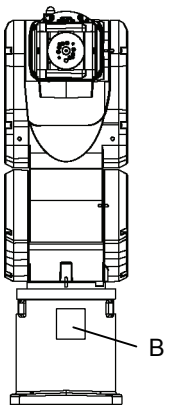
The following labels are attached around the locations of the Manipulator where specific dangers exist.
Be sure to comply with descriptions and warnings on the labels to operate and maintain the Manipulator safely.
Do not tear, damage, or remove the labels. Use meticulous care when handling those parts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

Location	Label	NOTE
A		To avoid getting hands or fingers caught, fold the Arm and fix it with a belt or a similar tool before removing the base mounting screws.
B		Do not enter the work space when the Manipulator is operating. It is extremely hazardous since the Arm may collide and cause serious safety problems,
C		Do not touch the current-carrying parts inside the Manipulator while the power is ON. It may cause electrical shock.
D		Be careful of the arm falling due to its own weight when pressing the brake release switch. These labels are attached on the optional brake release box
E	MODEL : C4-A601S SERIAL NO. : *C40E000001* MANUFACTURED : 12 / 2012 WEIGHT : 27kg MAXPAYLOAD : 4kg MOTOR POWER AXIS1 : 400W AXIS2 : 400W AXIS3 : 150W AXIS4 : 50W AXIS5 : 50W AXIS6 : 50W SEIKO EPSON CORPORATION MADE IN CHINA .	
F	Air pressure max. 0.59Mpa, 86psi	

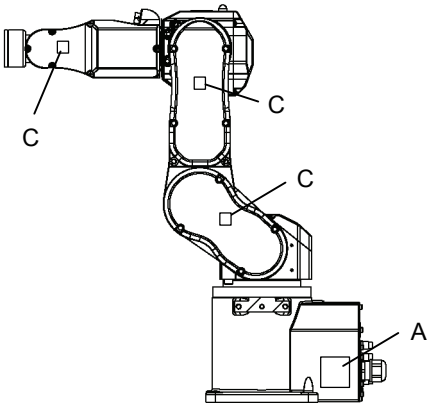
Location of Labels



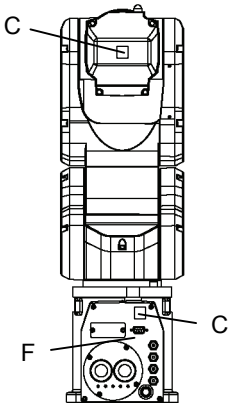
Top View



Front View



Lateral View



Back View

2. Specifications

2.1 Features of Manipulators

Speed & Accuracy

Increased productivity by balanced, best-in class fast and accurate operation.

C4

Average cycle time (300 mm)	0.39 second (Speed 100 / Accel 100)
	0.37 second (Speed 100 / Accel 120)
Repeatability error	± 0.02 mm

C4L

Average cycle time (300 mm)	0.49 second (Speed 100 / Accel 100)
	0.47 second (Speed 100 / Accel 120)
Repeatability error	± 0.03 mm

Slim Body

High space efficiency

Manipulator size is only 1/44 of its motion range

Small elbow area (Joint #3) which is half of that of the existing models

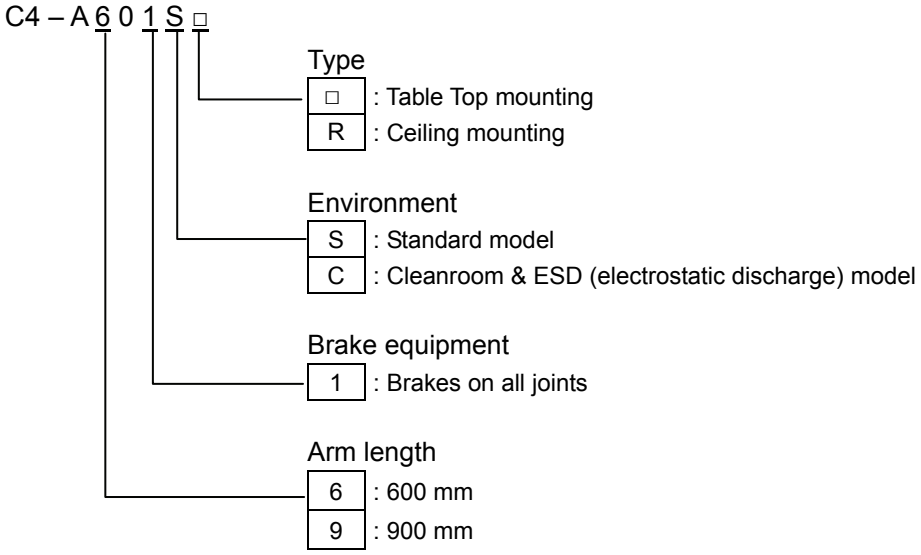
Less interference with peripherals, walls, and ceiling permits more compact installation

Skillful Wrist

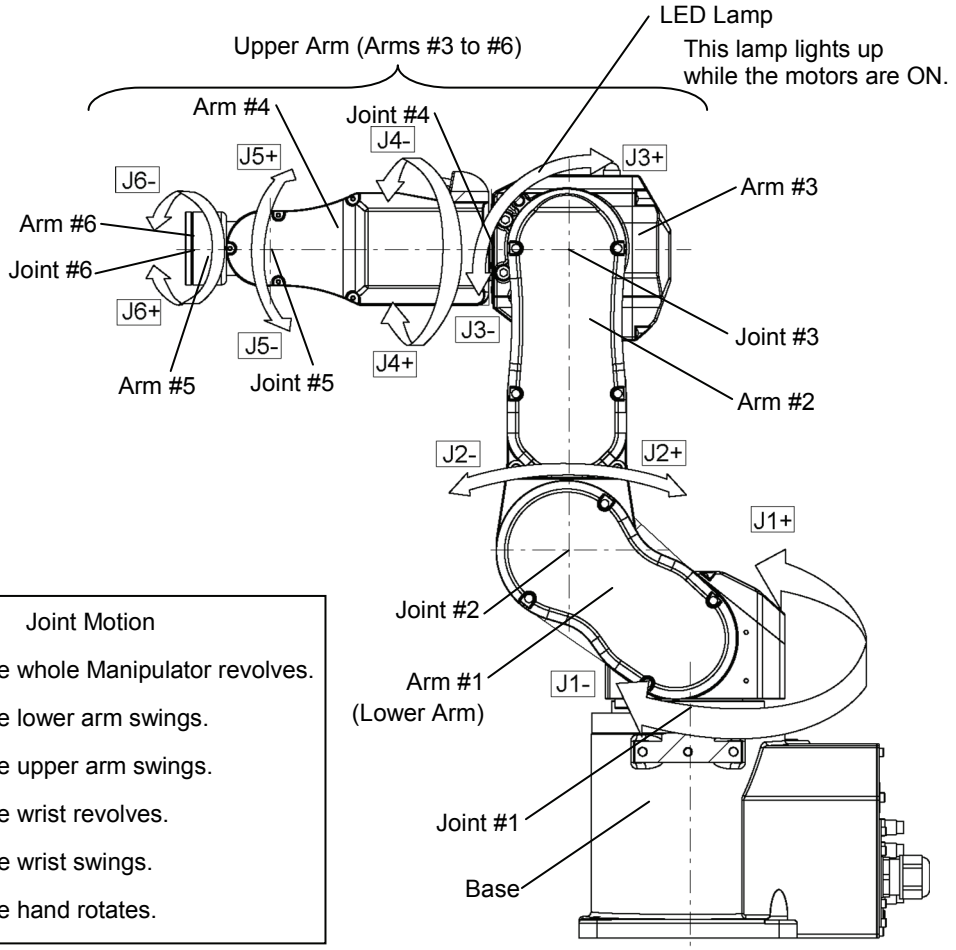
Compact wrist (Joint #5) with wide motion range enables smooth movement and the ability to work from many angles

Minimal interference with surroundings improves flexibility in hand design

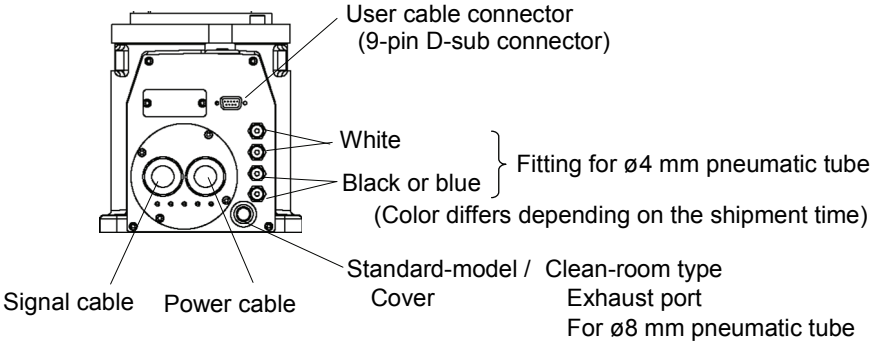
2.2 Model Number

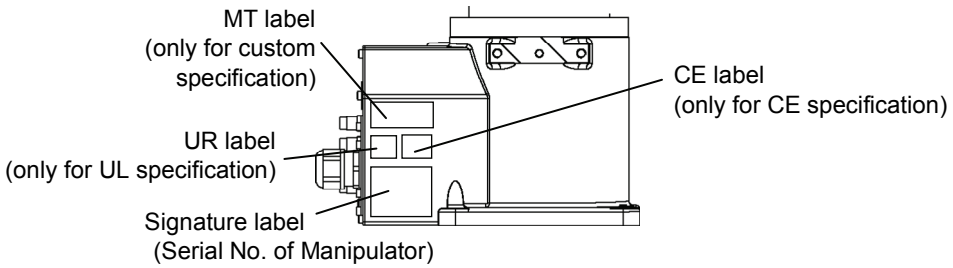


2.3 Part Names and Motion Range of Each Arm



Joint Motion
Joint #1 : The whole Manipulator revolves.
Joint #2 : The lower arm swings.
Joint #3 : The upper arm swings.
Joint #4 : The wrist revolves.
Joint #5 : The wrist swings.
Joint #6 : The hand rotates.





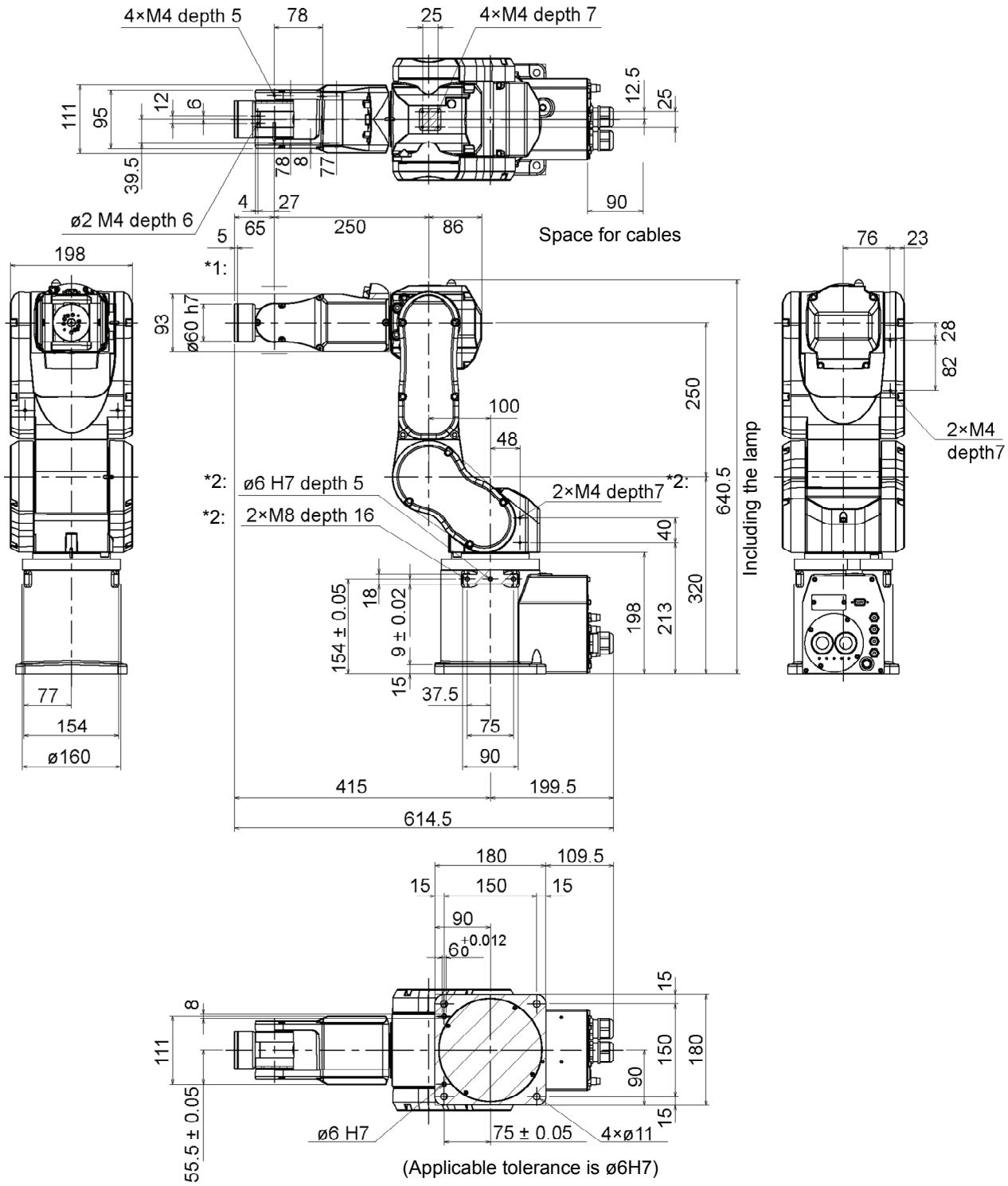
NOTE

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

2.4 Outer Dimensions

2.4.1 C4

[Unit: mm]

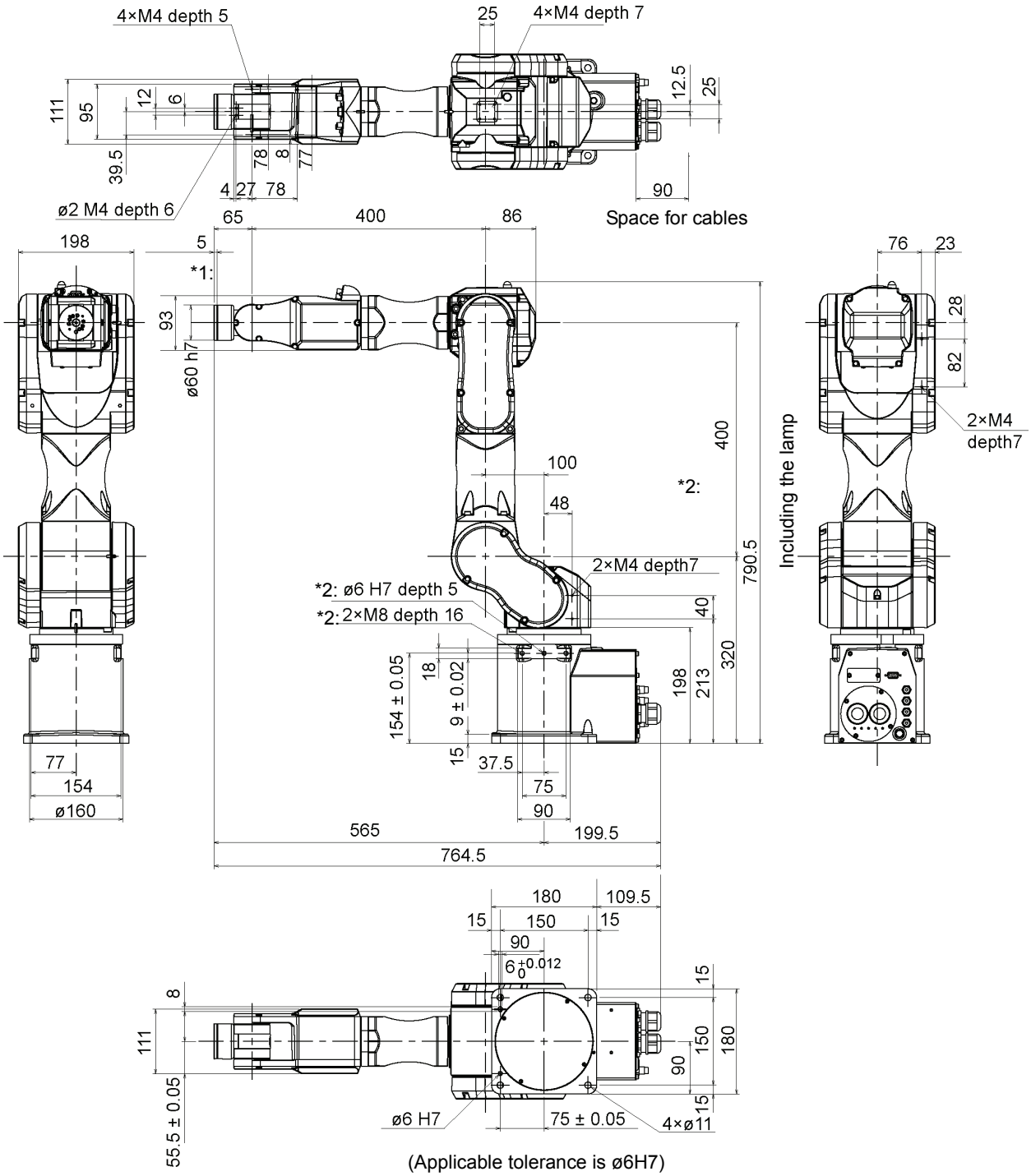


*1: Applicable area

*2: Same for the other side

2.4.2 C4L

[Unit: mm]



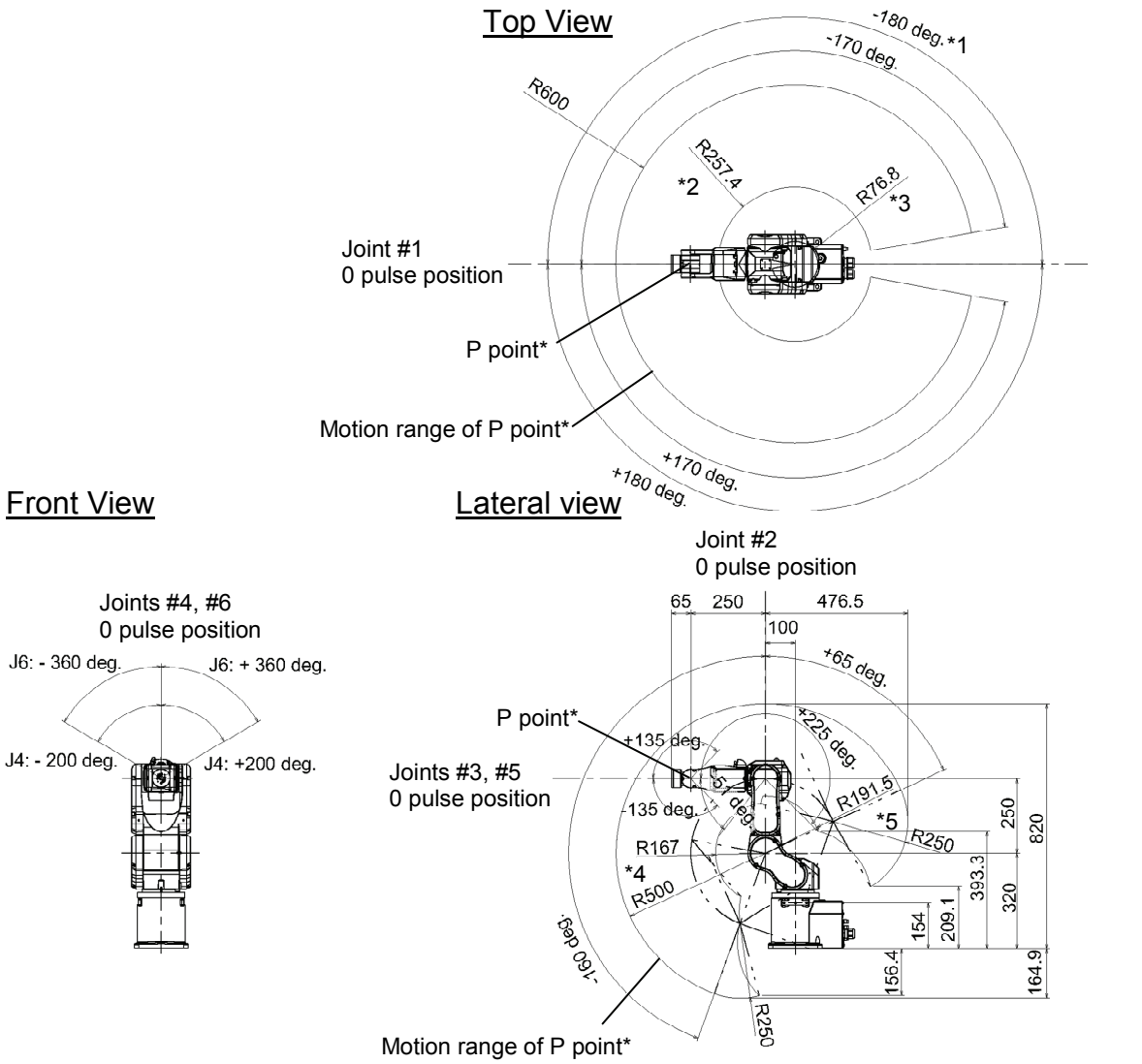
*1: Applicable area

*2: Same for the other side

2.5 Standard Motion Range

2.5.1 C4

[Unit: mm]



* P point : Intersection of the rotation centers for Joint #4, #5, and #6

*1 : Joint #1 without mechanical stop (±180 deg.)
For the mechanical stop removal procedure, refer to *Setup & Operation: 5.2.1 Motion Range Setting of Arm #1*.

*2 : P point from top with Joint #3 declining −51 deg. (Joint #1 center – P point center)

*3 : P point from top with Joint #3 tilting up +225 deg. (Joint #1 center – P point center)

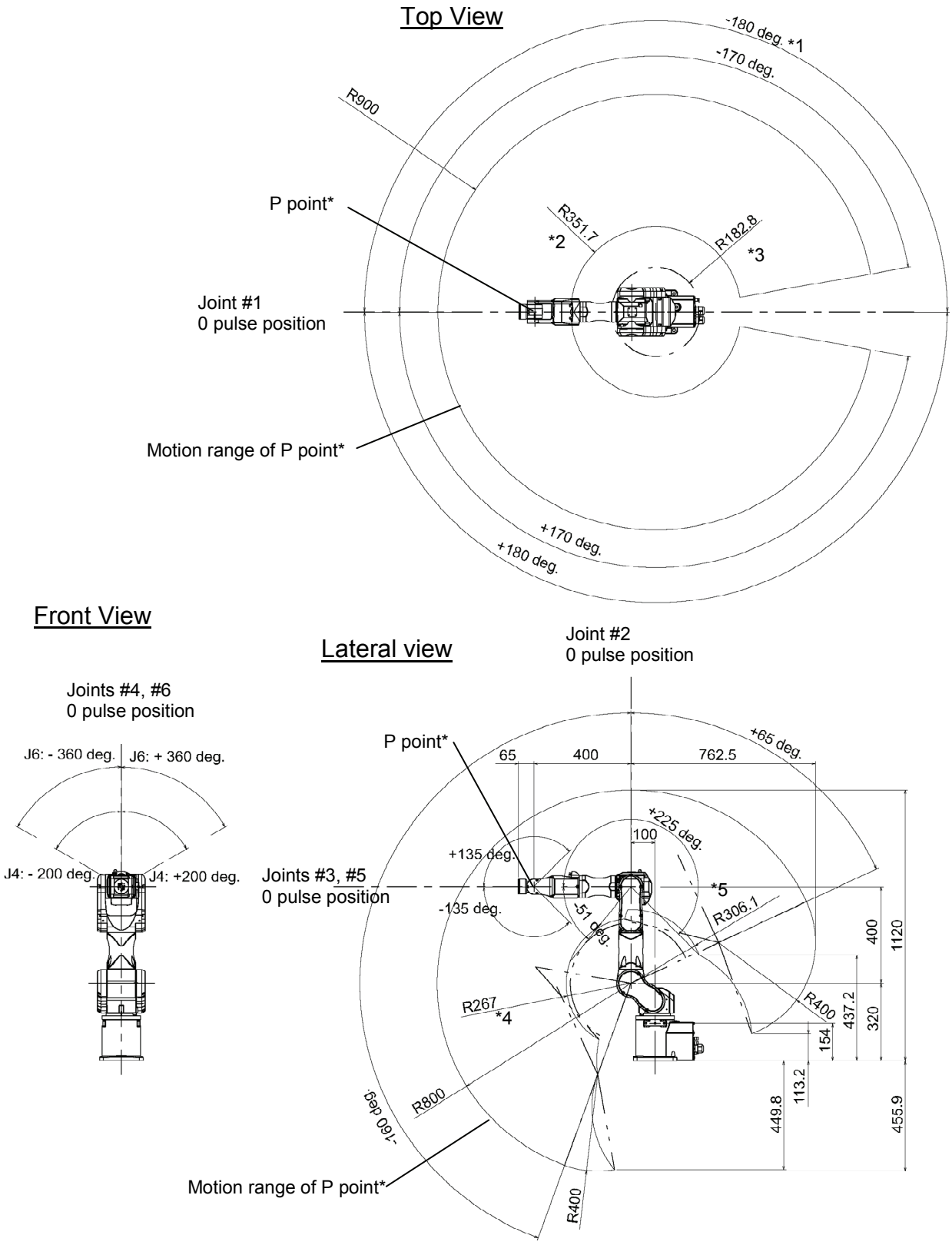
*4 : P point from lateral with Joint #3 declining -51 deg. (Joint #2 center – P point center)

*5 : P point from lateral with Joint #3 tilting up +225 deg. (Joint #2 center – P point center)

 CAUTION	Pay attention to the arm pose of the basic arms (Arms #1, #2, and #3) when operating the Manipulator. Arm #5 moves keeping a constant angle regardless of the arm pose. Depending on the arm pose of the basic arms, the wrist may collide with the Manipulator. The collision may cause equipment damage to and/or malfunction of the Manipulator.

2.5.2 C4L

[Unit: mm]



* P point : Intersection of the rotation centers for Joint #4, #5, and #6

*1 : Joint #1 without mechanical stop (±180 deg.)
For the mechanical stop removal procedure, refer to *Setup & Operation: 5.2.1 Motion Range Setting of Arm #1*.

*2 : P point from top with Joint #3 declining −50 deg. (Joint #1 center – P point center)

*3 : P point from top with Joint #3 tilting up +210 deg. (Joint #1 center – P point center)

*4 : P point from lateral with Joint #3 declining -50 deg. (Joint #2 center – P point center)

*5 : P point from lateral with Joint #3 tilting up +210 deg. (Joint #2 center – P point center)

 CAUTION	■ Pay attention to the arm pose of the basic arms (Arms #1, #2, and #3) when operating the Manipulator. Arm #5 moves keeping a constant angle regardless of the arm pose. Depending on the arm pose of the basic arms, the wrist may collide with the Manipulator. The collision may cause equipment damage to and/or malfunction of the Manipulator.

2.6 Specifications

2.6.1 Specifications table

Item		Specification	
Name		C4	C4L
Mounting type		Table Top mounting	
Weight (not include the weight of cables or shipping jigs)		27 kg (59.5 lb.)	29 kg (63.9 lb.)
Driving method	All joints	AC servo motor	
Max. operating speed *1	Joint #1	450 deg/s	275 deg/s
	Joint #2	450 deg/s	275 deg/s
	Joint #3	514 deg/s	289 deg/s
	Joint #4	555 deg/s	
	Joint #5	555 deg/s	
	Joint #6	720 deg/s	
Repeatability	Joint #1 ~ #6	± 0.02 mm	± 0.03 mm
Max. motion range	Joint #1	± 170 deg (± 180 deg without the mechanical stop)	
	Joint #2	– 160 deg to + 65 deg	
	Joint #3	– 51 deg to + 225 deg	
	Joint #4	± 200 deg	
	Joint #5	± 135 deg	
	Joint #6	± 360 deg	
Max. pulse range	Joint #1	± 4951609 (± 5242880 without the mechanical stop)	
	Joint #2	– 4660338 to + 1893263	
	Joint #3	– 1299798 to + 5734400	
	Joint #4	± 4700057	
	Joint #5	± 3217222	
	Joint #6	± 6553600	
Resolution	Joint #1	0.0000343 deg/pulse	0.0000210 deg/pulse
	Joint #2	0.0000343 deg/pulse	0.0000210 deg/pulse
	Joint #3	0.0000392 deg/pulse	0.0000221 deg/pulse
	Joint #4	0.0000423 deg/pulse	
	Joint #5	0.0000423 deg/pulse	
	Joint #6	0.0000549 deg/pulse	
Motor power consumption	Joint #1	400 W	
	Joint #2	400 W	
	Joint #3	150 W	
	Joint #4	50 W	
	Joint #5	50 W	
	Joint #6	50 W	
Payload *2	Rated	1 kg	
	Max.	4 kg 5 kg with arm downward positioning	
Allowable moment	Joint #4	4.41 N·m (0.45 kgf·m)	
	Joint #5	4.41 N·m (0.45 kgf·m)	
	Joint #6	2.94 N·m (0.3 kgf·m)	

Item		Specification
Allowable moment of inertia ($GD^2/4$) *3	Joint #4	0.15 kg·m^2
	Joint #5	0.15 kg·m^2
	Joint #6	0.10 kg·m^2
Installed wire for customer use		9 wires (D-sub)
Installed pneumatic tube for customer use *4		4 pneumatic tubes, Allowable pressure: 0.59Mpa (6 kgf/cm^2) (89 psi)
Environmental requirements *5	Ambient Temperature	5 to 40 deg C
	Ambient relative humidity	20 to 80 % (no condensation)
	Vibration	4.9 m·s^2 (0.5 G) or less
Noise level *6		LAeq = 80 dB (A) or under
Environment		Standard / Cleanroom model *7 & ESD
Applicable Controller		RC700
Default values (Max. setting values)	SPEED	5, 5 (120, 120)
	ACCEL	50 (2000)
	SPEEDS	200 (25000)
	ACCELS	10000, 10000, 10000, 10000, 10000, 10000 (65535, 65535, 65535, 65535, 65535, 65535)
	FINE	1 (5)
	WEIGHT	5, 5 (120, 120)
Safety standard		Machinery Directive : EN ISO 12100-1, EN ISO 12100-2, EN ISO 10218, EN 60204-1, EN ISO 13849-1 EMC Directive: EN55011, EN61000-6-2 ANSI/RIA : R15.06, JIS B 8433-1, CE Marking, KC Marking, RoHS Directive, REACH

*1 In case of PTP control

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

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

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

*5 For details of the environmental requirements, refer to the *Setup & Operation 3.1 Environmental Conditions*.

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

*7: The exhaust system in the Cleanroom-model Manipulator draws air from the base interior and arm cover interior.
A crack or other opening in the base unit can cause loss of negative air pressure in the outer part of the arm, which can cause increased dust emission.
Do not remove the covers.
Seal the exhaust port and the exhaust tube with vinyl tape so that the joint is airtight.
If the exhaust flow is not sufficient, dust particle emission may exceed the specified maximum level.
Cleanliness level : Class ISO 3 (ISO14644-1)
(Number of particles of 0.1μm or larger in a sample air (28317cm^3:1cft) around the center of the motion area = less than 10 particles)
Exhaust System : Fitting for ø8 mm pneumatic tube
Refer to *Setup & Operation: 3.6 User Wires and Pneumatic Tubes*.
60 L/min vacuum
Exhaust tube : Polyurethane tube
Outer diameter: ø8 mm (Inner diameter: ø5 to 6 mm)

2.6.2 Option

C4 series have the following options.

Brake release unit
Camera mounting plate
PS compatible plate (Tool adapter, Base adapter)
Base side angled fittings
Base side fittings
Adjustable Mechanical Stop (Joint #2: Only C4L)

For details of options, refer to *Setup& Operation: 6. Options*.

2.7 How to Set the Model

The Manipulator for your system has been set before shipment.
Normally, no model setting is necessary.

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 an MT label is attached to the side of the Manipulator, the Manipulator has custom specifications. If the Manipulator has custom specifications, the methods for setting the model may differ from those described below. Please contact us with the number on the MT label.

For the method of the Manipulator model setting, refer to the chapter *Robot Configuration* in the EPSON RC+ User's Guide.

3. Environment and Installation

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

3.1 Environmental Conditions

A suitable environment is essential 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 deg C to 40 deg C
Ambient relative humidity	20 % to 80 % (no condensation)
First transient burst noise	2 kV or less (Power supply wire) 1 kV or les (Signal wire)
Electrostatic noise	4 kV or less
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. - Keep away from shock or vibration. - Keep away from sources of electric noise.

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

NOTE


When using the Manipulators in inadequate environments that do not meet the above conditions, please contact us.

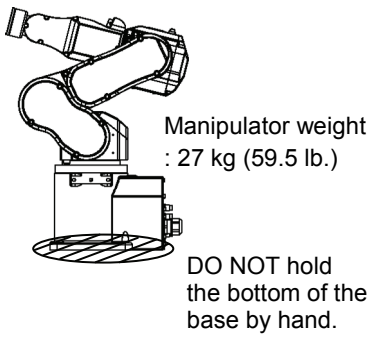
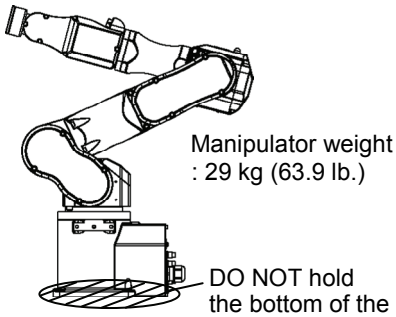
Be sure to transport and store the robot system in environments that meet the following conditions:

Item	Conditions
Ambient temperature	0 to 45 deg C
Ambient relative humidity	20 to 80 %

3.2 Unpacking, Transportation, and Relocation

Using a cart or similar equipment, transport the Manipulator in the same conditions as it was delivered. Observe the following when unpacking the Manipulator.
The installation shall be made by qualified installation personnel and should conform to all national and local codes.

WARNING	■ Only authorized personnel should perform sling work and operate a crane or 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	■ When removing the anchor bolts, support the Manipulator to prevent falling. Removing the anchor bolts without supporting the Manipulator may get hands, fingers, or feet caught as the Manipulator may fall. ■ To carry 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 screened parts in the figure). Holding these parts by hand is extremely hazardous and may cause your hands and fingers caught. C4  C4L  ■ Avoid excessive vibration or shock during Manipulator transporting. Excessive vibration or shock may cause equipment damage to and/or malfunction of the Manipulator.

During unpacking and relocation, avoid applying external force to the arms and motors 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 condensation occurs on the Manipulator during transport or storage, turn ON the power only after the condensation dries.
When using the Manipulator for the robot system again after long-term storage, perform a test run to verify that the Manipulator works properly. Then, operate the Manipulator thoroughly.

Relocating

Follow the procedures described below when relocating the Manipulator.

(1) Turn OFF the power for all devices and unplug the power cable connector and signal cable connector from the controller.
Do not unplug the M/C cable (power cable and signal cable) from the manipulator. (MC cable 3 m: 2 kg)

NOTE
☞ Remove the mechanical stops if using them to limit the motion range.
For details on the motion range, refer to the *Setup & Operation 5.2 Motion Range Setting by Mechanical Stops*.

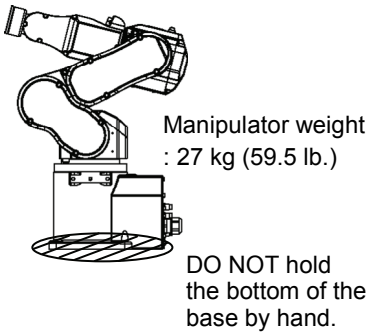
(2) Unscrew the anchor bolts. Then, remove the Manipulator from the base table.

(3) C4

Position the Manipulator as shown in the figure. Then, secure the Manipulator to the delivery equipment or have at least 2 people to carry the Manipulator.

Recommend: Joint #2 +65 deg.
Joint #3 –51 deg.

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

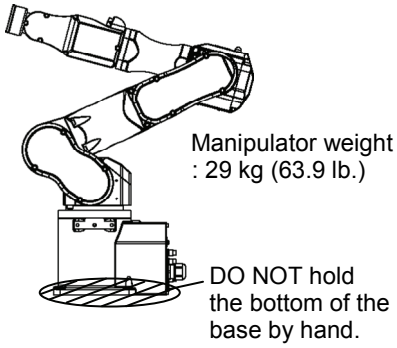


C4L

Position the Manipulator as shown in the figure. Then, secure the Manipulator to the delivery equipment or have at least 3 people to carry the Manipulator.

Recommend: Joint #2 +53 deg.
Joint #3 –51 deg.

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



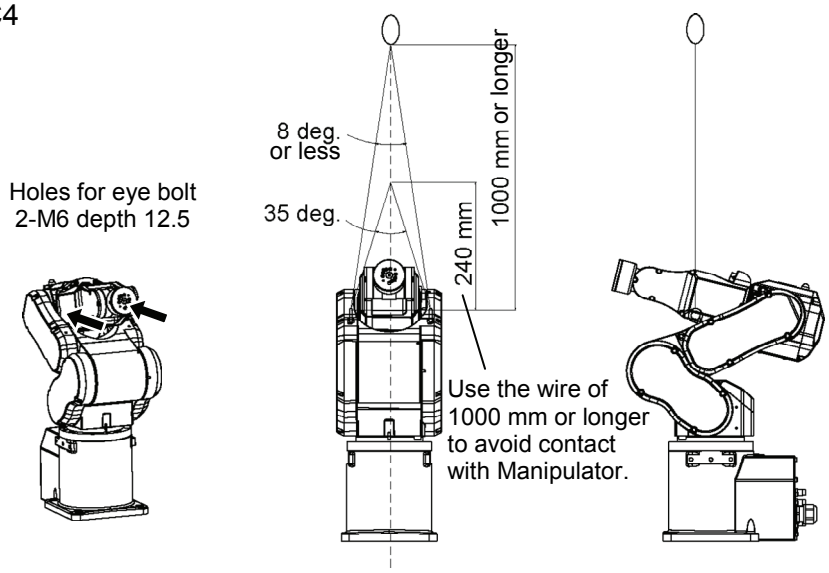
Using Eyebolt

Check that the eyebolts are securely fastened before carrying the Manipulator.
After transporting the Manipulator, remove the eyebolts and keep them for future use.

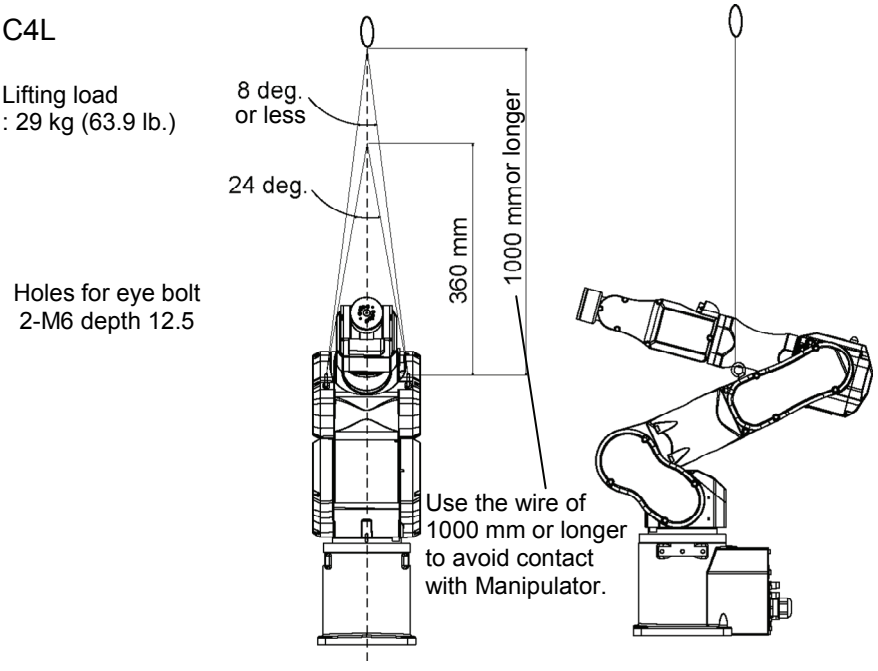
The eyebolts and wire must be strong enough to withstand the weight (See the figures below).
If you use the eyebolts to lift up the Manipulator, be sure to use the bifilar wire of 1 m long or more to avoid contact with the Arm #4 side cover.
Also, the Manipulator may swing while being lifted up even when using the appropriate length of wire, so be sure to handle it with care.

Take extra care if you use the wire of 240 mm-long or shorter (for C4), or 360 mm-long or shorter (for C4L), to lift the Manipulator, because the wire is likely to touch the Arm #4 side cover and break the Manipulator.

C4



C4L



3.3 Mounting Dimensions

Mounting Area

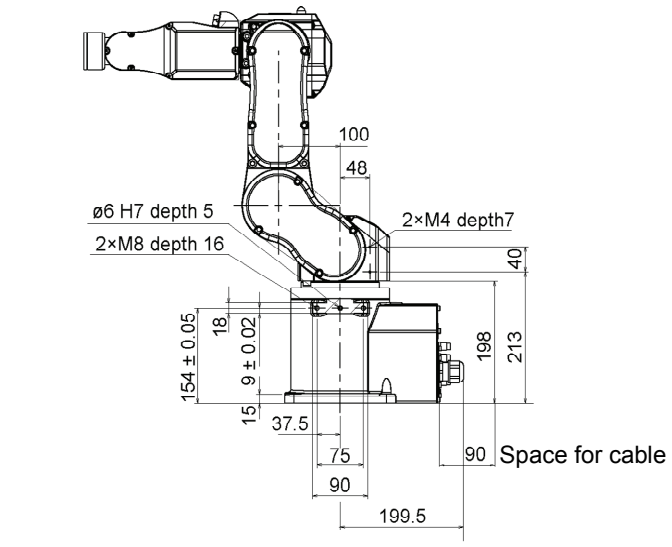
Be sure to have the following space available in addition to the space for mounting the Manipulator, Controller, and peripheral equipment.

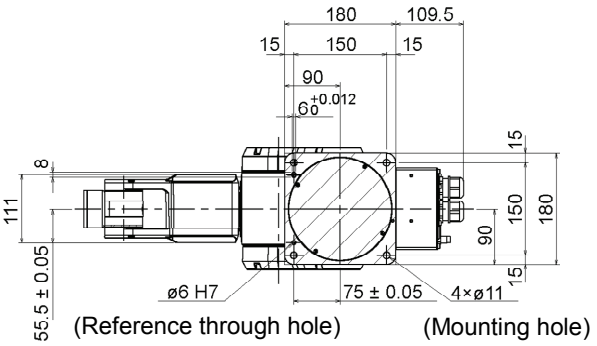
Space for teaching points
Space for maintenance and inspections (for installing jigs)
Space for cables
Space for mounting holes (only for V/P model)

NOTE


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

Mounting Dimensions (C4, C4L) [Unit: mm]





3.4 Installation

The installation shall be made by qualified installation personnel and should conform to all national and local codes.

 WARNING	■ To ensure safety, a safeguard must be installed for the robot system. For details on the safeguard, refer to the *Installation and Design Precautions* in the *Safety* chapter of the EPSON RC+ User's Guide. ■ Install the Manipulator in a location with sufficient space so that a tool or a work piece does not touch a wall or a safeguard when the Manipulator extends its arm fully while holding a work piece. Installing the Manipulator at a location with insufficient space is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system as a tool or a work piece may collide with a wall or a safeguard. ■ Anchor the Manipulator before turning ON the power to or operating the Manipulator. Turning ON the power to or operating the Manipulator that is not anchored is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system as the Manipulator may fall down. ■ Before installing and operating the Manipulator, make sure that all parts of the Manipulator are in place and have no external defects. Missing or defective parts may cause improper operation of the Manipulator. Improper operation of the Manipulator is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system.

 CAUTION	■ The Manipulator must be installed to avoid interference with buildings, structures, utilities, other machines and equipment that may create a trapping hazard or pinch points.

Mounting bolt

For the dimensions, refer to *Setup & Operation 3.3 Mounting Dimensions*.
There are four threaded holes for the Manipulator base.
Use M8 mounting bolts conforming to the strength of ISO898-1 property class 12.9.

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 differ depending on the intended use of the robot system. The following is the basic requirements of Manipulator table for your reference.

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. 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:

	C4	C4L
Max. Horizontal rotating torque	500 N·m	700 N·m
Max. Horizontal reaction force	800 N	800 N
Max. Vertical rotating torque	600 N·m	1000 N·m
Max. Vertical reaction force	2500 N	2500 N

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

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

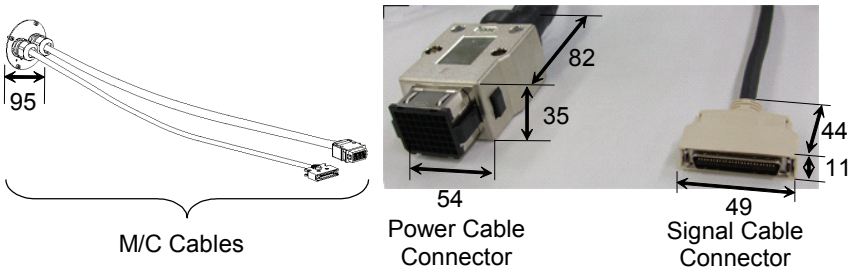
The Manipulator must be installed horizontally.

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

Connector

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

[unit : mm]



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

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

When using the Manipulator in the clean room, follow the steps below before the installation.

(1) Unpack it outside of the clean room.

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

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

(4) Carry the Manipulator in the clean room.

(5) Secure the Manipulator to the base table.

3.5 Connecting the Cables

 WARNING	■ Before performing any replacement procedure, turn OFF the Controller and related equipment, and then pull out the power plug from the power source. Performing any replacement procedure with the power ON is extremely hazardous and may result in electric shock and/or malfunction of the robot system. ■ Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source. To shut off power to the robot system, pull out the power plug from the power source. Performing any work while connecting the AC power cable to a factory power source is extremely hazardous and may result in electric shock and/or malfunction of the robot system. ■ 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. ■ Before wiring, turn OFF the Controller and related equipment, and then pull up a warning sign (e.g. DO NOT TURN ON THE POWER.). Wiring with the power ON is extremely hazardous and may result in electric shock and/or malfunction 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 and the Controller, make sure that the serial numbers on each equipment match. Improper connection between the Manipulator and Controller may not only cause improper function of the robot system but also safety problems. The connection method varies with the Controller used. For details on the connection, refer to the Controller manual. ■ 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.

Cleanroom-model Manipulator

For the Cleanroom-model, an exhaust system is necessary. For details, refer to *Setup & Operation: 2.6 Specifications*.

Connection method

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

3.6 User Wires and Pneumatic Tubes

3.6.1 Wiring and Piping

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	Outer Diameter	Note
AC/DC30 V	1 A	9	0.211 mm^2	ø8.3±0.3 mm	Shielded

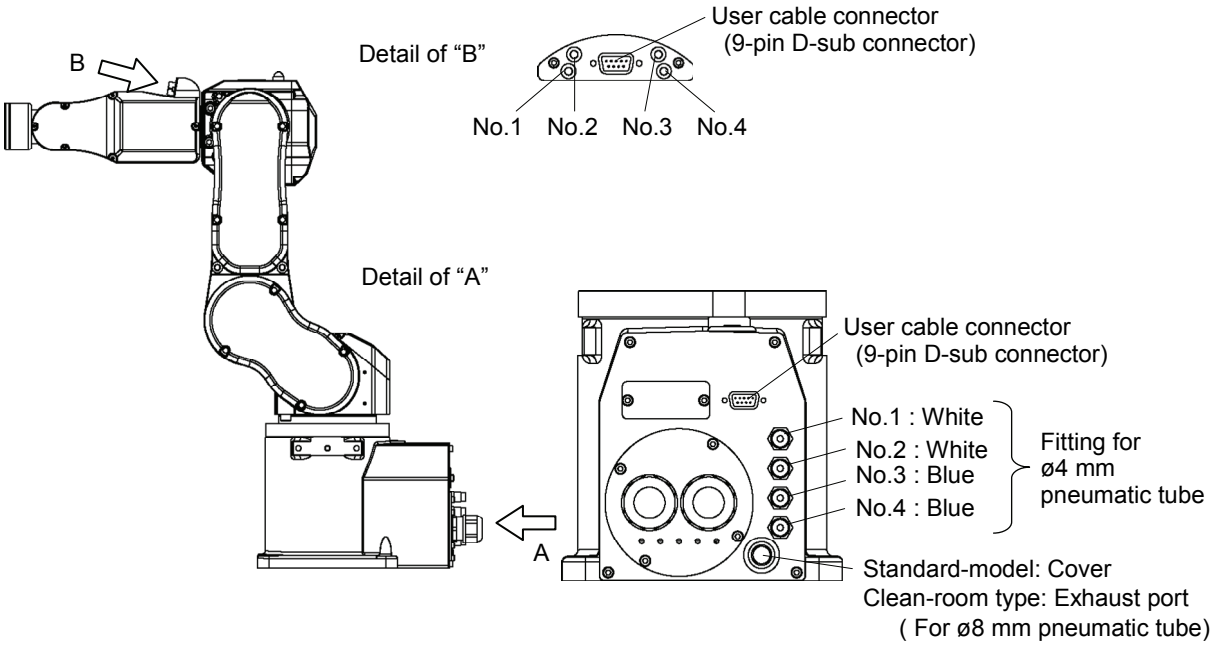
		Maker	Standard	
9 pin	Suitable Connector	JAE	DE-9PF-N	(Solder type)
	Clamp Hood	JAE	DE-C8-J9-F2-1 R	(Connector setscrew: #4-40 NC)

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)	4	ø4 mm × ø2.5 mm

Tubes with the same number, indicated in details of View A and B, are connected.



3.7 Checking the Basic orientation

After parts have been replaced (motors, reduction gear units, belts, etc.), the Manipulator cannot operate properly because a gap exists between the home positions stored in each motor and these stored in the Controller.

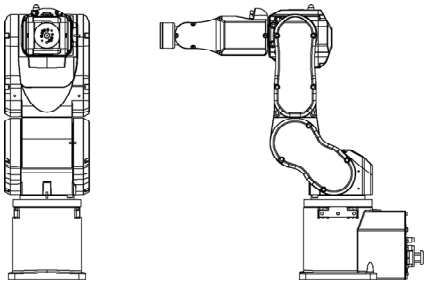
The process to compensate the position gap is called “Calibration”.

At shipment, the Manipulator is set the following basic position as origin.

After all setting is done, go through an origin return and make sure the manipulator moves to the right basic orientation.

To make the manipulator return to origin, select [Tool]-[Robot Manager]-[Control Panel] and click <Home>.

Contact us, the gap still exists and the manipulator cannot be in the basic orientation as below after the origin return.



Basic orientation

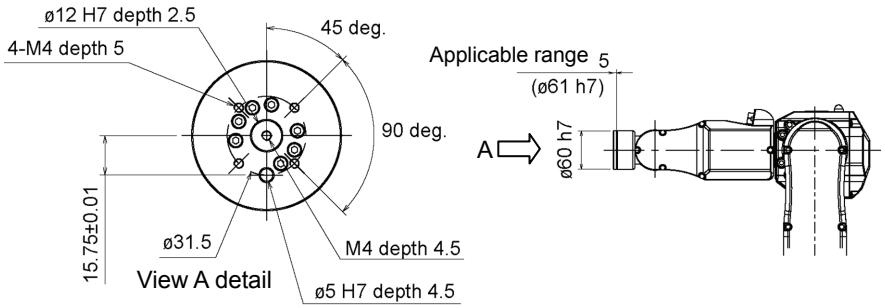
4. End Effectors

4.1 Attaching an End Effector

Create an end effector for your Manipulator. Flange dimensions of the wrist attached to the end of Arm #6 is as below.

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.

Wrist Flange



Arm #6

Attach an end effector to the end of the Arm #6 using the M4 bolts.

Layouts

When you operate the Manipulator with an end effector, the end effector may interfere with the Manipulator body depending on 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 close attention to the interference area of the end effector.

Compatibility with PS series:

To install the end effector used in the PS series to the C4 series, we provide the optional PS Compatible Plate. For details, refer to *Setup & Operation: 6. Options*.

4.2 Attaching Camera and Valves

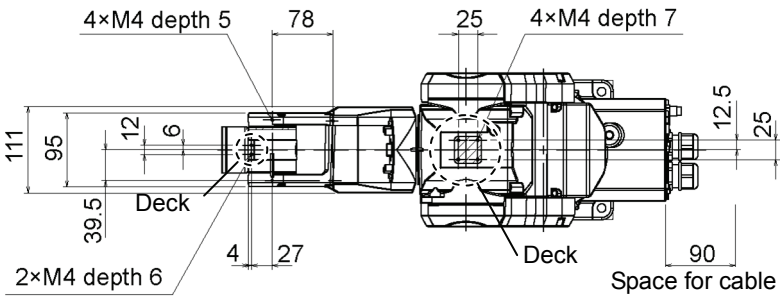
Decks are equipped to Arms #3 and #5 to enable the easy installation of air valve.

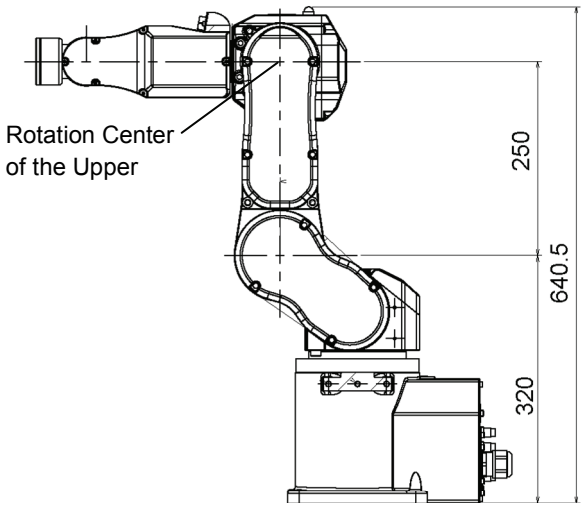
If the payload exceeds the maximum payload, refer to the section "*Restriction on payload exceeding the maximum payload*" in the *Setup & Operation 4.3.1 WEIGHT Setting*.

To mount the camera, the camera plate unit is necessary.
We provide the optional Camera Plate Unit. For details, refer to *Setup & Operation: 6. Options*.

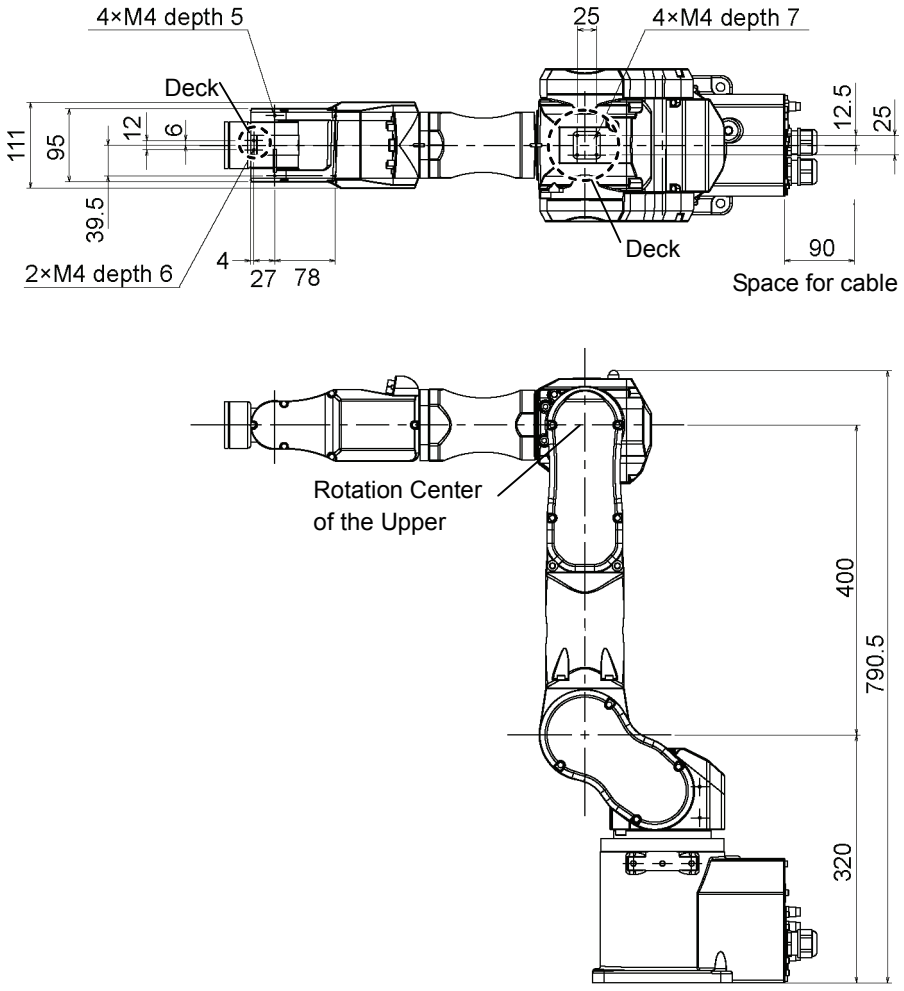
[Unit: mm]

C4





C4L


4×M4 depth 5
25
4×M4 depth 7
Deck
111
95
12
6
39.5
12.5
25
Deck
90
Space for cable
2×M4 depth 6
4
27
78
Rotation Center
of the Upper
400
790.5
320

4.3 WEIGHT and INERTIA Settings

The WEIGHT and INERTIA commands are for setting the load parameters of the Manipulator. These settings optimize the Manipulator motion.

WEIGHT Setting

The WEIGHT command is for setting the load weight. The more the load weight increases, the more the speed and acceleration/deceleration are reduced.

INERTIA Setting

The INERTIA command is for setting the inertia moment and the eccentricity of the load. The more the inertia moment increases, the more the acceleration and deceleration of the Arm #6 are reduced. The more the eccentricity increases, the more the acceleration and deceleration for the Manipulator movement are reduced.

To ensure optimum Manipulator performance, make sure that the load (weight of the end effector and work piece) and inertia moment of the load are within the maximum rating for the Manipulator, and that Arm #6 does not become eccentric.
If the load or the inertia moment exceeds the ratings or if the load becomes eccentric, follow the steps in the *Setup & Operation 4.3.1 WEIGHT Setting* and *4.3.2 INERTIA Setting*, to set parameters.
Setting parameters makes the operation 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 inertia moment of the end effector and work piece is bigger.

The allowable load for C4 series Manipulators is as follows:
Up to 4 (5) kg*

Due to the limitations shown in the tables below, the moment and the inertia moment should also meet these conditions.
If force is applied to the Manipulator instead of weight, it should not exceed the values shown in the table below.

* If the payload exceeds the maximum payload, refer to the section "*Restriction on payload exceeding the maximum payload*" in the *Setup & Operation 4.3.1 WEIGHT Setting*.

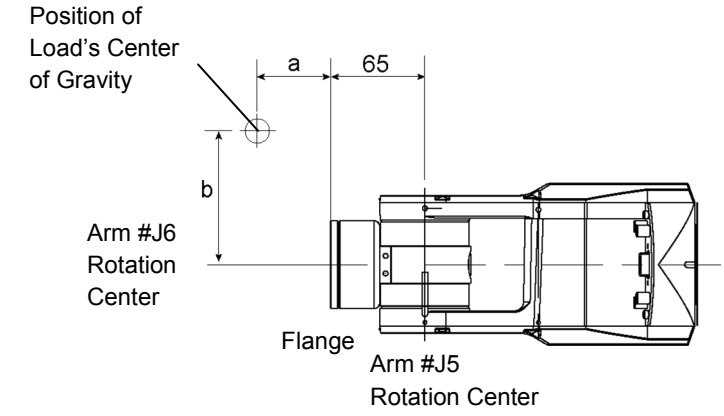
Allowable Load

Arm	Allowable Moment *1	$GD^2/4$ Allowable Moment of Inertia
#4	4.41 N·m (0.45 kgf·m)	0.15 kg·m^2
#5 *2	4.41 N·m (0.45 kgf·m)	0.15 kg·m^2
#6	2.94 N·m (0.3 kgf·m)	0.1 kg·m^2

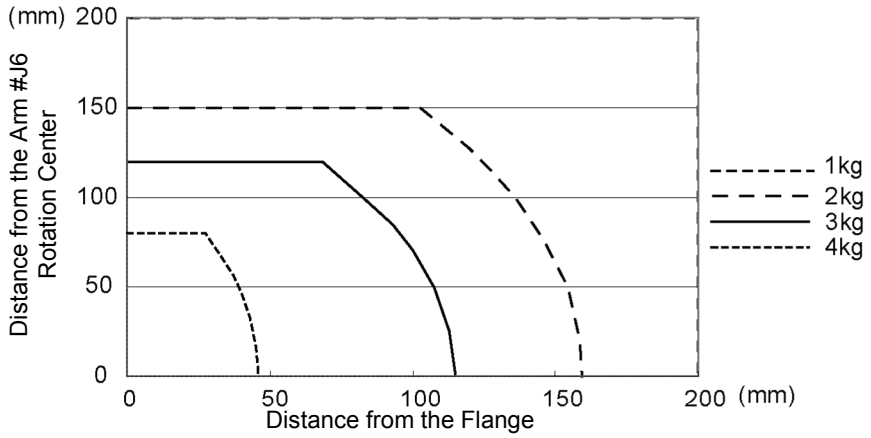
*1 Torque unit

*2 The allowable load for Arm #5 are calculated as follows:
Distance from the center of Arm #5 rotation (Figure: a + 65 [mm]).

Critical Dimension of Load



[Unit: mm]



When calculating the critical dimension of the load on the Arm #5 using the allowable moment and inertia moment, the calculated value represents a distance from the Arm #5 rotation center, not the distance from the flange. Therefore, to get a value of the critical dimension of the load on Arm #5, subtract 65 (mm) from the calculated distance as shown in the example below.

Example: Calculate the critical dimension of the load on the Arm #5 (c) when a 2.5 kg load is on the Arm #6 rotation center line (b = 0).

Allowable Moment of the Arm #5 (N·m) / Load (kg)

= Distance from the Arm #5 rotation center (m)

4.41 (N·m) / 9.8 / 2.5 (kg) = 0.18 → 0.18 (m) = 180 (mm)

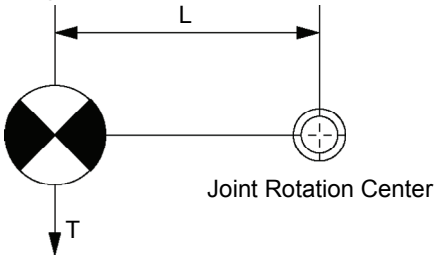
c = Distance from the Arm #5 rotation center (mm) – 65 (mm)

c = 180 (mm) – 65 (mm) = 115 (mm)

Moment

A moment is a necessary torque (holding torque) to counteract the gravity affecting the load.
Design an end effector so that the eccentric quantity at the position where the load is attached is within the allowable moment.
A maximum torque (T) is calculated by the following formula.

$T = m\ (kg) \times L\ (m) \times g\ (m/s^2)$



m: Weight of load (kg)
L: Eccentric quantity of load (m)
g: Gravitational acceleration (m/s^2)

Max. Eccentric Quantity of Load
(Distance between the joint rotation center and the load's center of gravity)

Axis	WEIGHT 1 kg	WEIGHT 2 kg	WEIGHT 2.5 kg	WEIGHT 3 kg
#4	200 mm	200 mm	150 mm	112 mm
#5	200 mm	200 mm	150 mm	112 mm
#6	200 mm	150 mm	100 mm	75 mm

(The maximum eccentric quantity of load is restricted to 200 mm or less.)

4.3.1 WEIGHT setting

CAUTION

- Set the total weight of the end effector and the work piece smaller than the maximum payload.
  The C4 Manipulators can operate without limitations on the condition unless and until the load exceeds this maximum payload. When the payload of the Manipulator exceeds the maximum payload, refer to the section "*Restrictions on payload exceeding the maximum payload*" in the later part of this section for details.
  Always set the Weight parameters of the WEIGHT command according to the load. Setting a value that is smaller than the actual load may cause errors, excessive shock, insufficient function of the Manipulator, and/or shorten the life cycle of parts/mechanisms.

The acceptable weight capacity (end effector and work piece) for C4 Manipulators is as follows:

Rated	Maximum
1 kg	4(5) kg*

When the load exceeds the rating, change the setting of the Weight parameter.
After changing the Weight parameter setting, the maximum acceleration/deceleration and speed of the robot system corresponding to the load is set automatically.

* If the payload exceeds the maximum payload, refer to the section "*Restriction on payload exceeding the maximum payload*" in the *Setup & Operation 4.3.1 WEIGHT Setting*.

Setting method of Weight parameters

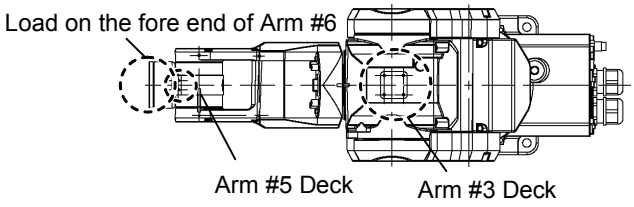
EPSON RC+

Select [Tools]-[Robot Manager]-[Weight] panel and set the value in [Weight:].
You may also execute the Weight command from [Command Window].

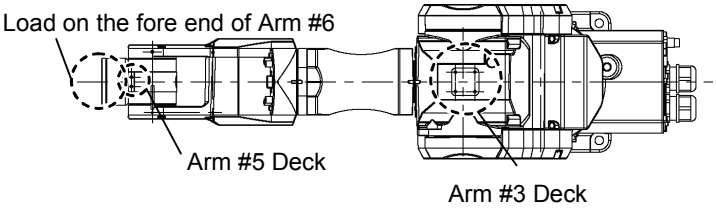
Load on the Manipulator

Mounting location of the load

C4

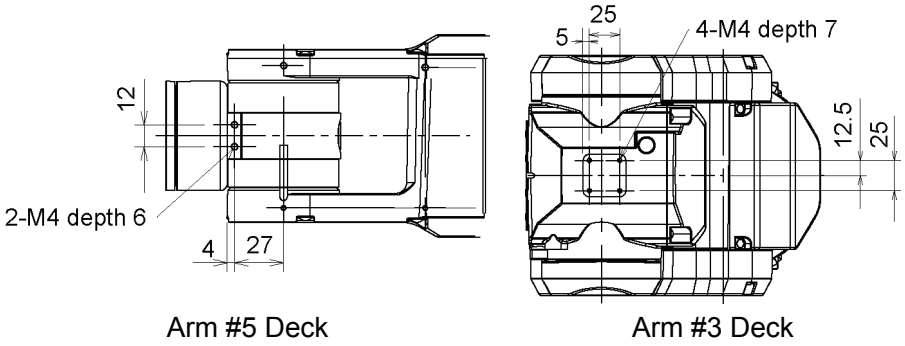


C4L



Deck detailed

C4
C4L



[Unit: mm]

When you attach the equipment to the decks on the upper arm, convert its weight into equivalent weight assuming that the equipment is attached to the end of the Arm #6. Then, this equivalent weight added to the load will be a Weight parameter.

Calculate the Weight parameter by using the formula below and enter the value.

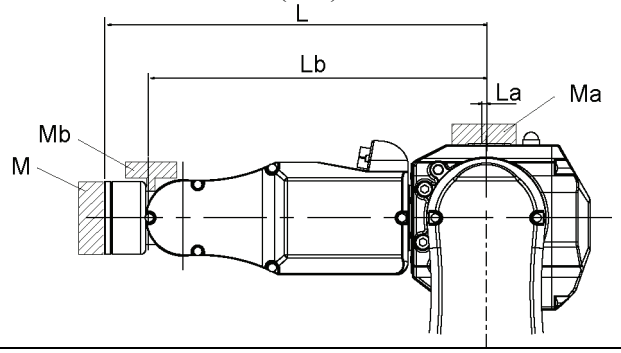
Weight Parameter Formula

Weight parameter = $M_w + W_a + W_b$

M_w : Load on the fore end of Arm #6 (kg)
W_a : Equivalent weight of the Arm #3 deck (kg)
W_b : Equivalent weight of the Arm #5 deck (kg)

$W_a = M_a (L_a)^2 / (L)^2$
$W_b = M_b (L_b)^2 / (L)^2$

M_a : Weight of the air valve on the Arm #3 deck
M_b : Weight of the camera on the Arm #5 deck
L : Length of the upper arm (315 mm)
L_a : Distance between the Joint #3 and the center of gravity of the air valve on the Arm #3 deck (mm)
L_b : Distance between the Joint #3 and the center of gravity of the camera on the Arm #5deck (mm)

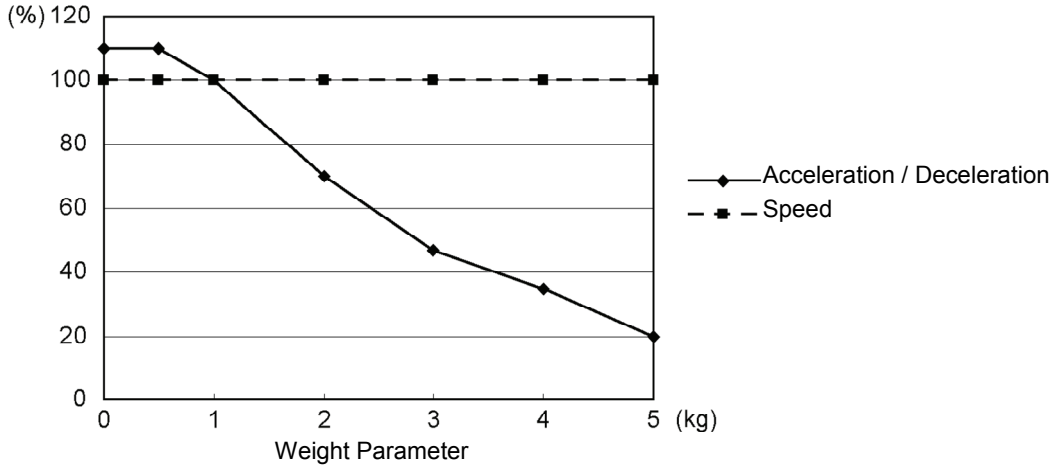


<Example> The fore end of the Arm #6 is 315 mm (L) away from the Joint #3.
Load on the fore-end of Arm #6 is 1 kg (M_w).
Load on the Arm #3 deck is 1.5 kg (M_a).
The deck is 0 mm (L_a) away from Joint #3.
Load on the Arm #5 deck is 0.5 kg (M_b).
The deck is 280 mm (L_b) away from the Joint #3.

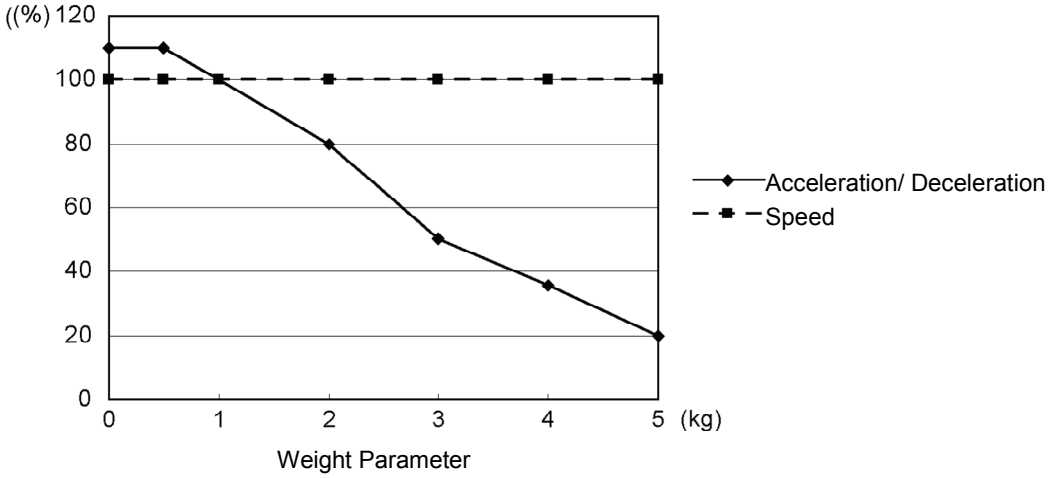
$W_a = 1.5 \times 0^2 / 315^2 = 0$
$W_b = 0.5 \times 280^2 / 315^2 = 0.395 \rightarrow 0.4$(round up)
$M_w + W_a + W_b = 1 + 0 + 0.4 = 1.4$

Enter “1.4” for the Weight parameter.

Automatic speed setting by Weight parameter (C4)



Automatic speed setting by Weight parameter (C4L)



* The percentage in the graph is based on the speed at rated weight (1 kg) as 100%.
* If the payload exceeds the maximum payload, refer to the section "*Restriction on payload exceeding the maximum payload*" in the *Setup & Operation 4.3.1 WEIGHT Setting*.

Restrictions on payload exceeding the maximum payload

Maximum payload for C4 Manipulators is as follows:

Payload can be increased by restricting the arm posture of the Arm #5 downward.

Max. Payload	Max. Payload with Pose Restriction
4 kg	5 kg

If the load exceeds the maximum payload, use the Arm #5 with a posture angle within the range indicated in the following graph.

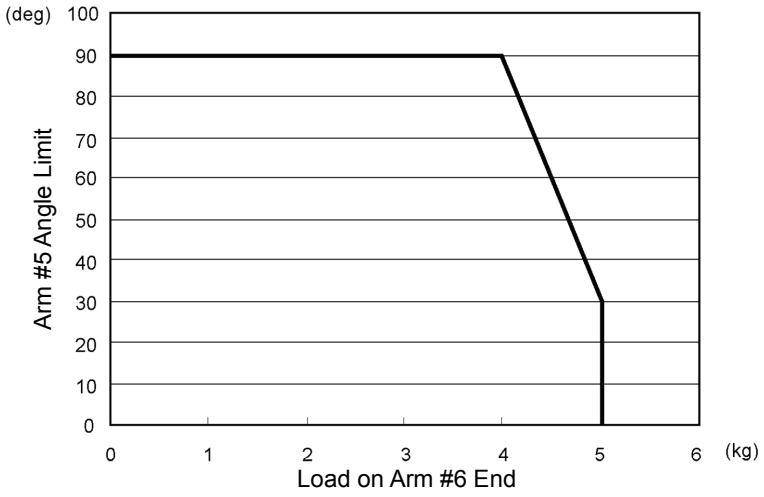
The graph shows the relation of the load weight and Arm #5 angle limit (A^1) measured in vertical direction (direction of gravity). Note that the heavier the load on the Arm #6, the smaller the angle limit becomes.

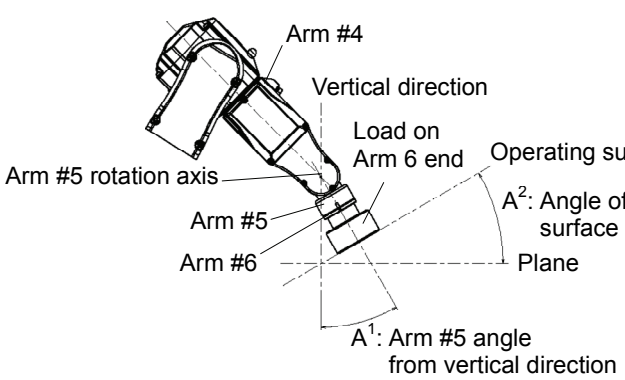
When the manipulator operates vertically to the operating surface, the limit of the Arm #5 is equivalent to the limit of the operating angle (A^2).

In addition, for the eccentric load, the angle limit is an angle of the line joining the center of the load and the Arm #5 rotation axis with the vertical direction (B).

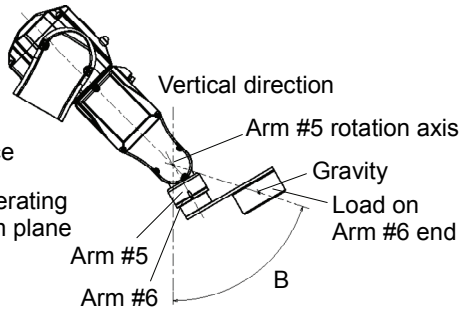
The eccentric quantity of the load should be within the allowable moment and inertia moment of Arms #4, #5, and #6.

Relation of load weight and Arm #5 angle limit





Relation of Arm #5 angle and operating surface



Angle limit for eccentric load

The figures above are S/C model.

4.3.2 INERTIA setting

Inertia Moment and the INERTIA Setting

The inertia moment 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 objects such as an end effector attached to the Arm #6, the moment of inertia of load must be considered.

 CAUTION	■ The inertia moment of the load (weight of the end effector and work piece) must be 0.1 kg·m^2 or less. The C4 Manipulators are not designed to work with inertia moment exceeding 0.1 kg·m^2. Always set the inertia moment (INERTIA) parameter according to the inertia moment. Setting a value that is smaller than the actual inertia moment may cause errors, excessive shock, insufficient function of the Manipulator, and/or shorten the life of parts/mechanisms.

The acceptable inertia moment of load for C4 Manipulator is 0.1 kg·m^2 nominal rating and 0.1 kg·m^2 maximum. When the inertia moment of the load exceeds the rating, change the setting of the inertia moment using the INERTIA command. After the setting has been changed, the maximum acceleration/deceleration speed of Arm #6 responding to “inertia moment” is set automatically.

Inertia moment of load on Arm #6

The inertia moment of the load (weight of the end effector and work piece) on the Arm #6 can be set by the “inertia moment (INERTIA)” parameter of the INERTIA command.

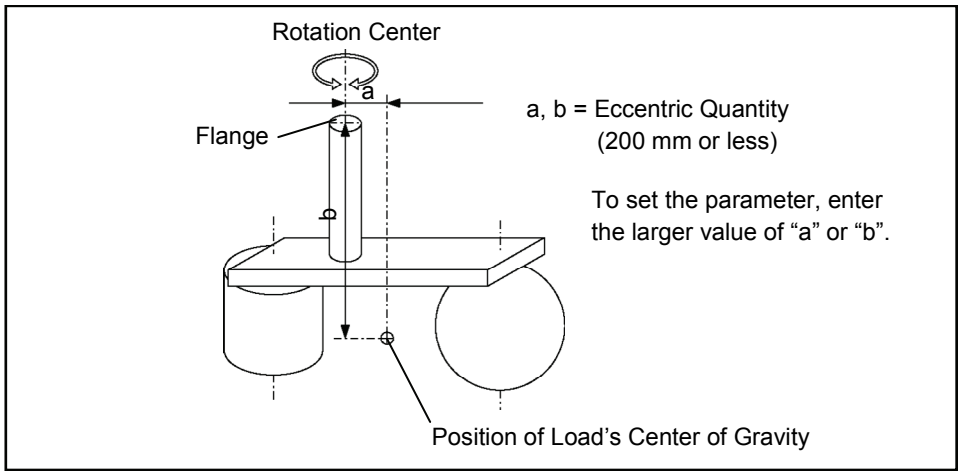
EPSON RC+

Select [Tools]–[Robot Manager]-[Inertia] panel and enter the value in [Load inertia:].
You may also execute the Inertia command from [Command Window].

Eccentric Quantity and the INERTIA Setting

CAUTION	■ The eccentric quantity of the load (weight of the end effector and work piece) must be 200 mm or less. The C4 Manipulators are not designed to work with eccentric quantity exceeding 200 mm. Always set the eccentric quantity parameter according to the eccentric quantity. Setting a value that is smaller than the actual eccentric quantity may cause errors, excessive shock, insufficient function of the Manipulator, and/or shorten the life cycle of parts/mechanisms.

The acceptable eccentric quantity of the load for C4 Manipulators is 30 mm at nominal rating and 200 mm at maximum. When the eccentric quantity of the load exceeds the rating, change the setting of eccentric quantity parameter using the INERTIA command. After changing the setting, the maximum acceleration/deceleration speed of Manipulator corresponding to "eccentric quantity" is set automatically.



Eccentric Quantity

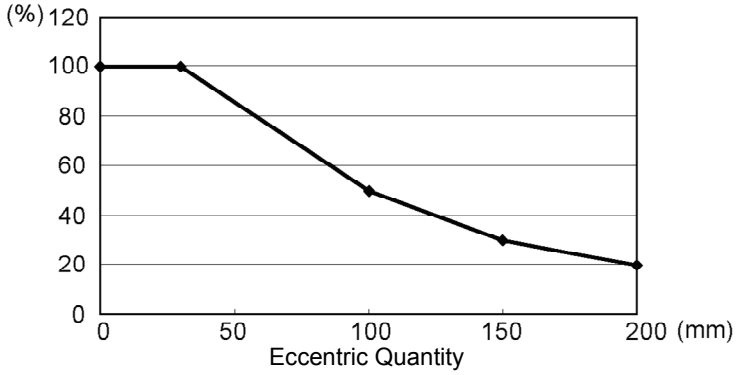
Eccentric quantity of load on Arm #6

The eccentric quantity of the load (weight of the end effector and work piece) on the Arm #6 can be set by the "eccentric quantity" parameter of the INERTIA command.
Enter the larger value of either "a" or "b" in the figure above to [Eccentricity].

EPSON RC+

Select [Tools]–[Robot Manager]-[Inertia] panel and enter the value into [Eccentricity:].
You may also execute the Inertia command from [Command Window].

Automatic acceleration/deceleration setting by INERTIA (eccentric quantity)



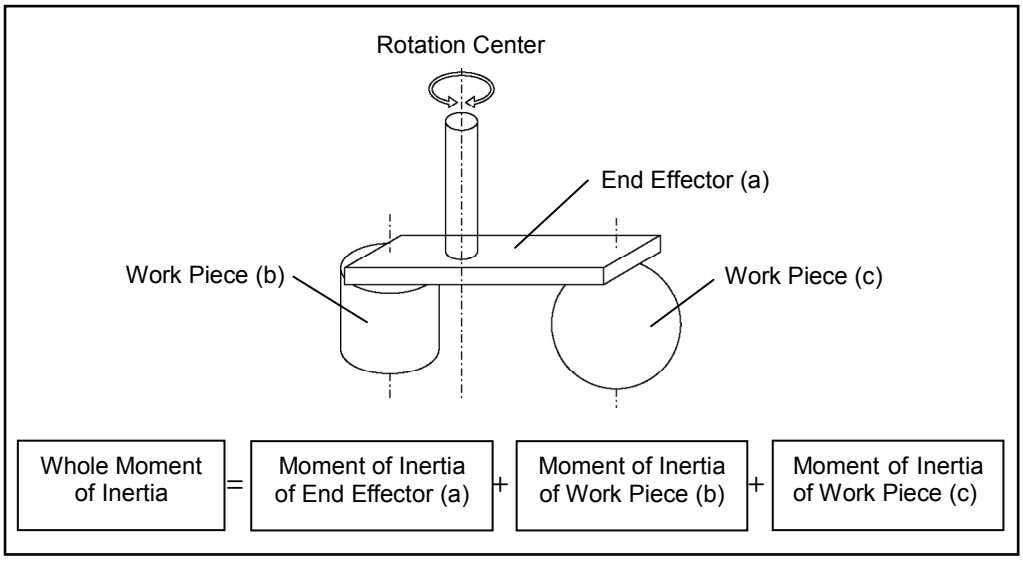
* The percentage in the graph is based on the acceleration/ deceleration at rated eccentricity (30 mm) as 100%.

INERTIA (eccentric quantity) is affected by the load setting. Refer to *Setup & Operation 4.3: WEIGHT and INERTIA Settings* and configure the load setting carefully.

Calculating the Inertia Moment

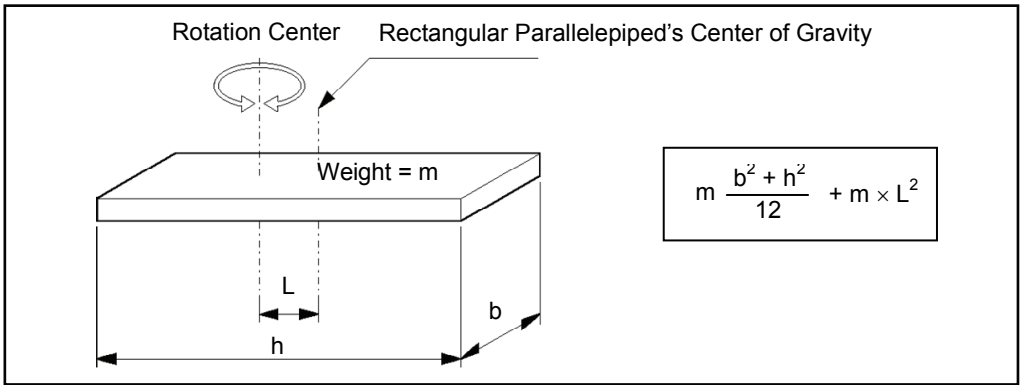
Refer to the following example formulas to calculate the inertia moment of the load (end effector with work piece).

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

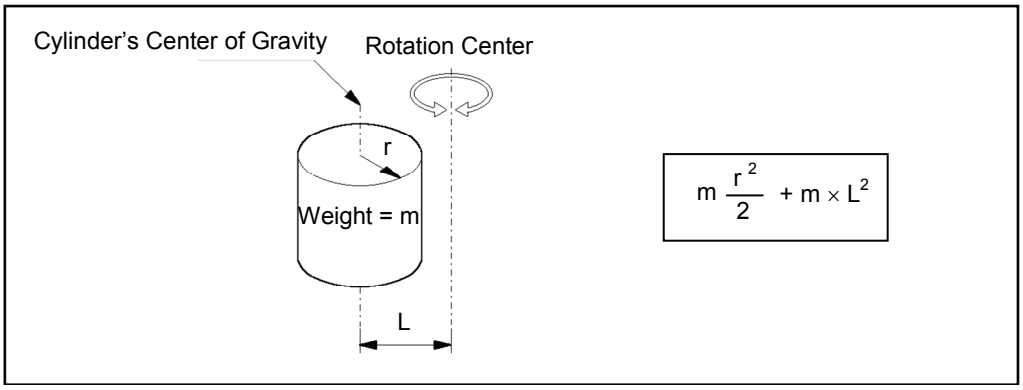


The methods for calculating the inertia moment for (a), (b), and (c) are shown in this and the next page. Figure out the whole inertia moment using the basic formulas below.

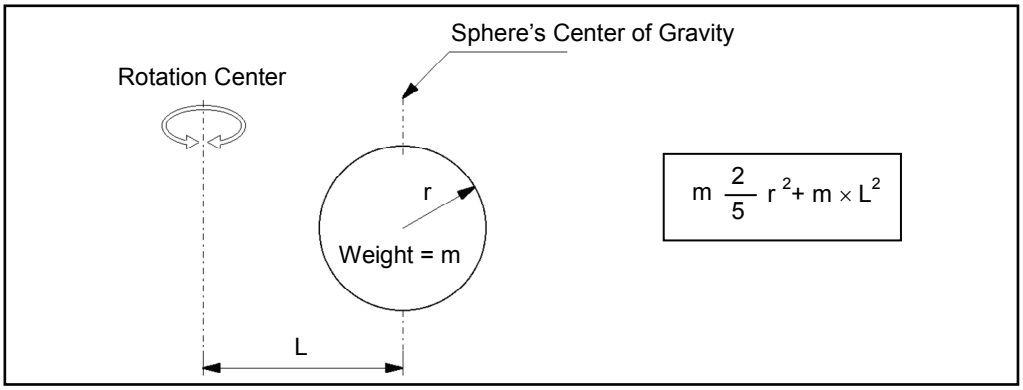
(a) Inertia moment of a rectangular parallelepiped



(b) Inertia moment of a cylinder



(c) Inertia moment of a sphere



4.4 Precautions for Auto Acceleration/Deceleration

The speed and acceleration/deceleration of the Manipulator motion are automatically optimized according to the values of WEIGHT and INERTIA and the Manipulator's postures.

WEIGHT Setting

The speed and acceleration/deceleration of the Manipulator are controlled according to the load weight set by the WEIGHT command.
The more the load weight increases, the more the speed and acceleration/deceleration are reduced to prevent residual vibration.

INERTIA Setting

The acceleration/deceleration of Arm #6 are controlled according to the inertia moment set by the INERTIA command. The acceleration/deceleration of the whole Manipulator are controlled according to the eccentricity set by the INERTIA command. The more the inertia moment and eccentricity of the load increase, the more the acceleration/deceleration are reduced.

Auto Acceleration/Deceleration According to Manipulator's Posture

The acceleration/deceleration are controlled according to the Manipulator's posture. When the Manipulator extends its arms or when the movement of the Manipulator produces vibration frequently, the acceleration/deceleration are reduced.

Set appropriate values for WEIGHT and INERTIA so that the Manipulator operation is optimized.

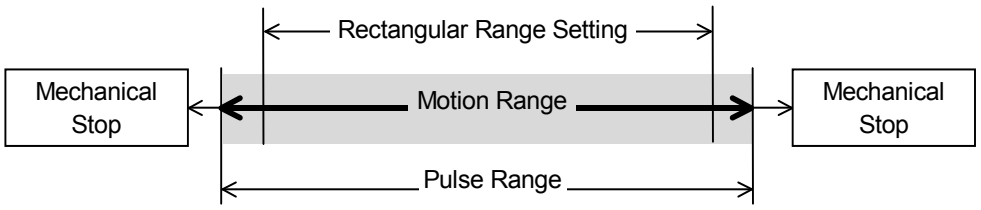
5. Motion Range

WARNING	■ When limiting the motion range for safety, be sure to set by both the pulse range and mechanical stops. Failure to do so may cause serious safety problems.

The motion range is preset at the factory as describes in the *Setup & Operation 2.5 Standard Motion Range*. This is the maximum motion range of the Manipulator.

Motion range is set by the following three methods:

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



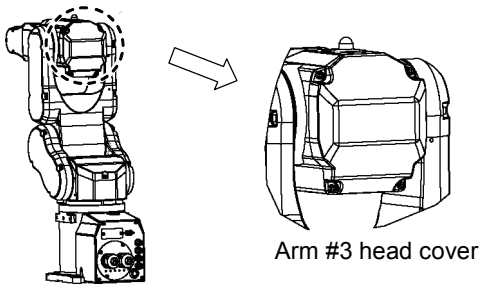
When the motion range is changed due to layout efficiency or safety, follow the descriptions in *5.1* through *5.4* to set the range.

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

Pulses are the basic unit of Manipulator motion. The motion range of the Manipulator is controlled by the pulse range (the lower limit and the upper limit) of each axis.
Pulse values are read from the encoder output of the servo motor.
The pulse range should be set within the mechanical stop range.

CAUTION	■ Do not set and/or use the Arm #4 with a pulse range exceeding the maximum value. The Arm #4 does not have a mechanical stop. Using the Arm #4 with a pulse range exceeding the maximum pulse range may cause the inner wiring damaged and/or malfunction to the Manipulator.

Torsion of the inner wiring can be checked by removing the Arm #3 head cover.



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.

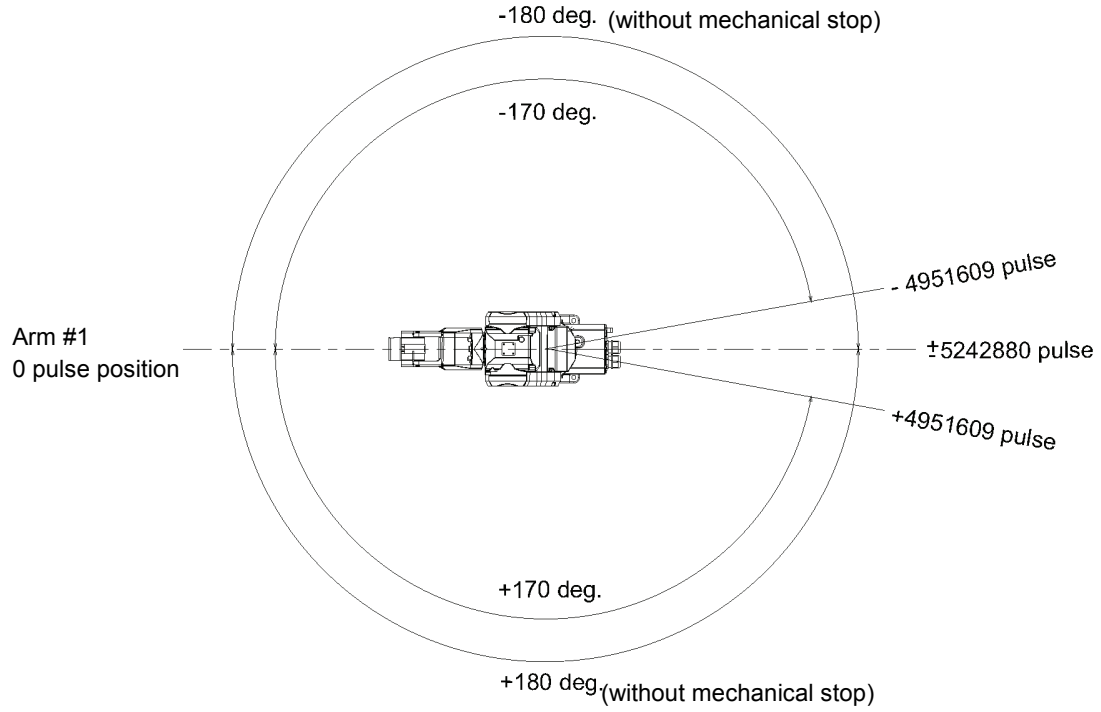
EPSON RC+

The pulse range can be set in [Tools]-[Robot manager]-[Range] panel.
You may also execute the Range command from the [Command Window].

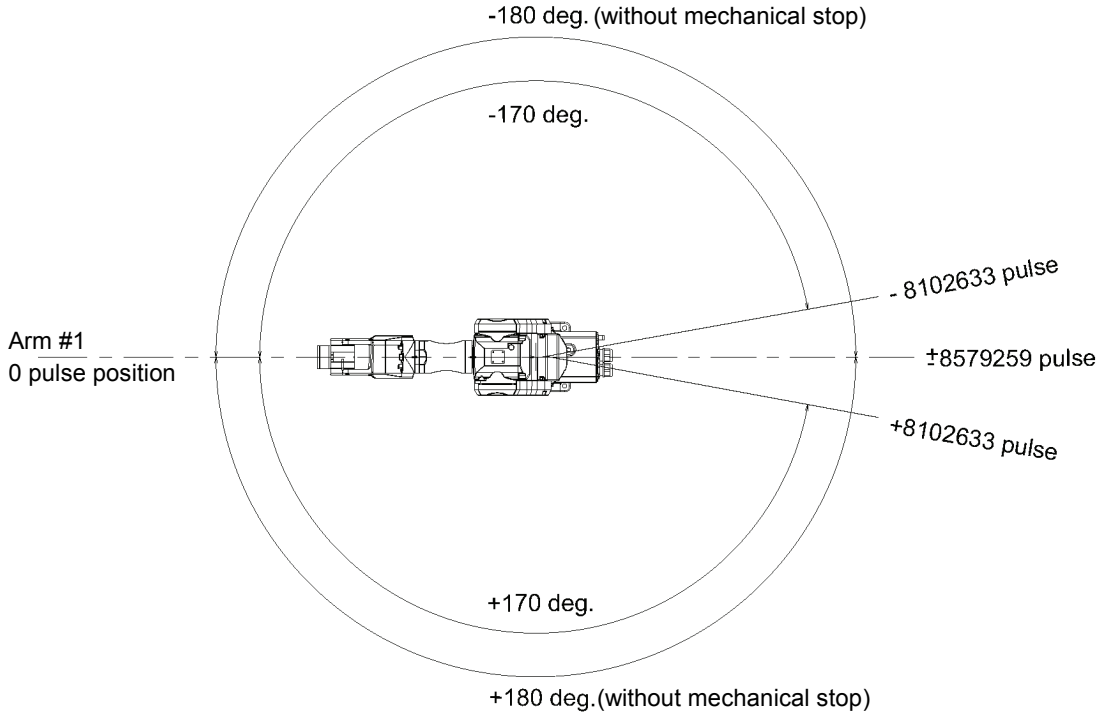
5.1.1 Max. Pulse Range of Arm #1

Pulse values in counterclockwise direction are positive (+) and values in clockwise direction are negative (−).

C4



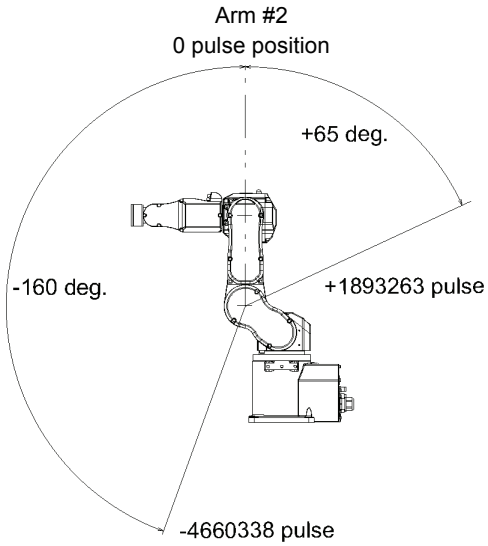
C4L



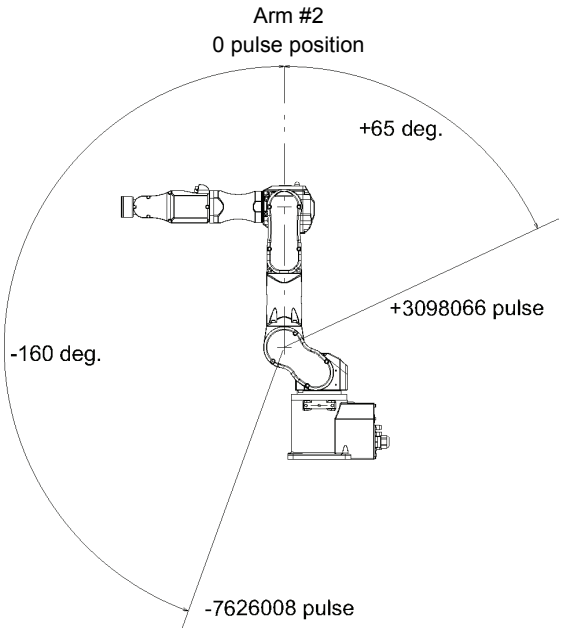
5.1.2 Max. Pulse Range of Arm #2

Pulse values in counterclockwise direction are positive (+) and values in clockwise direction are negative (−).

C4



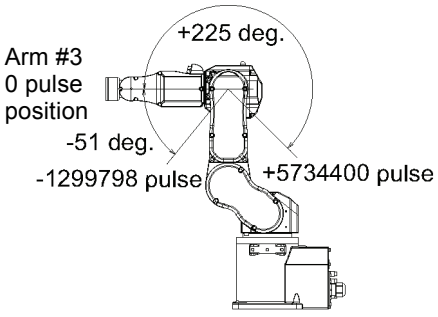
C4L



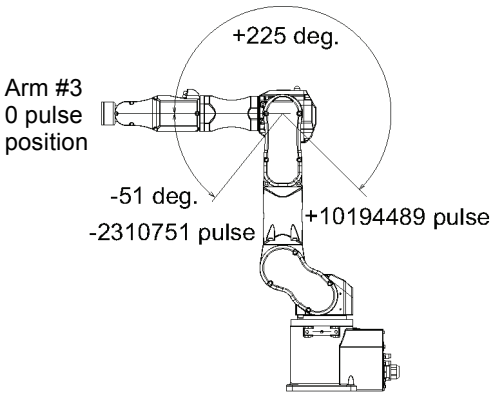
5.1.3 Max. Pulse Range of Arm #3

Pulse values in counterclockwise direction are positive (+) and values in clockwise direction are negative (−).

C4



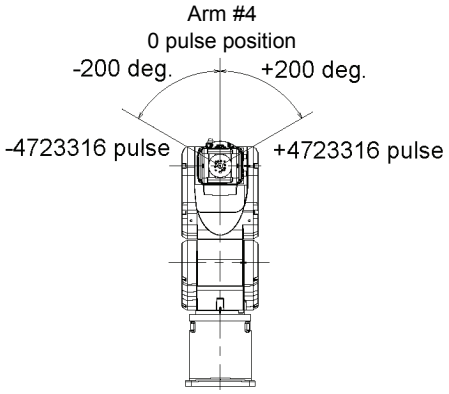
C4L



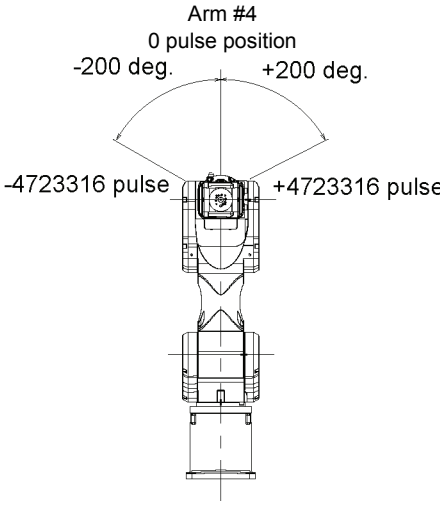
5.1.4 Max. Pulse Range of Arm #4

From the angle of arm end, clockwise pulse values are positive (+) and counterclockwise pulse values are negative (−).

C4

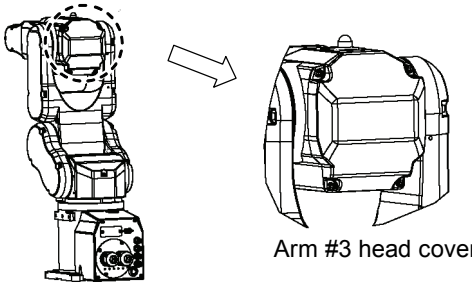


C4L



CAUTION	■ Do not set and/or use the Arm #4 with a pulse range exceeding the maximum value. The Arm #4 does not have a mechanical stop. Using the Arm #4 with a pulse range exceeding the maximum pulse range may cause the inner wiring damaged and/or malfunction to the Manipulator.

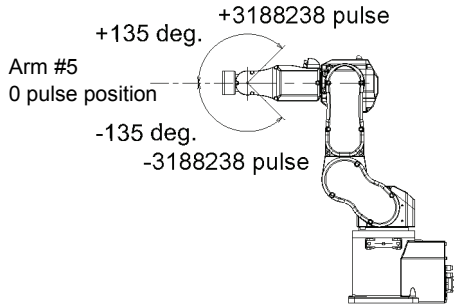
Torsion of the inner wiring can be checked by removing the Arm #3 head cover.



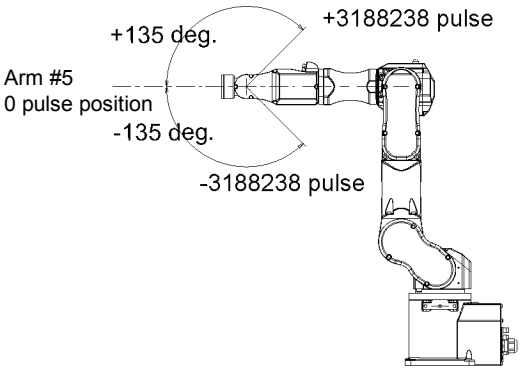
5.1.5 Max. Pulse Range of Arm #5

Pulse values in counterclockwise direction are positive (+) and values in clockwise direction are negative (−).

C4



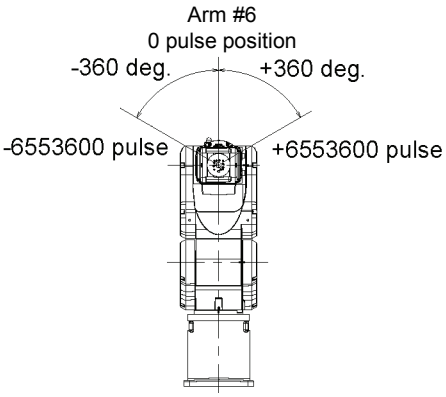
C4L



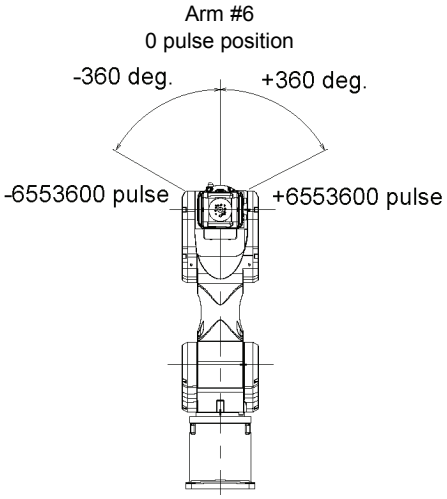
5.1.6 Max. Pulse Range of Arm #6

From the angle of arm end, clockwise pulse values are positive (+) and counterclockwise pulse values are negative (−).

C4



C4L



5.2 Motion Range Setting by Mechanical Stops

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

Be sure to turn OFF the Controller in advance.

Bolts are not provided, arrange for them by yourself.

Use bolts conforming to the strength specified by ISO-898-1, property class: 12.9.

Specify the pulse range again after changing the position of the mechanical stop.

For details on the pulse range setting, refer to the *Setup & Operation 5.1 Motion Range Setting by Pulse Range (for All Arms)*.

Be sure to set the pulse range not to exceed the setting angles of the mechanical stop.

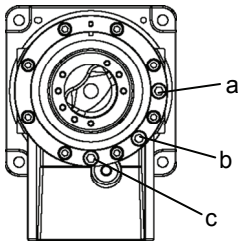
5.2.1 Motion Range Setting of Arm #1

Install the bolt to the threaded hole corresponding to the angle you want to set.

Normally a mechanical stop is equipped at [b].

[a] and [c] limit the one side of motion range.

Remove the bolts when the motion range of the Arm #1 is set to ±180 deg.



M8×15 hexagon socket head cap bolt

Tightening torque 3720 N·cm (380 kgf·cm)

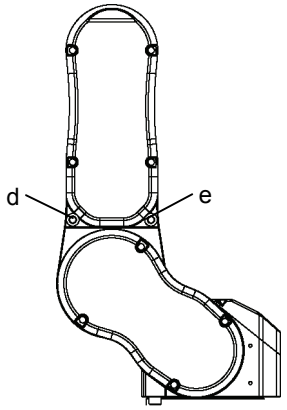
	a	b		c
Angle (deg.)	−125	±170	±180	+125
Pulse (pulse)	−3640889	±4951609	±5242880	−3640889
Bolt	Applied	Applied (Normal)	Not applied	Applied

5.2.2 Motion Range Setting of Arm #2

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

Normally there is no mechanical stop equipped.
(–160 deg. - +65 deg.)

[d] and [e] limit the one side of motion range.



C4

M10×15 hexagon socket head cap bolt

Tightening torque 7350 N·cm (750 kgf·cm)

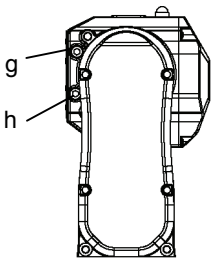
	d	e	-	-
Angle (deg.)	–143	+48	–160	+65
Pulse (pulse)	–4165177	+1398102	–4660338	+1893263
Bolt	Applied	Applied	Not applied (Normal)	Not applied (Normal)

Contact us about C4L.

5.2.3 Motion Range Setting of Arm #3

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

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



C4, C4L

M8×12 hexagon socket head cap bolt

Tightening torque 3720 N·cm (380 kgf·cm)

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

V/P model:

g, h : M6×15 hexagon head bolt

f, i : M8×12 hexagon head bolt

Tightening torque 3720 N·cm (380 kgf·cm)

	f	i	g	h
Angle (deg.)	+205	–48	+210	–50
Pulse (pulse)	+5971058	–1398102	+5352107	–1274312
Bolt	Applied	Applied	Applied (Normal)	Applied (Normal)

5.3 Restriction of Manipulator Operation by Joint Angle Combination

To prevent the arms of the Manipulator from interfering each other, the Manipulator operation is restricted in the specified motion range according to the joint angle combination of the Arm #1, #2, and #3.
The Manipulator operation is restricted and the Manipulator stops when the joint angles of the Arm are within the gray areas in the following figure.

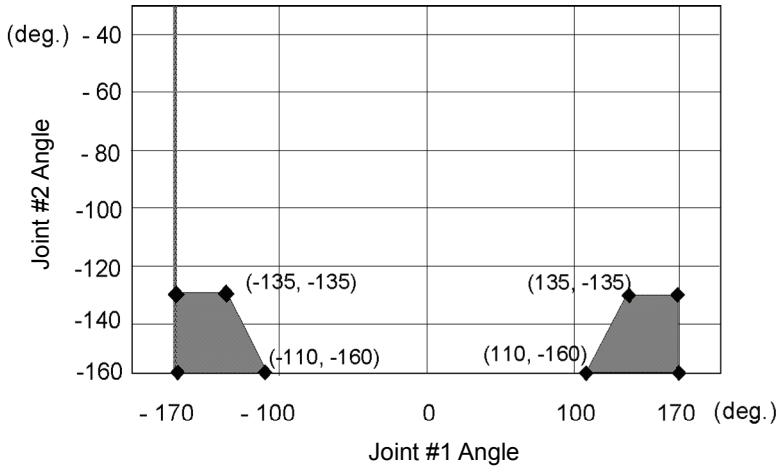
The restriction to Manipulator operation is enabled:

- During CP motion command execution
- When you attempt to execute the motion command for moving the Manipulator to a target point (or pose) in the specified motion range.

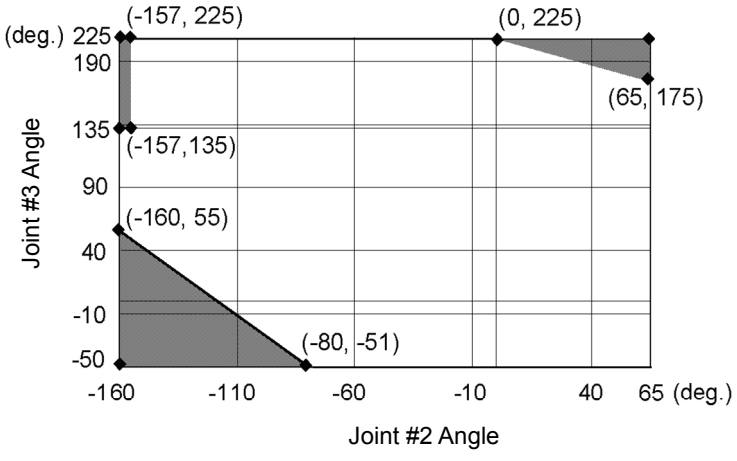
The restriction to the Manipulator operation is disabled:

- The Arms of the Manipulator momentarily go through the specified motion range during the PTP motion command execution even though the joint angles of the Arms are in the gray areas of the figures above.

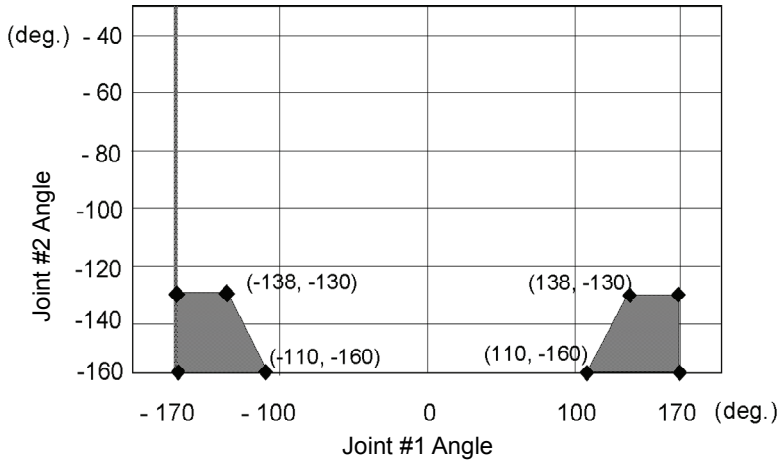
Combination of Joint #1 and #2 (C4)



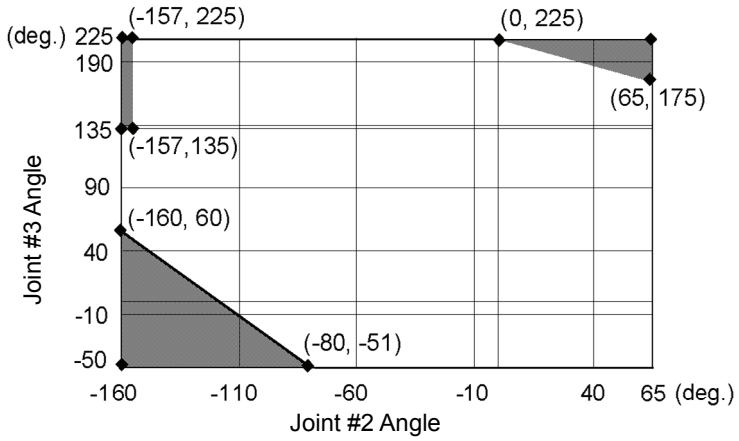
Combination of Joint #2 and #3 (C4)



Combination of Joint #1 and #2 (C4L)

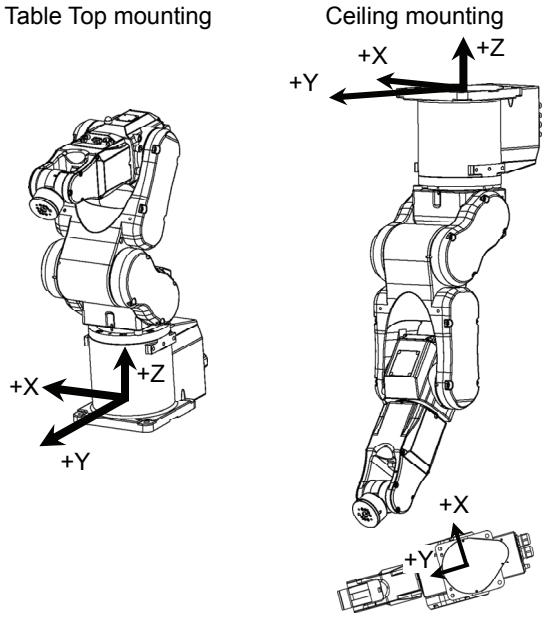


Combination of Joint #2 and #3 (C4L)



5.4 Coordinate System

The origin point is where the Manipulator base intersects with the rotation axis of Joint #1.
For details on the coordinate system, refer to the *EPSON RC+ Users Guide manual*.



5.5 Changing the Robot

This section describes how to change the manipulator model on EPSON RC+.

(Default setting is “table top mounting”.)

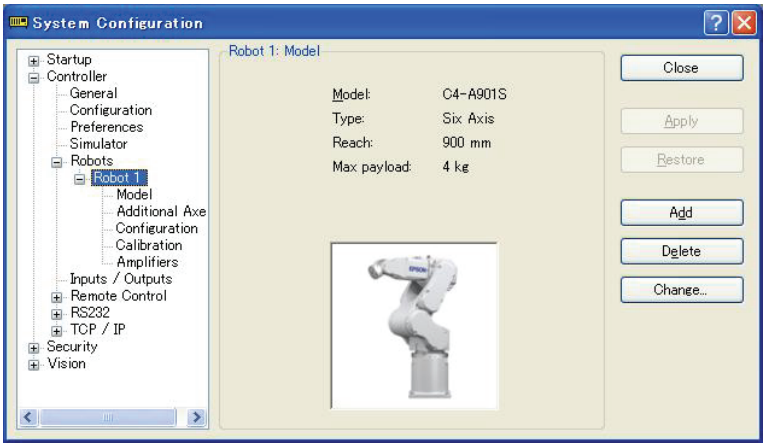
CAUTION

■ Changing the manipulator should be done with great caution. It initializes the robot calibration parameters (Hofs, CalPls), additional axis information, and PG parameter data.
Before changing the robot, make sure to save the calibration data by following the procedure below.

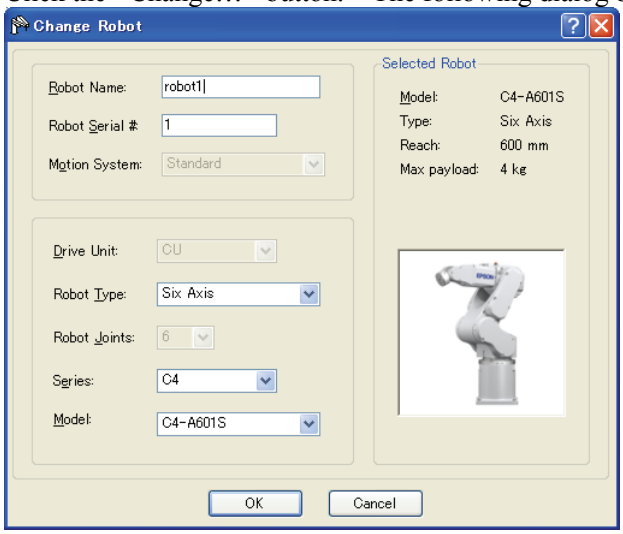
1. Select the EPSON RC+ 7.0 menu-[Setup]-[System Configuration].
2. Select [Robot]-[Robot**]-[Calibration] from the tree list. Then, click <Save>.

(1) Select the EPSON RC+ 7.0 menu-[Setup]-[System Configuration].

(2) Select [Robot]-[Robot**] from the tree list.



(3) Click the <Change…> button. The following dialog box will be displayed.



(4) Input the robot name and serial number printed on the name plate of the manipulator. Any serial number can be entered. However, enter the number printed on the manipulator.

(5) Select the robot type in the [Robot type] box.

(6) Select the series name of the manipulator in the [Series] box.

(7) Select the robot model in the [Model] box. Available robots will be displaed according to the format of the currently installed motor driver. When [Dry run] is used, all the manipulators of the series selected in Step 6 will be displayed.
For the ceiling mount type, select the model which ends with “R” (e.g. C4-A601SR).

(8) Click the <OK> button. The controller will be restarted.

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

The Cartesian (rectangular) range in the XY coordinate system of the Manipulator is specified by the limited Manipulator operation area and the XYLIM setting.
The limited Manipulator operation area is defined so that the end effector does not interfere with the rear side of the Manipulator. The XYLIM setting that you can determines the upper and lower limits of the X and Y coordinates.

The limited Manipulator operation area and the XYLIM setting apply only to the software. Therefore, these settings do not change the physical range. The maximum physical range is based on the position of the mechanical stops.

These settings are disabled during a joint jogging operation. Therefore, be careful not to allow the end effector to collide with the Manipulator or peripheral equipment.

The method for changing the XYLIM setting varies with the software used.

EPSON RC+

Set the XYLIM setting in [Tools]-[Robot manager]-[XYZ Limits] panel.
You may also execute the XYLim command from the [Command Window].

6. Options

C4 series manipulator has the following options.

6.1 Brake Release Unit
6.2 Camera Mounting Plate
6.3 PS Compatible Plate (Tool Adapter)
6.4 Base Side Angled Fittings
6.5 Base Side Fittings
6.6 PS Compatible Plate (Base Adapter)
6.7 Adjustable Mechanical Stop (Joint #2: Only C4L)

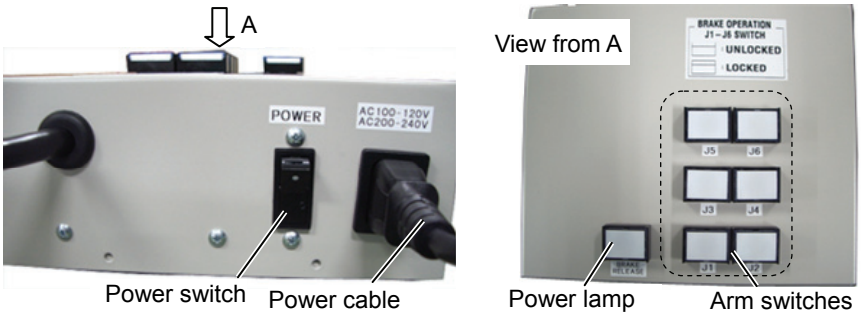
6.1 Brake Release Unit

With the electromagnetic brake is ON (such as in Emergency Stop status), all arms don't move.
You can move the Arms by hand using the brake release unit while the controller power is OFF or right after unpacking.

WARNING	■ Before connecting/disconnecting the connector of the Brake release unit, be sure to turn OFF the powers of the controller and break release unit. Otherwise, it leads to the electrical shock or breakdown.

CAUTION	■ Normally, release the brake of joints one by one. Take extra care if you need to release the brakes of two or more joints simultaneously. Releasing the brakes of two or more joints simultaneously may cause hands and fingers to be caught and/or equipment damage to or malfunction of the Manipulator as the arms of the Manipulator may move in unexpected directions. ■ Be careful of the arm falling when releasing the brake. While the brake is being released, the Manipulator's arm falls by its own weight. The arm falling may cause hands and fingers to be caught and/or may cause equipment damage to or malfunction of the Manipulator.

Width	180 mm
Depth	150 mm
Height	87 mm
Weight (Cables are not included.)	1.7 kg
Cable to the Manipulator	2 m
Power cable length	2 m
Power cable (US)	100 V specification
Power cable (EU)	200 V specification



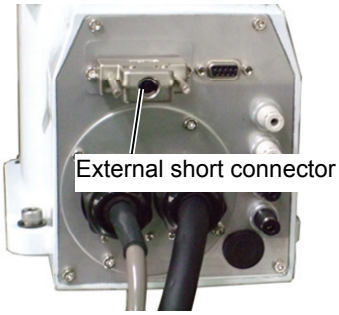
Precautions for use

CAUTION	■ After the brake release unit is disconnected, be sure to connect the external short connector. Otherwise, you cannot release the brakes. ■ Keep the external short connector. Otherwise you cannot release the brakes. ■ If you turn ON the brake release unit while the brake release switch is being pressed, an unintended arm may move downward. Before turning ON the brake release unit, make sure that the brake release switch is not pressed. ■ If you turn ON the brake release unit without the connector, it may lead to the short for the male pin used in the connector. Before turning ON the brake release unit, make sure that the connector is connected.

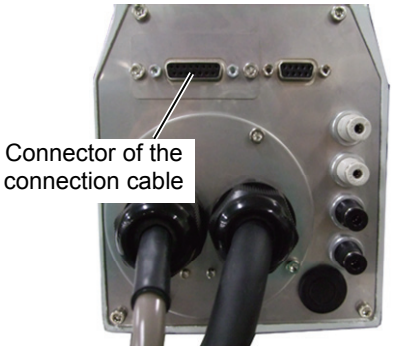
Mount the brake release unit

(1) Turn OFF the controller.

(2) Remove the external short connector.



(3) Connect the brake release unit to the connector of the connection cable.



Remove the brake release unit

(1) Turn OFF the brake release unit.

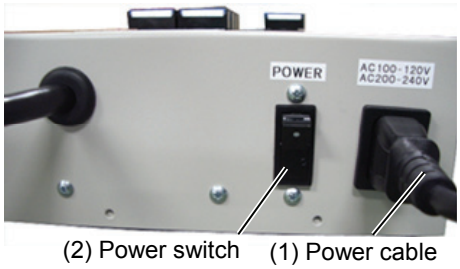
(2) Remove the power cable of the brake release unit.

(3) Disconnect the brake release unit from the connector of the connection cable.

(4) Connect the external short connector to the connector of the connection cable.

How to use the brake release unit

CAUTION	■ Be careful of the arm falling when releasing the brake. While the brake is being released, the Manipulator's arm falls by its own weight. The arm falling may cause hands and fingers to be caught and/or may cause equipment damage to or malfunction of the Manipulator. ■ If the arm you released its brake moves awkwardly or faster than usual, stop the operation promptly and contact us. The brake release unit may be broken. If you keep operating the manipulator, it may lead to the breakdown of the manipulator or you may get your hand or fingers caught.



(2) Power switch (1) Power cable

(2) Power lamp (3) Arm switches connector lock

(1) Disconnect the external short connector.

(2) Plug the power cable into the brake release unit.

(3) Plug the power cable into the power supply plug.

(4) Turn ON the brake release unit.
When the brake release unit is enabled, the power lamp lights up.

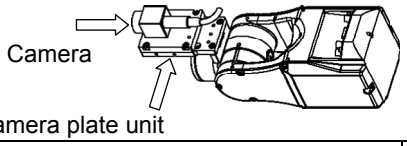
(5) Press the switch of the arm (J1 to J6) you want to move and then move the arm.
Press the switch again. The brake will be released.
The brake will be enabled by pressing the switch once again.

NOTE
Move the arm the brake is released by two persons or more (one presses the switch and one moves the arm). The arm can be very heavy and needs the significant force to move.

6.2 Camera Plate Unit

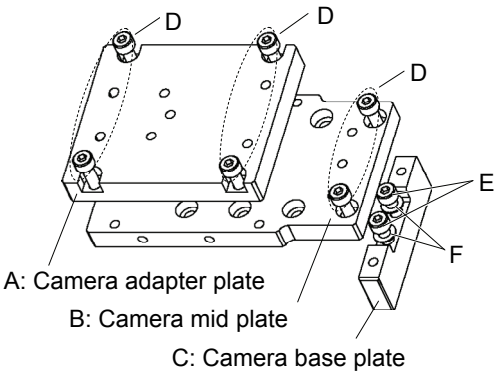
To mount a camera to the C4 series manipulator, you need to mount the camera plate unit first. (Only for S/C model)

Appearance of arm end with camera



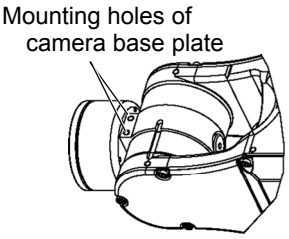
Camera plate unit

Parts included		unit
A	Camera adapter plate	1
B	Camera mid plate	1
C	Camera base plate	1
D	Hexagon socket head screws M4×12	6
E	hexagon socket head screws M4×20	2
F	Plain washer for M4 (small washer)	2



To mount the camera plate unit

(1) Mount the camera base plate to the manipulator.
2-M4 × 20 + Plain washer for M4 (small washer)



(2) Mount the camera mid plate to the base plate.

2-M4 × 12

NOTE ☞ The motion range and dimension of the manipulator with the camera installed may vary depending on the mounting hole of camera mid plate. The details are described in the table below.

(3) Mount the camera to the camera adapter plate.

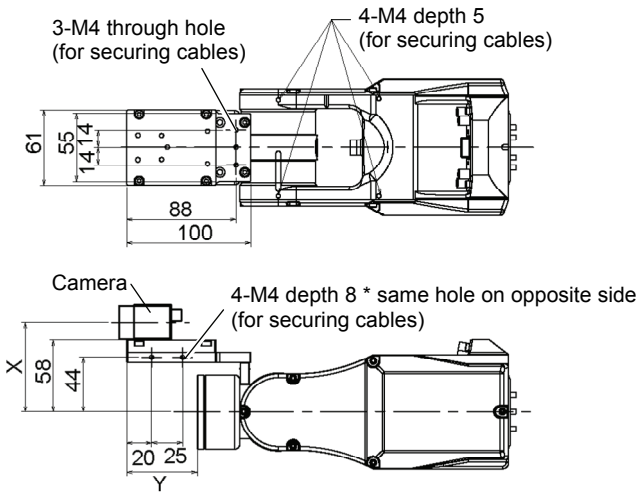
NOTE ☞ According to the camera, the available mounting hole of adapter plate will be different. The details are described below.

(4) Mount the camera adapter plate and camera to the camera mid plate.
4-M4 × 12

(5) Secure the cables at the position where they do not interfere with the manipulator motion.

NOTE ☞ When securing the cables, check if the cables bend radius is big enough and the cables are not rubbing against each other while the manipulator moves. Otherwise, the cables will be disconnected.

Dimension of the camera plate unit

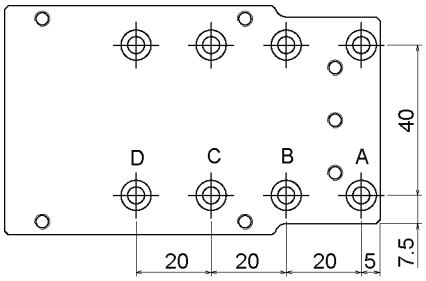


Dimensions X and Y will change depending on the position of camera mid plate and camera size. Refer to the table below for the values.

Camera mid plate

The camera mid plate uses the mounting holes A to D.

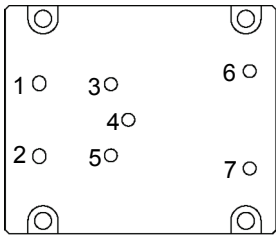
By using the different mounting holes, it can be mounted to the camera base plate in the different four positions.



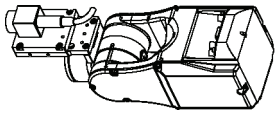
Camera adapter plate

Each camera uses the different mounting holes.

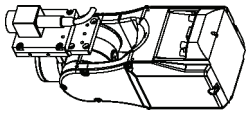
Sony XC-ES30, HR50, HR70	: 1, 2, 4
Matrox Iris	: 1, 2, 3, 5
JAI (Pulnix) CV-A1	: 6, 7



Mounting example



Using the mounting hole A



Using the mounting hole C

E.g.) Camera: XC-ES30

Camera and Joint #5 motion range (reference values)

The Joint #5 motion range varies depending on the mounting position of camera mid plate and the camera you are using.

The table below shows the motion range (reference values) based on the available cameras for this option and the mounting positions of the camera mid plate. The values in the table may vary depending on how to secure the cables.

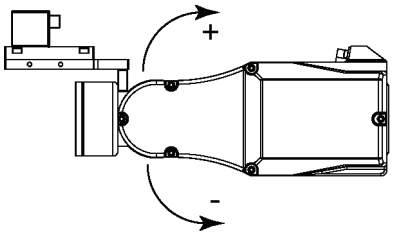
By changing the Y position, you can extend the distance from the end effector mounting surface to the camera. Also, you can attach the larger end effector. However, be careful about the Joint #5 motion range that will be limited in this case.

(° = degree)

	A	B	C	D	X
JAI (Pulnix) CV-A1 Sony XC-ES30, HR50, HR70	–135° to +60°	–135° to +50°	–135° to +35°	–135° to +25°	72.5 mm
Matrox Iris	–135° to +45°	–135° to +30°	–135° to +15°	–135° to +10°	83 mm

	A	B	C	D
Y	57 mm	37 mm	17 mm	7 mm

Direction of the Joint #5 motion

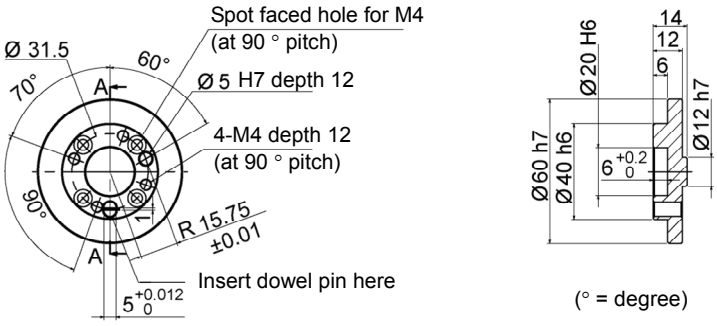


6.3 PS Compatible Plate (Tool Adapter)

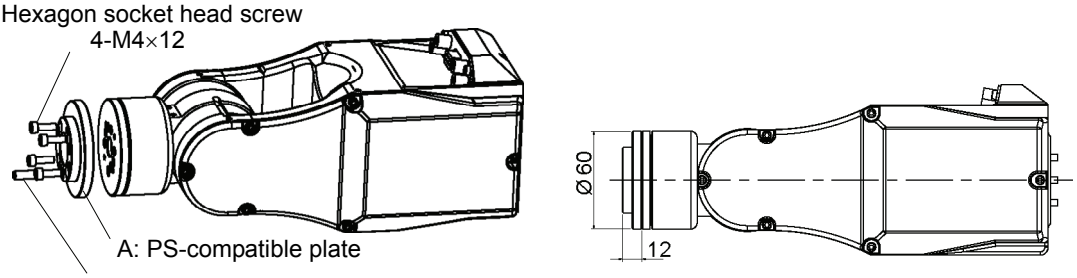
Using the PS compatible plate, you can mount the end effector used in the PS series to the C4 series.

Parts included	Unit
A PS compatible plate	1
B Dowel pin (M3 hole on one side)	1
C Hexagon socket head screw M4×12	4

Dimensions of PS-compatible plate



C: Hexagon socket head screw



To mount the PS compatible plate

(1) Align the hole on the arm end flange (ø12H7) to the projection on the PS compatible plate (ø12h7).

(2) Insert the dowel pin from the PS compatible plate side and position the arm and PS compatible plate. One side of the dowel pin has the M3 screw hole and you can adjust the depth using M3.

NOTE ☞ If you move the Manipulator with the dowel pin inserted, the dowel pin will fall out. To move the Manipulator with the dowel pin inserted, you need to secure the dowel pin with glue.

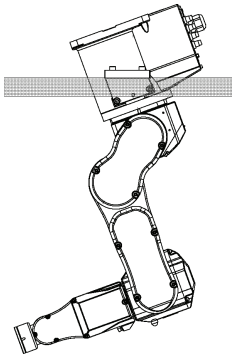
(3) Secure the PS compatible plate with 4 hexagon socket head screws.

4-M4 × 12

6.4 Base Side Angled Fittings

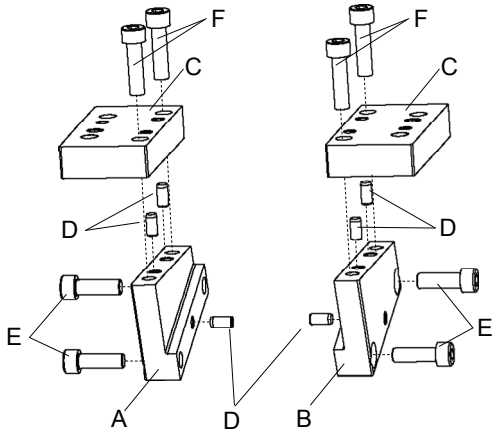
By using the base side angled fittings to the C4 series manipulator base, you can mount the manipulator in skewed position. The motion range expands with this mounting type compared to the normal ceiling mounting.

Mounting image using the base side angled fittings



For details of the mounting and precautions, refer to *Setup & Operation: 3. Environment and Installation*.

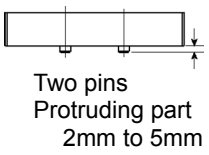
Parts included		Qty.
A	Base side angled plate (Left side)	1
B	Base side angled plate (Right side)	1
C	Base side plate (for Skewed mounting type)	2
D	Pin	6
E	Hexagon socket head screw M8 × 25	4
F	Hexagon socket head screw M8 × 30	4



To mount the base side angled fittings

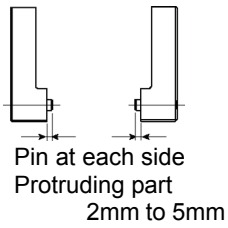
(1) Drive pins to the base side plate (for Skewed mounting type).

Protruding part of pins is approx. 2 to 5 mm.



(2) Drive pins to the base side angled plate (left & right sides).

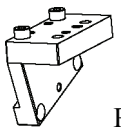
Protruding part of pins is approx. 2 to 5 mm.



(3) Create a base side angled fittings.

Fit the pins of the plate for Skewed mounting type in the step (1) with the holes on the plate in the step (2) and secure with the screws.

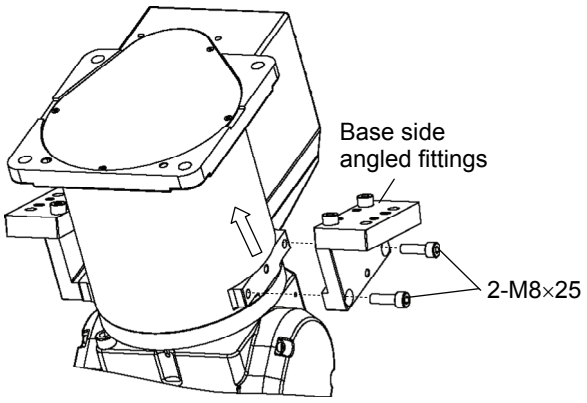
Hexagon socket head screw M8 × 30


Right side

(4) Mount the base side angled fittings to the both sides of manipulator base.

Fit the pins drove in the step (2) with the holes on the base. Secure the fittings by pressing it to the indicated direction in the figure below.

Left & Right side Hexagon socket heat screw 2- M8 × 25



NOTE The shape of the base side angled fittings is asymmetry. Be sure to mount the fittings in correct direction.
Otherwise, the motion range of Arm #2 is limited in the backside.

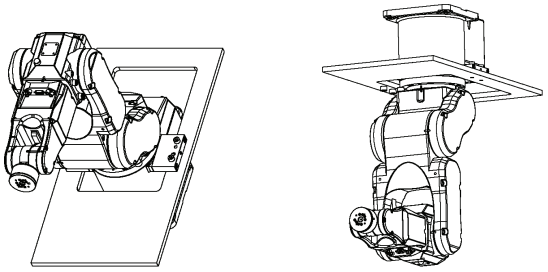
NOTE The recommended base plate thickness is between 30 mm and 40 mm. If the thickness is more than 40 mm, the manipulator may contact the base plate when the Arm #1 rotates depending on the center cut dimension in the base plate.

The base plate securing the manipulator should be prepared by users. The torque value and reaction force generated in the manipulator motions are described in *Setup & Operation: 3.4 Installation*.

6.5 Base Side Fittings

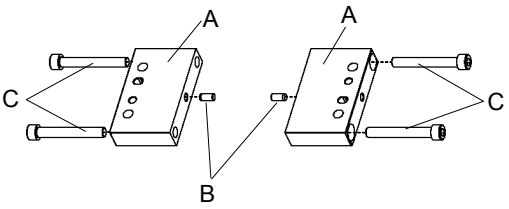
Using the base side fittings to the C4 manipulator base, you can mount the manipulator in the place where limits the mounting height or use the open room for the base.

Mounting image using the base side fittings



For the information on how to mount and precautions, refer to *Setup & Operation: 3. Environment and Installation*.

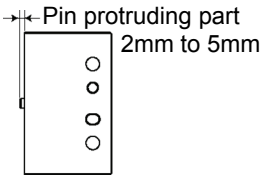
Parts included		Qty.
A	Base side plate	2
B	Pin	2
C	Hexagon socket head screw M8 × 60	4



To mount the base side plate

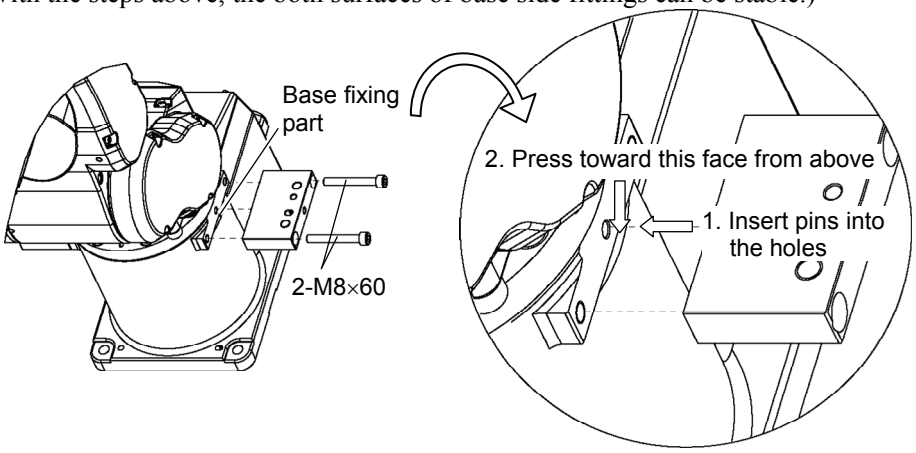
(1) Drive the pins to the base side plate.

Protruding part of pins is approx. 2 to 5 mm.

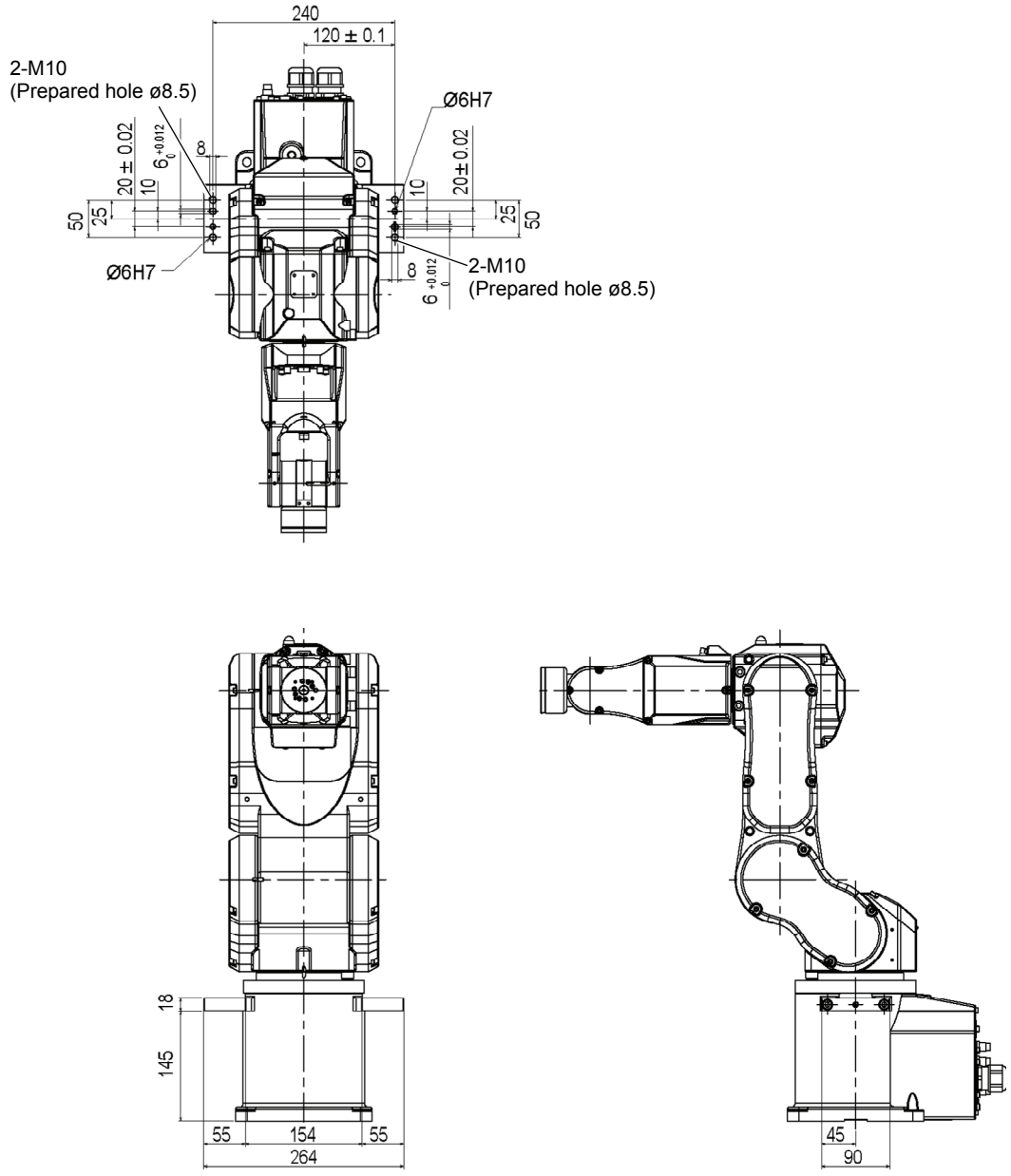


(2) Mount the base side plate with the pins driven to the both sides of the base.

Fit the pins with the holes and secure the base side plate by pressing it from above to the base fixing part.
(With the steps above, the both surfaces of base side fittings can be stable.)



Dimension of the manipulator with the base side fittings



Installation example

Screws

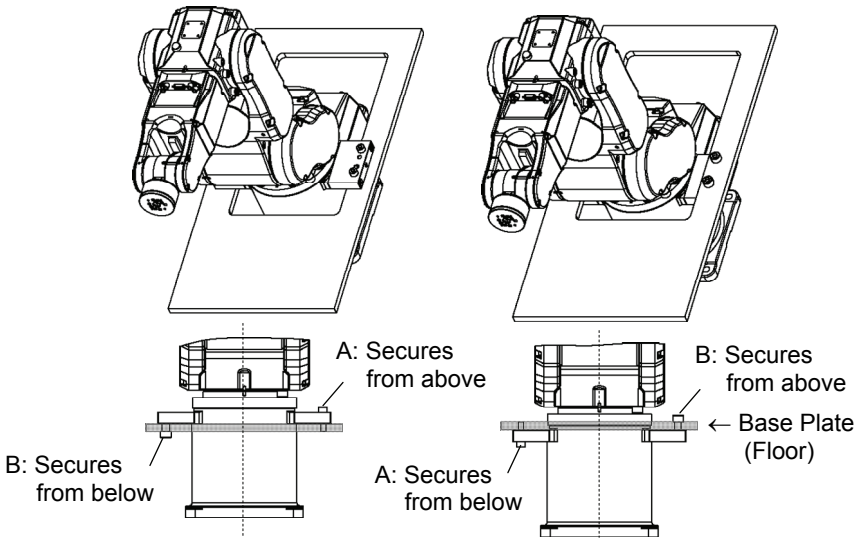
	Size	Recommended length
A	M8	30 mm or more
B	M10	15 mm + Base Plate or more

NOTE The base side plate has a M10 screw hole. You can secure the plate with a M10 screw or a M8 screw by using a prepared screw hole of ø8.5 to make a M8 screw hole on the mounting surface.

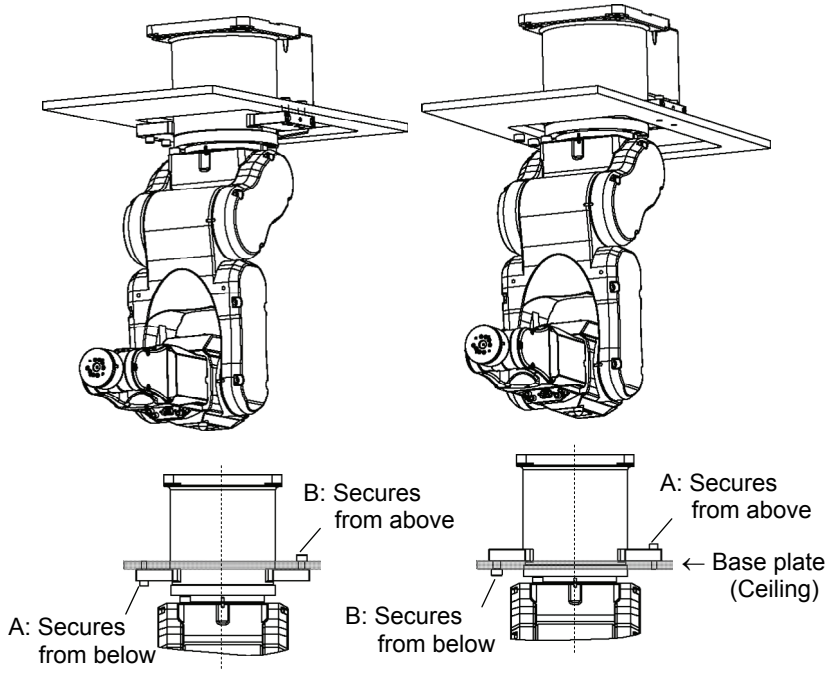
NOTE A: Securing from above
To secure from above, use the screw A in the table above.

When you install the manipulator for practical use, you need to insert the screws in the right/left side from the same direction (above or below).

Table Top mounting



Ceiling mounting



6.6 PS Compatible Plate (Base Adapter)

For details of options, please contact us.

6.7 Adjustable Mechanical Stop (Joint #2: only C4L)

For details of options, please contact us.

Maintenance

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

1. Safety Maintenance

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

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

 WARNING	■ Do not remove any parts that are not covered in this manual. Follow the maintenance procedure strictly as described in this manual. Improper removal of parts or improper maintenance may not only cause improper function of the robot system but also serious safety problems. ■ Keep away from the Manipulator while the power is ON if you have not taken the training courses. Do not enter the operating area while the power is ON. Entering the operating area with the power ON is extremely hazardous and may cause serious safety problems as the Manipulator may move even it seems to be stopped. ■ When you check the operation of the Manipulator after replacing parts, be sure to check it while you are outside of the safeguarded area. Checking the operation of the Manipulator while you are inside of the safeguarded area may cause serious safety problems as the Manipulator may move unexpectedly. ■ Before operating the robot system, make sure that both the Emergency Stop switches and safeguard switch function properly. Operating the robot system when the switches do not function properly is extremely hazardous and may result in serious bodily injury and/or serious damage to the robot system as the switches cannot fulfill their intended functions in an emergency.

 WARNING	■ To shut off power to the robot system, pull out the power plug from the power source. Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source. ■ Before performing any replacement procedure, turn OFF the Controller and related equipment, and then pull out the power plug from the power source. Performing any replacement procedure with the power ON is extremely hazardous and may result in electric shock and/or malfunction of the robot system.

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

2. General Maintenance

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

2.1 Schedule for Maintenance Inspection

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

	Inspection Point				
	Daily inspection	Monthly inspection	Quarterly inspection	Biannual inspection	Annual inspection
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)		√			
⋮	⋮	⋮	⋮	⋮	⋮

h = hour

2.2 Inspection Point

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

Inspection Point	Inspection Place	Daily	Monthly	Quarterly	Biannual	Annual
Check looseness or backlash of bolts/screws. Tighten them if necessary. (For the tightening torque, refer to *Maintenance: 2.4 Tightening Hexagon Socket Head Cap Bolts*.)	End effector mounting bolts	√	√	√	√	√
	Manipulator mounting bolts	√	√	√	√	√
	Each arm locking bolts	√	√	√	√	√
	Bolts/screws around shaft					√
	Bolts/screws securing motors, reduction gear units, etc.					√
Check looseness of connectors. If the connectors are loosen, push it securely or tighten.	External connectors on Manipulator (on the connector plates etc.)	√	√	√	√	√
	Manipulator cable unit		√	√	√	√
Visually check for external defects. Clean up if necessary.	External appearance of Manipulator	√	√	√	√	√
	External cables		√	√	√	√
Check for bends or improper location. Repair or place it properly if necessary.	Safeguard etc.	√	√	√	√	√
Check tension of timing belts. Tighten it if necessary.	Base Inside of Arms #1, 2, 3, 4				√	√
Grease conditions	Refer to *Maintenance: 2.3 Greasing*.					
Battery	—	Replace every year				

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

Inspection Point	Inspection Place	Daily	Monthly	Quarterly	Biannual	Annual
Check motion range	Each joint					√
Move the cables back and forth lightly to check whether the cables are disconnected.	External cables (including cable unit of the Manipulator)				√	√
Push each arm in MOTOR ON status to check whether backlash exists.	Each arm					√
Check whether unusual sound or vibration occurs.	Whole	√	√	√	√	√
Measure the accuracy repeatedly by a dial gauge.	Whole					√
When brake release unit is installed: Connect the brake release unit and check the sound of the electromagnetic brake with the brake released. If there is no sound, replace the brake. When brake release unit is not installed: Execute Brake off command (brake off, joint #) from the command window of the EPSON RC+ while the motors are OFF, and then check the sound of the electromagnetic brake. If there is no sound, replace the brake.	Brake	√	√	√	√	√

2.3 Greasing

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

CAUTION

- Keep enough grease in the Manipulator. Operating the Manipulator with insufficient grease will cause the noise or damage sliding parts and/or result in insufficient function of the Manipulator. Once the parts are damaged, a lot of time and money will be required for the repairs.
- If grease gets into your eyes, mouth, or on your skin, follow the instructions below.

  If grease gets into your eyes
  : Flush them thoroughly with clean water, and then see a doctor immediately.

  If grease gets into your mouth
  : If swallowed, do not induce vomiting. See a doctor immediately.
  : If grease just gets into your mouth, wash out your mouth with water thoroughly.

  If grease gets on your skin
  : Wash the area thoroughly with soap and water.

	Greasing part	Greasing Interval	Grease
Joint #1, 2, 3, 4	Reduction gear units	In the replacement of motor*	SK-1A
Joint # 5, 6	Reduction gear units	In the replacement of motor*	SK-2
Joint #6	Bevel gear	Once a year (every 8000 hours)	SK-2

* Under normal conditions, the reduction gear units need to be greased only when the motor is replaced. However, in case of severe working conditions (such as high duty, high speeds, large payloads, etc.), the reduction gear units must be greased every 10,000 hours.

2.4 Tightening Hexagon Socket Head Cap Bolts

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

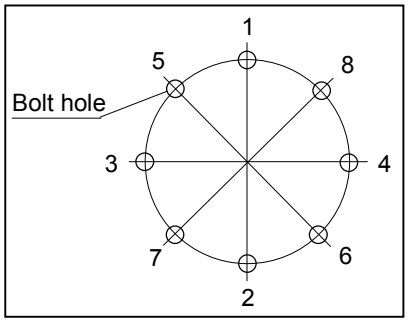
When it is required to refasten these bolts in some procedures in this manual (except special cases as noted), use a torque wrench so that the bolts are fastened with the appropriate tightening torques as shown below.

Bolt	Tightening Torque
M3	2.5 N·m (25 kgf·cm)
M4	4.9 N·m (50 kgf·cm)
M5	9.8 N·m (100 kgf·cm)
M6	17.6 N·m (180 kgf·cm)
M8	37.2 N·m (380 kgf·cm)
M10	73.5 N·m (750 kgf·cm)
M12	127.4 N·m (1,300 kgf·cm)

Refer below for the set screw.

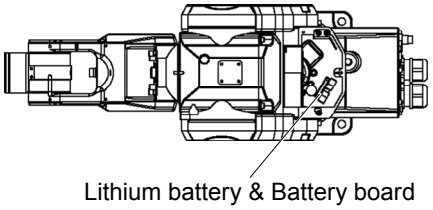
Set Screw	Tightening Torque
M4	2.5 N·m (25 kgf·cm)
M5	3.9 N·m (40 kgf·cm)

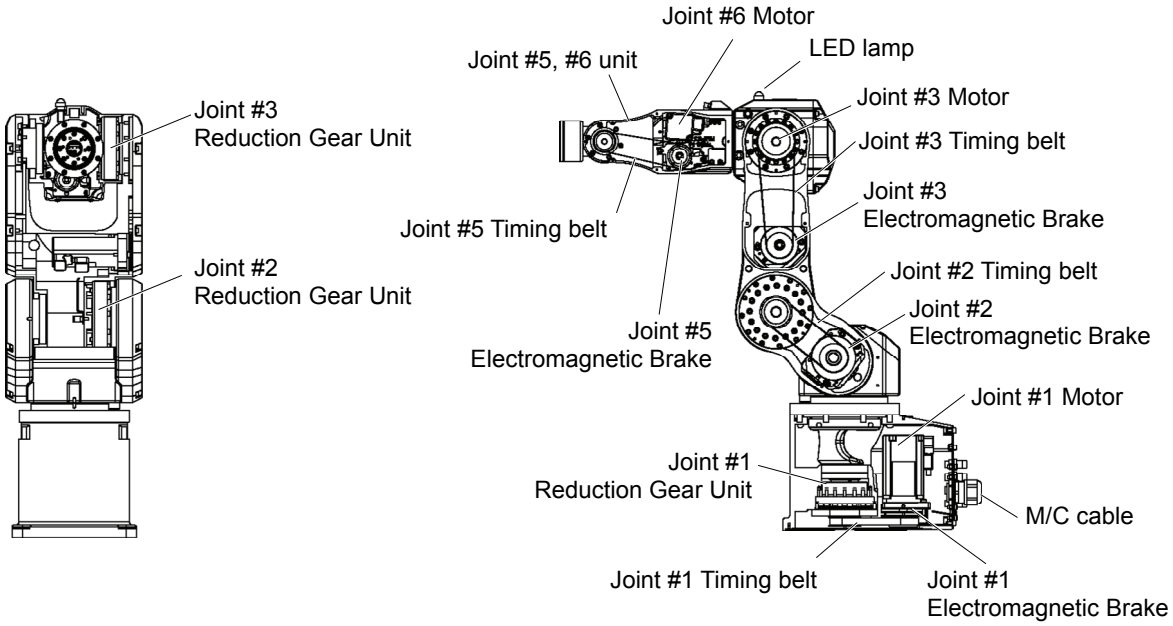
We recommend that the bolts aligned on a circumference should be fastened in a crisscross pattern as shown in the figure below.

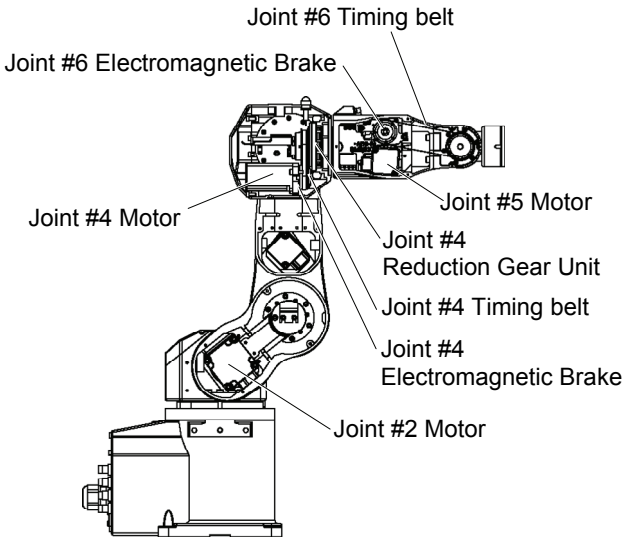


Do not fasten all bolts securely at one time. Divide the number of times to fasten the bolts into two or three and fasten the bolts securely with a hexagonal wrench. Then, use a torque wrench so that the bolts are fastened with tightening torques shown in the table above.

2.5 Layout of Maintenance Parts







3. Maintenance Parts List

Part Name			Code	Note
Motor	Joint #1, #2		R13N807011	400 W
	Joint #3		R13N807021	150 W + Brake
	Joint #4, #5, #6		R13N807031	50 W
Reduction Gear Unit *	Joint #1		R13N810041	
	Joint #2		R13N810051	
	Joint #3		R13N810061	
	Joint #4		R13B010023	
	Joint #5		R13B010024	
	Joint #6		R13B010025	
Pinion Gear			R13B031603	
Electromagnetic Brake	Joint #1, #2		R13N835021	
	Joint #4, #5, #6		R13N835011	
Timing Belt	Joint #1	C4	R13B030220	Width 10 mm
		C4L	R13N832031	
	Joint #2	C4	R13B030221	
		C4L	R13N832041	
	Joint #3	C4	R13N832081	Width 7 mm
		C4L	R13N832091	
	Joint #4		R13N832051	Width 6 mm
	Joint #5		R13N832071	
	Joint #6		R13N832061	

* Reduction Gear Unit: A reduction gear unit consists of the following three parts.
When replacing the reduction gear unit, replace the following parts all together as a set.

Waveform generator

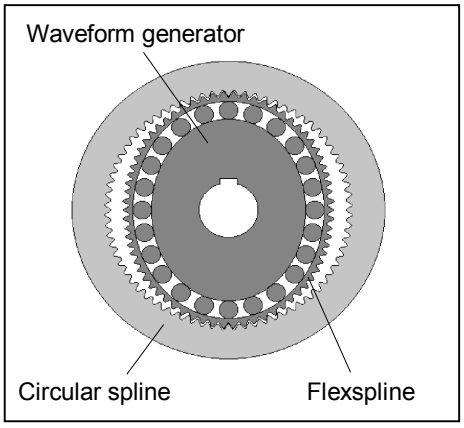
The waveform generator consists of an ellipsoidal cam and ball bearings on outer circumference.
The inner ring of the bearings is secured to the cam, while the outer ring is capable of flexible deformation through the ball bearings.

Flexspline

A thin, elastic, cup-shaped metal body with gear teeth around the outer circumference of the opening.

Circular spline

A rigid, ring-shaped body with gear teeth on the inner circumference.
The circular spline has two more teeth than the flexspline does.



The splines are greased. Be sure to keep the grease from being attaching to the clothes.

Part Name		Code	Note
Battery board		R13N84C011	
Battery		R13N860011	
Seal	Joint #4	R13A031200100	
Grease	Joints #1 to #4	R13ZA00330100	SK-1A (500 g)
	Pinion Gear	R13ZA00330400	SK-2 (500 g)
	Cable	R13B030304	Tube of GPL-224 (227 g)
Oil seal	Joint #1	R13B031224	
	Joint #6	R13B031248	
Grease seal	Joint #1, #2	R13B031249	
	Joint #3	R13B031250	
Gyro board	Arm #1,#3	R13B040502	
Noise Reduction Diode	Joint #1 to #3	R13N823011	
O ring	Joint #1	R13B031223	
	Joint #2	R13B031242	
	Joint #3	R13B031243	
	Joint #4	R13B031244	
	Arm #3, #4	R13B031245	
	Arm #5	R13B031247	For Plug
		R13N83C121	
Joint #5, #6 Unit		R13N882011	
LED Lamp		R13N830011	
M/C Cable		R13N824011	3 m
		R13N824021	5 m
		R13N824031	10 m
M/C Power Cable		R13N824041	3 m
		R13N824051	5 m
		R13N824061	10 m
M/C Signal Cable		R13N827011	3 m
		R13N827021	5 m
		R13N827031	10 m
Cable Unit	C4	R13N820011	
	C4L	R13N820021	

Part Name			Code	Note
Cover	Arm #1	Center cover	R13N834011	
		Side cover	R13N834021	
	Arm #2	Side cover	R13N834031	
	Arm #3	Head cover	R13N834041	
	Arm #4	Side cover (Right)	R13N834051	
		Side cover (Left)	R13N834061	
	Arm #1	Center cover	R13N834131	Stainless C
		Side cover	R13N834141	
	Arm #2	Side cover	R13N834151	
	Arm #3	Head cover	R13N834161	
	Arm #4	Side cover (Right)	R13N834171	
		Side cover (Left)	R13N834181	

Option

Part Name	Code	Note	Reference in Setup & Operation
Brake Release Unit (with cable and short connector)	R12B120805	For Europe	6.1
	R12B120806	For U.S. & Japan	
Brake Release Unit (Main unit only)	R12B120803	For Europe	
	R12B120804	For U.S. & Japan	
Camera Plate Unit	R12B031922		6.2
PS Compatible Plate	R12B031923		6.3
Base Side Angled Fitting	R12B031924		6.4
Base Side Fitting	R12B031925		6.5