EPSON

Robot System
Safety and Installation

Read this manual first

Rev.4 EM145B2737F

Robot Controller RC90
Programming Software EPSON RC+ 7.0

Manipulator LS series
(LS3 / LS6)

Robot System Safety and Installation (RC90 / EPSON RC+ 7.0) Rev.4

Robot System　Safety and Installation

(RC90 / EPSON RC+ 7.0)

Rev.4

FOREWORD

Thank you for purchasing our robot products.

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

Please carefully read this manual and other related manuals before installing the robot system.

Keep this manual handy for easy access at all times.

WARRANTY

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

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

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

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

Warnings, Cautions, Usage:

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

TRADEMARKS

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TRADEMARK NOTATION IN THIS MANUAL

Microsoft® Windows® XP Operating system

Microsoft® Windows® Vista Operating system

Microsoft® Windows® 7 Operating system

Microsoft® Windows® 8 Operating system

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

NOTICE

No part of this manual may be copied or reproduced without authorization.

The contents of this manual are subject to change without notice.

Please notify us if you should find any errors in this manual or if you have any comments regarding its contents.

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

Industrial Solutions Division

6925 Toyoshina Tazawa,

Azumino-shi, Nagano, 399-8285

JAPAN

TEL : +81-(0)263-72-1530

FAX : +81-(0)263-72-1495

SUPPLIERS

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

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
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) 27F DaeSung D-Polis A, 606, Seobusaet-gil, Geumcheon-gu, Seoul, 153-803 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)

NOTE

TP port of RC90 is for the Teach Pendant TP1 and TP2. Do not connect the followings to TP port of RC90. Connecting to the followings may result in malfunction of the device since the pin assignments are different.

OPTIONAL DEVICE dummy plug
Operation Pendant OP500
Operator Pendant OP500RC
Jog Pad JP500
Teaching Pendant TP-3** series
Operator Panel OP1

NOTE

For RC90, be sure to install the EPSON RC+7.0 to the development PC first, then connect the development PC and RC90 with the USB cable.
If RC90 and the development PC are connected without installing the EPSON RC+7.0 to the development PC, [Add New Hardware Wizard] appears. If this wizard appears, click the <Cancel> button.

NOTE

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

NOTE

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

Control System Configuration

This manual explains with the following combinations of Controllers and software.

Robot Controller RC90 with the following label attached.

Label	Controller	Software
	RC90	EPSON RC+ 7.0

		RC90 controller firmware
		Ver.7.0.2.0
EPSON RC+ 7.0	Before Ver.7.0.1	!!!
	Ver.7.0.2 or later	OK

OK: Compatible All functions of the EPSON RC+ 7.0 and the Controller are available.

!!!: Compatible Connection is OK. We recommend using EPSON RC+7.0 Ver. 7.0.2 or later.

NOTE

Manual PDF for this robot system is available from EPSON RC+ 7.0 Ver. 7.0.2

NOTE

This option is not available for Robot Controller RC90 (EPSON RC+ 5.0) without the label.

TABLE OF CONTENTS

1. Safety

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

Please read this manual and other related manuals before installing the robot system or before connecting cables.
Keep this manual handy for easy access at all times.

1.1 Conventions

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

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

1.2 Design and Installation Safety

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

To ensure safety, a safeguard must be installed for the robot system. For details on the safeguard, refer to the Installation and Design Precautions in the Safety chapter of the EPSON RC+ User's Guide.

The following items are safety precautions for design personnel:

WARNING

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

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

1.2.1 Relevant Manuals

Refer

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

1.2.2 Designing a Safe Robot System

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

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

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

Environmental Conditions

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

System Layout

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

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

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

Disabling Power to the System using lock out / tag out

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

1.8 Lockout/Tagout

End Effector Design

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

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

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

Peripheral Equipment Design

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

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

Remote Control

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

Emergency Stop

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

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

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

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

Safeguard System

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

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

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

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

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

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

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

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

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

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

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

Presence Sensing Device

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

Here are precautions that should be noted:

Design the system so that when the presence sensing device is not activated or a dangerous situation still exists that no personnel can go inside the safeguard area or place their hands inside it.

Design the presence sensing device so that regardless of the situation the system operates safely.

If the robot stops operating when the presence sensing device is activated, it is necessary to ensure that it does not start again until the detected object has been removed. Make sure that the robot cannot automatically restart.

Resetting the Safeguard

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

Robot Operation Panel

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

1.3 Operation Safety

The following items are safety precautions for qualified Operator personnel:

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

 WARNING	■ 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.

1.3.1 Safety-related Requirements

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

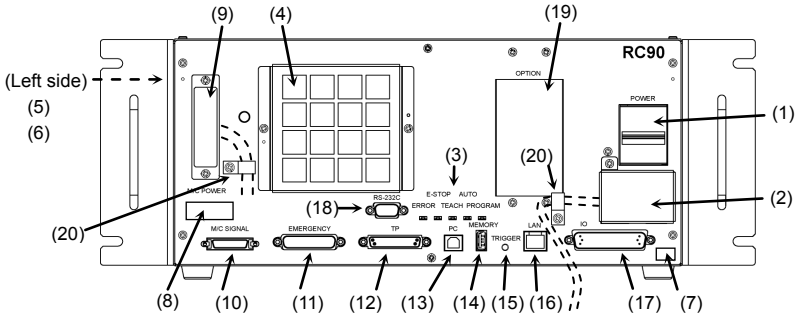
For the installation and operation of the robot system, be sure to comply with the applicable local and national regulations.

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

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

EN ISO 10218-1	Robots and robotic devices -- Safety requirements for industrial robots -- Part 1: Robots
EN ISO 10218-2	Robots and robotic devices -- Safety requirements for industrial robots -- Part 2: Robot systems and integration
ANSI/RIA R15.06	American National Standard for Industrial Robots and Robot Systems -- Safety Requirements
EN ISO 12100	Safety of machinery -- General principles for design -- Risk assessment and risk reduction
EN ISO 13849-1	Safety of machinery -- Safety-related parts of control systems -- Part 1: General principles for design
EN ISO 13850	Safety of machinery -- Emergency stop -- Principles for design
EN ISO 13855	Safety of machinery -- Positioning of safeguards with respect to the approach speeds of parts of the human body.
EN ISO 13857	Safety of machinery -- Safety distances to prevent hazard zones being reached by upper and lower limbs.
ISO14120 EN953	Safety of machinery -- Guards -- General requirements for the design and construction of fixed and movable guards
IEC 60204-1 EN 60204-1	Safety of machinery -- Electrical equipment of machines -- Part 1: General requirements
CISPR11 EN55011	Industrial, scientific and medical (ISM) radio-frequency equipment -- Electromagnetic disturbance characteristics -- Limits and methods of measurement
IEC 61000-6-2 EN 61000-6-2	Electromagnetic compatibility (EMC) -- Part 6-2: Generic standards -- Immunity for industrial environments

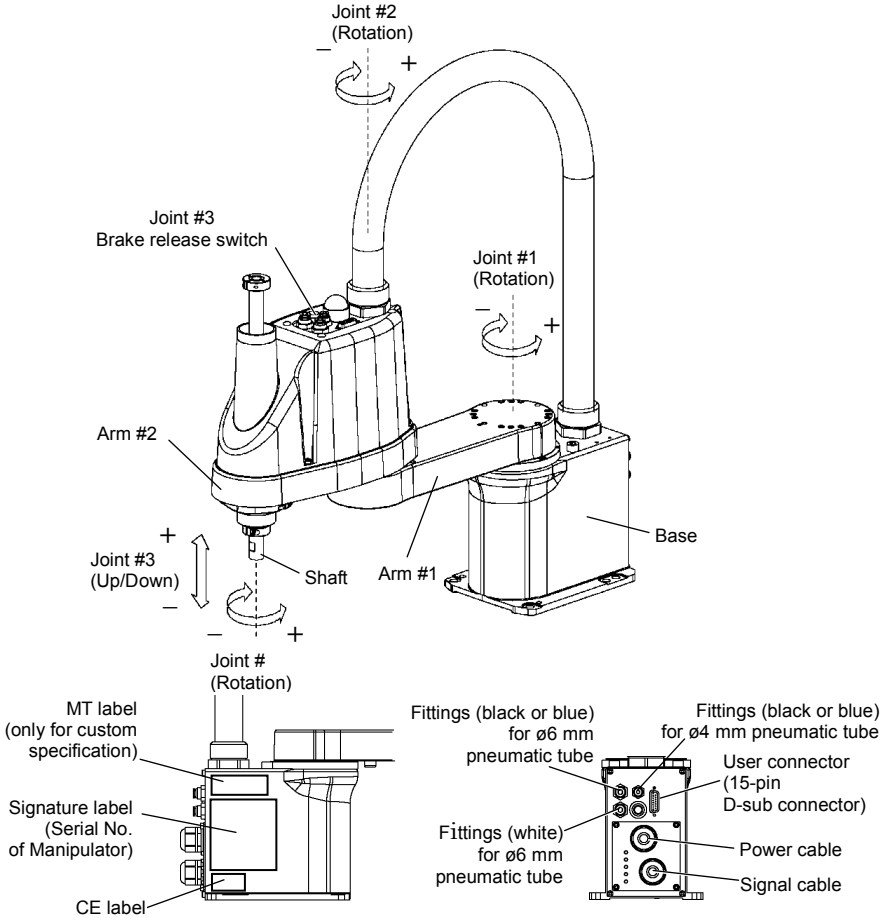
1.3.2 Part Names / Arm Motion



(1) POWER switch
(2) AC IN
(3) LED
(4) Fan Filter
(5) Signature label
(6) MT label
(7) Controller Number label
(8) Connection Check label
(9) M/C POWER connector
(10) M/C SIGNAL connector
(11) EMERGENCY connector
(12) TP port
(13) Development PC connection port
(14) Memory port
(15) Trigger Switch
(16) LAN (Ethernet communication) port
(17) I/O connector
(18) Standard RS-232C port
(19) Option slot
(20) Cable Clamp
(21) Battery (Mounted inside the controller)

LS3 / LS6 series

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



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

Arm #1 Push the arm by hand.

Arm #2 Push the arm by hand.

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

Joint #4 LS3: Rotate the shaft by hand.

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

NOTE

LS3: The brake release switch affects only Joint #3. When the brake release switch is pressed in emergency mode, the brake for Joint #3 is released.

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

LS6: The brake release switch affects both Joints #3 and #4. When the brake release switch is pressed in emergency mode, the brake for both Joints #3 and #4 are released simultaneously.

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

1.3.3 Operation Modes

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

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

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

1.4 Maintenance Safety

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

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

WARNING

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

 WARNING	■Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source. To shut off power to the robot system, pull out the power plug from the power source. Performing any work while connecting the AC power cable to a factory power source is extremely hazardous and may result in electric shock and/or malfunction of the robot system. ■Before performing any replacement procedure, turn OFF the Controller and related equipment, and then pull out the power plug from the power source. Performing any replacement procedure with the power ON is extremely hazardous and may result in electric shock and/or malfunction of the robot system. ■Be sure to connect the cables properly. Do not allow unnecessary strain on the cables. (Do not put heavy objects on the cables. Do not bend or pull the cables forcibly.) The unnecessary strain on the cables may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system.

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

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

1.5 Emergency Stop

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

However, avoid pressing the Emergency Stop switch unnecessarily while the Manipulator is running normally. Otherwise, the Manipulator may hit the peripheral equipment since the operating trajectory while the robot system stops is different from that in normal operation. It may also result in short life of the reduction gear unit due to the shock or the electromagnetic brake due to the worn friction plate.
To place the robot system in emergency mode during normal operation, press the Emergency Stop switch when the Manipulator is not moving.
Refer to the Controller manual for instructions on how to wire the Emergency Stop switch circuit.

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

Do not turn OFF the Controller while the Manipulator is operating.
If you attempt to stop the Manipulator in emergency situations such as “Safeguard Open”, make sure to stop the Manipulator using the E-STOP switch of the Controller.
If the Manipulator is stopped by turning OFF the Controller while it is operating, following problems may occur.

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

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

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

If there is a position gap, perform calibration by referring to *Maintenance: Calibration* in the manipulator manual.
Manipulator manuals contain information on the Emergency Stop. Please also read the descriptions in the manuals and use the robot system properly.

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

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

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

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

To check brake problems, refer to the following manuals.
Manipulator Manual Maintenance
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)

1.5.1 Free running distance in emergency

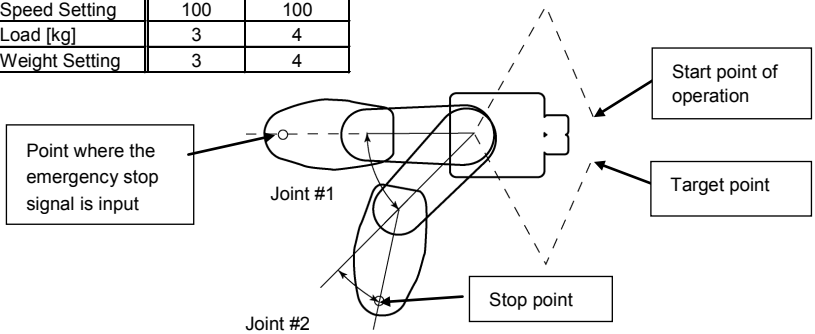
The operating Manipulator cannot stop immediately after the Emergency Stop switch is pressed.
The free running time/angle/distance of the Manipulator are shown below.
However, remember that the values vary depending on following conditions.

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

LS3 / LS6 series

Conditions for Measurement

	LS3-401*	LS6-602*
Accel Setting	100	100
Speed Setting	100	100
Load [kg]	3	4
Weight Setting	3	4

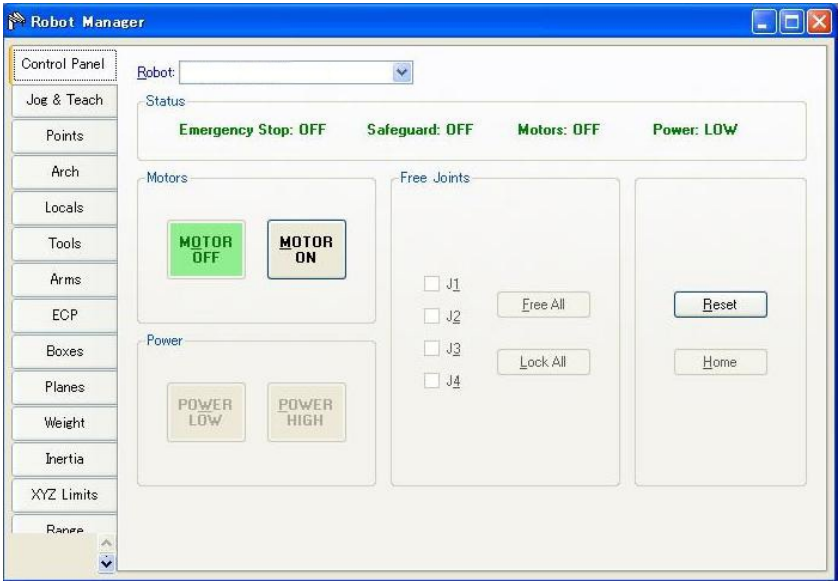


		Controller	RC90	
		Manipulator	LS3-401*	LS6-602*
Free running time	Joint #1 + Joint #2	[sec.]	0.4	0.7
	Joint #3	[sec.]	0.1	0.2
Free running angle	Joint #1	[deg.]	110	100
	Joint #2	[deg.]	20	45
	Joint #1 + Joint #2	[deg.]	130	130
Free running distance	Joint #3	[mm]	20	50

1.5.2 How to Reset the Emergency Mode

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

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

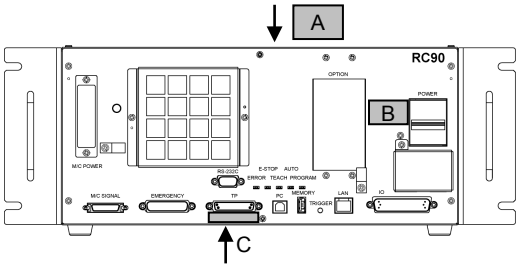


1.6 Labels

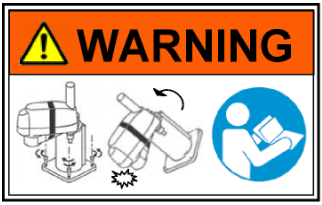
Labels are attached around the locations of the Controller and Manipulator where specific dangers exist.
Be sure to comply with descriptions and warnings on the labels to operate and maintain the Robot System safely.
Do not tear, damage, or remove the labels. Use meticulous care when handling those parts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

1.6.1 Controller

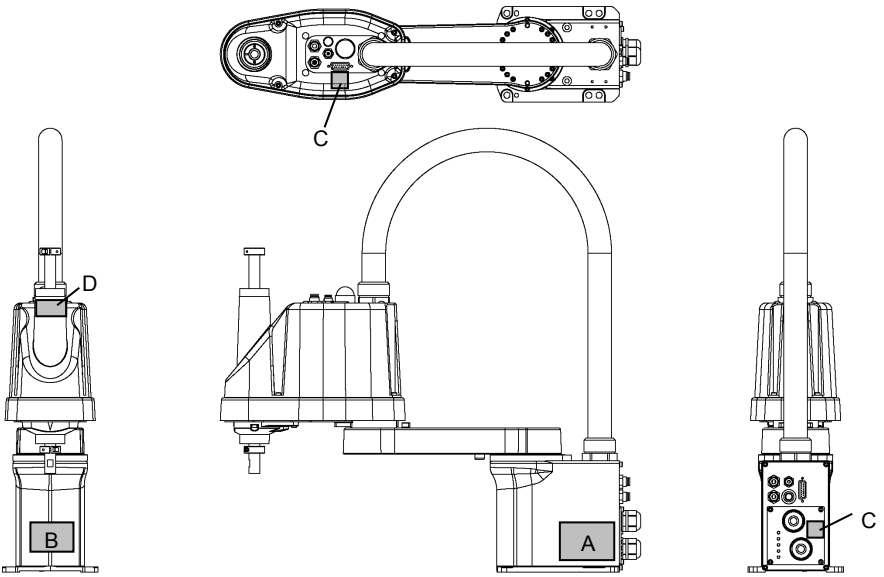
Location	Label	Note
A		Residual voltage exists. To avoid electric shock, do not open the cover while the Power is ON, or for 300 seconds after the Power is OFF.
B		Disconnect and lockout main power before performing maintenance and repair.
C		TP port of RC90 is for the Teach Pendant TP1 and TP2. Do not connect the followings to TP port of RC90. Connecting to the followings may result in malfunction of the device. OPTIONAL DEVICE dummy plug, OP500, OP500RC, JP500, TP-3** series, and OP1 Refer to *4.3 Connection of Option Teaching Pendant.*



1.6.2 Manipulator

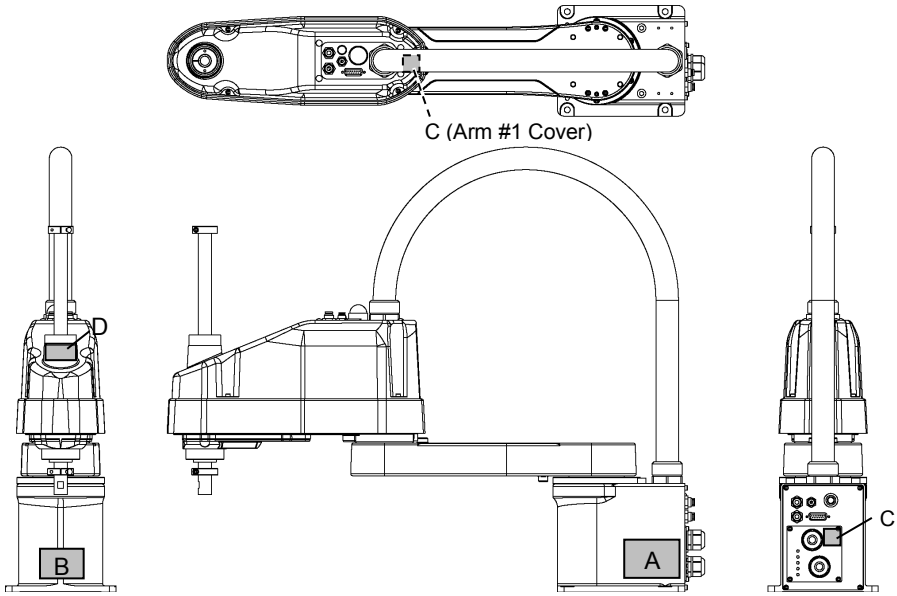
Location	Label	Note
A		Before loosening the base mounting screws, hold the arm and secure it tightly with a band to prevent hands or fingers from being caught in the Manipulator. For installation and transportation of robots, follow the directions in this manual.
B		Do not enter the operation area while the Manipulator is moving. The robot arm may collide against the operator. This is extremely hazardous and may result in serious safety problems.
C		Hazardous voltage exists while the Manipulator is ON. To avoid electric shock, do not touch any internal electric parts.
D		You can catch your hand or fingers between the shaft and cover when bringing your hand close to moving parts. Manipulators with bellows do not have this label for no danger of your hand or fingers being caught

LS3-401*



(Figure: LS3-401S)

LS6-602*



(Figure: LS6-602S)

1.7 Safety Features

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

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

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

Emergency Stop Switch

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

Safety Door Input

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

Low Power Mode

The motor power is reduced in this mode.

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

Dynamic Brake

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

Motor Overload Detection

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

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

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

Motor Speed Error Detection

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

Positioning Overflow -Servo Error- Detection

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

Speed Overflow -Servo Error- Detection

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

CPU Irregularity Detection

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

Memory Check-sum Error Detection

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

Overheat Detection at the Motor Driver Module

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

Relay Deposition Detection

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

Over-Voltage Detection

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

AC Power Supply Voltage Drop Detection

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

Temperature Anomaly Detection

The temperature anomaly is detected.

Fan Malfunction Detection

Malfunction of the fan rotation speed is detected.

1.8 Lockout / Tagout

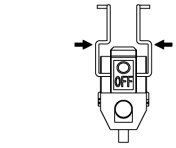
Lockout / tagout is a method to prevent anyone from turning ON the robot system by mistake while someone else is within the safeguarded area for maintenance or repair.

When performing maintenance and repair, lockout and tagout using the following procedure. Use the lockout attachment for RC90.

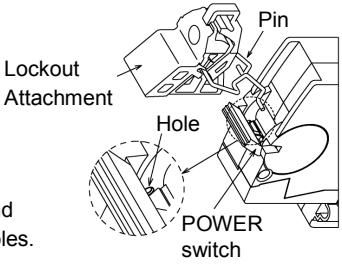
Installing the Lockout Attachment

(1) Turn OFF the POWER switch and place the lockout attachment on the POWER switch.

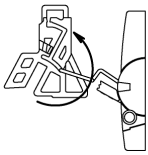
Insert the pin in the holes under the retractable actuator.



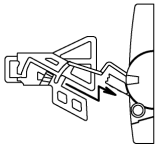
Push the pin in the direction of arrows, and insert the pin in the holes.



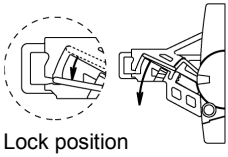
(2) Turn the lockout attachment.



(3) Install the lockout attachment on the switch.



(4) Slide the pin to the lock position.



Padlock Size and Weight

The padlock is not supplied with the lockout attachment and must be supplied by the user.

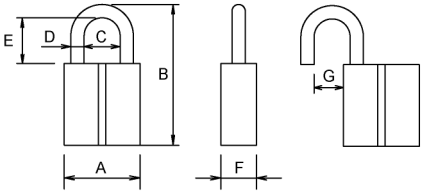
The total weight of the padlock can be a maximum of 45 g.

Make sure the padlock weight does not exceed 45 g, otherwise the POWER switch may be damaged.

Applicable Padlock

(A)	(B)	C	D	E	(F)	G
19 to 25	35 to 42	9 to 11.5	4 to 4.5	11 to 15	8 to 10	7.5 to 9.0

(A) , (B) , (F) : Reference dimension



Recommended Padlock	
Manufacturer	Type No.
Alpha	1000-25
Master Lock	4120

Safety Precautions

When using the padlock, do not use the controller where it is subject to vibration or shock, otherwise failure or damage may result.

Do not apply a force of more than 50N on the lockout attachment; otherwise the lockout attachment will be damaged.

1.9 Manipulator Specifications

LS3 / LS6

Item		LS3-401*	LS6-602*
Arm length	Arm #1, #2	400 mm	600 mm
	Arm #1	225 mm	325 mm
	Arm #2	175 mm	275 mm
Max. operating speed *1	Joints #1, #2	6000 mm/s	6800 mm/s
	Joint #3	1100 mm/s	
	Joint #4	2600 deg./s	2000 deg/s
Repeatability	Joints #1, #2	± 0.01 mm	± 0.02 mm
	Joint #3	± 0.01 mm	
	Joint #4	± 0.01 deg.	
Payload (Load)	Rated	1 kg	2 kg
	Max.	3 kg	6 kg
Joint #4 allowable moment of inertia *2	Rated	0.005 kg·m^2	0.01 kg·m^2
	Max.	0.05 kg·m^2	0.12 kg·m^2
Resolution	Joint #1	0.000439 deg./pulse	0.000275 deg/pulse
	Joint #2	0.000439 deg./pulse	
	Joint #3	0.000799 mm/pulse	0.000814 mm/pulse
	Joint #4	0.001927 deg./pulse	0.001465 deg/pulse
Hand	Shaft diameter	ø 16 mm	ø 20 mm
	Through hole	ø 11 mm	ø 14 mm
Mounting hole		120 × 120 mm / 135 × 120 mm (Free choice of either hole.)	150 × 150 mm
		4-M8	
Weight (cables not included)		14 kg : 31 lb	17 kg : 37.5 lb
Driving method	All joints	AC servo motor	
Motor energy consumption	Joint #1	200 W	
	Joint #2	100 W	200 W
	Joint #3	100 W	
	Joint #4	100 W	
Option	Installation environment	Cleanroom *3	
Joint #3 down force		100 N	
Installed wire for customer use		15 (15 pin: D-sub)	

Item		LS3-401*	LS6-602*
Installed pneumatic tube for customer use		2 pneumatic tubes (ø6 mm) : 0.59 Mpa (6 kgf/cm^2 : 86 psi)	
		1 pneumatic tubes (ø4 mm) : 0.59 Mpa (6 kgf/cm^2 : 86 psi)	
Environmental requirements	Ambient Temp.	5 to 40 degrees C (with minimum temperature variation)	
	Ambient relative humidity	10 to 80% (no condensation)	
Noise level *4		L_{Aeq} = 70 dB (A)	
Applicable Controller		RC90	
Assignable Value ( ) Default values	SPEED	1 to (5) to100	
	ACCEL *5	1 to (10) to 120	
	SPEEDS	1 to (50) to 2000	
	ACCELS	1 to (200) to 25000	
	FINE	0 to (1250) to 65000	
	WEIGHT	0,175 to (1,175) to 3,175	0,275 to (2,275) to 6,275
Safety standard		CE Mark EMC Directive Machinery Directive RoHS Directive KC Mark / KCs Mark	

Item		LS3-401S	LS3-401C	LS6-602S	LS6-602C
Max. motion range	Joint #1	± 132 deg			
	Joint #2	± 141 deg		± 150 deg	
	Joint #3	150 mm	120 mm	200 mm	170 mm
	Joint #4	± 360 deg			
Max. pulse range	Joint #1	– 95574~505174 pulse		– 152918~808278 pulse	
	Joint #2	± 320854 pulse		± 341334 pulse	
	Joint #3	–187734~0 pulse	–150187~0 pulse	–245760~0 pulse	–208896~0 pulse
	Joint #4	± 186778 pulse		± 245760 pulse	

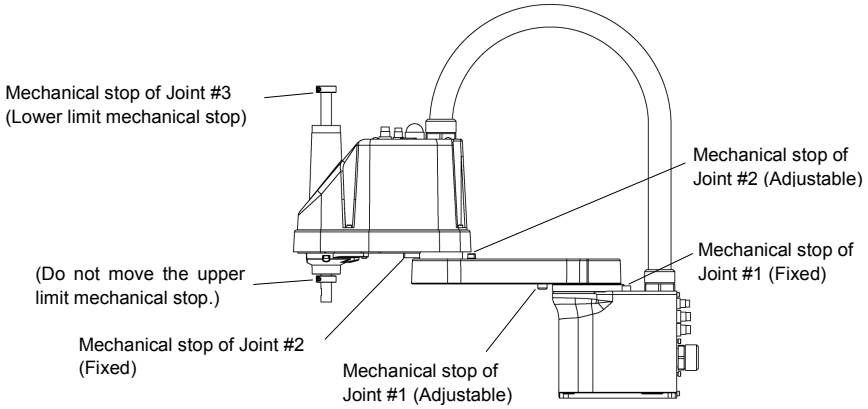
1.10 Motion Range Setting by Mechanical Stops

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

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

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

LS3 / LS6



1.11 End User Training

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

Training should include at least the following:

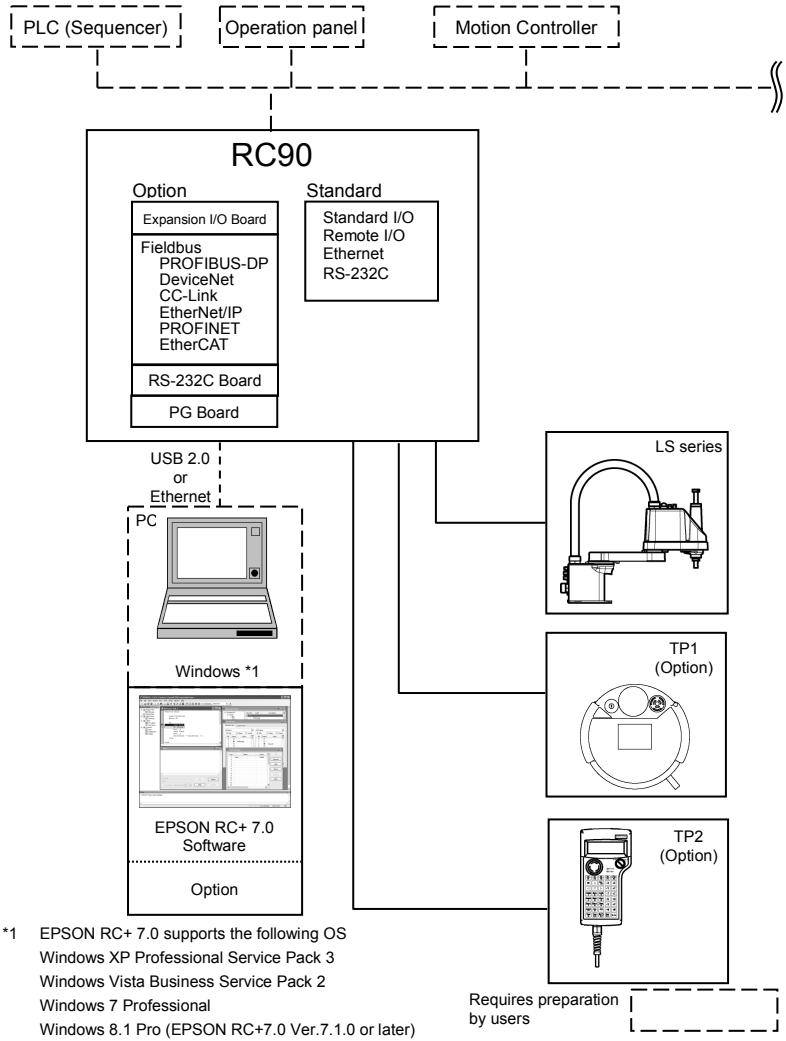
- Study of regulation safety procedures, and safety-related recommendations by robot manufacturers and system designers.
- Clear explanation of the work involved.
- Description of all control equipment required for the work and their functions.
- Explanation of potential hazards involved in the work.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

2. Installation

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

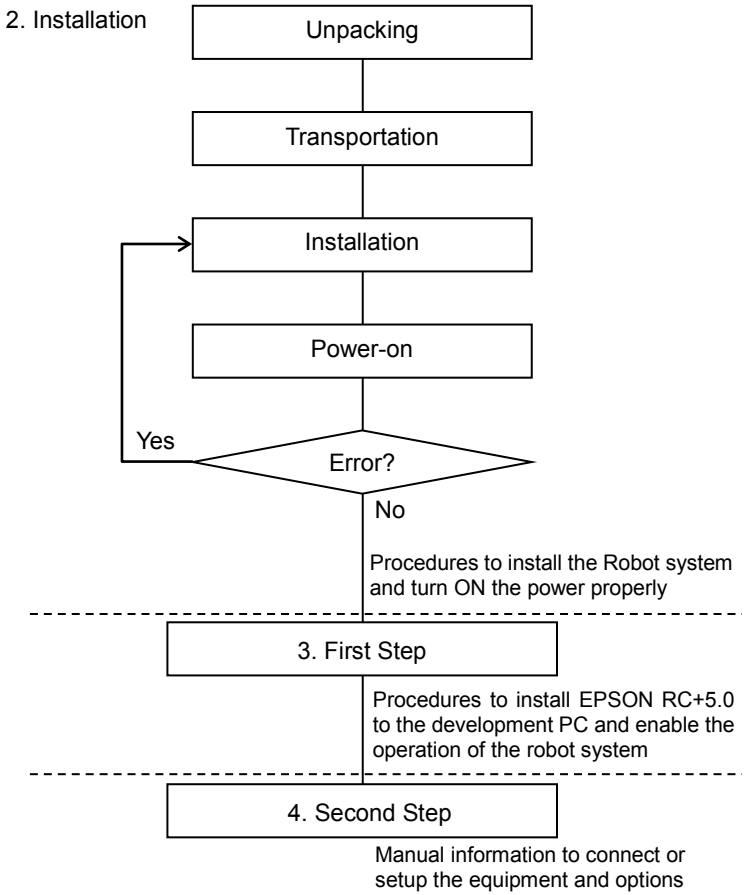
The outline to install the robot system is indicated on 2.1 Outline from Unpacking to Operation of Robot System. Refer to each section and/or the Manipulator manual and the Controller manual for unpacking, transportation, and installation.

System Example



*1 EPSON RC+ 7.0 supports the following OS
Windows XP Professional Service Pack 3
Windows Vista Business Service Pack 2
Windows 7 Professional
Windows 8.1 Pro (EPSON RC+7.0 Ver.7.1.0 or later)
When using the fieldbus master, until Windows 7 is supported.

2.1 Outline from Unpacking to Operation of Robot System



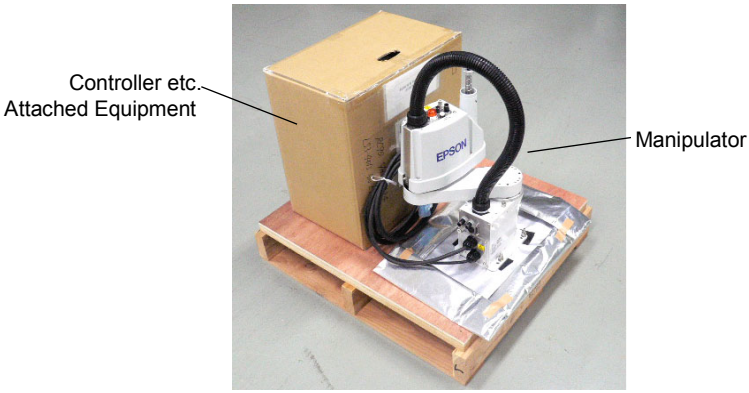
2.2 Unpacking

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

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

2.2.1 Package Components Example

The following figure illustrates the package at delivery.



2.2.2 Unpacking Precautions

Transportation procedure

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

Vibration at transportation

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

Anchor bolt

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

Wire tie

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

2.3 Transportation

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

2.3.1 Transportation Precautions

Transportation procedure

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

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

Vibration at transportation

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

Anchor bolt

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

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

Wire tie

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

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

Hoisting procedure

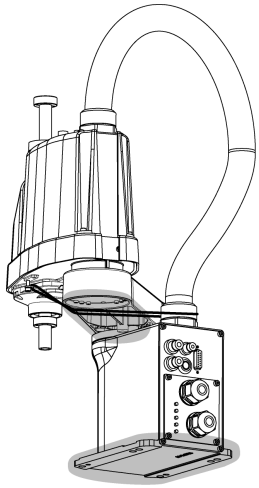
: Stabilize the Manipulator with your hands when hoisting it. Unstable hoisting is extremely hazardous and may results in serious bodily injury and/or severe equipment damage to the robot system as the fall of the Manipulator.

2.3.2 Manipulator Transportation

LS3 / LS6

To carry the Manipulator, have two or more people to work on it and secure the Manipulator to the delivery equipment or hold the areas indicated in gray in the figure (bottom of Arm #1 and bottom of the base) by hand.

When holding the bottom of the base by hand, be very careful not to get your hands or fingers caught.



LS3-401* : approx. 14 kg: 31 lb.
LS3-602* : approx. 17 kg: 37.5 lb.

2.4 Manipulator Installation

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

2.4.1 Installation Precautions

Safeguard installation

: To ensure safety, a safeguard must be installed for the robot system. For details on the safeguard, refer to the *Installation and Design Precautions* in the *Safety* chapter of the *EPSON RC+ User's Guide*.

Space between safeguard and Manipulator

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

Manipulator check before installation

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

2.4.2 Environment

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

NOTE

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

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

2.4.3 Noise level

Noise level by movement of manipulator.

LS series: LAeq = 70 dB (A)

Operating conditions

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

Measurement point

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

2.4.4 Base Table

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

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

	LS3-401*	LS6-602*
Max. Reaction torque on the horizontal plate	250 Nm	350 Nm
Max. Horizontal reaction force	1000 N	1500 N
Max. Vertical reaction force	1000 N	1500 N

The threaded holes required for mounting the Manipulator base are LS3/LS6:M8. Use mounting bolts with specifications conforming to ISO898-1 property class: 10.9 or 12.9.

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

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

The Manipulator must be installed horizontally.

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

2.4.5 Installation Procedure

NOTE

When the Manipulator is Clean-model, unpack it outside of the clean room.

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

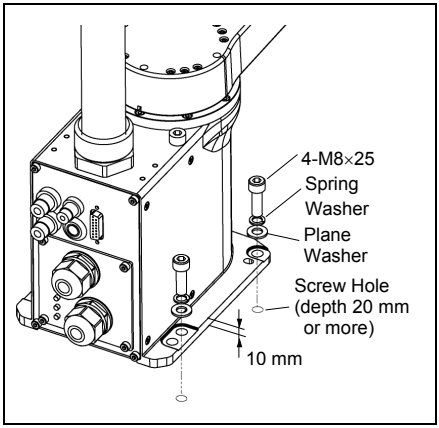
LS3 / LS6

CAUTION	■ Install the LS3 / LS6 series Manipulator with two or more people. The Manipulator weights are as follows. Be careful not to get hands, fingers, or feet caught and/or have equipment damaged by a fall of the Manipulator. LS3-401* : approx. 14 kg: 31 lb. LS6-602* : approx. 17 kg: 37.5 lb.

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

NOTE

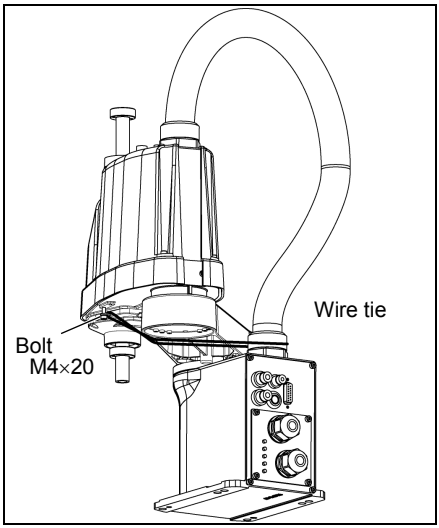
Use bolts with specifications conforming to ISO898-1 Property Class: 10.9 or 12.9.



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

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

(4) Remove the shipping bolt and jigs.



2.5 Controller Installation

2.5.1 Installation Precautions

Environment conditions

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

For Clean-room installation

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

Installation procedure

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

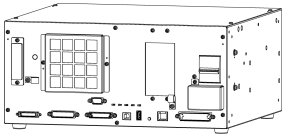
Cable

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

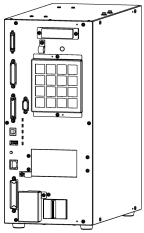
2.5.2 Installation

Install the controller on a flat surface such as wall, floor, and controller box in the direction shown from (A) to (C).

(A) Flat mounting

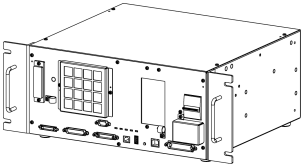


(B) Upright mounting



* The rubber foot needs to be replaced.

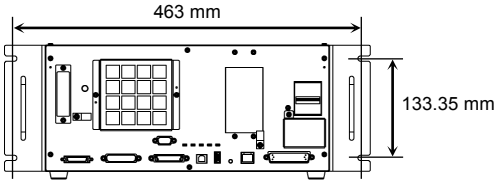
(C) Rack mounting



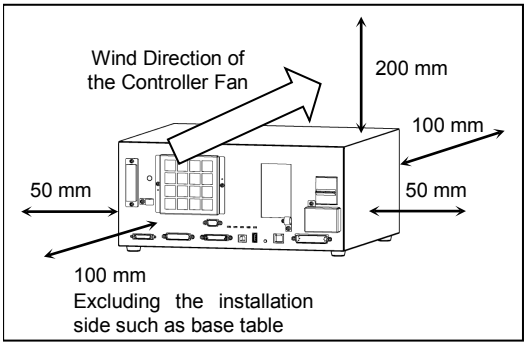
* Rack-mount plate is required.

NOTE

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



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



Hot air with higher temperature than the ambient temperature (about 10 deg.C) comes out from the in/out of the Controller.

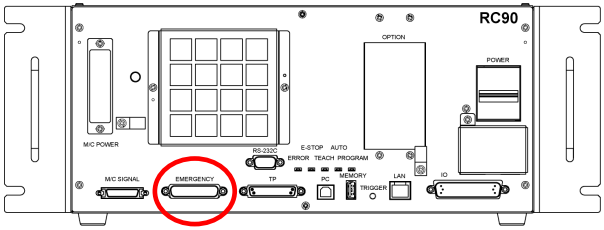
Make sure that heat sensitive devices are not placed near the outlet.

Arrange the cables in front of the Controller so that you can pull the Controller forward.

2.6 Connection to EMERGENCY Connector (Controller)

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

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



EMERGENCY Connector

2.6.1 Safety Door Switch and Latch Release Switch

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

Connector	Standard
EMERGENCY connector (Controller side)	D-sub 25 Pin (male) Mounting style #4-40

2.6.2 Safety Door Switch

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

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

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

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

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

2.6.3 Latch Release Switch

The controller software latches the following conditions:

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

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

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

Closed : The latch release switch releases the latched conditions.

NOTE

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

2.6.4 Checking Latch Release Switch Operation

NOTE

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

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

(1) Turn ON the Controller while the safety door is open in order to boot the controller software.
(2) Make sure that "Safety" is displayed on the EPSON RC+ 7.0 status bar.
(3) Close the safety door, and turn ON the switch connecting to the latch release input.
    Make sure that the "Safety" is dimmed on the status bar.

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

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

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

NOTE

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

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

2.6.5 Emergency Stop Switch

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

The Emergency Stop switch connected must comply with the following:

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

NOTE

The signal from the Emergency Stop switch is designed to use two redundant circuits.
If the signals at the two circuits differ by two seconds or more, the system recognizes it as a critical error. Therefore, make sure that the Emergency Stop switch has double contacts and that each circuit connects to the specified pins on the EMERGENCY connector at the Controller. Refer to the Controller Manual RC90 *Setup & Operation: Circuit Diagrams*.

2.6.6 Checking Emergency Stop Switch Operation

NOTE

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

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

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

(2) Make sure that E-STOP LED of the controller is lighting.

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

(4) Release the Emergency Stop Switch.

(5) Execute the RESET command.

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

2.6.7 Pin Assignments

The EMERGENCY connector pin assignments are as follows:

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

*1 Do not connect anything to these pins.

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

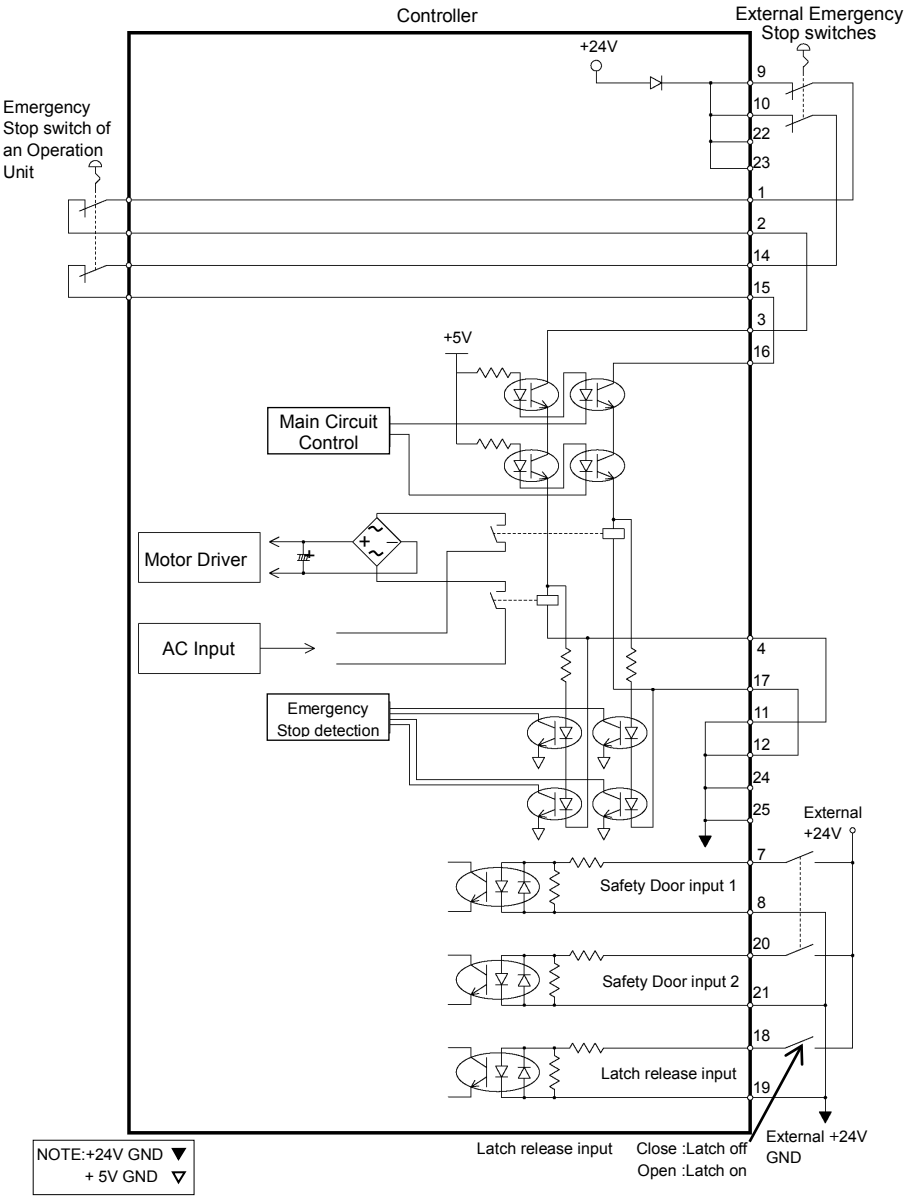
*3 A critical error occurs if the input values from the Emergency Stop switch contact 1 and Emergency Stop switch contact 2 are different for two or more seconds. They must be connected the same switch with two sets of contacts.

Emergency Stop switch output rated load	+30 V 0.3 A or under	1-2, 14-15 pin
Emergency Stop rated input voltage range Emergency Stop rated input current	+24 V ±10% 37.5 mA ±10% / +24V input	3-4, 16-17 pin
Safety Door rated input voltage range Safety Door rated input current	+24 V ±10% 10 mA / +24 V input	7-8, 20-21 pin
Latch Release rated input voltage range Latch Release rated input current	+24 V ±10% 10 mA / +24 V input	18-19 pin

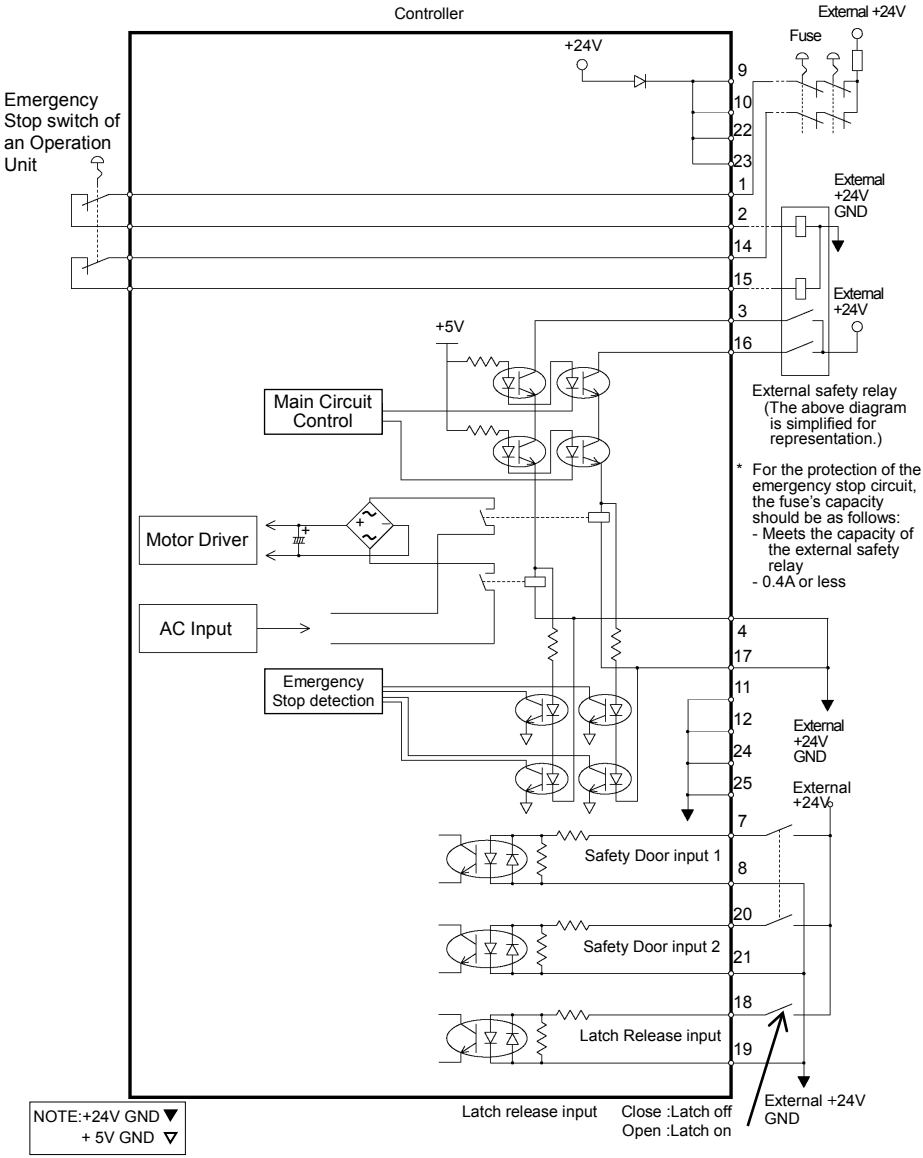
NOTE The total electrical resistance of the Emergency Stop switches and their circuit should be 1 Ω or less.

2.6.8 Circuit Diagrams

Example 1: External emergency stop switch typical application



Example 2: External safety relay typical application



2.7 Power supply / AC power cable / Breaker

2.7.1 Power Supply

Ensure that the available power meets following specifications.

Item	Specification
Voltage	200 VAC to 240 VAC
Phase	Single phase
Frequency	50/60 Hz
Momentary Power Interrupt	10 msec. Or less
Power Consumption	Max. 2.5 kVA Actual consumption depends on the model, motion, and load of the Manipulator. Rated consumption = (150 W + total Manipulator rated consumption × 0.8) / 0.6 Refer to Manipulator manual for Manipulator rated consumption.
Peak Current	When power is turned ON: approximately 70 A (2 msec.) When motor is ON: approximately 50 A (2 msec.)
Leakage Current	Max. 3.5 mA
Ground Resistance	100 Ω or less

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

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

2.7.2 AC Power Cable

WARNING

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

The AC plug is the optional part.

Attach a proper plug to the cable that is suitable for the factory power supply.

Connection Specification of Cable Wire

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

Specification of Power plug (option)

Name	Model	Manufacturer
AC plug	4222R	AMERICAN DENKI

Cable length: 3 m (Standard)

M/C Power Cable Connection

(1) Mount the M/C Power Cable as shown in the picture and form the cables.

(2) Set the M/C Power Cable in the clamp for the M/C Power Cable.

(3) Mount the cover for the M/C Power Connector.

(4) Secure the cover with the screw.

2.8 Connecting Manipulator and Controller

2.8.1 Connecting Precautions

Before Connection

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

Connecting procedure

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

Cable

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

Connection

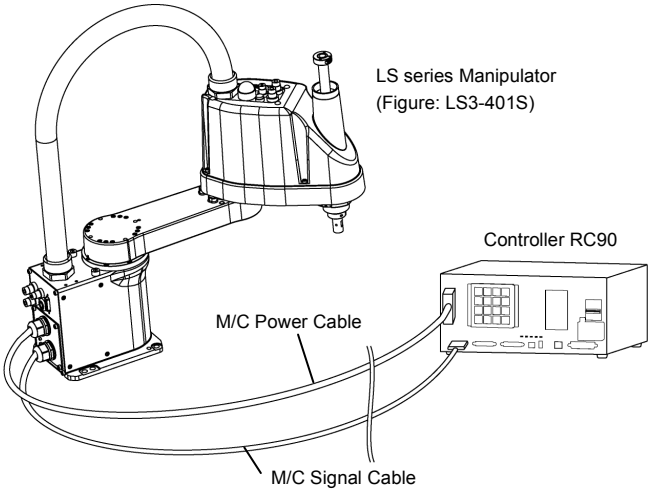
: When connecting the Manipulator and the Controller, make sure that the serial numbers on each equipment match. Improper connection between the Manipulator and Controller may not only cause improper function of the robot system but also safety problems.
The serial number of supported Manipulator is labeled on the controller.

Wiring

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

For Clean-model

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



2.9 Power-on

2.9.1 Power-on Precautions

Manipulator check

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

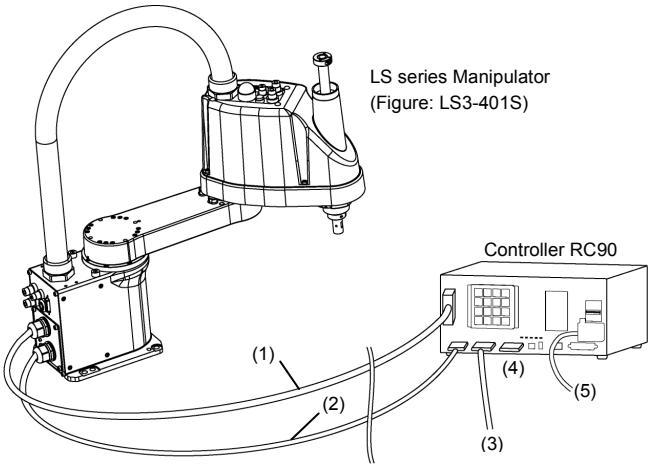
Shipping bolts and jigs check before turning ON

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

Power activation

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

2.9.2 Power ON Procedure



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

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

(3) Check the EMERGENCY connector connection.

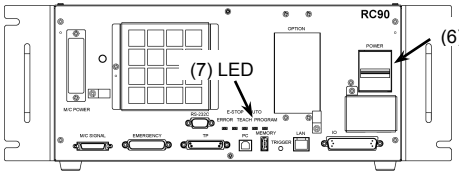
(4) Connect the TP bypass plug to the TP port of the RC90 Controller.

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

(6) Turn ON the POWER switch of the RC90 Controller.

(7) The PROGRAM LED blinks approximately 30 seconds after Controller starts up normally.

If the ERROR LED is turned ON or blinking, check the connection in step (1) to (5) and turn ON the power again.
If the ERROR LED is still ON or blinking, contact the supplier.



2.10 Saving Default Status

The controller has been already setup with the purchased robot(s) at shipment. However, just in case, we recommend saving the default controller status. A USB memory is necessary to save the controller status.

For the procedure of controller status storage, refer to *Robot controller manual RC90 (EPSON RC+ 7.0): Setup & Operation 6.1 What is Controller Status Storage Function?*.

3. First Step

This section indicates the procedure to install the development PC EPSON RC+, and execute simple program after connecting the development PC and Controller with a USB.

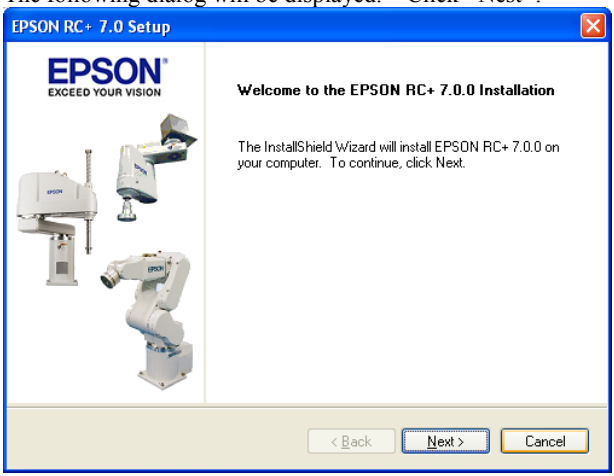
Make sure that the Robot system is installed safely by following the description in *1. Safety* and *2. Installation*. Then, operate the Robot system in the following procedures.

3.1 Installing EPSON RC+ 7.0 Software

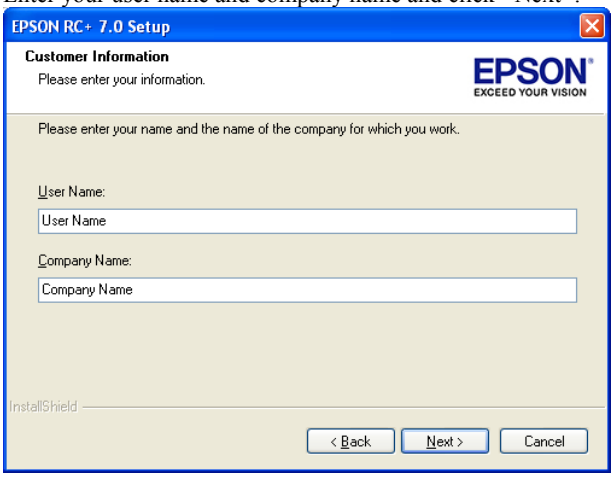
The EPSON RC+ 7.0 software needs to be installed on your development PC.

(1) Insert the EPSON RC+ 7.0 Setup DVD in the DVD drive.

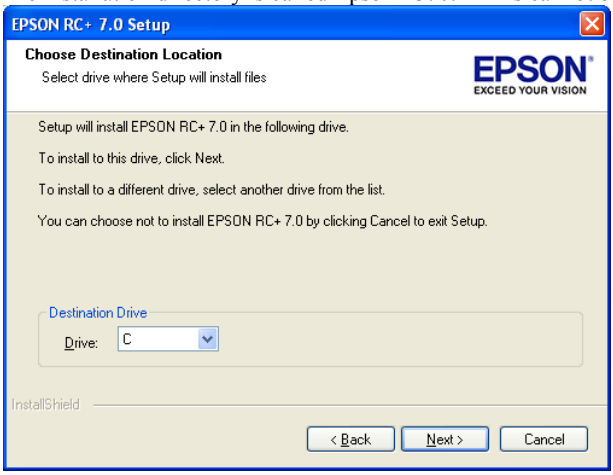
(2) The following dialog will be displayed. Click <Nest>.



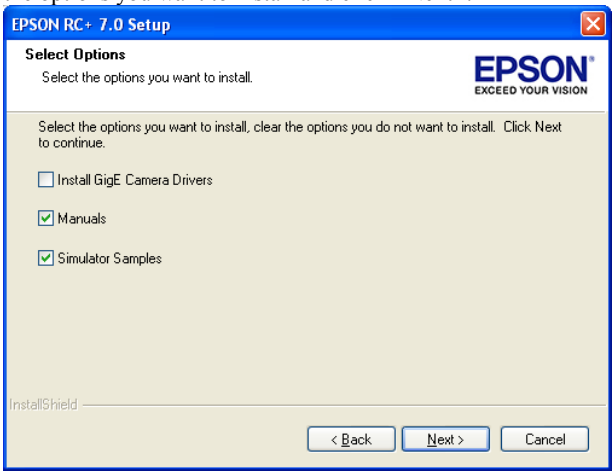
(3) Enter your user name and company name and click <Next>.



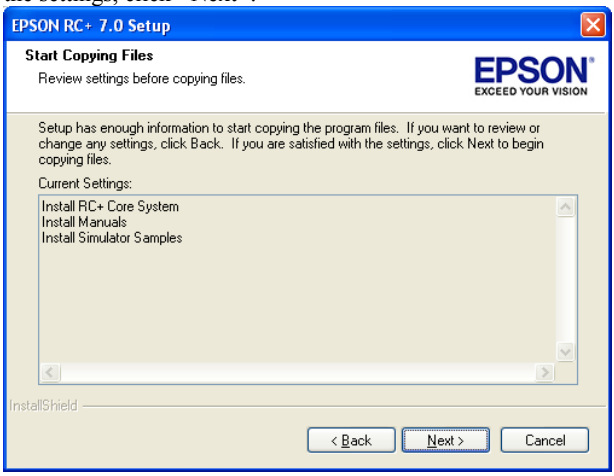
(4) Select the drive where you want to install EPSON RC+ 7.0 and click <Next>.
The installation directory is called EpsonRC70. This cannot be changed.



(5) The dialog for selecting the options to be installed will be displayed. Check the options you want to install and click <Next>.



(6) The dialog to review the settings will be displayed. If you are satisfied with the settings, click <Next>.



(7) If required, install “Windows Installer” and “Microsoft .NET Framework 3.5” on your system. This may take several minutes.

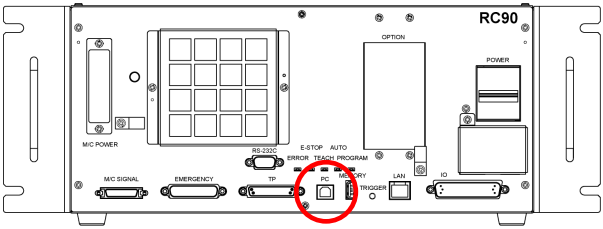
NOTE

Adobe Reader needs to be installed on your PC in order to view the EPSON RC+ 7.0 manuals. If the installer cannot find Adobe Reader on your system, it will be installed at this time. Follow the instructions in the Adobe installer. Do not restart the system after the Adobe Reader installation has completed.

(8) After the installation has completed, restart your computer.
The EPSON RC+ 7.0 software installation is now completed.

3.2 Development PC and Controller Connection

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



Development PC connection Port

NOTE

For other details of development PC and Controller connection, refer to *EPSON RC+ 7.0 User's Guide: PC to Controller Communications Command*.

For RC90, be sure to install the EPSON RC+7.0 to the development PC first, then connect the development PC and RC90 with the USB cable.
If RC90 and the development PC are connected without installing the EPSON RC+7.0 to the development PC, [Add New Hardware Wizard] appears. If this wizard appears, click the <Cancel> button.

3.2.1 About Development PC Connection Port

Development PC connection port supports following USB.

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

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

Connect the Controller and development PC by a USB cable to develop the robot system or set the Controller configuration with the EPSON RC+ 7.0 software installed in the development PC.

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

3.2.2 Precaution

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

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

3.2.3 Software Setup and Connection Check

Connection of the development PC and the Controller is indicated.

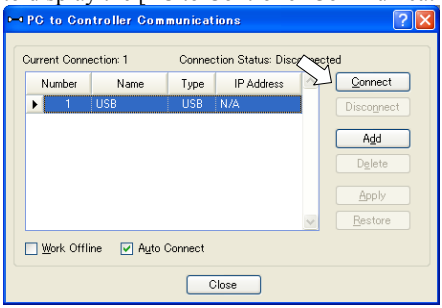
(1) Make sure that software EPSON RC+ 7.0 is installed to the Controller connected to the development PC.
(Install the software when it is not installed.)

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

(3) Turn ON the Controller.

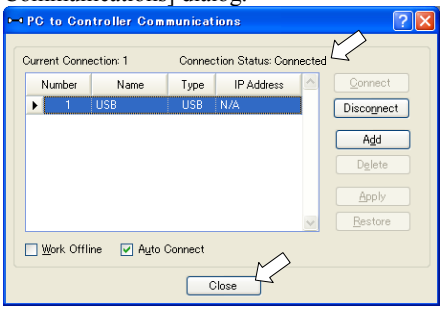
(4) Start the software EPSON RC+ 7.0.

(5) Select the EPSON RC+ 7.0 menu-[Setup]-[PC to Controller Communications] to display the [PC to Controller Communications] dialog.



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

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



Connection of the development PC and the Controller is completed. Now robot system can be used from EPSON RC+ 7.0.

3.2.4 Backup the initial condition of the Controller

Backup the Controller data configured before shipment.

Follow these steps to backup the project and system configuration:

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

3.2.5 Disconnection of Development PC and Controller

Disconnection of the development PC and the Controller is indicated.

(1) Select the EPSON RC+ 7.0 menu-[Setup]-[PC to Controller Communications] to display the [PC to Controller Communications] dialog.

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

NOTE

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

3.2.6 Moving the Robot to Initial Position

Robot can be operated by following methods other than creating and executing the program.

Manual operation

Jog motion by the Teach Pendant

Command execution from the EPSON RC+

Jog motion from the EPSON RC+

This section explains about following methods.

A: Manual operation

B: Command execution from the EPSON RC+

C: Jog motion from the EPSON RC+

A: Manual operation

Move the non-excited robot manually.

Joints with no electromagnetic brake can be moved manually as they are.
Joints with the brakes (Joint #3 only, or Joints #3 and #4) can be moved manually while the break release switch on the manipulator is being pressed with the controller ON.

Also, manipulators can be moved manually by releasing the electromagnetic brake from the command window of the EPSON RC+.

 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.

(1) Start the EPSON RC+ 7.0.
Double click the <EPSON RC+ 7.0> icon on the desktop.

(2) Open the command window.
EPSON RC+ 7.0 menu-[Tool]-[Command Window]

(3) Execute the following command in [Command Window].

```
>Reset
```

```
>Brake Off,[Arm # (1 to 6) whose brake will be released]
```

Execute the following command to turn on the brake again.

```
>Brake On,[Arm # (1 to 6) whose brake will be turned on]
```

B: Command execution from the EPSON RC+

Move the robot by exciting the robot motors and executing the command.

Following explains the example of moving all joints to the 0 pulse positions by specifying the pulse for each joint.

(1) Start the EPSON RC+ 7.0.
Double click the <EPSON RC+ 7.0> icon on the desktop.

(2) Open the command window.
EPSON RC+ 7.0 menu-[Tools]-[Command Window]

(3) Execute the following command in [Command Window].

```
>Motor On
>Go Pulse (0,0,0,0)
```

For position and posture of Manipulator at 0 pulse position, refer to *Motion Range* in each Manipulator manual.

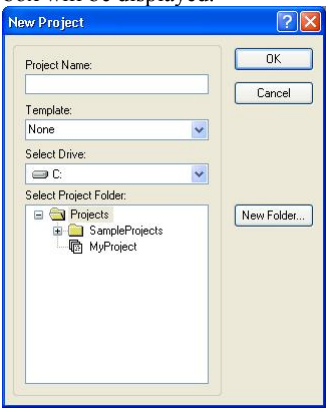
C: Jog motion from the EPSON RC+

Move the robot by exciting the motors and operating from the Jog & Teach window of the EPSON RC+.

(1) Start the EPSON RC+ 7.0.
Double click the <EPSON RC+ 7.0> icon on the desktop.

(2) Create a new project.

1. EPSON RC+ 7.0 menu-[Project]-[New Project]. [New Project] dialog box will be displayed.

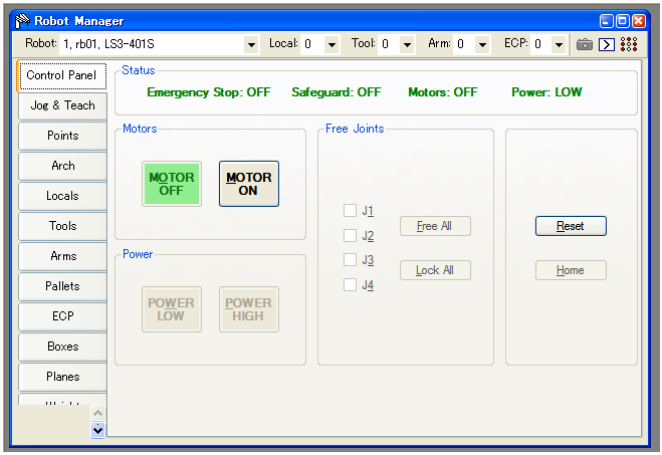


2. Enter the project name in [Project Name] box. (Ex: FirstApp)

3. Click the <OK> button and create the new project.

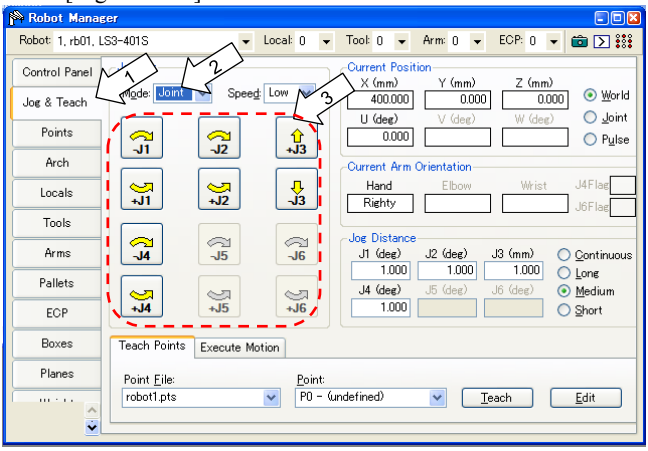
(3) Open the robot manager.
EPSON RC+ 7.0 menu-[Tools]-[Robot Manager].

(4) Turn ON the motors.
Check that the [Control Panel] tab is open. Click the <MOTOR ON> button.



(5) Move the manipulator with Jog motion.

1. Select [Jog & Teach] tab.



2. Select “Joint” in [Jogging]-<Mode>.
3. Move the manipulator by joint by clicking J1-J6 jog keys.
Manipulator can be moved by setting to other modes or setting the jog distance.

3.3 Writing your first program

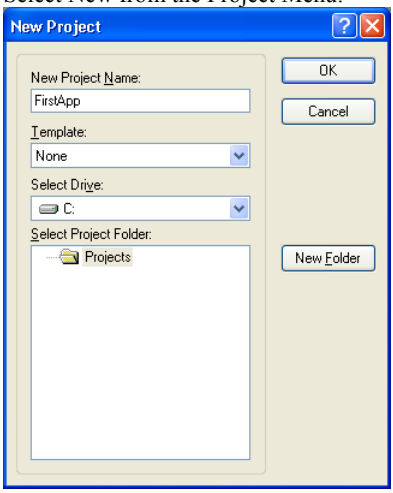
After installing the RC90 controller, robot, and EPSON RC+ 7.0 software on your PC, follow these instructions to create a simple application program so that you will become more familiar with the EPSON RC+ 7.0 development environment.

1. Start EPSON RC+ 7.0

   Double-click the EPSON RC+ 7.0 icon on the desktop.

2. Create a new project

   (1) Select New from the Project Menu.



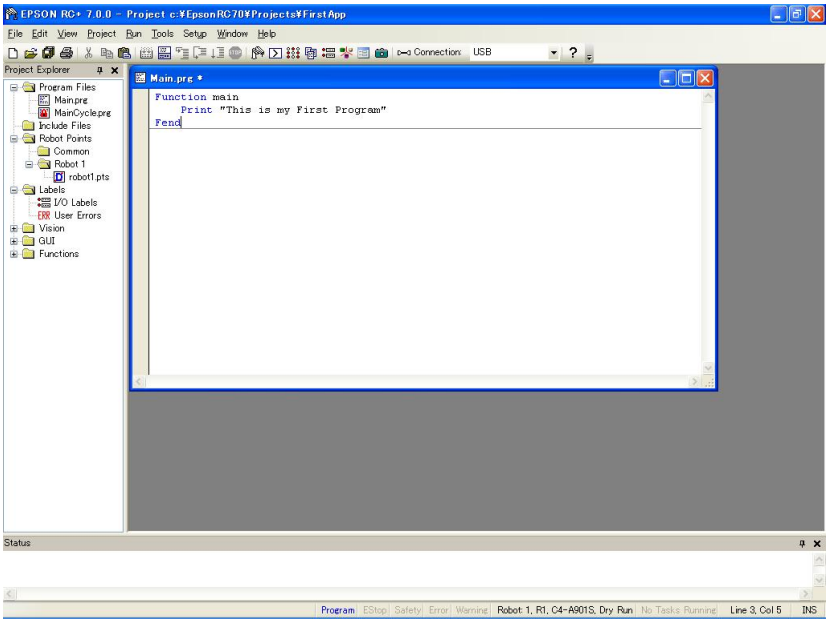
   (2) Type in a name for a project in the [New Project Name] box.
   (e.g. FirstApp)

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

3. Edit the program

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

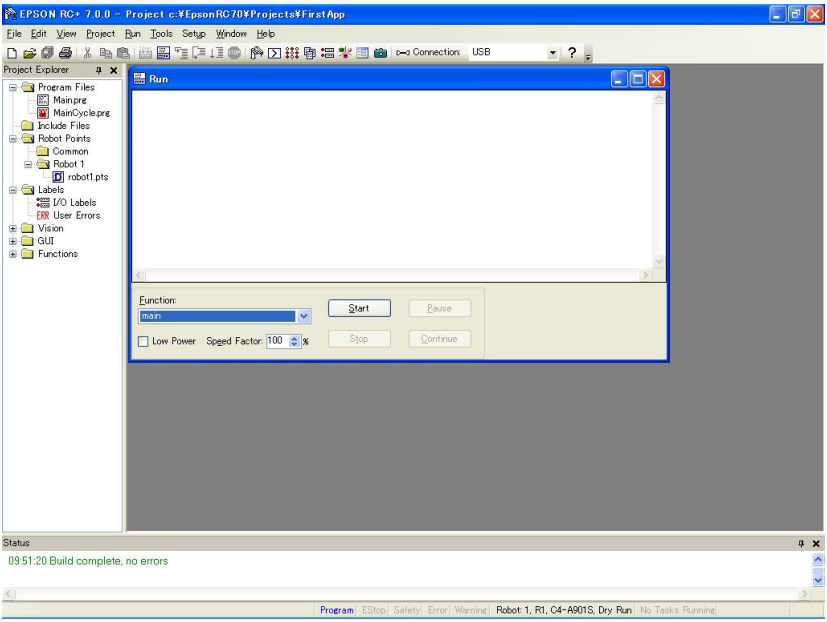
```
Function main
    Print "This is my first program."
Fend
```



4. Run the program

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

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



(3) Click the Start button on the Run window to run the program.

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

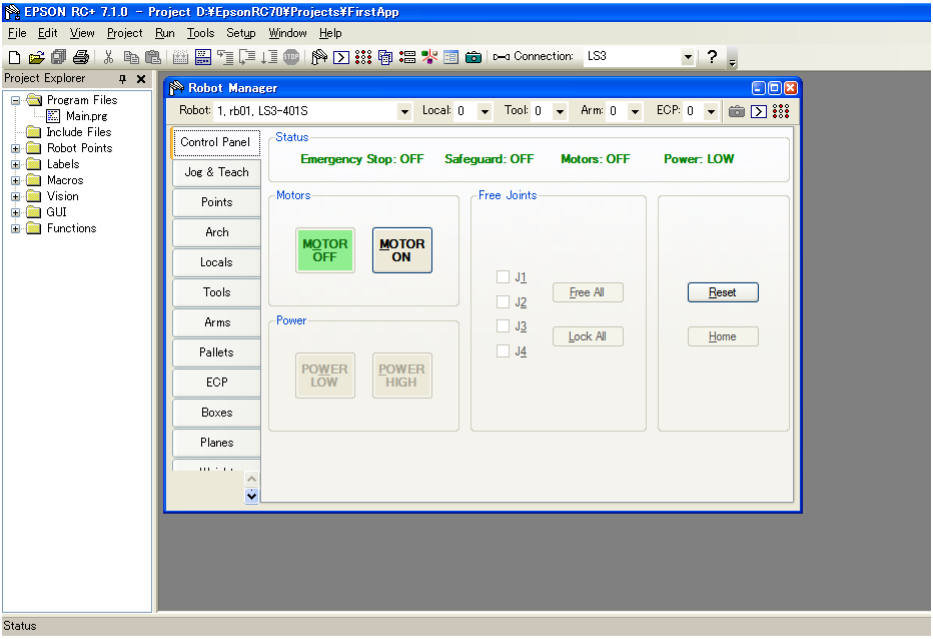
```
19:32:45 Task main started

19:32:45 All tasks stopped
```

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

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

5. Teach robot points

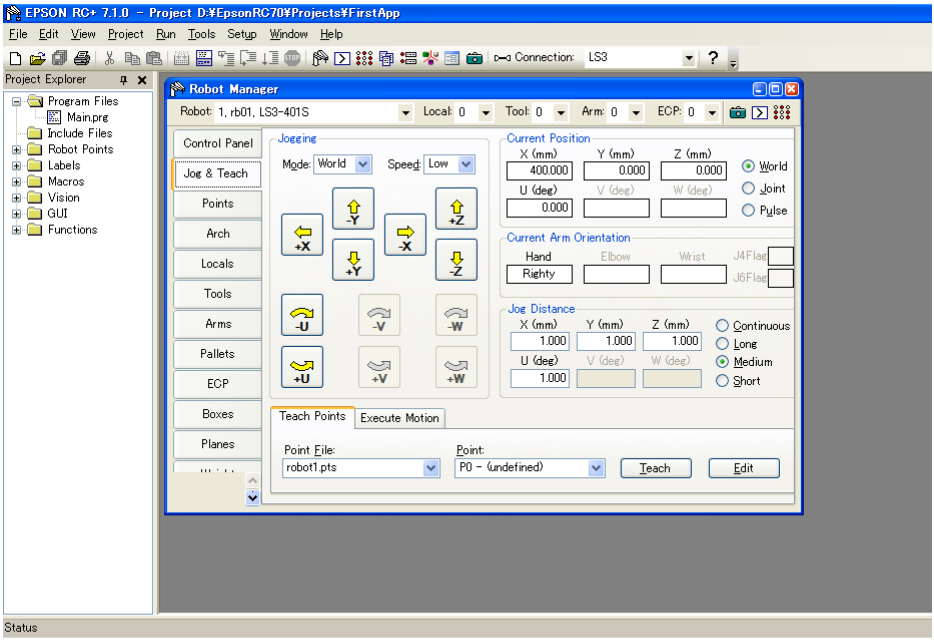
(1) Ensure that it is safe to operate the robot. Click the <Robot Manager> button on the toolbar. You will see the [Robot Manager] window with the [Control Panel] page displayed.



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

(3) Answer <Yes> to continue.

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



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

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

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

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

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

(10) Answer <Yes>.

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

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

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

(14) Answer <Yes>.

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

6. Modify the program to include robot motion commands

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

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

(2) Run the program by pressing F5 and then click on the <Start> button on the Run window.

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

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

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

```
Function main
    Print "This is my first program."
    Power High
    Speed 50
    Accel 50, 50
    Go P1
    Go P2
    Go P0
Fend
```

(2) Run the program by pressing F5

(3) Click on the <Start> button on the Run window.

The robot should go to each of the points you taught at 50% speed, acceleration, and deceleration. The Power High statement enables your program to run the robot at high (normal) power, which in turn allows the robot speed and acceleration to be increased.

8. Backup the project and system configuration

Even though this is only a sample project, we will backup the project and controller configuration. This is easy to do with EPSON RC+ 7.0. It is important that you keep regular backups of your applications on an external media such as a USB memory key.

Follow these steps to backup the project and system configuration:

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

(2) Change the [Destination Drive] to an arbitrary drive.

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

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

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

(6) Select the arbitrary drive.

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

4. Second Step

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

4.1 Connection with External Equipment

4.1.1 Remote Control

EPSON RC+ 7.0 User's Guide
Remote Control
ROBOT CONTROLLER RC90 (EPSON RC+ 7.0) manual
Setup & Operation: 12. I/O Remote Set Up

I/O
EPSON RC+ 7.0 User's Guide
I/O Setup
ROBOT CONTROLLER RC90 (EPSON RC+ 7.0) manual
Setup & Operation: 11. I/O Connector
Setup & Operation: 13.2 Expansion I/O Board (Option)

Fieldbus I/O (Option)
ROBOT CONTROLLER RC700 / RC90 Option Fieldbus I/O Board

4.1.2 Ethernet

EPSON RC+ 7.0 User's Guide
Ethernet Communication
ROBOT CONTROLLER RC90 (EPSON RC+ 7.0) manual
Setup & Operation: 7. LAN Ethernet) Port

4.1.3 RS-232C (Option)

EPSON RC+ 7.0 User's Guide
RS-232C Communication
ROBOT CONTROLLER RC90 (EPSON RC+ 7.0) manual
Setup & Operation: 13.4 RS-232C Board

4.2 Ethernet Connection of Development PC and Controller

EPSON RC+ 7.0 User's Guide
Ethernet Communication
ROBOT CONTROLLER RC90 (EPSON RC+ 7.0) manual
Setup & Operation: 7. LAN (Ethernet) Port

4.3 Connection of Option Teaching Pendant

Robot Controller RC90 (EPSON RC+ 7.0) manual
Setup & Operation: 8. TP Port
ROBOT CONTROLLER RC700 / RC90 Option Teach Pendant TP1
Function & Installation: 3. Installation
ROBOT CONTROLLER RC700 / RC90 Option Teach Pendant TP2
Function & Installation: 3. Installation

5. General Maintenance

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

5.1 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	Monthly	Quarterly	Biannual	Annual
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

5.2 Inspection Point

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

Manipulator

Inspection Point	Inspection Place	Daily	Monthly	Quarterly	Biannual	Annual
Check looseness or backlash of bolts/screws. Tighten them if necessary. (For the tightening torque, refer to *Tightening Hexagon Socket Head Cap Bolts*.)	End effector mounting bolts	√	√	√	√	√
	Manipulator mounting bolts	√	√	√	√	√
	Each arm locking bolts	√	√	√	√	√
	Bolts/screws around shaft					√
	Bolts/screws securing motors, reduction gear units, etc.					√
Check looseness of connectors. If the connectors are loosen, push it securely or tighten.	External connectors on Manipulator (on the connector plates etc.)	√	√	√	√	√
	Manipulator cable unit		√	√	√	√
Visually check for external defects. Clean up if necessary.	External appearance of Manipulator	√	√	√	√	√
	External cables		√	√	√	√
Check for bends or improper location. Repair or place it properly if necessary.	Safeguard etc.	√	√	√	√	√
Check tension of timing belts. Tighten it if necessary.	Inside of Arm #2				√	√
Grease conditions	Refer to *Greasing*.					
Battery	-	Every 1.5 years				

Controller

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

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

Manipulator

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

Controller

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

5.2.3 Tightening Hexagon Socket Head Cap Bolts

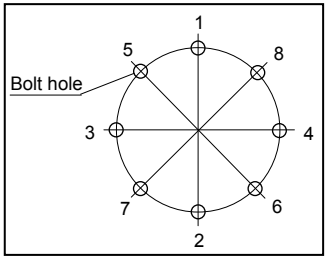
Hexagon socket head cap bolts are used in places where mechanical strength is required. (A hexagon socket head cap bolt will be called a "bolt" in this manual.) These bolts are fastened with the tightening torques shown in the following table. When it is necessary to refasten these bolts in some procedures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

Bolt	Tightening Torque
M3	200 N·cm (20.4 kgf·cm)
M4	400 N·cm (40.8 kgf·cm)
M5	800 N·cm (81.6 kgf·cm)
M6	1,300 N·cm (132.5 kgf·cm)
M8	2,940 N·cm (300 kgf·cm)
M10	5,785 N·cm (590 kgf·cm)
M12	12,740 N·cm (1,300 kgf·cm)

Refer below for the set screw.

Set Screw	Tightening Torque
M4	250 N·cm (25.5 kgf·cm)
M5	390 N·cm (39.8 kgf·cm)

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



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

5.2.4 Greasing

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

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

CAUTION

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

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

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

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

	Greasing part	Greasing Interval
Joint #1	Reduction gear units	In the replacement of motor*
Joint #2	Reduction gear units	In the replacement of motor*
Joint #3	Ball screw spline shaft	Every 6 months

* Under normal conditions, the reduction gear units shall 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.

5.2.5 Handling and Disposal of Batteries

 CAUTION	■ Use meticulous care when handling the lithium battery. Improper handling of the lithium battery as mentioned below is extremely hazardous, may result in heat generation, leakage, explosion, or inflammation, and may cause serious safety problems. ・Battery Charge ・Deformation by Pressure ・Disassembly ・Short-circuit (Polarity; Positive/Negative) ・Incorrect Installation ・Heating (85°C or more) ・Exposing to Fire ・Soldering the terminal of the lithium battery ・Forced Discharge directly ■ When disposing of the battery, consult with the professional disposal services or comply with the local regulation. Spent battery or not, make sure the battery terminal is insulated. If the terminal contacts with the other metals, it may short and result in heat generation, leakage, explosion, or inflammation.

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

Robot Controller

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

Make sure to use the designated lithium battery.

Manipulator

When the lithium battery power is low, an error will occur to warn the user about the low battery status when the Controller is turned ON (when software is started up).

When the error occurs, the position data in motors will be lost and all joints need to be completely calibrated again.

The life span of the lithium battery is 1.5 years. Even if the Manipulator is constantly connected to power, the lithium battery needs to be replaced every 1.5 years.

Be sure to use the designated lithium battery and the battery board.

Be sure to set the correct polar when installing the battery.

6. Manuals

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

Select EPSON RC+ 7.0-[Help]-[PDF Manual] to view the PDF manuals from a PC. (Click <Start>-[Program]-[EPSON RC+ 7.0] from the Windows desktop.)

Software

EPSON RC+ 7.0 User's Guide

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

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

EPSON RC+ 7.0 SPEL+ Language Reference

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

- Details of the commands
- Error Messages
- Precaution of EPSON RC+ 4.0, 5.0, 6.0 Compatibility etc.

Software Options

Followings manuals contain information on the software options and commands.

- RC+ API 7.0
- Vision Guide 7.0
- Vision Guide 7.0 Properties & Results Reference
- GUI Builder 7.0
- Remote Control Reference

Controller

ROBOT CONTROLLER RC90 (EPSON RC+ 7.0)

This manual indicates descriptions of the Robot Controller RC90 and Robot system.

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

Controller Options

This manual indicates descriptions of the Controller option.

- PG Motion System
- Fieldbus I/O
- Teach Pendant TP1
- Teach Pendant TP2

Manipulator

EPSON SCARA ROBOT LS series (LS3 / LS6)

This manual indicates descriptions of the LS3, LS6 series manipulator.

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

7. Directives and Norms

These products conform to the following directives and norms.

For more details of controller and manipulator, please refer to each manual.

Product Name	Model
Controller	RC90
Manipulator	LS series

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

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