

EPSON

*Robot System
Safety and Installation*

Read this manual first

Rev.7

EM187B3743F

Programming Software EPSON RC+ 7.0

Manipulator T3 T6

4133885-06



Robot System Safety and Installation (T / EPSON RC+ 7.0) Rev.7

Robot System Safety and Installation
(T / EPSON RC+ 7.0)

Rev.7

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FOREWORD

Thank you for purchasing our robot products.

This manual contains the information necessary for the correct use of the robot system.

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.

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Microsoft® Windows® 7 Operating system

Microsoft® Windows® 8 Operating system

Microsoft® Windows® 10 Operating system

Throughout this manual, Windows 7, Windows 8, and Windows 10 refer to above respective operating systems. In some cases, Windows refers generically to Windows 7, Windows 8, and Windows 10.

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Regarding battery disposal



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

This information only applies to customers in the European Union, according to DIRECTIVE 2006/66/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL OF 6 September 2006 on batteries and accumulators and waste batteries and accumulators and repealing Directive 91/157/EEC and legislation transposing and implementing it into the various national legal systems.

For other countries, please contact your local government to investigate the possibility of recycling your product.

The battery removal/replacement procedure is described in the following manuals:

T series Manipulator Manual *Maintenance: 14.2 Replacing the Lithium Battery*

For California customers only

The lithium batteries in this product contain

Perchlorate Material - special handling may apply,

See www.dtsc.ca.gov/hazardouswaste/perchlorate.

Before Reading This Manual

NOTE



T series manipulators can use the Teach Pendant TP2 and TP3. Do not connect the other devices to TP port except TP2 and TP3. Connecting other devices may result in malfunction of the device since the pin assignments are different.

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

T series manipulator system is configured by a combination of the following software.

T3-401S		Controller Firmware
		Ver.7.3.51.1 or later
EPSON RC+ 7.0	Before Ver.7.3.0	!!!
	Ver.7.3.1 or later	OK

T6-602S		Controller Firmware
		Ver.7.3.53.0 or later
EPSON RC+ 7.0	Before Ver.7.3.3	!!!
	Ver.7.3.4 or later	OK

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

!!!: Compatible Connection is OK. It is recommended to use the following versions or later. Display or control may not be operated properly.

T3-401S: EPSON RC+7.0 Ver.7.3.1

T6-602S: EPSON RC+7.0 Ver.7.3.4

China RoHS

This sheet and environmental protection use period label are based on the regulation in China. These are not necessary to be concerned in other countries.

产品中有害物质的名称及含量

机器人型号名称		T系列					
部件名称		有害物质					
		铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
机器人部		×	○	○	○	○	○
电机（执行器单元、电机单元）		×	○	○	○	○	○
减速机单元		×	○	○	○	○	○
电磁制动器		×	○	○	○	○	○
同步皮带		○	○	○	○	○	○
电池单元 (电池、电池固定架、电池基板)		×	○	○	○	○	○
密封 (密封填料、油封、密封脂、 垫片、O型环)		×	○	○	○	○	○
润滑脂		○	○	○	○	○	○
电缆（M/C电缆、连接电缆）		×	○	○	○	○	○
散热片		○	○	○	○	○	○
LED指示灯		○	○	○	○	○	○
电路板		×	○	○	○	○	○
滚珠丝杠花键		○	○	○	○	○	○
制动解除开关		×	○	○	○	○	○
外罩		○	○	○	○	○	○
扎带		○	○	○	○	○	○
原点标记		○	○	○	○	○	○
气管接头		×	○	○	○	○	○
选件	相机安装板	×	○	○	○	○	○

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控制器型号名称		T系列					
部件名称		有害物质					
		铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr (VI))	多溴 联苯 (PBB)	多溴 二苯醚 (PBDE)
控制器部	电路板	×	○	○	○	○	○
	开关电源	×	○	○	○	○	○
	线束	×	○	○	○	○	○
	存储卡	×	○	○	○	○	○
	电池	○	○	○	○	○	○
	连接器附件	×	○	○	○	○	○
选 件	电路板	×	○	○	○	○	○
	接线	×	○	○	○	○	○
	接线端子	×	○	○	○	○	○
	紧急停止开关	×	○	○	○	○	○
	TP2	×	○	○	○	○	○
	TP3	×	○	○	○	○	○
	Hot Plug Kit	×	○	○	○	○	○
	CV1	×	○	○	○	○	○
	CV2	×	○	○	○	○	○
	相机	×	○	○	○	○	○
	延长管	×	○	○	○	○	○
	GigE相机PoE转换器	×	○	○	○	○	○
	GigE相机PoE交换集线器	×	○	○	○	○	○
	GigE相机三脚架适配器	×	○	○	○	○	○
	以太网交换机	×	○	○	○	○	○
USB选件密钥	×	○	○	○	○	○	

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

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:

 <p>WARNING</p>	<ul style="list-style-type: none">■ Personnel who design and/or construct the robot system with this product must read the <i>Safety</i> chapter in the <i>EPSON RC+ User's Guide</i> 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 robot system 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.
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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



This manual : *2. Installation*

Manipulator manual : *Setup & Operation 3. Environment and Installation*

1.2.2 Designing a Safe Robot System

It is important to operate Manipulator safely. It is also important for Manipulator 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 Manipulator 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 Manipulator 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 Manipulator 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 Manipulator, 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.

End Effector Design

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

Design the Manipulator 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 Manipulator 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 Manipulator body and Manipulator 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 Manipulator, 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 Manipulators 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 the emergency stop, the power supplied to the motor for driving the robot is shut off, and the robot is stopped due to the dynamic brake.

Make sure that all external components that shut off the power in case of emergency are turned OFF by the emergency stop circuit. Do not design to turn OFF the robot controller by using outputs of all I/O boards. For example, if the I/O board is faulty, the controller cannot turn OFF the power of external components. The emergency stop on the controller is hardwired to disconnect the motor power from the robot, but not the external power supplies.

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

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 Manipulator 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 from sharp corners and projections, and that the safeguard system itself is not dangerous.

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 Manipulator EMERGENCY connector. The safeguard input informs the Manipulator that an operator may be inside the safeguard area. When the safeguard input is activated, the Manipulator 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 Manipulator 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 Manipulator 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 Manipulator cannot automatically restart.

Resetting the Safeguard

Ensure that the robot system can only be restarted through careful operation from outside the safeguarded system. The Manipulator 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.

Manipulator Operation Panel


When using the Manipulator 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:



- 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 speed 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 operation of 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.

 <p>WARNING</p>	<ul style="list-style-type: none">■ To shut off power to the robot system, disconnect the power plug from the power source. Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source.■ Before performing any replacement procedure, turn OFF the Robot System and related equipment, and then disconnect the power plug from the power source. Performing any replacement procedure with the power ON is extremely hazardous and may result in electric shock and/or malfunction of the robot system.■ Do not connect or disconnect the motor connectors while the power to the robot system is turned ON. Connecting or disconnecting the motor connectors with the power ON is extremely hazardous and may result in serious bodily injury as the Manipulator may move abnormally, and also may result in electric shock and/or malfunction of the robot system.
---	---

 <p>CAUTION</p>	<ul style="list-style-type: none">■ Whenever possible, only one person should operate the robot system. If it is necessary to operate the robot system with more than one person, ensure that all people involved communicate with each other as to what they are doing and take all necessary safety precautions.■ Joint #1, #2, and #4: If the joints are operated repeatedly with the operating angle less than 5 degrees, they may get damaged early because the bearings are likely to cause oil film shortage in such situation. To prevent early breakdown, move the joints larger than 50 degrees for about five to ten times a day. Joint #3: If the up-and-down motion of the hand is less than 10 mm, move the joint a half of the maximum stroke for five to ten times a day.
--	---



- Oscillation (resonance) may occur continuously in low speed Manipulator motion (Speed: approx. 5 to 20%) depending on combination of Arm orientation and end effector load. Oscillation arises from natural oscillation frequency of the Arm and can be controlled by following measures.

Changing Manipulator speed

Changing the teach points

Changing the end effector load

- Manipulator may be warmed up due to motor heat or similar causes. Do not touch the Manipulator until temperature falls. Also, make sure the temperature of the Manipulator falls and is not hot when you touch it. Then perform teaching or maintenance.

1.3.1 Safety-related Requirements

Specific tolerances and operating conditions for safety are contained in the manuals for the Manipulator, 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.

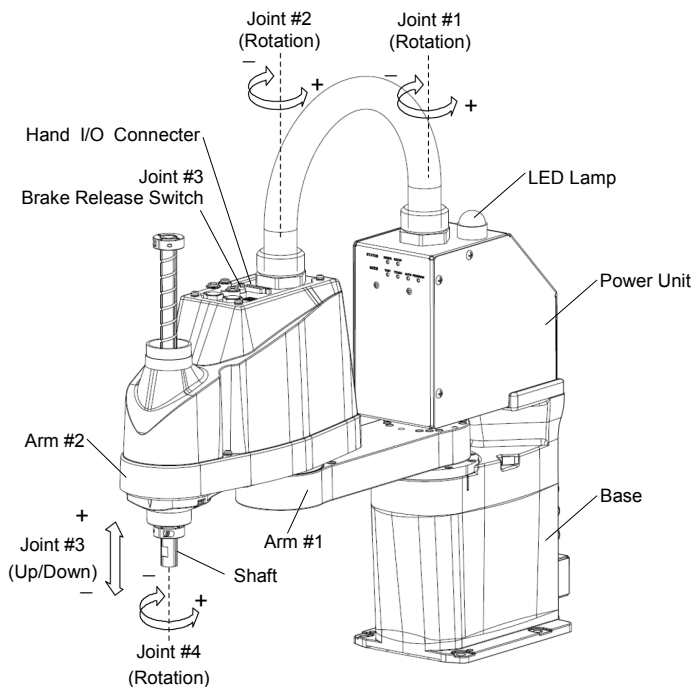
Robot system safety standards and other examples are given in this chapter. To ensure that safety measures are satisfied, also refer to these standards.

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

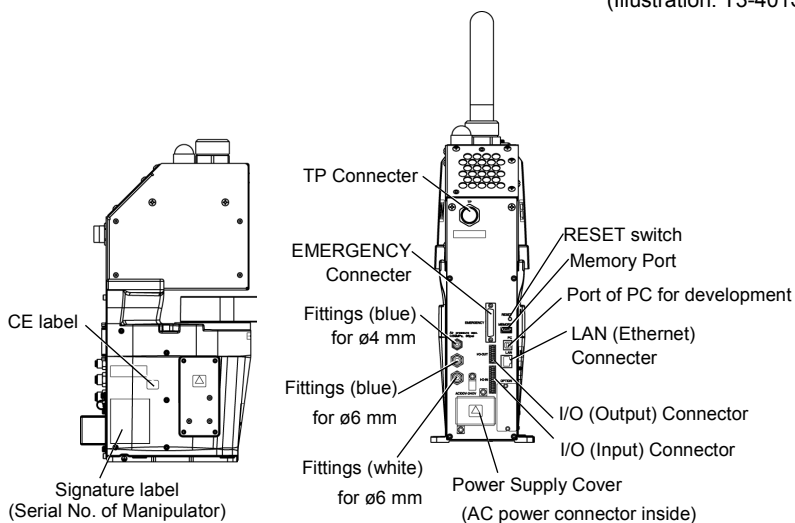
EN ISO 10218-1	Robots and robotic devices -- Safety requirements for industrial robots -- Part 1: Robots
EN ISO 10218-2	Robots and robotic devices -- Safety requirements for industrial robots -- Part 2: Robot systems and integration
ANSI/RIA R15.06	American National Standard for Industrial Robots and 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

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





(Illustration: T3-401S)



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 Rotate the shaft by hand.

 **NOTE** 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.

 **NOTE** When the following errors are occurred, the manipulator brake is not released even if pressing the brake release switch. Check the cable connections and remove the error causes. Then, apply the power again and release the brake.

Errors: 1552, 2118, 4003, 4004, 4009, 4100, 4101, 4103, 4187, 4188, 4189, 4191, 4192, 4233, 4240, 4285-4292, 9633, 9640, 9691, 9685-9692

1.3.3 Operation Modes

The Robot system has three operation modes.

- TEACH mode** This mode enables point data teaching and checking close to the Robot using the Teach Pendant. In this mode the Robot operates in Low power status.
- AUTO mode** This mode enables automatic operation (program execution) of the Robot system for the manufacturing operation, and also programming, debug, adjustment, and maintenance of the Robot system. This mode cannot operate the Robots or run programs with the Safety Door open.
- TEST mode** This mode enables program verification while the Enable Switch is held down and the safeguard is open. This is a low speed program verification function (T1: manual deceleration mode) which is defined in Safety Standards. This mode can operate the specified Function with multi-task / single-task, multi-Manipulator / single-Manipulator at low speed.

1.4 Maintenance Safety


Please read this section, *Maintenance* of the Manipulator 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.



- 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. 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.

 <p>WARNING</p>	<ul style="list-style-type: none">■ 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, disconnect 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 Manipulator and related equipment, and then disconnect the power plug from the power source. Performing any replacement procedure with the power ON is extremely hazardous and may result in electric shock and/or malfunction of the robot system.■ Be sure to connect the cables properly. Do not allow unnecessary strain on the cables. (Do not put heavy objects on the cables. Do not bend or pull the cables forcibly.) The unnecessary strain on the cables may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system.
--	--

 <p>CAUTION</p>	<ul style="list-style-type: none">■ 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.<ul style="list-style-type: none">- 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.
--	---



- 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.
- Manipulator may be warmed up due to motor heat or similar causes. Do not touch the Manipulator until temperature falls. Also, make sure the temperature of the Manipulator falls and you do not feel hot when you touch it. Then perform teaching or maintenance.

1.5 Emergency Stop

1.5.1 Free running distance in emergency

If the Manipulator moves abnormally during operation, immediately press the Emergency Stop switch. Pressing the Emergency Stop switch immediately changes the Manipulator to deceleration motion and stops it at the maximum deceleration speed.

However, avoid pressing the Emergency Stop switch unnecessarily while the Manipulator is running normally. Pressing the Emergency Stop switch locks the brake and it may cause wear on the friction plate of the brake, resulting in the short life of the brake.

Normal brake life cycle: About 2 years (when the brakes are used 100 times/day)

To place the system in emergency mode during normal operation, press the Emergency Stop switch when the Manipulator is not moving.

Refer to the Manipulator manual for instructions on how to wire the Emergency Stop switch circuit.

Do not turn OFF the Manipulator while the Manipulator is operating.

If you attempt to stop the Manipulator in emergency situations such as “Safeguard Open”, make sure to stop the Manipulator using the Emergency Stop switch.

If the Manipulator is stopped by turning OFF 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 Manipulator was forced to be turned OFF by blackouts and the like while the Manipulator is operating, make sure to check the following points after power restoration.

- Whether or not the reduction gear is damaged

- Whether or not the joints are in their proper positions

If there is a position gap, perform calibration by referring to the *Maintenance 16*.

Calibration in the Manipulator manual. Also, the same troubles may occur if an error occurs and the Manipulator stops in emergency during the operation. Check the Manipulator condition and perform calibration if necessary.

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

2.1.2 Inspection Point - Inspection While the Power is ON

(Manipulator is operating)

Safety and Installation

5.1.1 Manipulator - Inspection While the Power is ON

(Manipulator is operating)

Free running distance in emergency

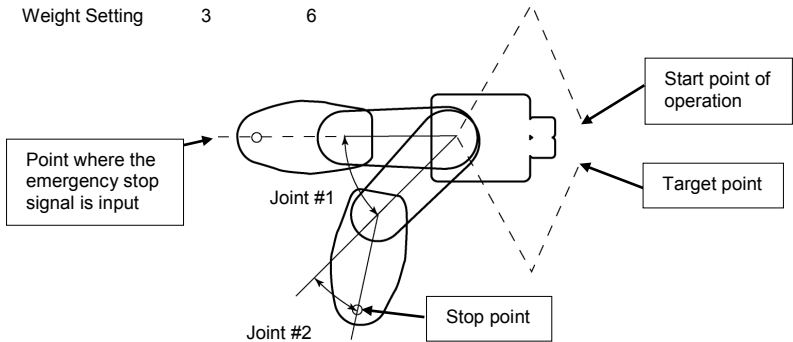
The operating Manipulator cannot stop immediately after the Emergency Stop switch is pressed.

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.

Conditions for Measurement	T3-401S	T6-602S
Accel Setting	100	100
Speed Setting	100	100
Load [kg]	3	6
Weight Setting	3	6

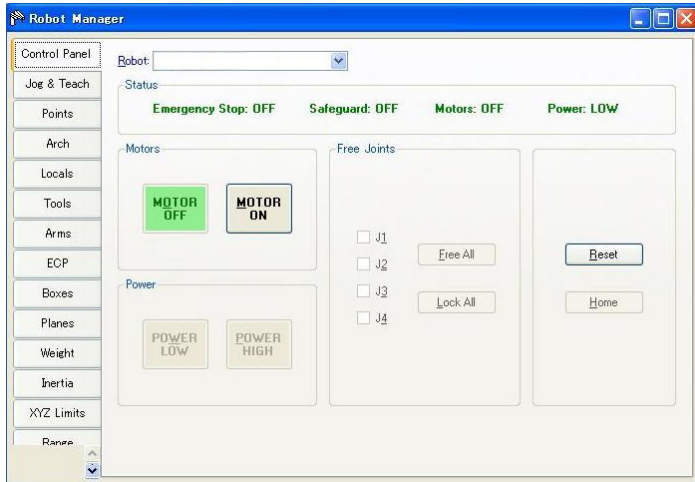


			T3-401S	T6-602S
Free running time	Joint #1 + Joint #2	[s]	0.5	0.4
	Joint #3	[s]	0.2	0.2
Free running angle	Joint #1	[deg]	50	60
	Joint #2	[deg]	50	30
	Joint #1 + Joint #2	[deg]	100	90
Free running distance	Joint #3	[mm]	20	40

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

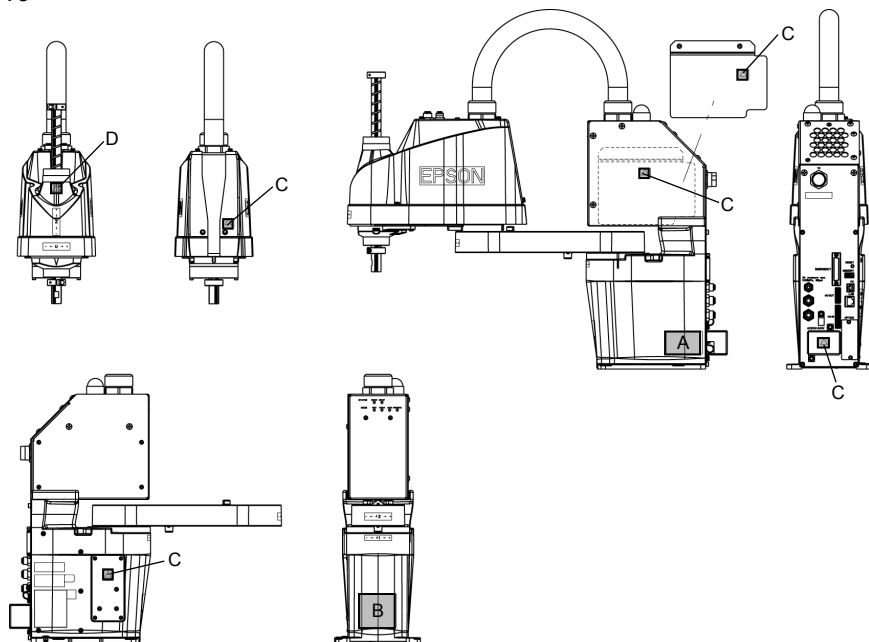
Labels are attached around the locations of the Manipulator where specific dangers exist.

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

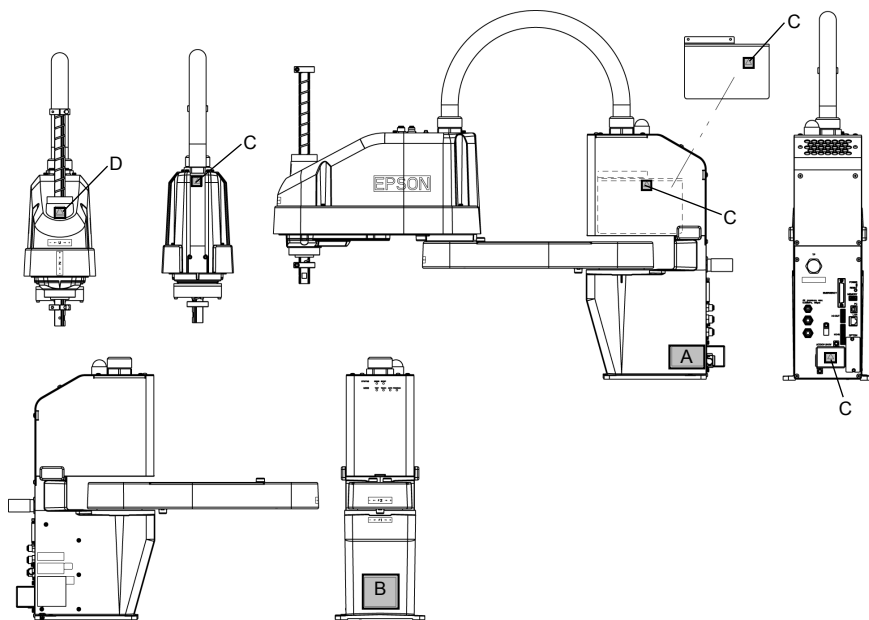
Do not tear, damage, or remove the labels. Use meticulous care when handling those parts or units to which the following labels are attached as well as the nearby areas:

Location	Label	Note
A		<p>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.</p> <p>For installation and transportation of robots, follow the directions in this manual.</p>
B		<p>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.</p>
C		<p>Hazardous voltage exists while the Manipulator is ON. To avoid electric shock, do not touch any internal electric parts.</p>
D		<p>You can catch your hand or fingers between the shaft and cover when bringing your hand close to moving parts.</p>

T3



T6



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 *2.6.1 Safety Door Switch and Latch Release Switch*.

Emergency Stop Switch

The EMERGENCY connector on the Manipulator 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 Manipulator.

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 Manipulator 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 Manipulator 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 of the Manipulator is detected.

1.8 Manipulator Specifications

Item		T3-401S	T6-602S
Arm length	Arm #1, #2	400 mm	600 mm
	Arm #1	225 mm	325 mm
	Arm #2	175 mm	275 mm
Weight (cables not included)		16 kg: 35 lb.	22 kg: 49 lb
Driving method	All joints	AC servo motor	
Max. operating speed*1	Joints #1, #2	3700 mm/s	4180 mm/s
	Joint #3	1000 mm/s	1000 mm/s
	Joint #4	2600 deg/s	1800 deg/s
Repeatability	Joints #1, #2	± 0.02 mm	± 0.04 mm
	Joint #3	± 0.02 mm	± 0.02 mm
	Joint #4	± 0.02 deg	± 0.02 deg
Max. motion range	Joint #1	± 132 deg	± 132 deg
	Joint #2	± 141 deg	± 150 deg
	Joint #3	150 mm	200 mm
	Joint #4	± 360 deg	± 360 deg
Max. pulse range	Joint #1	- 95574 ~ 505174	- 152918 ~ 808278
	Joint #2	± 320854	± 341334
	Joint #3	-187734 ~ 0	- 245760 ~ 0
	Joint #4	± 71760	± 245760
Resolution	Joint #1	0.000439 deg/pulse	0.000275deg/pulse
	Joint #2	0.000439 deg/pulse	0.000439 deg/pulse
	Joint #3	0.000799 mm/pulse	0.000814 mm/pulse
	Joint #4	0.005017deg/pulse	0.01465deg/pulse
Motor energy consumption	Joint #1	200 W	300 W
	Joint #2	100 W	200 W
	Joint #3	100 W	
	Joint #4	100 W	
Payload (Load)	Rated	1 kg	2 kg
	Max.	3 kg	6 kg
Joint #4 allowable moment of inertia *2	Rated	0.003 kg·m ²	0.01 kg·m ²
	Max.	0.01 kg·m ²	0.08 kg·m ²
Hand	Shaft diameter	ø 16 mm	ø 20 mm
	Through hole	ø 11 mm	ø 14 mm
Joint #3 down force		83 N	
Hand I/O Connector		15 pin: D-sub	
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)	
Mounting hole		120 × 120 mm	150 × 150 mm
		4-M8	
Environmental requirements	Ambient Temp.	5 to 40 degrees C (with minimum temperature variation)	
	Ambient relative humidity	20 to 80% (no condensation)	
Noise level *3		L _{Aeq} = 80 dB (A)	

1. Safety

Item		T3-401S	T6-602S
Noise level *3		L _{Aeq} = 80 dB (A)	
Assignable Value () Default values	Speed	1 ~ (5) ~ 100	1 ~ (5) ~ 100
	Accel *4	1 ~ (10) ~ 120	1 ~ (10) ~ 120
	SpeedS	0.1 ~ (50) ~ 2000	0.1 ~ (40) ~ 2000
	AccelS	0.1 ~ (200) ~ 10000	0.1 ~ (200) ~ 10000
	Fine	0 ~ (1250) ~ 65000	0 ~ (1250) ~ 65000
	Weight	0,175 ~ (1,175) ~ 3,175	0,275 ~ (2,275) ~ 6,275
Motion Control	Development Environment	EPSON RC+ 7.0	
	Programming Language	SPEL+ (multi-tasking robot language)	
	Joint Control	Standard 4 joints simultaneous control Digital AC servo control	
	Positioning Control	PTP (Point-To-Point control) CP (Continuous Path control)	
	Speed Control	PTP motion : Programmable in the range of 1 to 100% CP motion : Programmable (Actual value to be manually entered.)	
	Acceleration/ Deceleration Control	PTP motion : Programmable in the range of 1 to 100%; Automatic CP motion : Programmable (Actual value to be manually entered.)	
External Interface	EMERGENCY		EMERGENCY STOP: Redundant (Category 3) Supported for internal/external power supply Safeguard System: Redundant (Category 3) Supported for external power supply
	I/O	Standard I/O (Rear side of Manipulator)	Input: 18 points Output: 12 points Non-polar, Supported for both Sink and Source
		Remote I/O (Remote functions are applied to Standard I/O)	Input: 8 points Program: 3 points Start, Stop, Pause, Continue, Reset Output: 8 points Ready, Running, Paused, ErrorEStopOn, SafeguardOn, SError, Warning
		Hand I/O (Upper side of Arm #2)	Input: 6 points Output: 4 points Non-polar, Supported for both Sink and Source
		Power supply: up to 24V 500mA	Power supply: up to 24V 700mA

Item		T3-401S	T6-602S
External Interface	Field bus Slave (Option)	Input: 256 points Output: 256 points Enable to add only one more module	
	TP Connection Port	Supported for teach pendant (Option: TP2, TP3)	
	PC Connection Port	USB B connector Supported for USB 2.0 High Speed / Full Speed	
	USB Memory Connection Port	USB A connector Supported for USB 2.0 High Speed / Full Speed	
	Ethernet Port	Supported for 10/100 Mbps Available up to 8 ports	
	RESET Switch	Enable to use for reset of system	
Display	Mode Display LED	TEACH, AUTO, PROGRAM, TestMode, Error, E-STOP	
Controller Status Save		Save to USB memory Save in RC+ (PC)	
Voltage		100 V ~ 240 VAC	
Phase		Single phase	
Frequency		50 / 60 Hz	
Momentary Power Interrupt		Less than 10 ms	
Power Consumption		660 VA	1,200 VA
Peak Current (When AC power is turned ON)		Max. 30A (Less than 2 ms.)	Max. 60A (Less than 2 ms.)
Leak Current		Max. 10 mA	
Ground Resistance		Less than 100Ω	
Safety standard		CE Mark EMC Directive, Machinery Directive ANSI/RIA R15.06-2012 NFPA 79 (2007 Edition)	

*1: In the case of PTP command.

Maximum operating speed for CP command is 2000 mm/s on horizontal plane.

*2: In the case where the center of gravity is at the center of Joint #4.

If the center of gravity is not at the center of Joint #4, set the parameter using Inertia command.

*3: Conditions of Manipulator during measurement as follows:

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

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

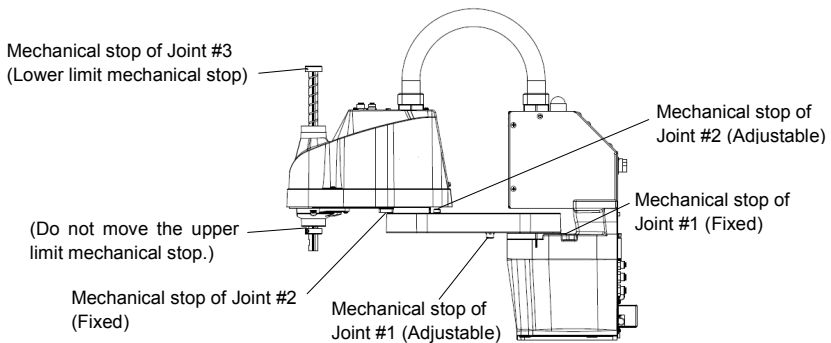
*4: In general use, Accel setting 100 is the optimum setting that maintains the balance of acceleration and vibration when positioning. Although values larger than 100 can be set to Accel, it is recommended to minimize the use of large values to necessary motions since operating the Manipulator continuously with the large Accel setting may shorten the product life remarkably.

1.9 Motion Range Setting by Mechanical Stops

Mechanical stops physically limit the absolute area that the Manipulator cannot 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.



1.10 End User Training

Persons in charge of safety management should confirm that the operators who program, operate, and maintain the robot and robot system take proper training and have 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.

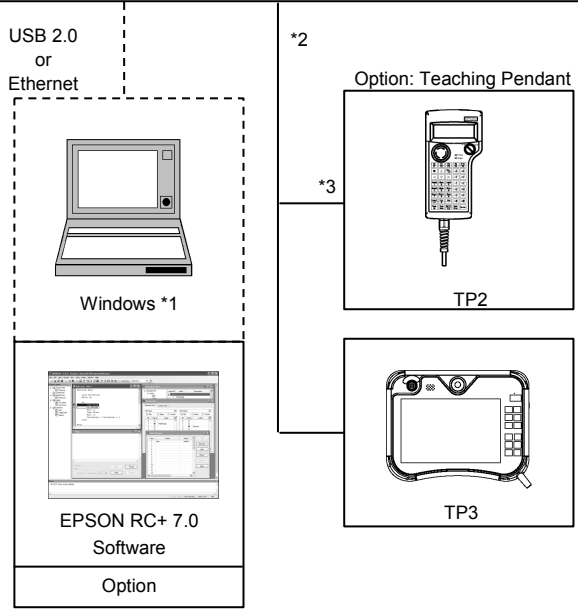
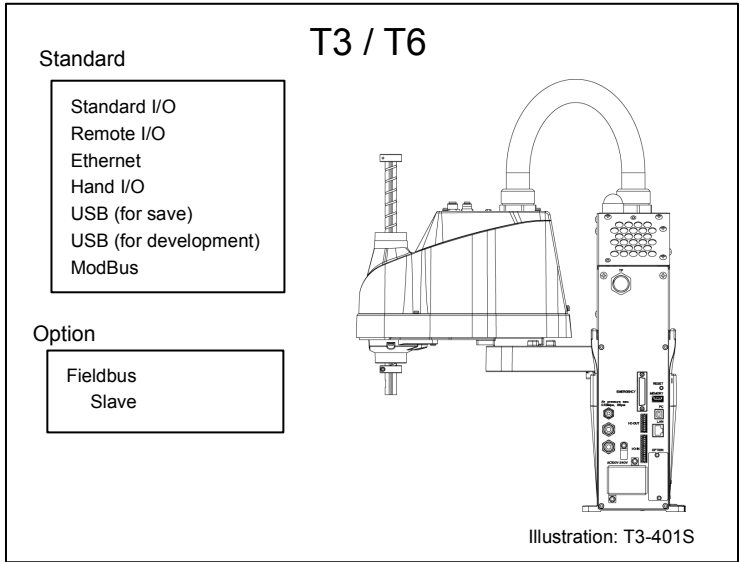
2. Installation

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

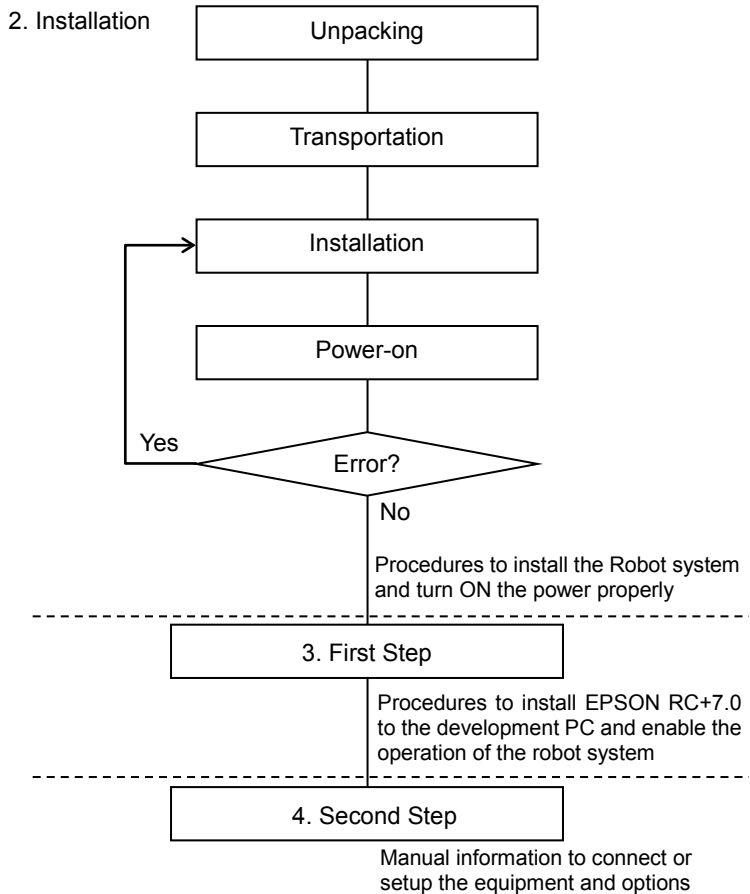
The workflow for installing the robot system is described in *2.1 Outline from Unpacking to Operation of Robot System*. For unpacking, transportation, and installation, refer to the respective section and the Manipulator manuals.

System Example

- *1 EPSON RC+ 7.0 supports the following OS
 - Windows 7 Professional Service Pack 1
 - Windows 8.1 Pro (EPSON RC+7.0 Ver.7.1.0 or later)
 - Windows 10 Pro (EPSON RC+7.0 Ver.7.2.0 or later)
- *2 Either teaching pendant is available.
- *3 If connecting to T series, dedicated convert cable is necessary.



2.1 Outline from Unpacking to Operation of Robot System



2.2 Unpacking

Installation and transportation of manipulators 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 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 manipulators 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.

Sheet

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

Hoisting procedure

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

2.3.2 Manipulator Transportation

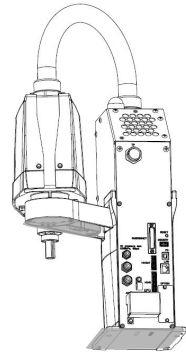
To carry the Manipulator, have two or more people to work on it and secure the Manipulator to the delivery equipment or hold the bottom of Arm #1 and or bottom of the base areas (indicated in gray in the figure) by hand.

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

T3-401S: approx. 16 kg: 35 lb.

T6-602S: approx. 22 kg: 49 lb.

Make sure not to hold the power unit when carrying the manipulator.



(Illustration: T3-401S)

2.4 Manipulator Installation

Installation and transportation of manipulators 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

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

Item	Conditions
Ambient temperature *	5 to 40°C (with minimum temperature variation)
Ambient relative humidity	20 to 80% (no condensation)
First transient burst noise	2 kV or less
Electrostatic noise	4 kV or less
Environment	<ul style="list-style-type: none"> - Install indoors. - Keep away from direct sunlight. - Keep away from dust, oily smoke, salinity, metal powder or other contaminants. - Keep away from flammable or corrosive solvents and gases. - Keep away from water. - Keep away from shocks or vibrations. - Keep away from sources of electric noise. - Keep away from strong electric or magnetic fields.

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

Special Environmental Conditions

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

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

If your requirements specify that the Manipulator handles food, please consult your distributor to check whether the Manipulator will damage the food or not.

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



- Use an earth leakage breaker on the AC power cable of the manipulators to avoid electric shock and circuit breakdown caused by short circuit.



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

2. Installation

2.4.3 Noise level

Noise level by movement of the Manipulator.

T series: LAeq = 80 dB (A) or less

Operating conditions

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

Measurement point

Rear 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:

	T3	T6
Max. Reaction torque on the horizontal plate	150 Nm	350 Nm
Max. Horizontal reaction force	500 N	750 N
Max. Vertical reaction force	900 N	1500 N

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

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




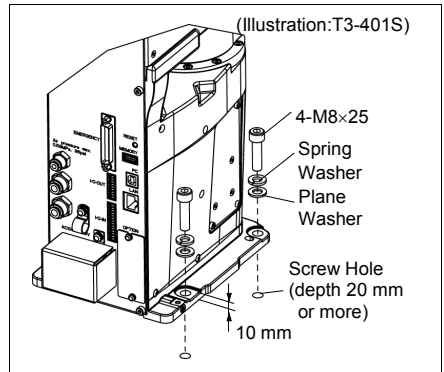
- Install the Manipulator with two or more people.
The Manipulator weights are as follows. Be careful not to get hands, fingers, or feet caught and/or have equipment damaged by a fall of the Manipulator.
T3-401S: approx. 16 kg: 35 lb.
T6-602S: approx. 22 kg: 49 lb.

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

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

Tightening torque:
 $32.0 \pm 1.6 \text{ N}\cdot\text{m}$

NOTE  Make sure to remove wire tie for mechanical stop protector.

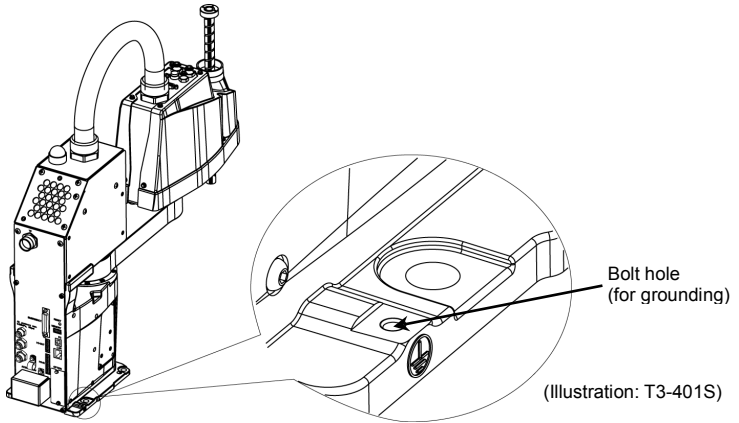


2. Installation

Grounding

Follow local regulations for grounding. It is recommended that the core size of the grounding wire be 5.5 mm² or more.

Directly connect the ground line to the Manipulator using bolt hole in the figure below.



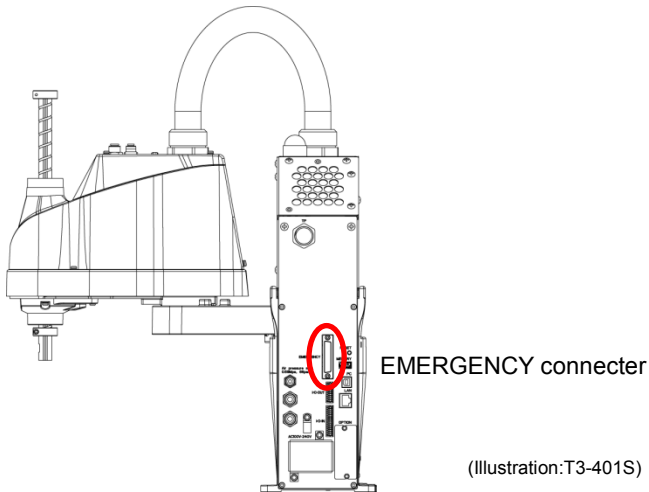
2.5 Connection to EMERGENCY Connector

Connect a safeguard switch or Emergency Stop switch to the EMERGENCY connector for safety.

When nothing is connected to the EMERGENCY connector, Controller does not operate normally.



- Make sure that emergency stop or safety door operate properly before operating, not only booting but also usage changed such as options added or parts replaced as maintenance.
- Before connecting the connector, make sure that the pins are not bent. Connecting with the pins bent may damage the connector and result in malfunction of the robot system.



2.5.1 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 (Manipulator side)	D-Sub 25 pin female (board side) D-Sub 25 pin male (cable side)

2.5.2 Safety Door Switch



- 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. covering the switch with tape). 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 set up around the Manipulator. The safeguard must have an interlock switch at the entrance to the working zone. 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 regards it as 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.

2.5.3 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.



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.

2.5.4 Checking Latch Release Switch Operation

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.



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.

2.5.5 Emergency Stop Switch

If it is desired to create an external Emergency Stop switch in addition to the Emergency Stop on the Teach Pendant, 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:

The Emergency Stop switch connected must comply with the following and related safety standard (IEC60947-5-5, etc.):

- 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 install the switch by referring to the 2.5.8: *Circuit Diagrams*.

2.5.6 Checking Emergency Stop Switch Operation

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 Manipulator to boot the controller software while pressing the Emergency Stop switch.
- (2) Make sure that E-STOP LED of the Manipulator 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.

2.5.7 Pin Assignments

The EMERGENCY connector pin assignments are as follows: (D-Sub 25 pin male)

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 (+) * ⁴	16	ESTOP2+	Emergency Stop circuit 2 (+) * ⁴
4	ESTOP1-	Emergency Stop circuit 1 (-) * ⁴	17	ESTOP2-	Emergency Stop circuit 2 (-) * ⁴
5	Not used	* ¹	18	SDLATCH1	Safety Door Latch Release
6	Not used	* 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	Not used	* ¹			


*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.

*⁴ Do not apply reverse voltage to the Emergency Stop circuit.

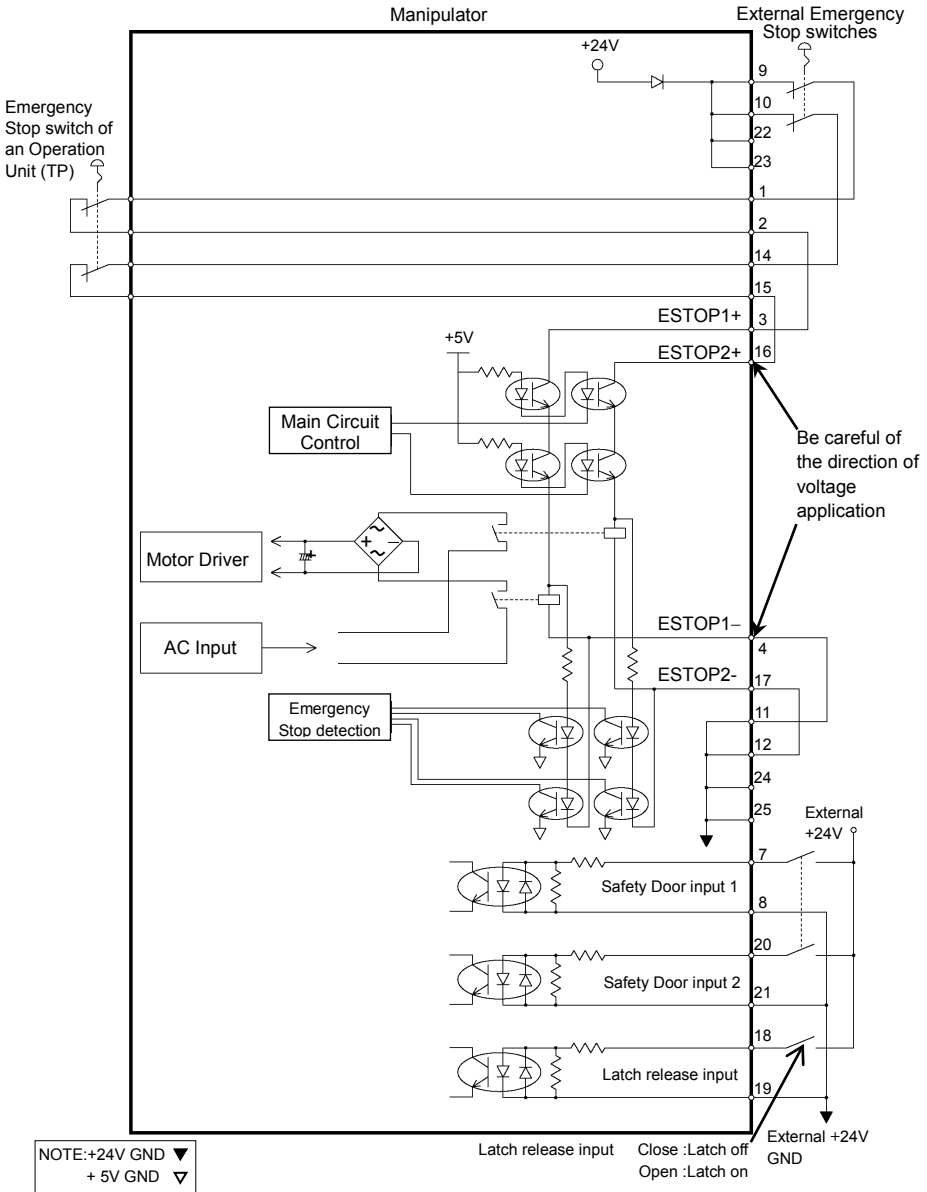
Emergency Stop switch output rated load	+30 V 0.3 A or under	1-2, 14-15 pin
Emergency Stop rated input voltage range	+24 V $\pm 10\%$	3-4, 16-17 pin
Emergency Stop rated input current	37.5 mA $\pm 10\%$ / +24V input	
Safety Door rated input voltage range	+24 V $\pm 10\%$	7-8, 20-21 pin
Safety Door rated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

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

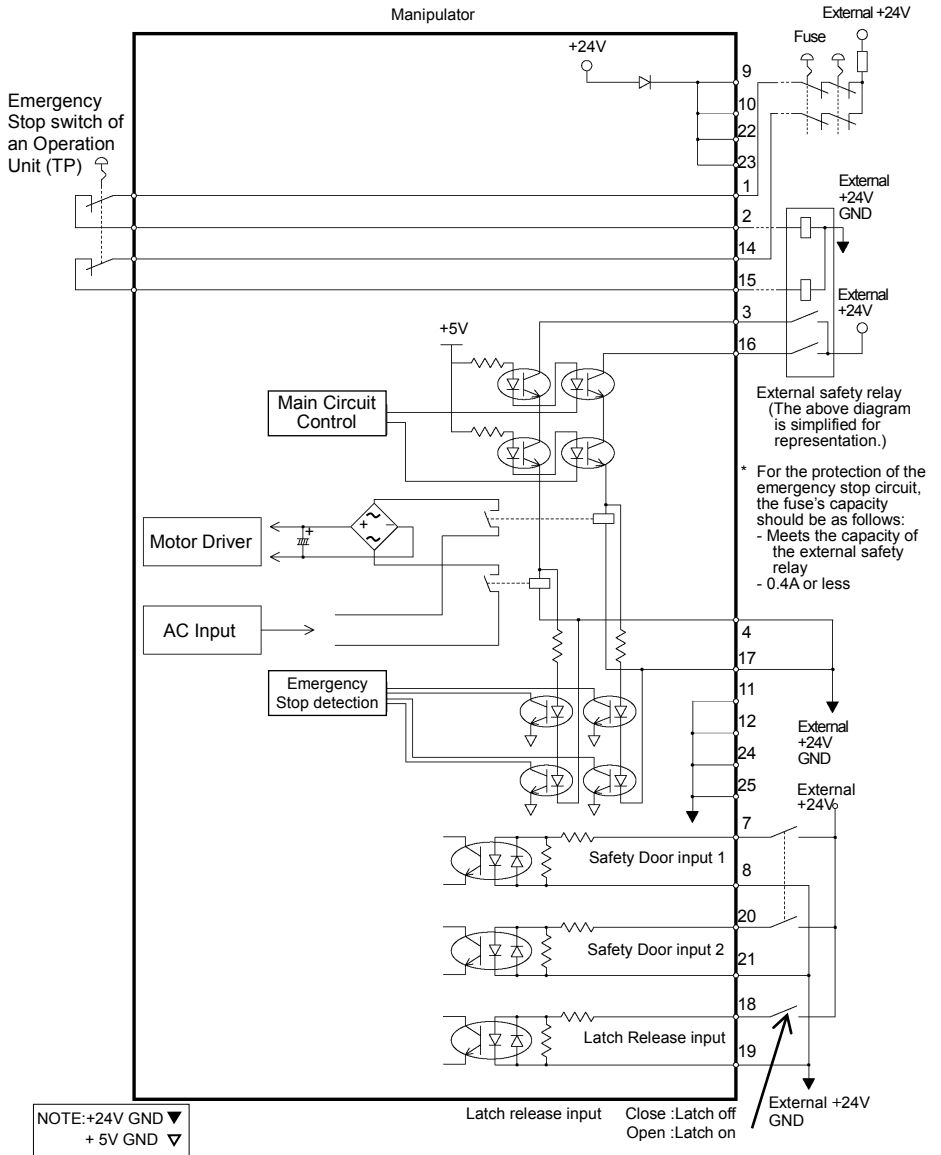
 CAUTION	<ul style="list-style-type: none"> ■ The 24 V output is for emergency stop. Do not use it for other purposes. Doing so may result in system malfunction. ■ Do not apply reverse voltage to the Emergency Stop circuit. Doing so may result in system malfunction.
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2.5.8 Circuit Diagrams


Example 1: External emergency stop switch typical application



Example 2: External safety relay typical application



2.6 Power supply, AC power cable, Breaker

	<ul style="list-style-type: none"> There is no power switch on the Manipulator. Right after inserting power plug to power, the Robot System turns ON. Be careful about electric shock when inserting power plug.
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2.6.1 Power Supply

Ensure that the power meets the following specifications.

Item	Specification
Voltage	100 to 240 VAC (Input voltage should be with in $\pm 10\%$ of the rated voltage.)
Phase	Single phase
Frequency	50/60 Hz
Momentary Power Interrupt	Less than 10 ms.
Power Consumption	T3: 660 VA T6: 1,200 VA
Peak Current (When AC power is turned ON)	T3: approximately 30A (Less than 2 ms.) T6: approximately 60A (Less than 2 ms.)
Leakage Current	Max. 10 mA
Ground Resistance	Less than 100 Ω

Install an earth leakage circuit breaker or a circuit breaker in the AC power cable line.

For the rated electric current of the circuit breaker, refer to the following and set values.

Manipulator	Power	Rated electric current
T3	AC100V	10A
	AC200V	5A
T6	AC100V	20A
	AC200V	10A

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.

2.6.2 AC Power Cable



- Make sure that operations are done by a qualified personal.
- Be sure to connect the earth wire (green/yellow) of the AC power cable to the earth terminal of the factory power supply.
Also, we recommend to ground directly via a hole on the base to ground the manipulator completely.
The equipment must be grounded properly at all times to avoid the risk of electric shock.
- Always use a power plug or a disconnecting device for power connecting cable. Never connect the Controller directly to the factory power supply.
- Select the plug or a disconnecting device which conform safety standards for nations.

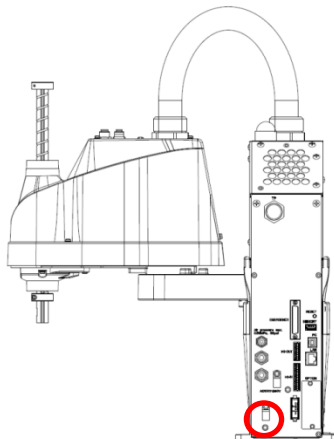
When connecting the connector of AC cable to the Manipulator, make sure to insert completely.

Item	Specification
AC power wire (2 cables)	Black, White
Ground wire	Green/Yellow
Cable length	5 m
Terminal	M4 round solderless terminal

NOTE



Use cable clamp on rear side of the Manipulator to fix AC power cable.



AC power Cable Clamp
(Illustration:T3-401S)

2.7 Power-on

2.7.1 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. If an error occurs, stop the operation and contact us.

Shipping bolts and jigs check before turning ON

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

Power activation

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

When supplying the power again

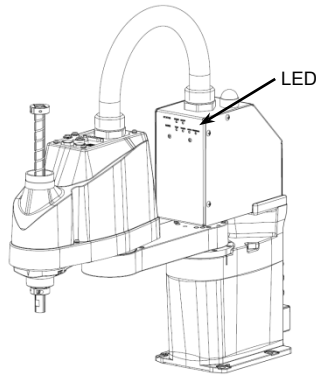
- : When supplying the power to the Manipulator again, turn OFF the controller and wait for 5 seconds or more. Then, turn ON the Manipulator again.

2.7.2 Power ON Procedure

- (1) Check the EMERGENCY connector connection.
- (2) Connect the TP bypass plug to the TP port.
- (3) Connect the AC power cable to the Manipulator
- (4) Connect the AC power cable to the power supply socket.
- (5) The PROGRAM LED blinks approximately 30 seconds after Controller starts up normally.

If the ERROR LED is turned ON or blinking, check connection in step (1) to (4) and turn ON the power again.

If the ERROR LED is still ON or blinking, contact the supplier in your region.



(Illustration: T3-401S)

2.8 Saving Default Status

The Manipulator is already setup with the purchased Manipulator (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 following.

T series Manipulator manual: Setup & Operation 8. Memory port

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 Manipulator 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.

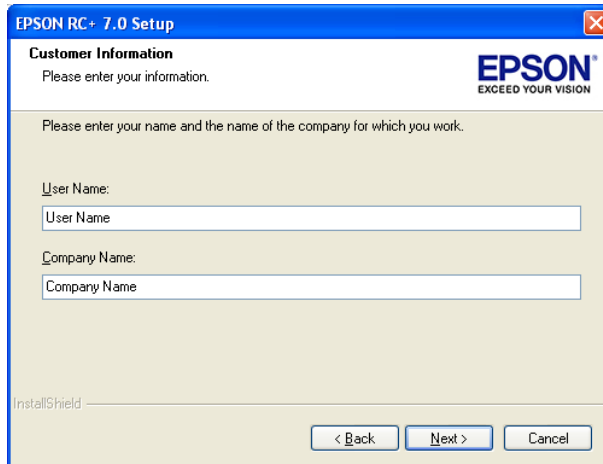
3.1 Installing EPSON RC+ 7.0 Software

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 <Next>.



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

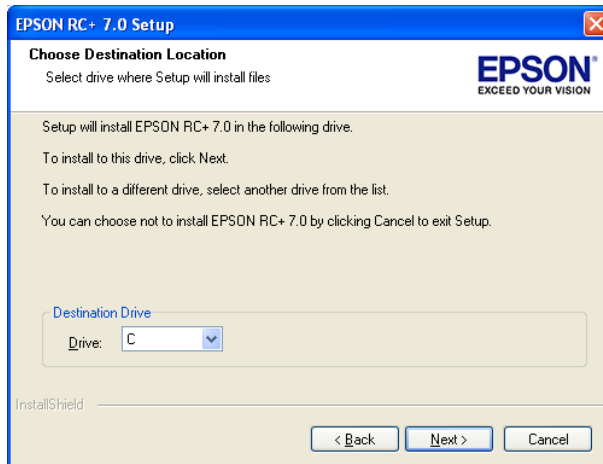


The screenshot shows the 'Customer Information' dialog box for EPSON RC+ 7.0 Setup. The window title is 'EPSON RC+ 7.0 Setup'. The main heading is 'Customer Information' with the instruction 'Please enter your information.' and the EPSON logo. Below this, it says 'Please enter your name and the name of the company for which you work.' There are two text input fields: 'User Name' and 'Company Name'. At the bottom, there are three buttons: '< Back', 'Next >', and 'Cancel'. The 'InstallShield' logo is visible in the bottom left corner.

- (4) Select the drive where you want to install EPSON RC+ 7.0 and click <Next>.

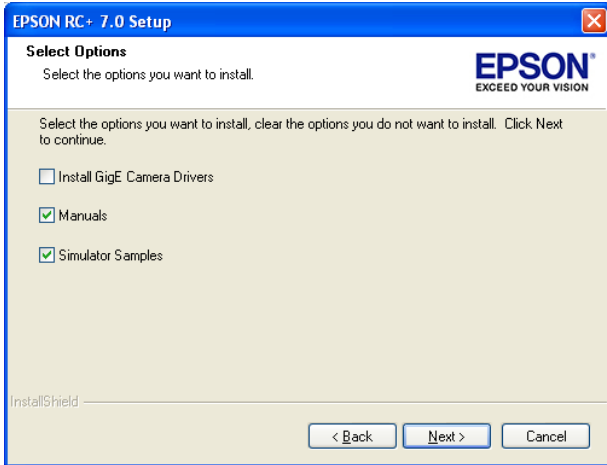


The installation directory is called EpsonRC70. This cannot be changed.

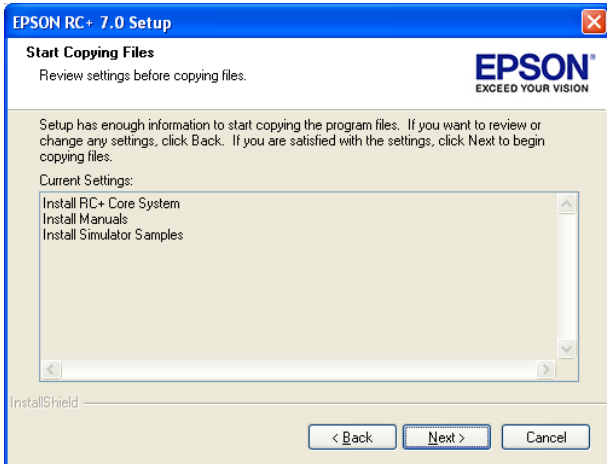


The screenshot shows the 'Choose Destination Location' dialog box for EPSON RC+ 7.0 Setup. The window title is 'EPSON RC+ 7.0 Setup'. The main heading is 'Choose Destination Location' with the instruction 'Select drive where Setup will install files' and the EPSON logo. Below this, it says 'Setup will install EPSON RC+ 7.0 in the following drive. To install to this drive, click Next. To install to a different drive, select another drive from the list. You can choose not to install EPSON RC+ 7.0 by clicking Cancel to exit Setup.' There is a 'Destination Drive' section with a dropdown menu showing 'Drive: C'. At the bottom, there are three buttons: '< Back', 'Next >', and 'Cancel'. The 'InstallShield' logo is visible in the bottom left corner.

- (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.

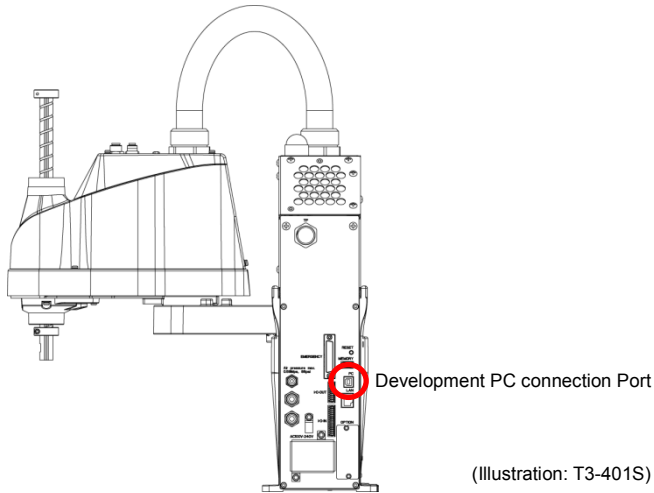


Adobe Reader needs to be installed on your PC in order to view the EPSON RC+ 7.0 manuals. If the installer cannot find Adobe Reader on your system, it will be installed at this time. Follow the instructions in the Adobe installer. Do not restart the system after the Adobe Reader installation has completed.

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

3.2 Development PC and Manipulator Connection

Connect the development PC and the development PC connection port for connection.



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

Be sure to install the EPSON RC+7.0 to the development PC first, then connect the development PC and Manipulator with the USB cable.

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

3. First Step

Development PC connection port supports hot plugging. Insertion and removal of the cables while the power of the development PC and the Manipulator are ON is available. However, the manipulator stops when the USB cable is removed while the Manipulator and the development PC are connected.

3.2.2 Precaution

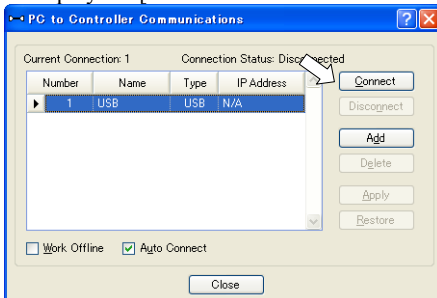
When connecting the development PC and the Manipulator, make sure of the following.

- Connect the development PC and the Manipulator 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 apply excessive force to the connector.
- When development PC and the Manipulator is connected, do not insert or remove other USB devices from the development PC. Connection with the Manipulator may disconnect.

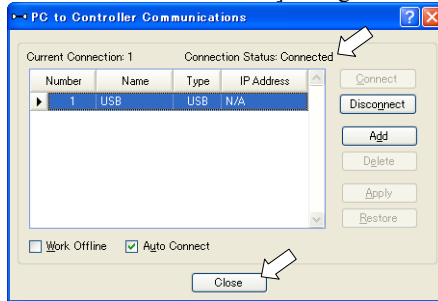
3.2.3 Software Setup and Connection Check

The following is the steps of connecting the development PC and the Manipulator.

- (1) Make sure that the EPSON RC+ 7.0 is installed on the Manipulator connected to the development PC. (Install the software when it is not installed.)
- (2) Connect the development PC and the Manipulator by the USB cable.
- (3) Turn ON the Manipulator.
- (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 Manipulator 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 Manipulator is completed. Now robot system can be used from EPSON RC+ 7.0.

3.2.4 Backup the Initial Condition of the Manipulator

Backup the Manipulator data configured before shipment.

Project and system configuration backup procedure:

- (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 Manipulator

Disconnection of the development PC and the Manipulator 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.
Manipulator and the development PC is disconnected and USB cable can be removed.

NOTE



If the USB cable is removed while the Manipulator and the development PC are connected, the Manipulator stops. Be sure to click the <Disconnect> button in the [PC to Controller Communications] dialog before removing the USB cable.

3.2.6 Moving the Manipulator to Initial Position

Manipulator can be operated by the 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

Manually move the Manipulator that is free from the servo control.

You can move Joint #3 by hand while the break release switch on the Manipulator is being pressed with the controller ON.

Joints #1, #2, and #4 can be moved by hand.

Also, you can move the Manipulator manually by releasing the solenoid brake from the command window of the EPSON RC+.

B: Command execution from the EPSON RC+

Move the Manipulator by exciting the Manipulator 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].

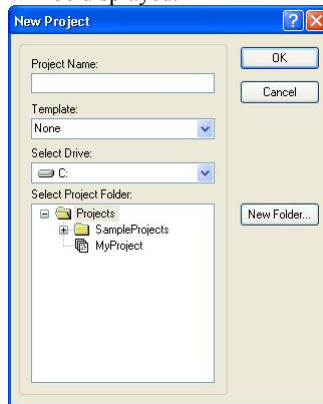
```
>Motor On  
>Go Pulse (0,0,0,0)
```

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

C: Jog motion from the EPSON RC+

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

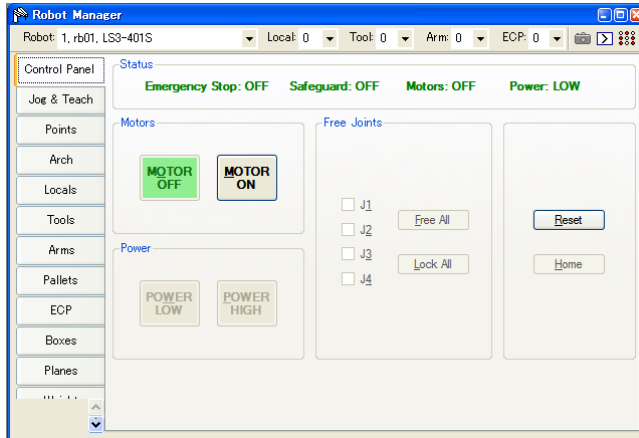
- (1) Start the EPSON RC+ 7.0.
Double click the <EPSON RC+ 7.0> icon on the desktop.
- (2) Create a new project.
 1. Select [New] from the [Project] Menu. The [New Project] dialog box will be displayed.



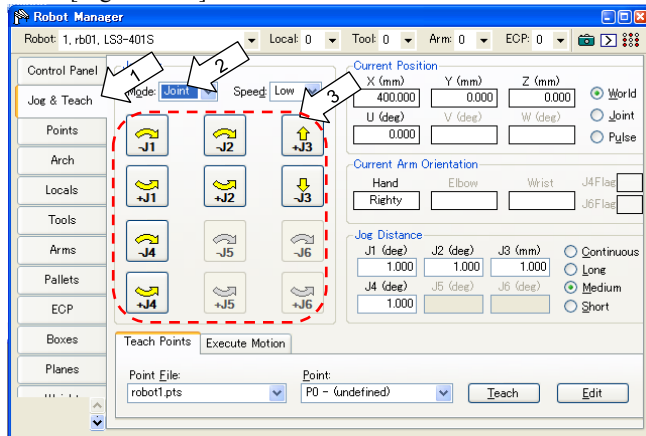
2. Type a project name in the [New Project Name] box.
(e.g. FirstApp)
 3. Click the <OK> button to create the new project.
- (3) Open the Robot Manager.
EPSON RC+ 7.0 menu-[Tools]-[Robot Manager].

3. First Step

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



- Move the manipulator with Jog motion.
 - Select [Jog & Teach] tab.



- Select "Joint" in [Jogging]-<Mode>.
- Move the manipulator by joint by clicking J1-J4 jog keys.
Manipulator can be moved by setting to other modes or setting the jog distance.

3.3 Writing Your First Program

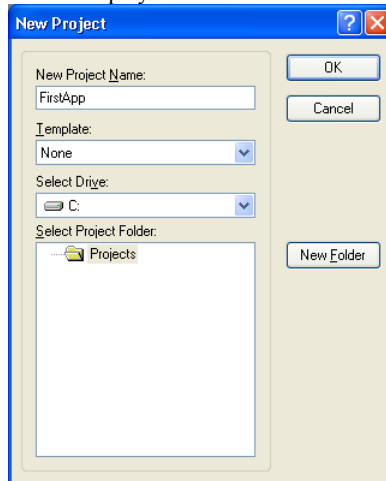
After installing the Manipulator and EPSON RC+ 7.0 software on your PC, follow the instructions below to create a simple application program so that you will become more familiar with the EPSON RC+ 7.0 development environment.

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. The [New Project] dialog box will be displayed.



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

(3) Click the <OK> button to create the new project.

When the new project is created, a program called Main.prg is created. The window titled Main.prg will be displayed with a cursor flashing in the upper left corner.

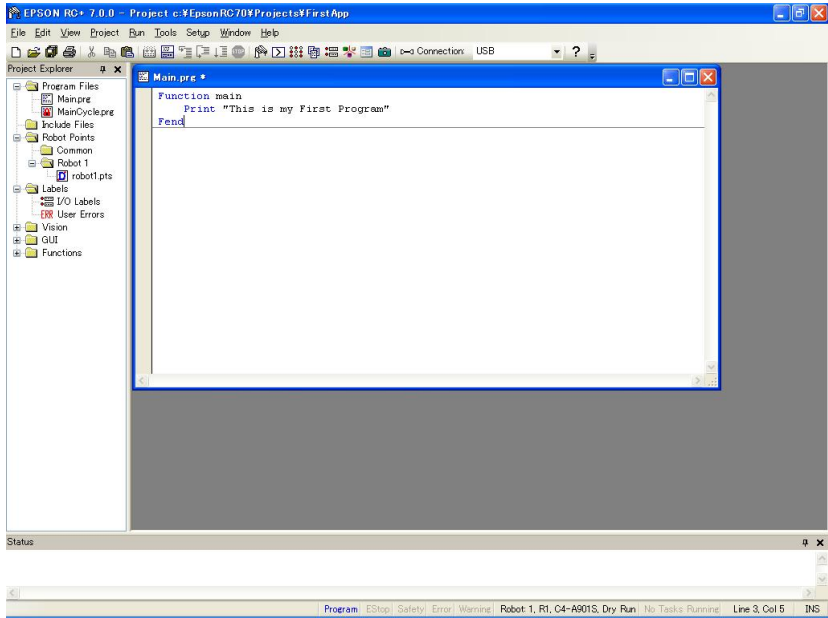
Now you are ready to start entering your first program.

3. First Step

3. Edit the program

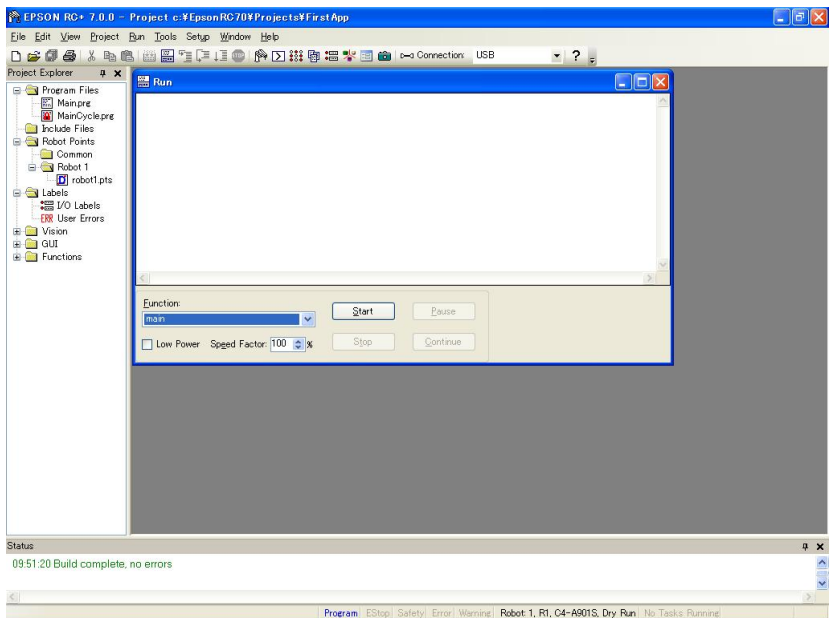
Type the following program lines in the Main.prg edit window.

```
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 Manipulator 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) The tasks like the following will be displayed in the status window.

19:32:45 Task main started


19:32:45 All tasks stopped

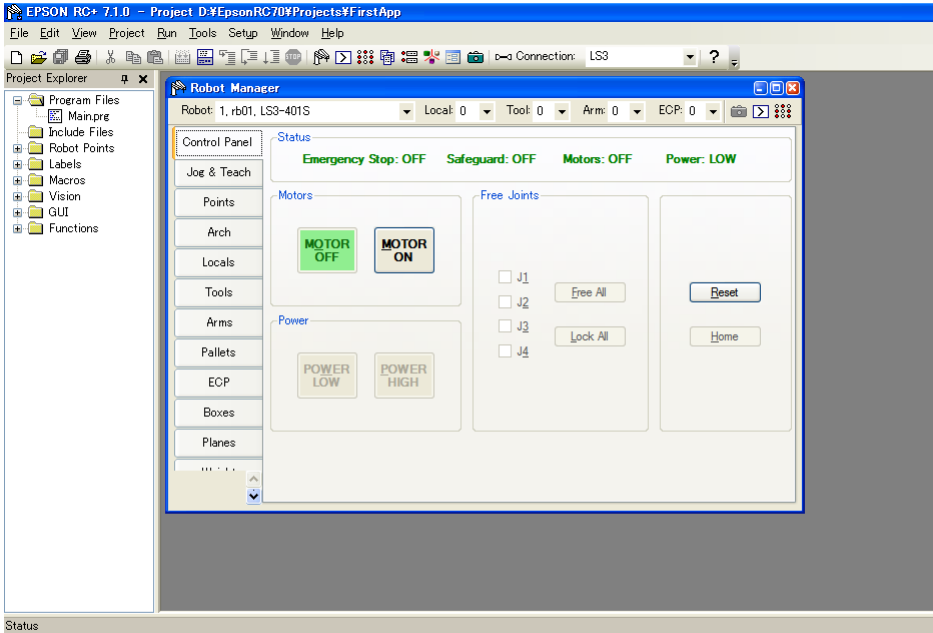
On the Run window, you will see the output of the print statement.

3. First Step

Now let's teach some Manipulator points and create a program to move the Manipulator.

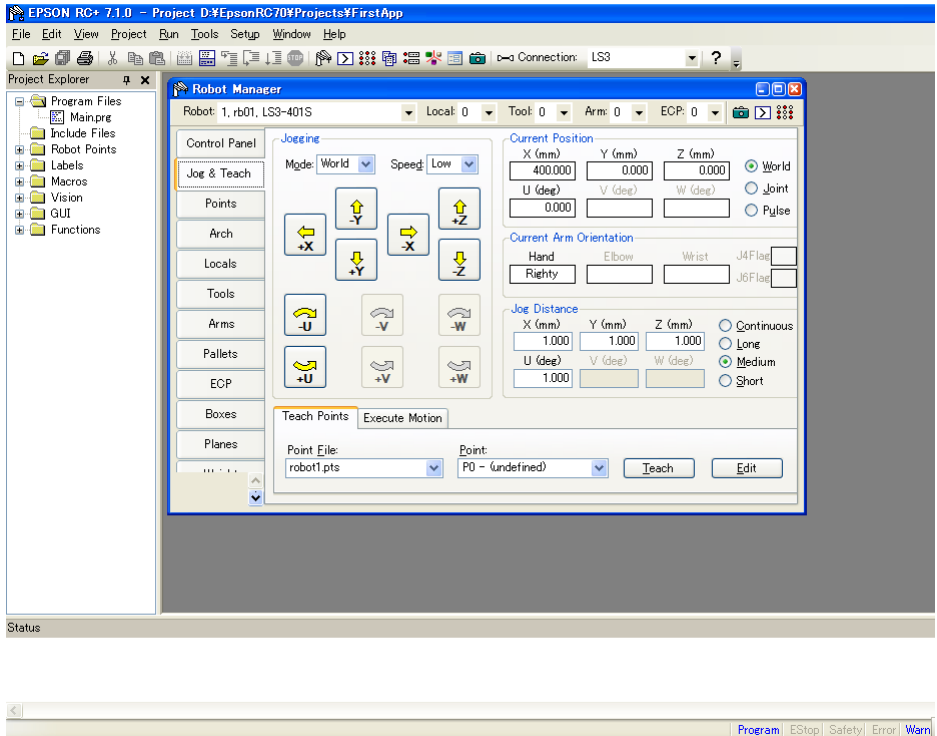
5. Teach robot points

- (1) Make sure that it is safe to operate the Manipulator. Click the <Robot Manager> button  on the toolbar to display the [Robot Manager] window.




- (2) Click the [Control Panel] tab.
Then, click the <Motor On> button to turn on the Manipulator motors. You will be prompted to confirm the operation.
- (3) Click the <Yes> button 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) Click the <+Y> jog button to jog the robot in +Y direction. Hold down the button to keep jogging. Move the Manipulator until it reaches the middle of the work envelope.
- (7) Click the <-Z> button to lower the Z axis of the Manipulator.
- (8) Select "P1" in the [Point (P)] dropdown list which is next to the <Teach> button. The current point is set to P1.
- (9) Click the <Teach> button. You will see a confirmation message to teach the point.
- (10) Click the <Yes> button.
- (11) Click the <+X> button to jog the Manipulator in the +X direction.
- (12) Select "P2" in the [Point (P)] dropdown list which is next to the <Teach> button. The current point is set to P2.

3. First Step

- (13) Click the <Teach> button. You will see a confirmation message to teach the point.
- (14) Click the <Yes> button.
- (15) Click the <Save Project>  toolbar button to save the changes.

6. Modify the program to include Manipulator 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) Press F5 to display the Run window.
- (3) Click the <Start> button to execute the program.
The Manipulator will move to the points you taught.

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

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

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

- (2) Press F5 to display the Run window.
- (3) Click the <Start> button to execute the program.
The Manipulator will move to each of the points you taught at 20% speed, acceleration, and deceleration. The Power High statement executes the program to operate the robot with increased speed and acceleration.

8. Backup the project and system configuration

Even though this is only a sample project, we will backup the project and Manipulator configuration. Backup can be done easily 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 the steps below to back up the project and system configuration:

- (1) Select the EPSON RC+ 7.0 menu - [Project] - [Copy].
- (2) Change the [Destination Drive] to an arbitrary drive.
- (3) Click <OK>. The project will be copied to the external media.
- (4) Select the EPSON RC+ 7.0 menu - [Tools] - [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

After operating the robot system as instructed in 3. *First Step*, setup other functions as necessary.

This section shows the manuals which contains information of necessary settings and setting procedure.

(For details of the manuals, refer to 6. *Manuals*.)

4.1 Connection with External Equipment

4.1.1 Remote Control

EPSON RC+ 7.0 User's Guide *Remote Control*

T series Manipulator Manual *Setup & Operation: 14. I/O Remote Set Up*

I/O

EPSON RC+ 7.0 User's Guide *I/O Setup*

T series Manipulator Manual *Setup & Operation: 12. Standard I/O Connector Setup & Operation: 13. Hand I/O Connector*

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*

T series Manipulator Manual *Setup & Operation: 7. LAN (Ethernet) Port*

4.2 Ethernet Connection of Development PC and Manipulator

EPSON RC+ 7.0 User's Guide *Ethernet Communication*

T series Manipulator Manual *Setup & Operation: 7. LAN (Ethernet) Port*

4.3 Connection of Option Teaching Pendant

T series Manipulator Manual *Setup & Operation: 10. TP Port*

ROBOT CONTROLLER RC700 / RC90 Option Teach Pendant TP2

Function & Installation: 3. Installation

ROBOT CONTROLLER RC700-A Option Teach Pendant TP3

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

h = hour

5. General Maintenance

Inspection While the Power is ON (Manipulator is operating)

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

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

Inspection Point	Inspection Place	Daily	Monthly	Quarterly	Biannual	Annual
Check looseness or backlash of bolts/screws. Tighten them if necessary. (For the tightening torque, refer to <i>Tightening Hexagon Socket Head Cap Bolts.</i>)	End effector mounting bolts	√	√	√	√	√
	Manipulator mounting bolts	√	√	√	√	√
	Each joint	√	√	√	√	√
	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 <i>5.4 Greasing.</i>					
Lithium Battery	Refer to <i>5.5 Handling and Disposal of Lithium Batteries</i>					

5.2 Overhaul (Parts Replacement)



- Overhaul timing is based on an assumption that all joints are operated for equal distance. If a particular joint has a high duty or high load, it is recommended to overhaul all joints (as many as possible) before exceeding 20,000 operation hours with the joint as a basis.

The parts for the manipulator joints may cause accuracy decline or malfunction due to deterioration of the manipulator resulting from long term use. In order to use the manipulator for a long term, it is recommended to overhaul the parts (parts replacement).

The time between overhauls is 20,000 operation hours of the Manipulator as a rough indication. (When operated with the maximum motion speed and maximum acceleration / deceleration in continuous operation) However, it may vary depending on usage condition and the load applied on the Manipulator.



For the EPSON RC+ 7.0 the recommended replacement time for the parts subject to maintenance (motors, reduction gear units, and timing belts) can be checked in the [Maintenance] dialog box.

For details, refer to the following manual.

T series Manipulator Manual: *Maintenance 4. Alarm*

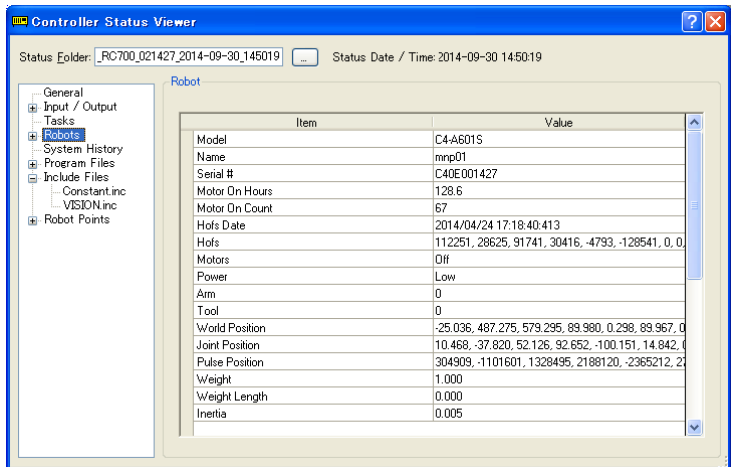
Note:

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

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

- (1) Select EPSON RC+ menu-[Tools]-[Controller] to open the [Controller Tools] dialog.
- (2) Click the <View Controller Status> button to open the [Browse For Folder] dialog.
- (3) Select the folder where the information is stored.
- (4) Click the <OK> button to view the [Controller Status Viewer] dialog.

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



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

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

Please contact the distributors of your region for further information.

5.3 Tightening Hexagon Socket Head Cap Bolts

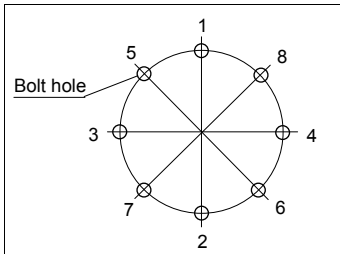
Hexagon socket head cap bolts are used in places where mechanical strength is required. (A hexagon socket head cap bolt will be called a “bolt” in this manual.) These bolts are fastened with the tightening torques shown in the following table. When it is necessary to refasten these bolts in some procedures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

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

Refer below for the set screw.

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

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




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

5.4 Greasing

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

This section contains information of the parts requiring lubrication and greasing intervals. For details of the lubrication procedure, refer to the Manipulator manual.

 CAUTION	<ul style="list-style-type: none"> ■ Keep enough grease in the Manipulator. Operating the Manipulator with insufficient grease damages the sliding parts resulting in insufficient Manipulator performance. It may also require a lot of time and money for repair. ■ If grease gets into your eyes, mouth, or on your skin, follow the instructions below. <p>If grease gets into your eyes: Flush them thoroughly with clean water, and then see a doctor immediately.</p> <p>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.</p> <p>If grease gets on your skin Wash the area thoroughly with soap and water.</p>
---	--

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

Joint #1, 2 reduction gear units

As a rough indication, perform greasing at the same timing as overhaul.

However, the timing may vary depending on usage condition and the load applied on the Manipulator (such as when operated with the maximum motion speed and maximum acceleration / deceleration in continuous operation).

Joint #3 Ball screw spline unit

The recommended greasing interval is at 100 km of operation.

However, greasing timing also can be checked from the grease condition.

Perform greasing if the grease is discolored or becomes dry as shown in the photos below.




Normal grease



Discolored grease

Perform greasing at 50 km of operation for the first time of greasing.

NOTE  For the EPSON RC+ 7.0 the recommended replacement time for the grease can be checked in the [Maintenance] dialog box.

For details, refer to the following manual.

T series Manipulator Manual: *Maintenance 4. Alarm*

5.5 Handling and Disposal of Lithium Batteries



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



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

The life span of the lithium battery varies depending on the energizing hours and installation environment of the Manipulator. It is about 7 years as a rough guide (when the Controller is connected to power for 8 hours a day). When the Manipulator is not connected to power, the battery consumption will significantly increase compared to when the Manipulator is energized. If warnings of voltage reduction occur, replace the lithium battery even if it has not reached the above product life.

NOTE



For the EPSON RC+ 7.0 the recommended replacement time for the battery can be checked in the [Maintenance] dialog box.

For details, refer to the following manual.

T series Manipulator Manual: *Maintenance 4. Alarm*

The battery may run out if it passes the recommended replacement time.

If no warnings of voltage reduction occur, the calibration for all joints is not necessary. You need to perform calibration if the position moves from the originals after replaced the battery.

Be sure to use the designated lithium battery.

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

6. Manuals

This section describes contents of each manual.

The manuals below are provided in PDF format for using the robot system.

To read the PDF manuals on a PC, select EPSON RC+ 7.0-[Help]-[PDF Manual].

(Click <Start>-[Program]-[EPSON RC+ 7.0] from the Windows desktop.)

Software

EPSON RC+ 7.0 User's Guide

This manual contains information on 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

EPSON RC+ 7.0 SPEL+ Language Reference

This manual contains information on the SPEL+ programming language.

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

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
- Fieldbus I/O
- Teach Pendant TP2, TP3

Manipulator

EPSON SCARA ROBOT T series

The manipulator manuals contain information on the T3 / T6 series manipulator.

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

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	T series
Manipulator	

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

