EPSON

Industrial Robot: SCARA ROBOT

T-B series

MANUAL

Rev.6 ENM238R5896F

Original instructions

SCARA Robots T-B series Manual Rev.6

Industrial Robot: SCARA ROBOT

T-B series Manual

Rev.6

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FOREWORD

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

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

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

TRADEMARKS

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

TRADEMARK NOTATION IN THIS MANUAL

Microsoft® Windows® 8 operating system
Microsoft® Windows® 10 operating system
Microsoft® Windows® 11 operating system
Throughout this manual, Windows 8, Windows 10 and Windows 11 refer to above respective operating systems. In some cases, Windows refers generically to Windows 8, Windows 10 and Windows 11.

NOTICE

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

MANUFACTURER

SEIKO EPSON CORPORATION

CONTACT INFORMATION

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

Robot System Safety Manual Read this manual first

DISPOSAL

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

Regarding battery disposal

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

Maintenance Manual

For European Union customers only



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.

NOTE

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, and to customers in countries in Europe, Middle East and Africa (EMEA) where they have implemented equivalent regulations.
For other countries, please contact your local government to investigate the possibility of recycling your product.

For Users in Taiwan region



Please separate used 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.

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

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

CAUTION	■ Necessity of organizational measures for cyber security The following organizational measures should be taken to address cyber security risks: - Perform risk analysis based on security threats and vulnerabilities related to your organization's assets. - Develop a security policy to address risks and educate and train appropriate personnel. - Create guidelines for how to respond when security issues arise and make them known throughout your organization. ■ Security measures for network connections Epson robot systems are designed to be used within a closed local area network. Please refrain from connecting to networks with Internet access. If a connection to the Internet is required, please implement the necessary technical measures* to protect from malicious attacks and vulnerabilities over the Internet. *: These measures include, but are not limited to, access controls, firewalls, data diodes, and so on.

NOTE "T-B" and "T-B series" described in this manual are the following models.

T3-B series

T6-B series

NOTE T-B series Manipulators can use the Teach Pendant (TP2, 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 Manipulator.

NOTE If written T series in the reference information, read it as T-B series.

Features of T-B series Manipulators

The T-B series Manipulators are Controller integrated Manipulators.

Structure of Robot System

The T-B series Manipulators can be used with the following combinations of software.

T3-B401S, T6-B602S		Controller Firmware
		Ver.7.5.51.1 or later
EPSON RC+ 7.0	Ver.7.5.1 or earlier	!!!
	Ver.7.5.1A or later	OK

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

!!!: Compatible Connection is OK. It is recommended to use the EPSON RC+ 7.0 Ver.7.5.1A or later. Display or control may not be operated properly.

Shape of Motors

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

Setting by Using Software

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



The Manuals of This Product

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

Safety Manual (book, PDF)

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

Read this manual first.

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

T-B series Manual (PDF) (Controller integrated Manipulators)

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

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

Status Code/Error Code List (PDF)

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

T-B series Maintenance Manual (PDF) (Controller integrated Manipulators)

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

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

EPSON RC+ 7.0 User's Guide (PDF)

This manual describes general information about program development software.

EPSON RC+ 7.0 SPEL+ Language Reference (PDF)

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

Other Manual (PDF)

Manuals for each option are available.

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Installation

This volume describes the flow from unpacking to operation, and designing the robot system.

1. Safety

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

Please read "*Safety Manual*" before installing the robot system or before connecting cables and check the safety considerations.

Keep this manual handy for easy access at all times and reread it when you find anything unclear.

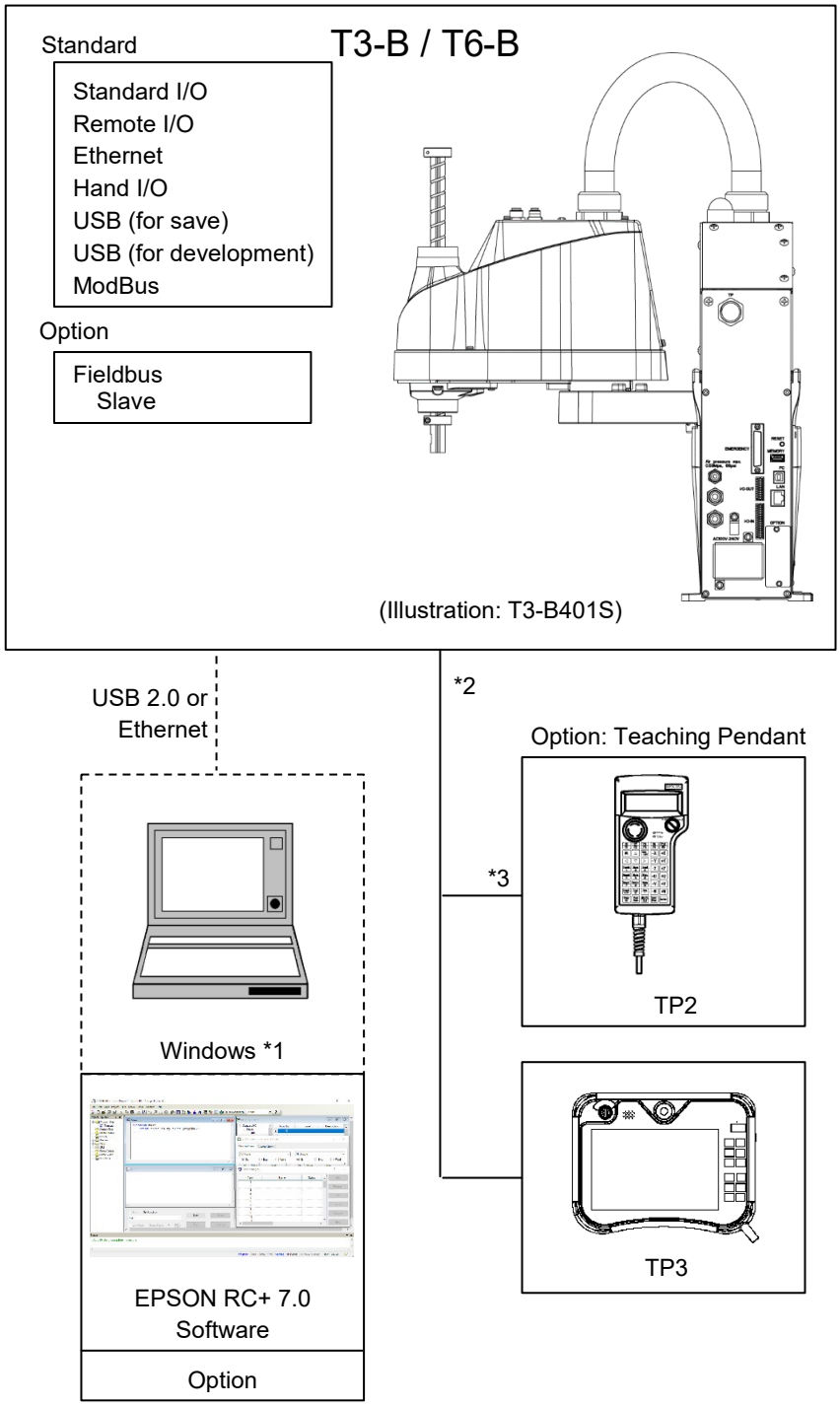
1.1 Conventions

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

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

2. Installation

2.1 System Example



*1 For system requirements, refer to the following manual:
EPSON RC+ 7.0 User's Guide

*2 Either teaching pendant is available.

*3 If connecting to T3-B/T6-B Manipulator, dedicated convert cable is necessary.

2.2 Unpacking

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

Please read "*Safety Manual*" before installing the robot system or before connecting cables and check the safety considerations.

2.3 Transportation

2.3.1 Transportation Precautions

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

Please read "*Safety Manual*" before installing the robot system or before connecting cables and check the safety considerations.

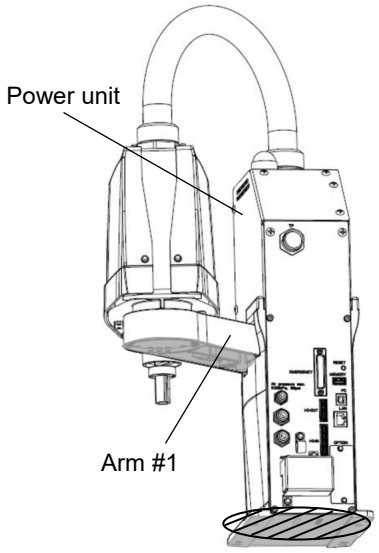
2.3.2 Holding Position and Number of People to Transport Manipulator

Holding position when transporting: Under arm #1 or bottom of base*

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

The number of people to transport: At least two

Prohibited part to hold: Power unit



(Illustration: T3-B401S)

2.4 Environments and Installation

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

Please read "*Safety Manual*" before installing the robot system or before connecting cables and check the safety considerations.

For details, refer to "*T3-B T6-B Manipulator 3. Environments and Installation*".

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.

For details, refer to "*T3-B T6-B Manipulator 11. EMERGENCY*".

3. Power-On

3.1 Power supply, Power cable, Braker

 WARNING	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.

For power supply, power cable, and braker, refer to "*T3-B T6-B Manipulator 3.6 Power Supply*".

3.2 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.

3.3 Power On Procedure

(1) Check the EMERGENCY connector connection.

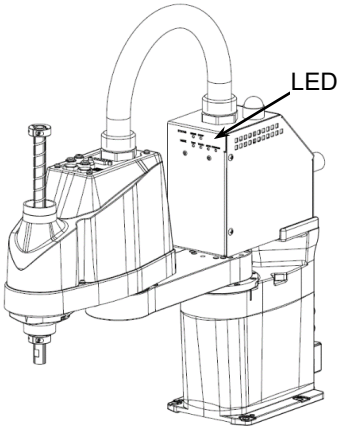
(2) Connect the TP bypass plug to the TP port.

(3) Connect the power cable to the Manipulator.

(4) Connect the 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-B401S)

3.4 Saving the Factory Default

The manipulator you purchased is set up in the manipulator as the factory default. It is recommended to save the factory default state of the Controller in case of emergency. For saving, prepare a USB memory.

For saving the Controller state, refer to "*T3-B T6-B Manipulator 8. Memory Port*".

4. 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.

4.1 Installing EPSON RC+ 7.0 Software

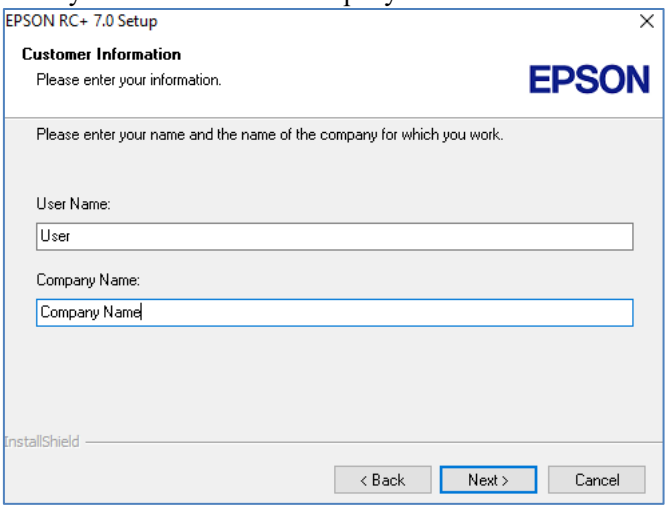
The EPSON RC+ 7.0 software needs to be installed on your development PC.

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

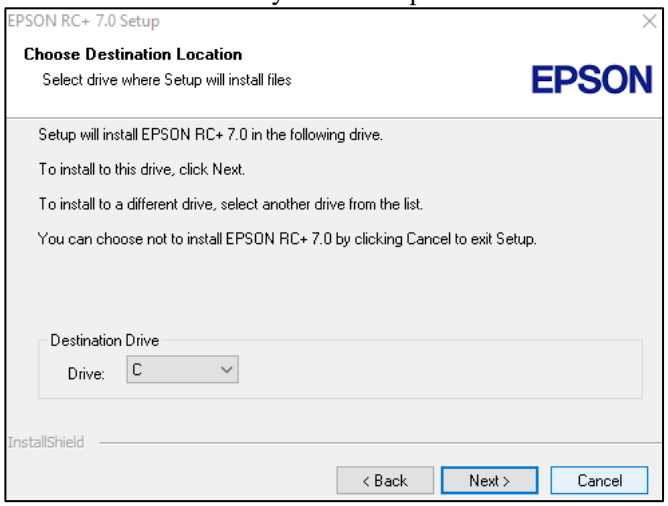
(2) The following dialog will be displayed. Click <Next>.



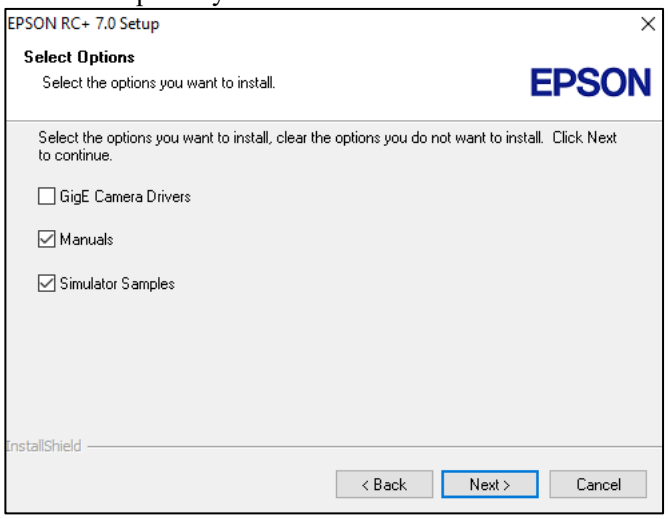
(3) Enter your user name and company name and click <Next>.



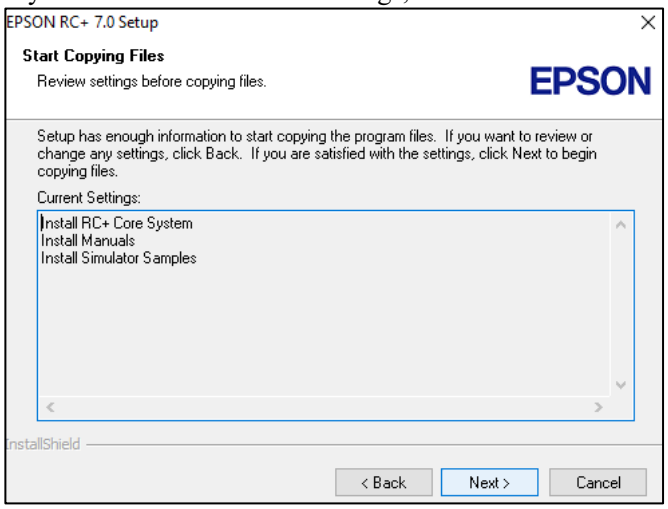
(4) Select the drive where you want to install EPSON RC+ 7.0 and click <Next>.
The installation directory is called EpsonRC70. This cannot be changed.



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



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



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

NOTE Manuals are provided in PDF. To refer to the manual, use the pre-installed PDF viewer in Windows, or install a PDF viewer such as Adobe Acrobat Reader.

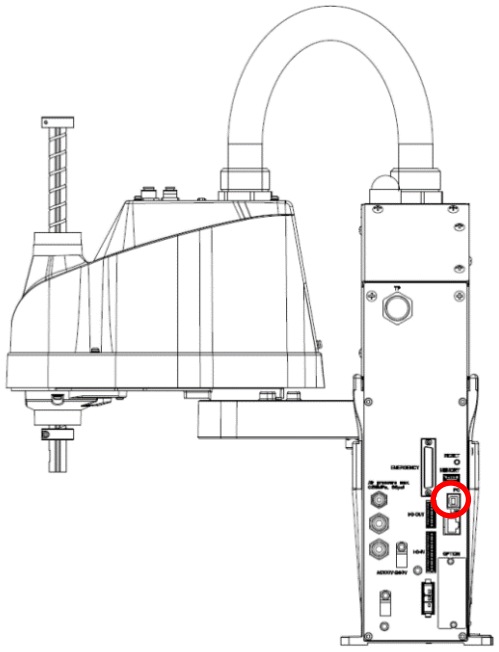
(8) After the installation has completed, restart your computer.
The EPSON RC+ 7.0 software installation is now completed.



NOTE When installing RC, an error “Cannot create parser instance.” may occur.
If the error occurs, uninstall RC+ once and execute Microsoft\VC151719.exe in the DVD and re-install RC+.

4.2 Development PC and Manipulator Connection

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



(Illustration: T3-B401S)

NOTE
- For other details of development PC and Manipulator connection, refer to *EPSON RC+ 7.0 User’s Guide* “*PC to Controller Communications Command (Setup Menu)*”.
- 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.

4.2.1 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.
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.

4.2.2 Precautions

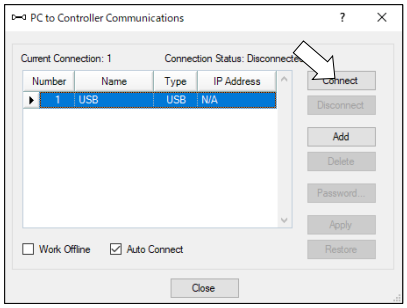
When connecting the development PC and the Manipulator, make sure of the following.

- 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.

4.2.3 Software Setup and Connection Check

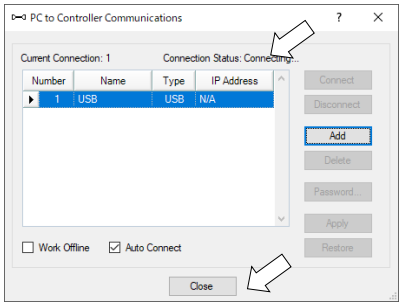
The following is the steps of connecting the development PC and the Manipulator.

(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.

4.2.4 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.

4.2.5 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.

4.2.6 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+.

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

(1) Start EPSON RC+ 7.0.
Double click the <EPSON RC+ 7.0> icon on the desktop.
(2) Open the command window.
EPSON RC+ 7.0 menu-[Tool]-[Command Window]
(3) Execute the following command in [Command Window].
`>Reset`
`>Brake Off,` [Arm # (1 to 4) whose brake will be released]
Execute the following command to turn on the brake again.
`>Brake On,` [Arm # (1 to 4) whose brake will be turned on]

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 "*T3-B T6-B Manipulator 5. Motion Range*" in the Manipulator manuals.

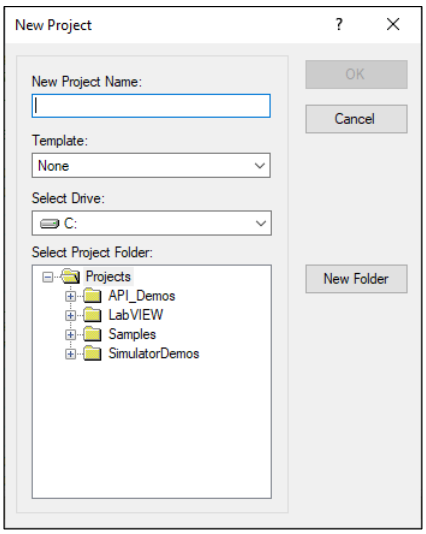
C: Jog motion from the EPSON RC+

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.

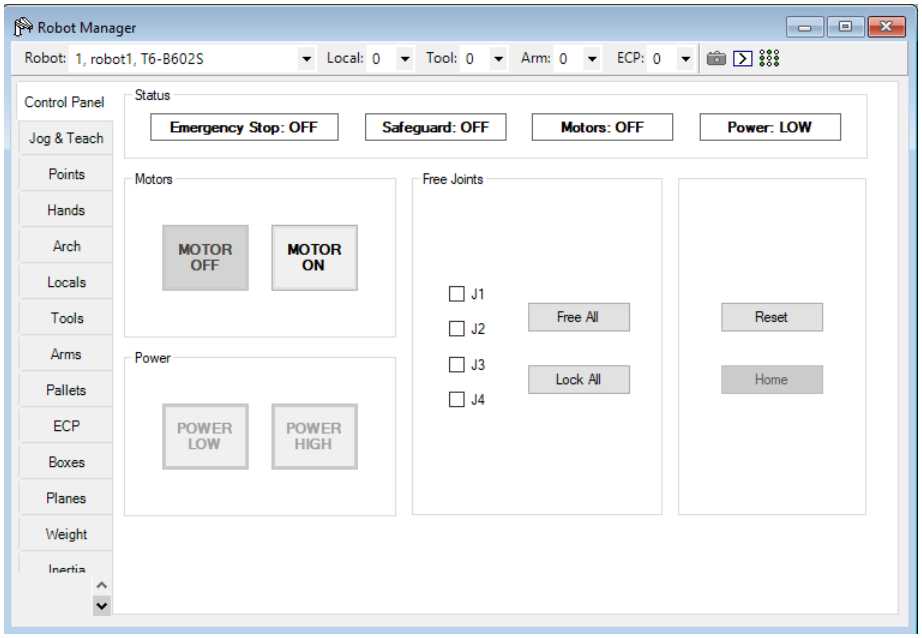


2. Type a project name in the [New Project Name] box. (e.g. FirstApp)

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

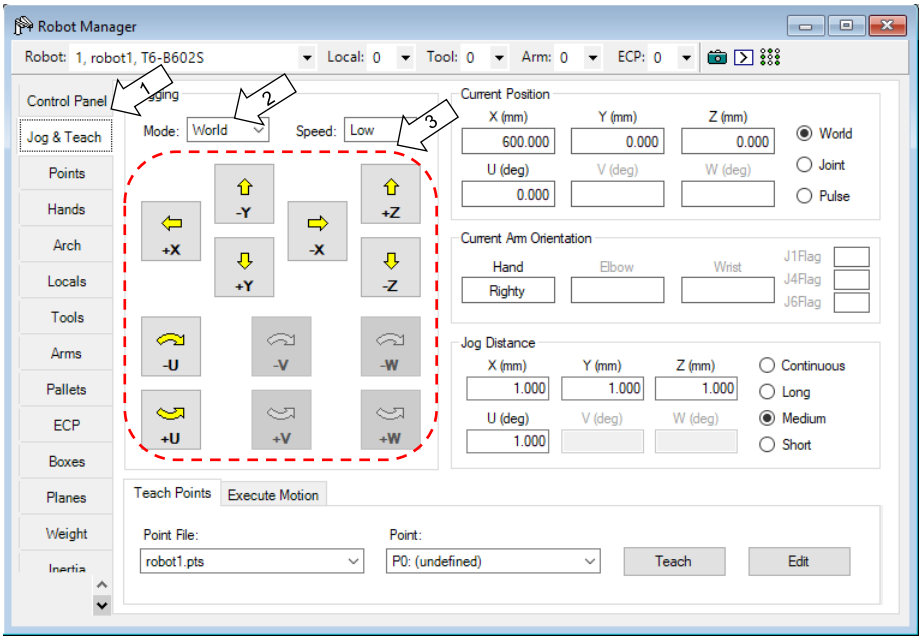
(3) Open the Robot Manager.
EPSON RC+ 7.0 menu-[Tools]-[Robot Manager].

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



(5) Move the Manipulator with Jog motion.

1. Select [Jog & Teach] tab.

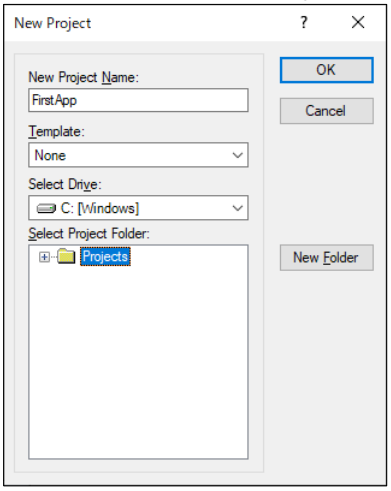


2. Select “Joint” in [Jogging]-<Mode>.
3. Move the Manipulator by joint by clicking J1-J4 jog keys.
Manipulator can be moved by setting to other modes or setting the jog distance.

4.3 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.

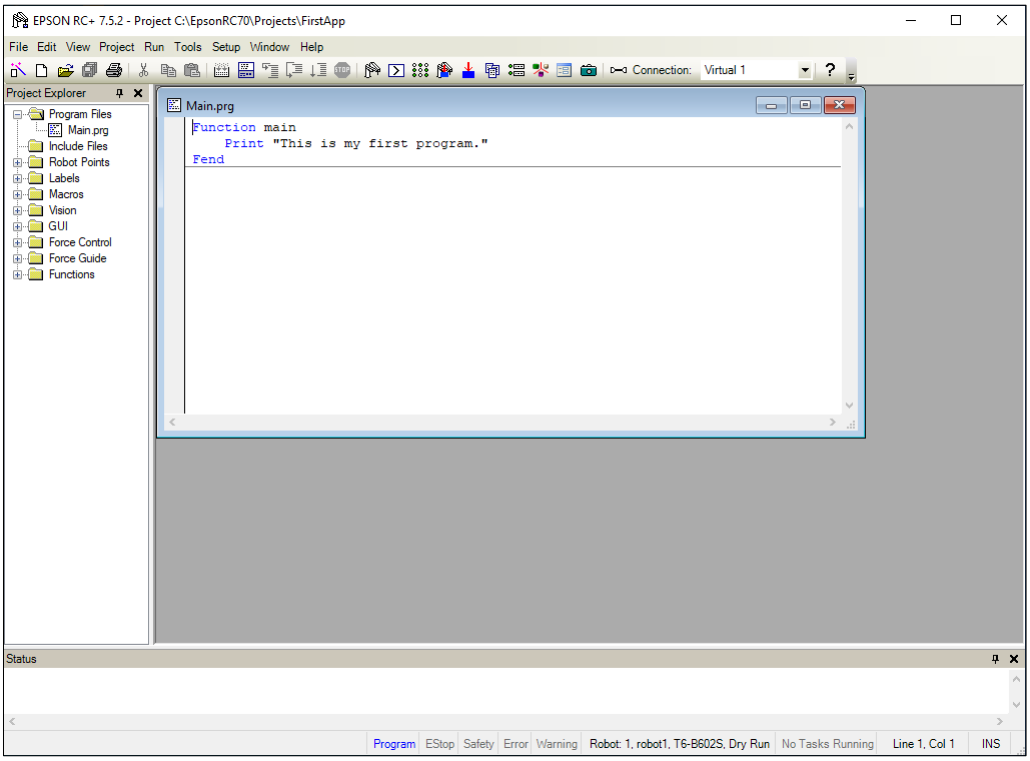
1. Start EPSON RC+ 7.0
   Double-click the EPSON RC+ 7.0 icon on the desktop.
2. Create a new project
   (1) Select [New] from the [Project] Menu. The [New Project] dialog box will be displayed.



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

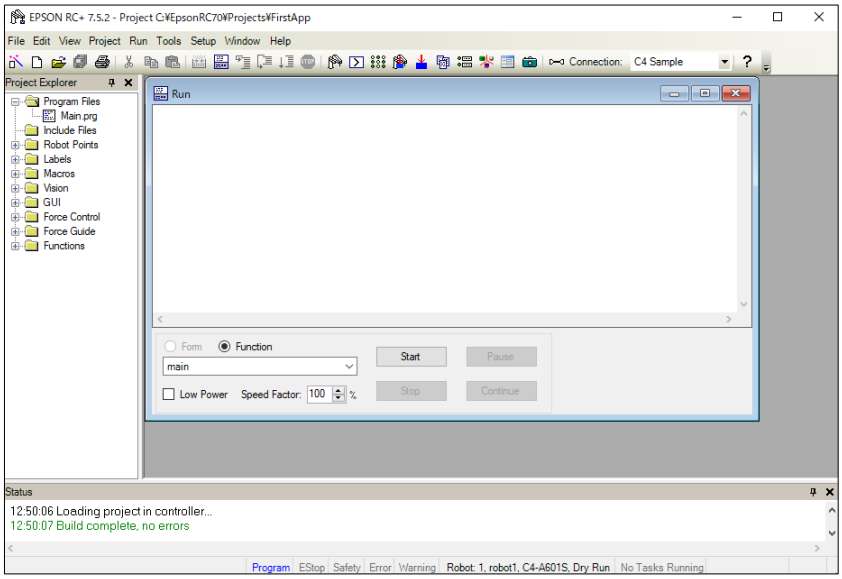
```
Function main
   Print "This is my first program"
Fend
```



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.

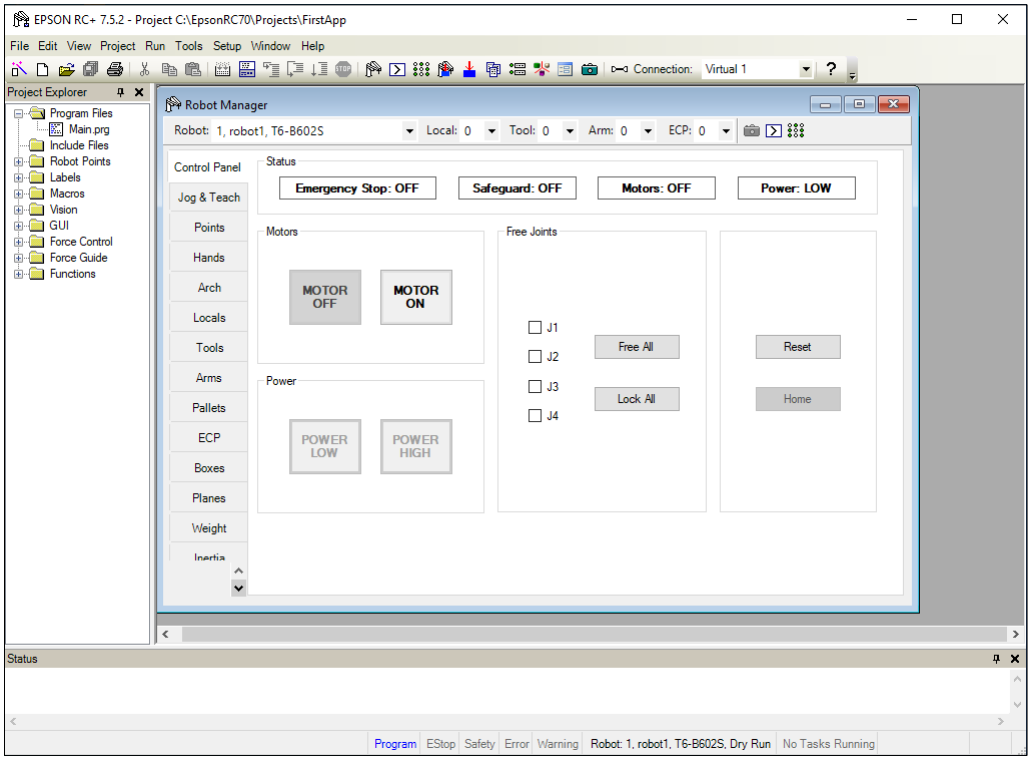
Now let's teach some Manipulator points and create a program to move the Manipulator.

NOTE

Teaching described in this procedure should be done outside the safeguard.

5. Teach robot points

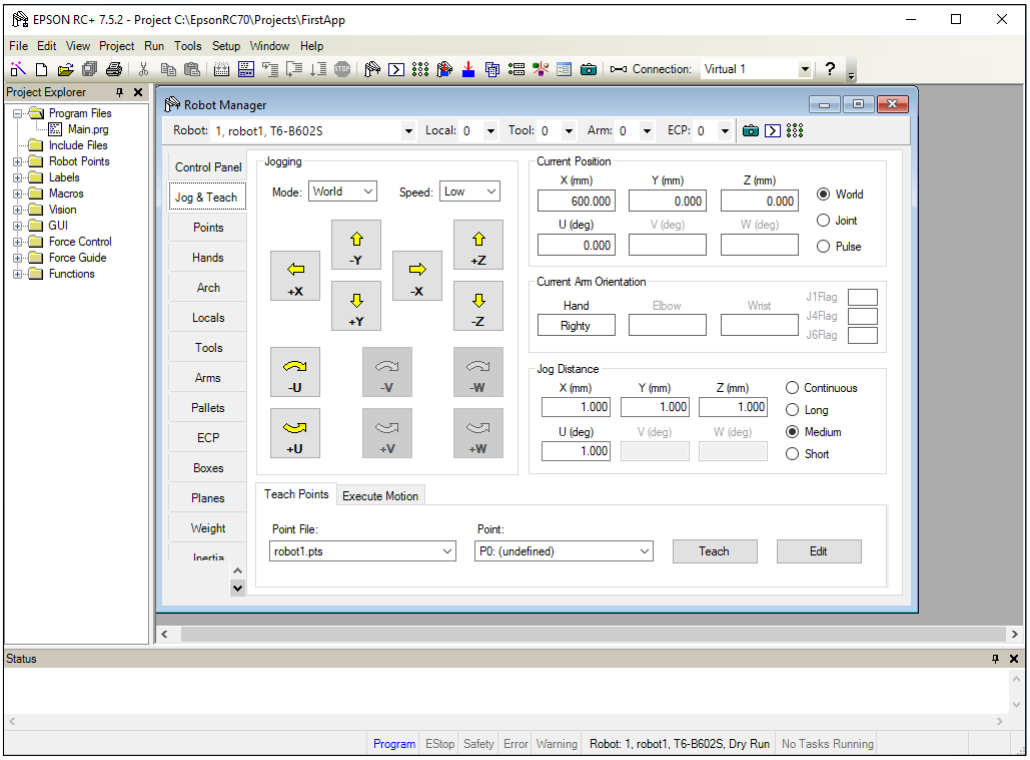
(1) Make sure that it is safe to operate the Manipulator.
Click the <Robot Manager> button on the toolbar to display the [Robot Manager] window.



(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.

(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, and deceleration.
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.

5. Second Step

After operating the robot system as instructed in *4. First Step*, setup other functions as necessary.
This section shows the manuals which contains information of necessary settings and setting procedure.

5.1 Connection with External Equipment

5.1.1 Remote Control

EPSON RC+ 7.0 User's Guide "*Remote Control*"
"*T3-B T6-B Manipulator 14. I/O Remote Set Up*"

I/O
EPSON RC+ 7.0 User's Guide "*I/O Setup*"
"*T3-B T6-B Manipulator 12. Standard I/O Connector*"
"*T3-B T6-B Manipulator 13. Hand I/O Connecter*"

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

5.1.2 Ethernet

EPSON RC+ 7.0 User's Guide
"*1.9 Security for Controller Ethernet Connection*"
"*1.10 Security for Compact Vision CV2-A Ethernet Connection*"
"*1.11 Security for Feeder Ethernet Connection*"
"*4.3.3 Ethernet Communication*"
"*T3-B T6-B Manipulator 9. LAN (Ethernet) Port*"

5.2 Ethernet Connection of Development PC and Manipulator

EPSON RC+ 7.0 User's Guide
"*1.9 Security for Controller Ethernet Connection*"
"*1.10 Security for Compact Vision CV2-A Ethernet Connection*"
"*1.11 Security for Feeder Ethernet Connection*"
"*4.3.3 Ethernet Communication*"
"*T3-B T6-B Manipulator 9. LAN (Ethernet) Port*"

5.3 Connection of Option Teaching Pendant

"*T3-B T6-B Manipulator 10. TP Port*"
ROBOT CONTROLLER Option Teach Pendant TP2
"*Function & Installation: 3. Installation"*
ROBOT CONTROLLER Option Teach Pendant TP3
"Function & Installation: 3. Installation"

T3-B T6-B Manipulator

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

1. Safety

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

1.1 Conventions

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

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

1.2 Design and Installation Safety

This product is intended for transporting and assembling parts in a safely isolated area.
Design and installation of robot system shall be performed by personnel who has taken robot system training held by us and suppliers.
To ensure safety, a safeguard must be installed for the robot system. For details on the safeguard, refer to the *1.5 Safeguard*.
The following items are safety precautions for design personnel:

⚠ WARNING	■ Personnel who design and/or construct the robot system with this product must read *"Safety Manual"*. 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. ■ When designing or installing a robot system, wear at least the following protective gear. Working without protective gear may cause serious safety problems. Work clothes suitable for work Helmet Safety shoes

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

Strength of the Ball Screw Spline

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

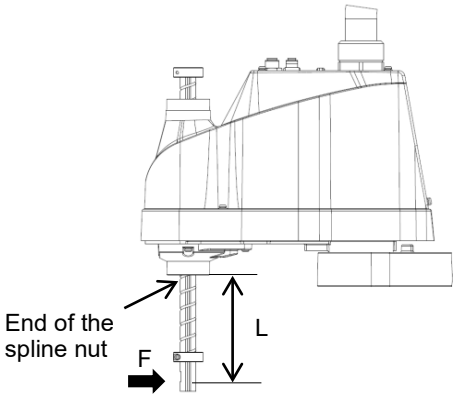
For calculating the allowable load, see the calculation formula below.

[Allowable bending moment]

T3-B: $M=13{,}000\ N{\cdot}mm$

T6-B: $M=27{,}000\ N{\cdot}mm$

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



[Moment]

$M=F{\cdot}L=200{\cdot}100=20{,}000\ N{\cdot}mm$

1.3 Operation Safety

The following items are safety precautions for qualified Operator personnel:

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

WARNING	■ To shut off power to the robot system, disconnect the power plug from the power source. Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source.

CAUTION	■ Whenever possible, only one person should operate the robot system. If it is necessary to operate the robot system with more than one person, ensure that all people involved communicate with each other as to what they are doing and take all necessary safety precautions. ■ Joint #1, #2, and #4: If the joints are operated repeatedly with the operating angle less than 5 degrees, they may get damaged early because the bearings are likely to cause oil film shortage in such situation. To prevent early breakdown, move each joint larger than 50 degrees for about once an hour. Joint #3: If the up-and-down motion of the hand is less than 10 mm, move the joint a half of the maximum stroke for about once an hour. ■ Oscillation (resonance) may occur continuously in low speed Manipulator motion (Speed: approx. 5 to 20%) depending on combination of Arm orientation and end effector load. Oscillation arises from natural oscillation frequency of the Arm and can be controlled by following measures. Changing Manipulator speed Changing the teach points Changing the end effector load ■ Manipulator may be heated due to motor heat etc. Do not touch the Manipulator until temperature falls. After confirming that the temperature of the Manipulator falls and is not hot when you touch it. Then perform teaching or maintenance.

1.4 Emergency Stop

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.

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

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

To place the system in emergency mode during normal operation, press the Emergency Stop switch when the Manipulator is not moving.
Refer to "*11. EMERGENCY*" for instructions on how to wire the Emergency Stop switch circuit.

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

If the Manipulator is stopped by turning OFF the power 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 "*T-B series Maintenance Manual 17. Calibration*". 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 following.

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

To check brake problems, refer to "*Regular Inspection 1. T3-B T6-B Manipulator Regular Inspection*".

NOTE

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

Stopping distance in emergency

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

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

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

1.5 Safeguard

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

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

Safeguard open : The robot stops immediately, motors are turned OFF, and further operation is impossible until either the safeguard is closed or TEACH or TEST mode is turned ON and the enable circuit is engaged.
Safeguard closed : The robot can automatically operate in unrestricted (high power) state.

Do not open the safeguard unnecessarily while motor is ON. Frequent safeguard inputs affect the life of the relay.
Rough normal relay life: Approximately 20,000 times

For the safeguard, do not use the E-STOP circuit.
For details of wiring instructions, refer to "*11. EMERGENCY*".

NOTE

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

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

Stopping distance when the safeguard is opened

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

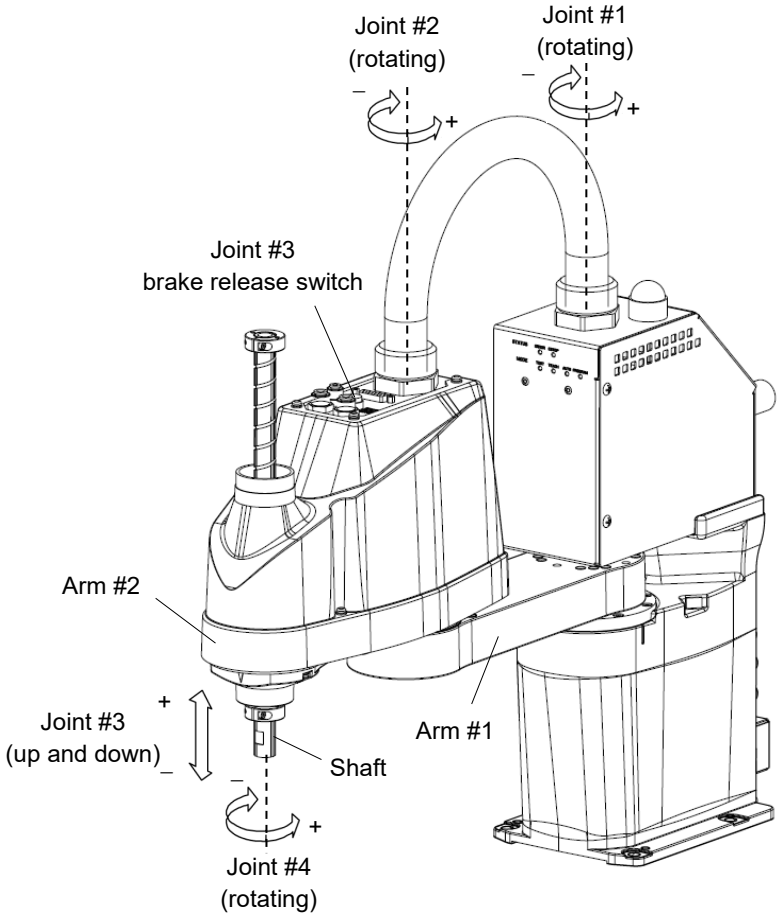
Hand weight	WEIGHT Setting	ACCEL Setting
Workpiece weight	SPEED Setting	Posture etc.

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

1.6 Emergency Movement Without Drive Power

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

Arm #1	Push the arm by hand.
Arm #2	Push the arm by hand.
Joint #3	The joint cannot be moved up/down by hand until the 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.



(Illustration: T3-B401S)

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

1.7 ACCELS Setting for CP Motions

To make the Manipulator move in CP motion, see the following and set ACCELS properly according to the tip load and the Z-axis height.

NOTE

Improper setting may cause following problems.

- Decline in the life and damage of the ball screw spline

Set the ACCELS as follows depending on the Z axis height.

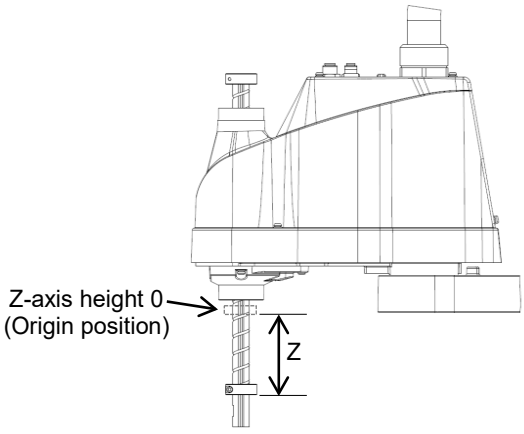
ACCELS setting values by Z-axis height and tip load

T3-B

Z axis height (mm)	Tip load		
	1kg or less	2kg or less	3kg or less
0 > Z >= - 50	10000 or less		
- 50 > Z >= - 100			
- 100 > Z >= - 150			

T6-B

Z axis height (mm)	Tip load		
	1kg or less	2kg or less	3kg or less
0 > Z >= - 50	10000 or less		
- 50 > Z >= - 100			
- 100 > Z >= - 150			
- 150 > Z >= - 200			



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

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

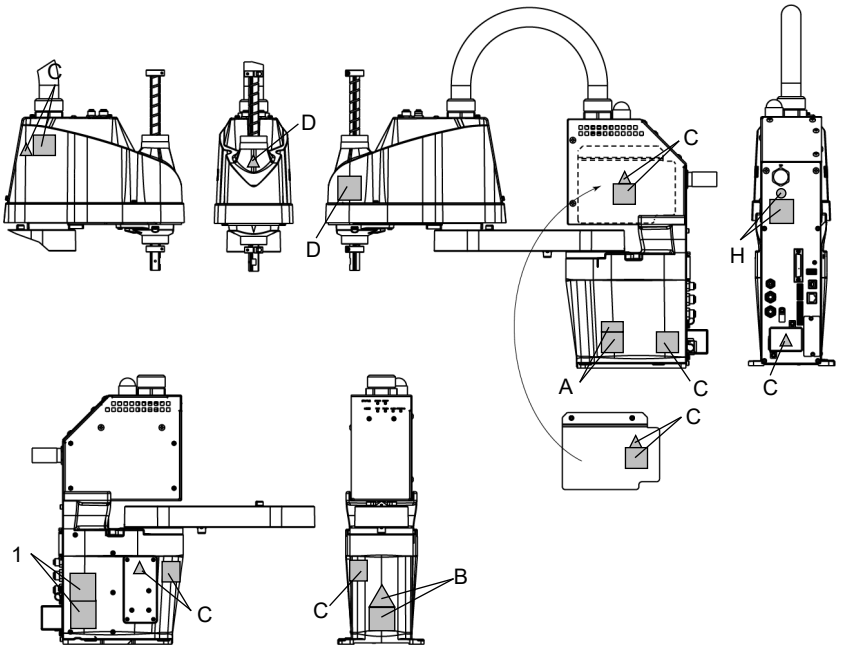
1.8 Labels

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

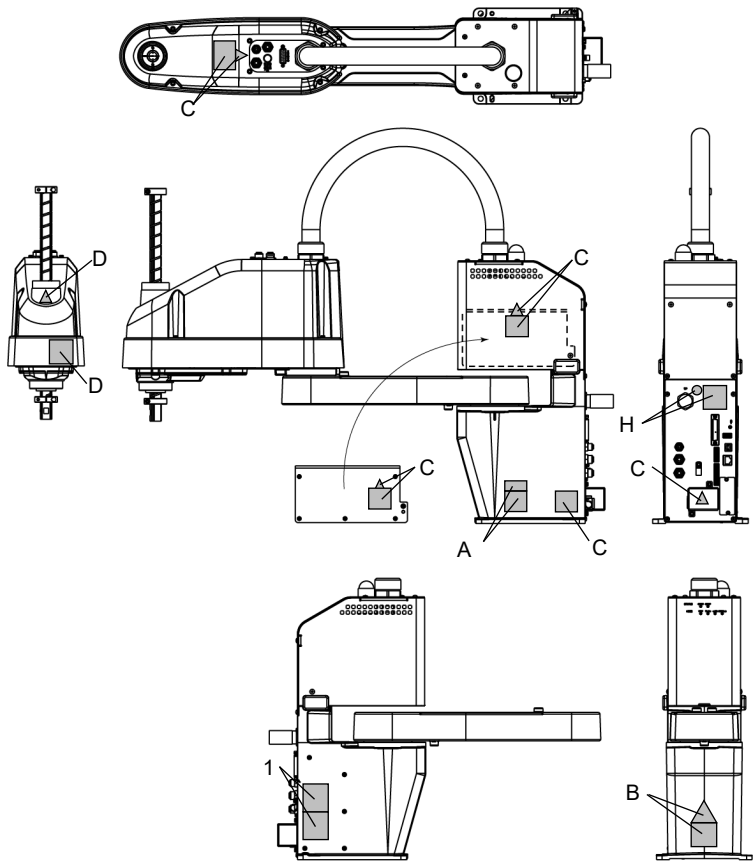
Location	Warning Label	NOTE
A		Before loosening the base mounting screws, hold the arm and secure it tightly with a band to prevent hands or fingers from being caught in the Manipulator.
B		Do not enter the operation area while the Manipulator is moving. The robot arm may collide against the operator. This is extremely hazardous and may result in serious safety problems.
C		Hazardous voltage exists while the Manipulator is ON. To avoid electric shock, do not touch any internal electric parts.
D		You can catch your hand or fingers between the shaft and cover when bringing your hand close to moving parts.
H		Do not connect the followings to the TP port of the Manipulator that attached this label. Connecting to the followings may result in malfunction of the device because pin assignments are different. OPTIONAL DEVICE dummy plug Operation Pendant OP500 Operation Pendant OP500RC Jog Pad JP500 Teaching Pendant TP-3** Operator Panel OP1

Location	Label	NOTE
1	-	The product name, model name, serial number, information which laws and regulations are supported, product specifications, manufacturer, importer, date of manufacture, country of manufacture, etc. are listed. For details, see the label affixed to the product.

Location of Labels T3-B



Location of Labels T6-B



1.9 Response for Emergency or Malfunction

1.9.1 Collision

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

1.9.2 Getting body caught in Manipulator

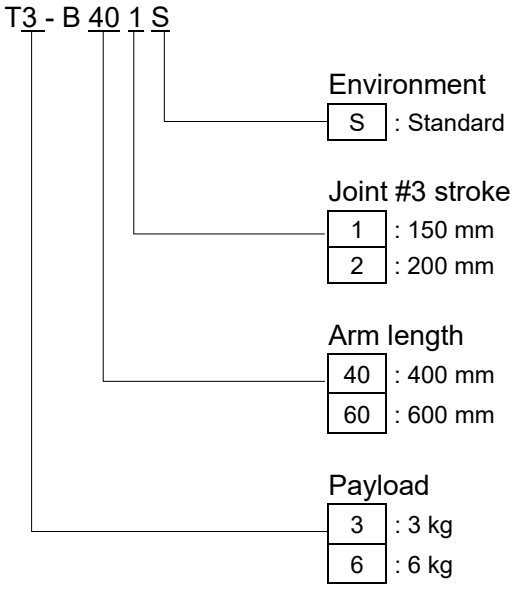
When the operator is caught between the Manipulator and a mechanical part such as a base table, press the emergency stop switch to release the brake on the subject arm, and then move the arm by hand.

How to release a brake

For details, refer to "*1.6 Emergency Movement Without Drive Power*".

2. Specifications

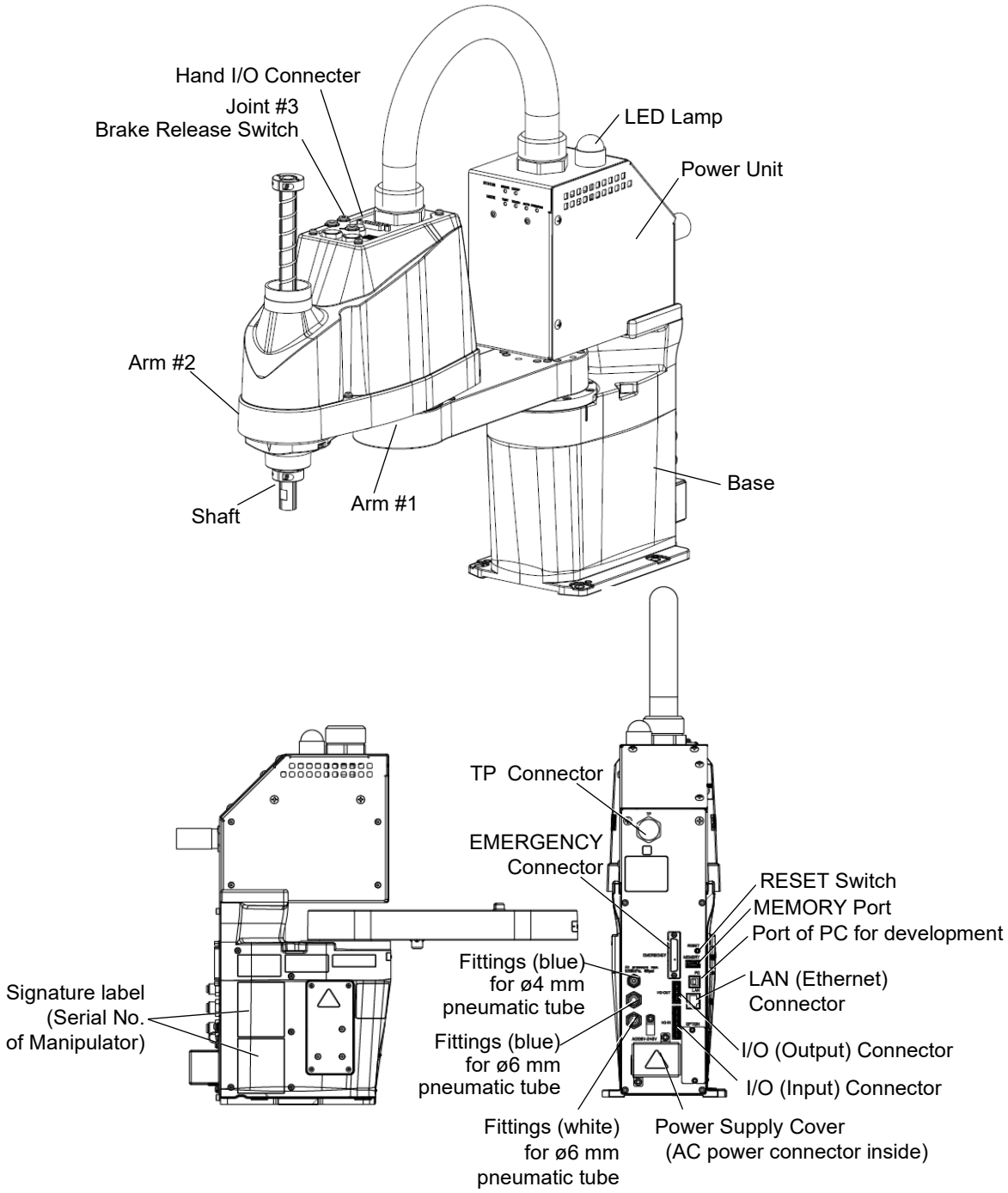
2.1 Model Number



For details on the specifications, refer to "*Appendix A: T3-B T6-B Specifications*".

2.2 Part Names

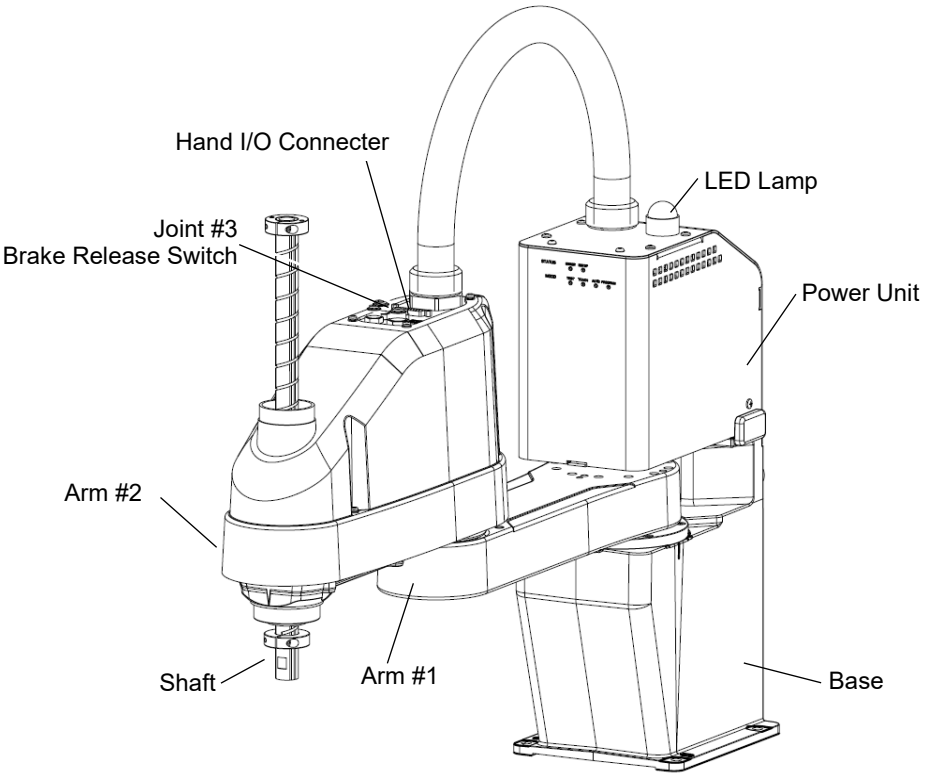
2.2.1 T3-B

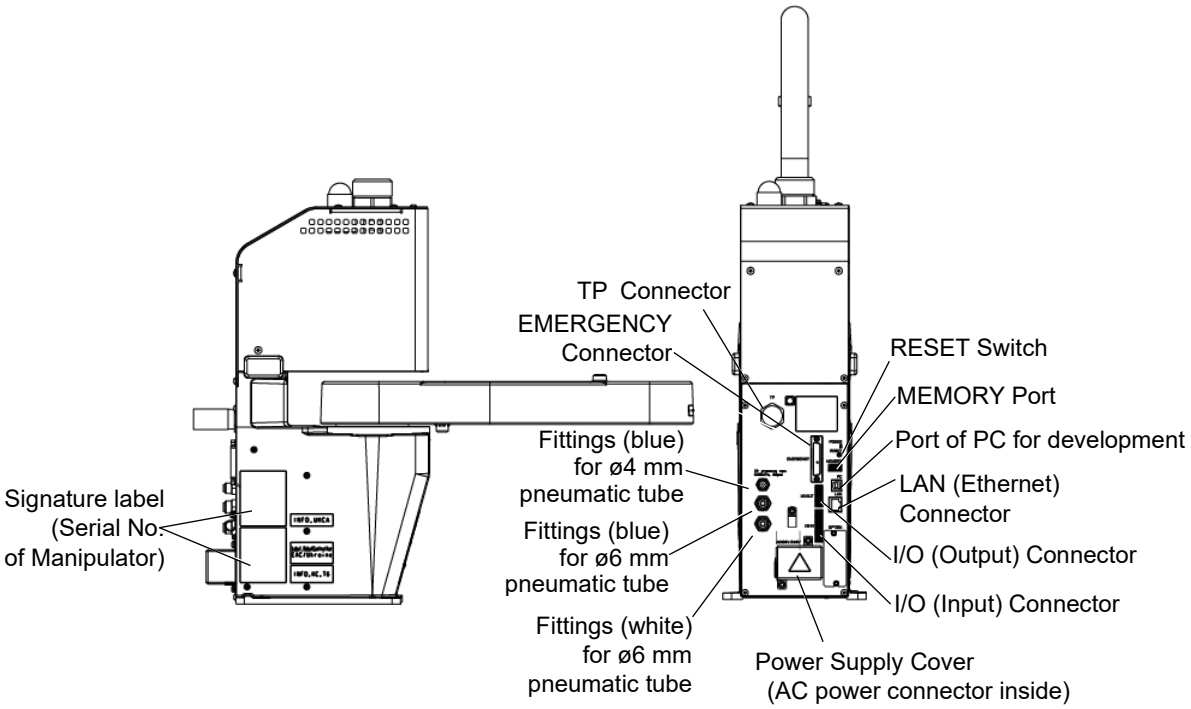


NOTE

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

2.2.2 T6-B



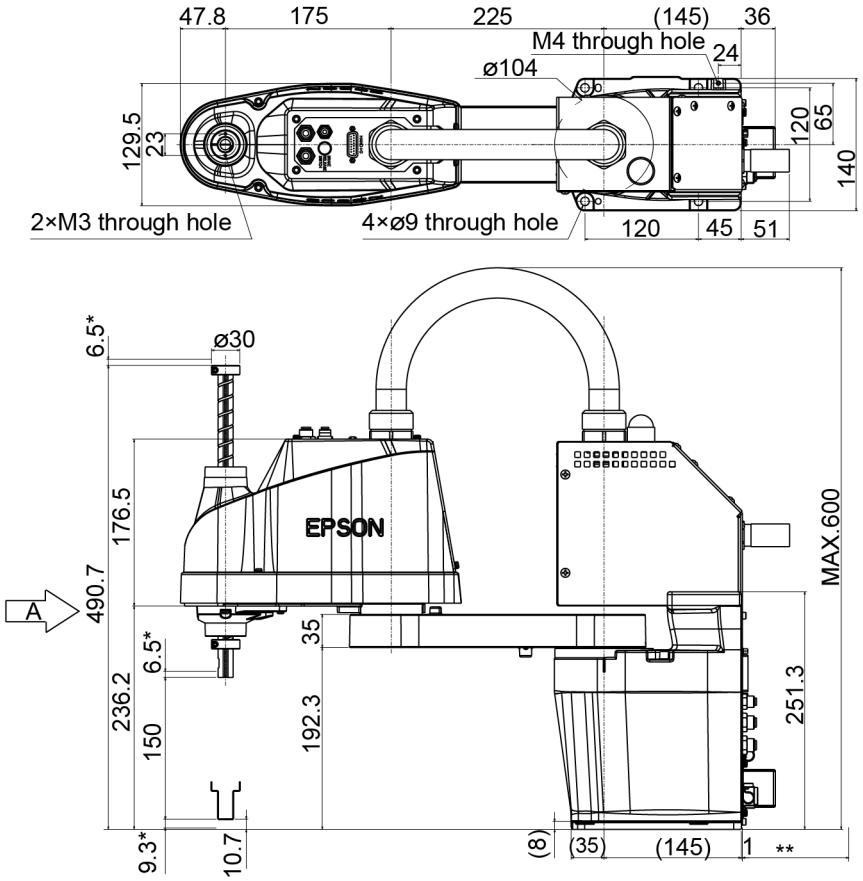


NOTE

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

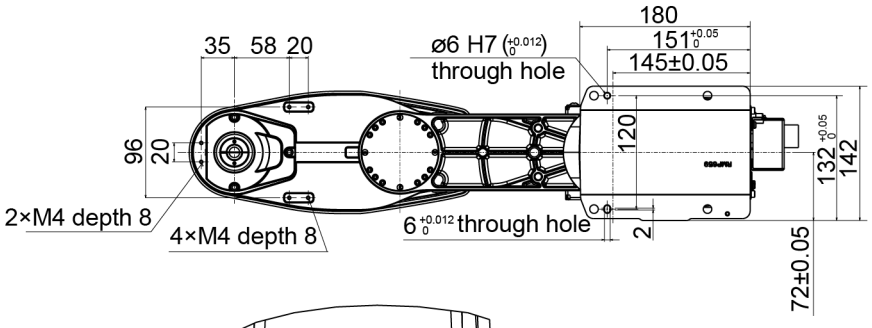
2.3 Outer Dimensions

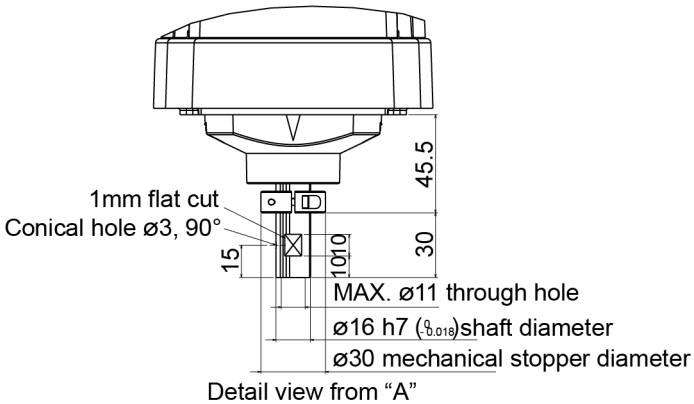
2.3.1 T3-B



(*) Indicates the stroke margin by mechanical stopper

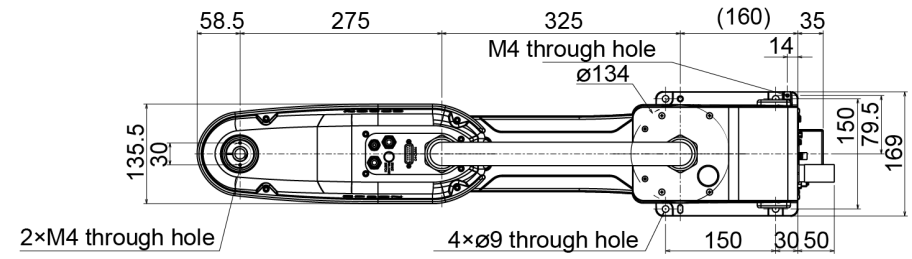
(**) 90 or more space for cables

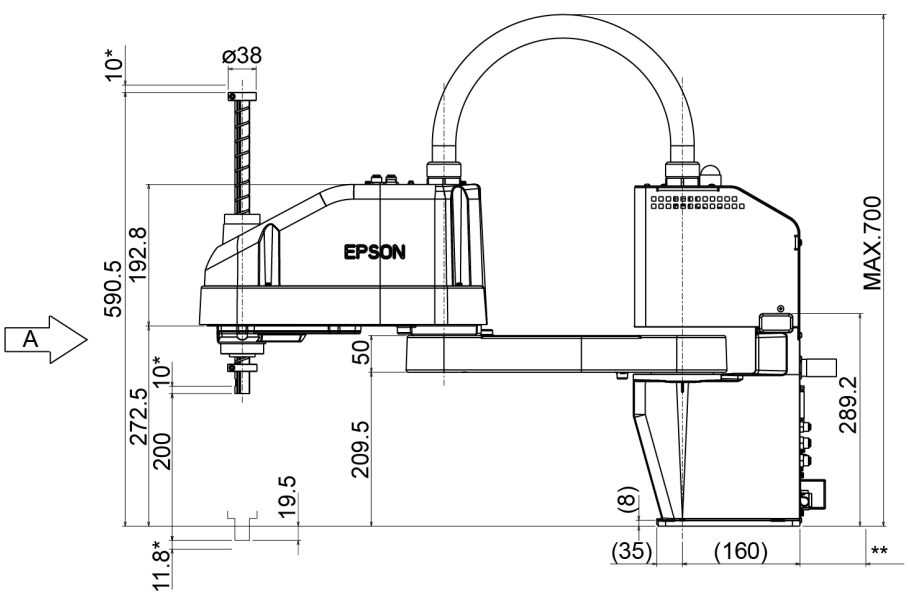


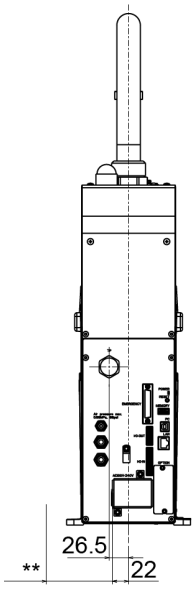


Detail view from “A”
(Calibration point position of Joints #3 and #4)

2.3.2 T6-B

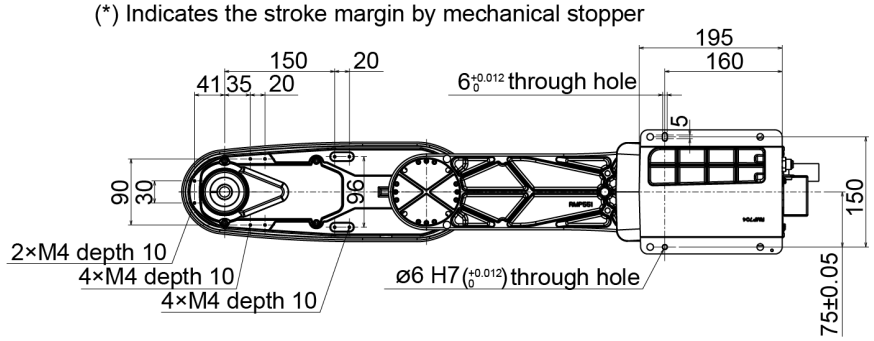


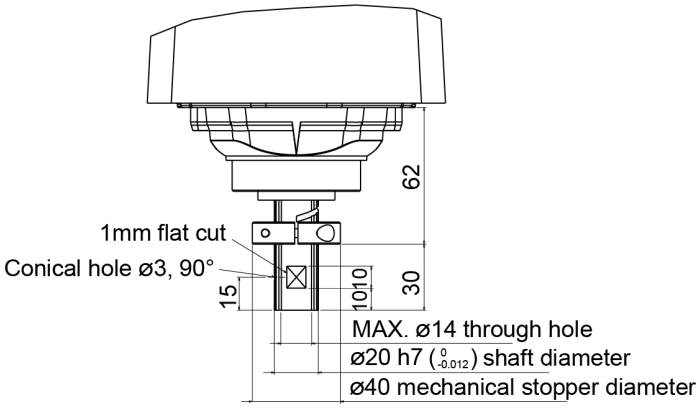




(*) Indicates the stroke margin by mechanical stopper

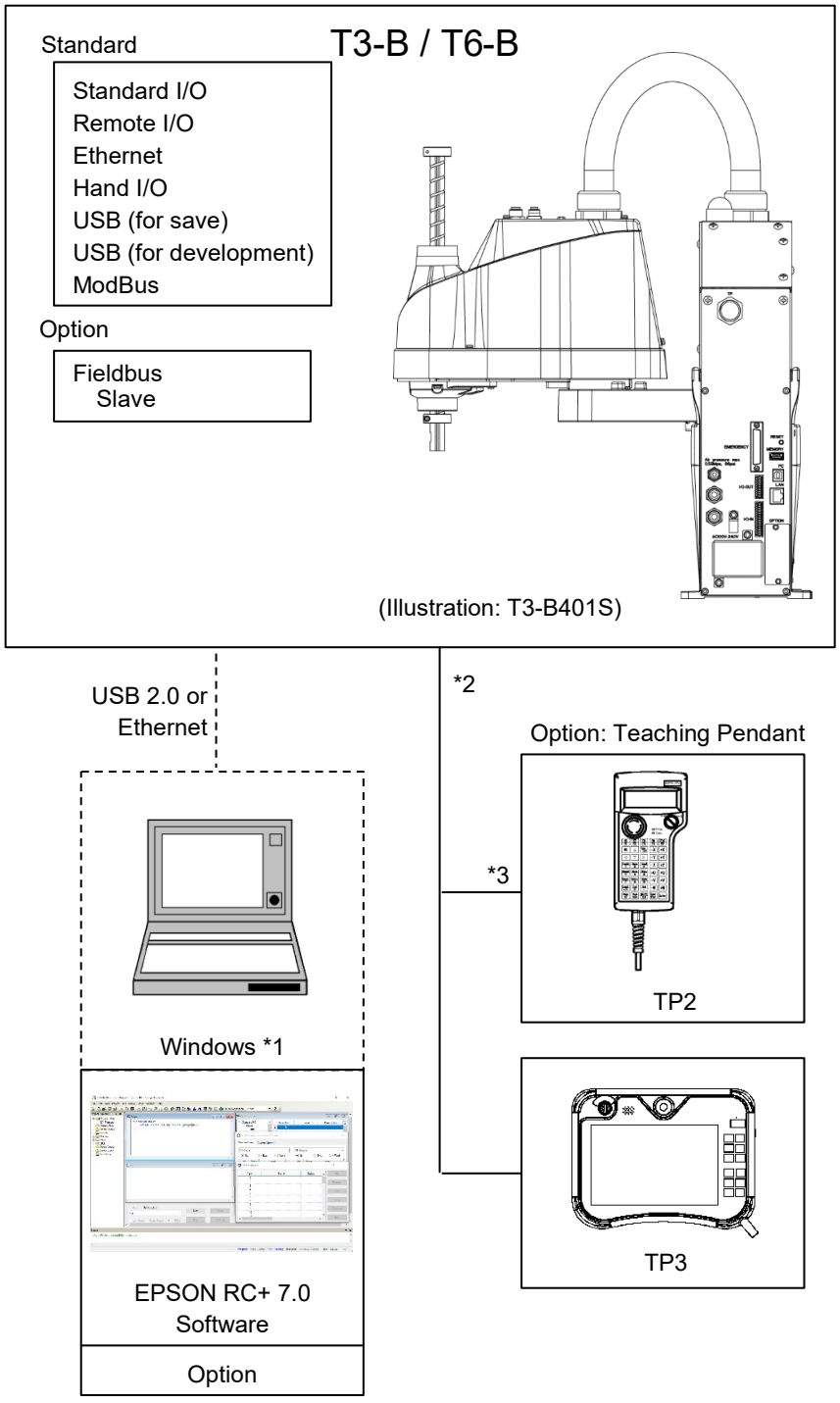
(**) 90 or more space for cables





Detail view from “A”
(Calibration point position of Joints #3 and #4)

2.4 System Example



*1 For system requirements, refer to the following manual:
EPSON RC+ 7.0 User's Guide

*2 Either teaching pendant is available.

*3 When connecting to T3-B/T6-B, specified convert cable is necessary.

2.5 Specifications

For the specifications of each model, refer to "*Appendix A: Specifications*".

2.6 How to Set the Model

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

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

NOTE

If the custom specifications number (MT***) is described on MODEL of the signature label (S/N label), the Manipulator has custom specifications. The custom specifications may require a different configuration procedure; check the custom specifications number (MT***) and contact the supplier of your region when necessary.

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

3. Environments and Installation

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

3.1 Environmental Conditions

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

Item	Conditions
Ambient temperature*	5 to 40°C
Ambient relative humidity	20 to 80% (with no condensation)
Fast transient burst noise	2 kV or less (Power supply wire) 1 kV or less (Signal wire)
Electrostatic noise	4 kV or less
Altitude	1000 m or lower
Environment	- Install indoors - Keep away from direct sunlight - Keep away from dust, oily smoke, salinity, metal powder or other contaminants - Keep away from flammable or corrosive solvents and gases - Keep away from water - Keep away from shock or vibration - Keep away from sources of electric noise - Keep away from strong electric or magnetic fields - Keep away from explosive area - Keep away from a large quantity of radiation

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

NOTE

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

Special Environmental Conditions

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

Rapid change in temperature and humidity can cause condensation inside the Manipulator. If your requirements specify that the Manipulator handles food, please contact the supplier of your region to check whether the Manipulator will damage the food or not.

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

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

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

3.2 Base Table

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

Base table is necessary for support not only the weight of the manipulator but also dynamic motion when operating at the maximum acceleration/deceleration. Provides enough beams to give sufficient strength.

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

	T3-B	T6-B
Max. Reaction torque on the horizontal plate	150 N·m	350 N·m
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.
For dimensions, refer to "*3.3 Mounting Dimensions*".

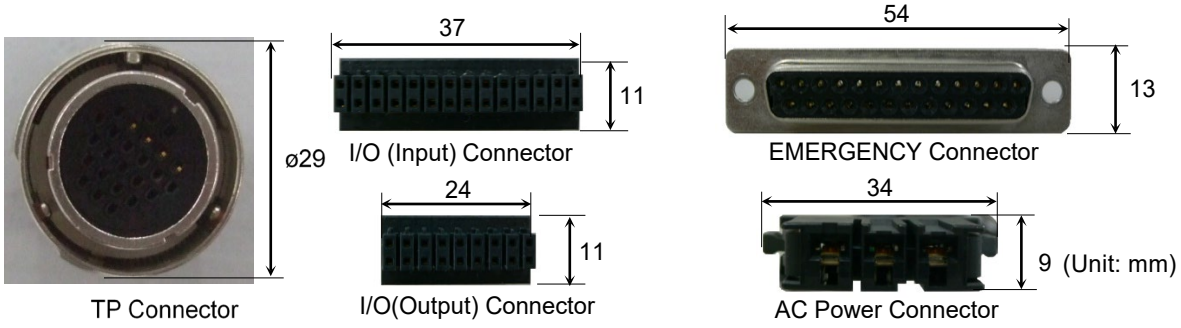
The plate for the Manipulator mounting face should be 20 mm thick or more and made of steel to reduce vibration. The surface roughness of the steel plate should be 25 μm or less.

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

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

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

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



WARNING	■ To ensure safety, a safeguard must be installed for the robot system. For details on the safeguard, refer to the *1.5 Safeguard*.

3.3 Mounting Dimensions

The maximum space described in figures shows that the radius of the end effector is 60 mm or less. If the radius of the end effector exceeds 60 mm, define the radius as the distance to the outer edge of maximum space.
If a camera or solenoid valve extends outside of the arm, set the maximum range including the space that they may reach.

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

Space for teaching

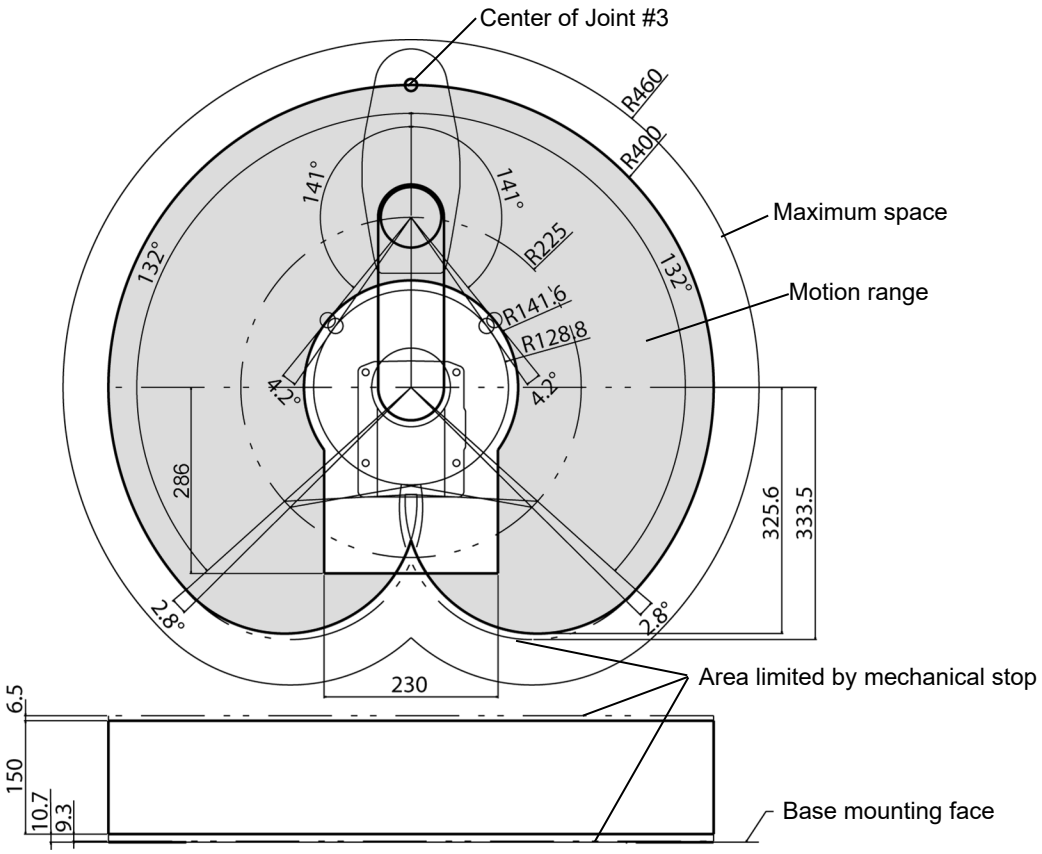
Space for maintenance and inspection
(Ensure a space to open the covers and plates for maintenance.)

Space for cables

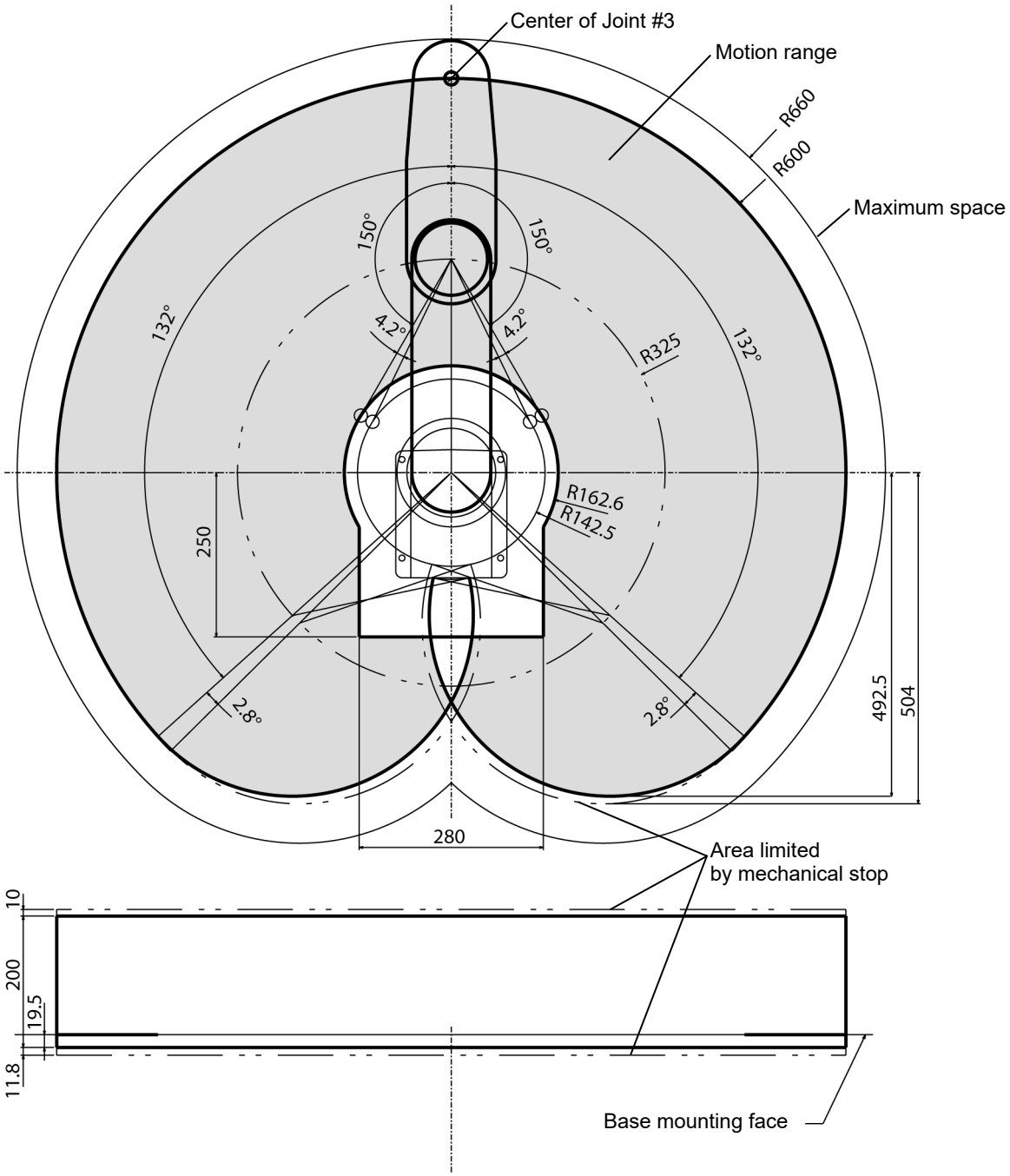
The minimum bend radius of the power cable is 90 mm. When installing the cable, be sure to maintain sufficient distance from obstacles. In addition, leave enough space for other cables so that they are not bent forcibly.

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

T3-B



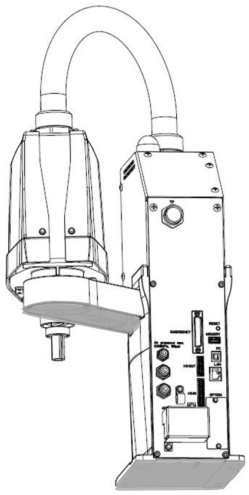
T6-B


Center of Joint #3
Motion range
R660
R600
Maximum space
150°
150°
132°
132°
4.2°
4.2°
R325
R162.6
R142.5
250
2.8°
2.8°
492.5
504
280
Area limited
by mechanical stop
10
200
19.5
11.8
Base mounting face

3.4 Unpacking and Transportation

Using a cart or similar equipment, transport the Manipulator in the same conditions as it was delivered. Observe the following when unpacking the Manipulator.
Unpacking, transportation, and relocation shall be performed by personnel who has taken robot system training held by us and suppliers and should conform to all national and local codes.

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

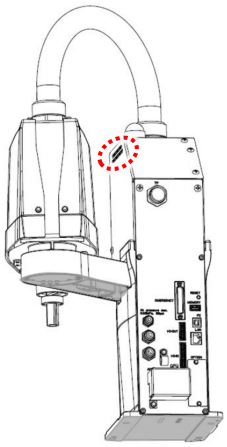
⚠ CAUTION	■ Using a cart or similar equipment, transport the Manipulator in the same manner as it was delivered. ■ When removing the anchor bolts, support the Manipulator to prevent falling. Removing the anchor bolts without supporting the Manipulator may get hands, fingers, or feet caught as the Manipulator may fall. ■ 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. ■ 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-B401S: approx.14kg: 31lbs. T6-B602S: approx.21kg: 46lbs.  (Illustration: T3-B401S) ■ Make sure not to hold the power unit when carrying the manipulator. ■ When transporting the Manipulator for a long distance, secure it to the delivery equipment directly so that the Manipulator never falls. If necessary, pack the Manipulator in the same style as it was delivered.

3.5 Installation Procedure

The installation shall be made by personnel who has taken robot system training held by us and suppliers and should conform to all national and local codes.

CAUTION

- The Manipulator must be installed to avoid interference with buildings, structures, utilities, other machines and equipment that may create a trapping hazard or pinch points.
- Install the Manipulator in order to secure ventilation around the air supply/exhaust port.



- Oscillation (resonance) may occur during operation depending on rigidity of the installation table.
  If the oscillation occurs, improve rigidity of the table or change the speed or acceleration and deceleration settings.
- Install the Table Top Mounting Manipulator with two or more people.
  The Manipulator weights are as follows. Be careful not to get hands, fingers, or feet caught and/or have equipment damaged by a fall of the Manipulator.

  T3-B401S: approx.14kg: 31lbs.
  T6-B602S: approx.21kg: 46lbs.

Secure the base to the base table with four bolts.

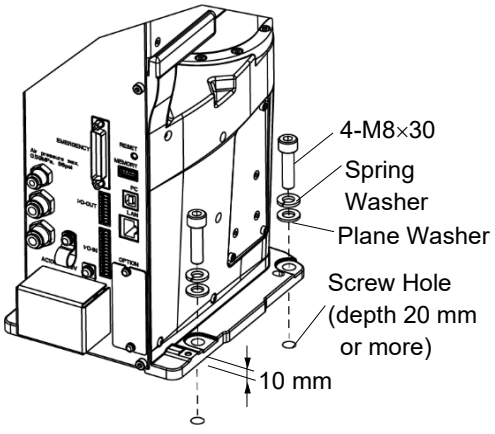
NOTE

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

Tightening torque: 32.0±1.6 N·m

NOTE

Make sure to remove the protective tape and the wire tie for mechanical stop protector.



(Illustration: T3-**B**401S)

3.6 Power Supply

 WARNING	■ 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.

3.6.1 Specifications

Ensure that the available power meets following specifications.

Item	Specification
Voltage	100 to 240 VAC (Input voltage should be with in ±10 % of the rated voltage.)
Phase	Single phase
Frequency	50/60 Hz
Momentary Power Interrupt	Less than 10 msec.
Rated Capacity	T3-B: 660 VA T6-B: 1,200VA
Short-circuit Current Rating	5kA
Maximum Load Current	T3-B: 3.3A T6-B: 6.0A
Inrush Current (When AC power is turned ON)	T3-B: Max. 30A (2 ms or less) T6-B: Max. 60A (2 ms or less)
Leakage Current	Max. 10 mA
Ground Resistance	TN ground (100 Ω or less)

3.6.2 AC Power Cable

WARNING	■ Make sure that the 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, 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 plug or a disconnecting device for power connecting cable. Never connect the Manipulator directly to the factory power supply. ■ Select a plug or a disconnecting device which conforms to safety standards of each country.

When connecting the connecter of AC cable to the Manipulator, make sure to insert completely until you hear a “click”.

The specification for the power supply connection side is the table below.

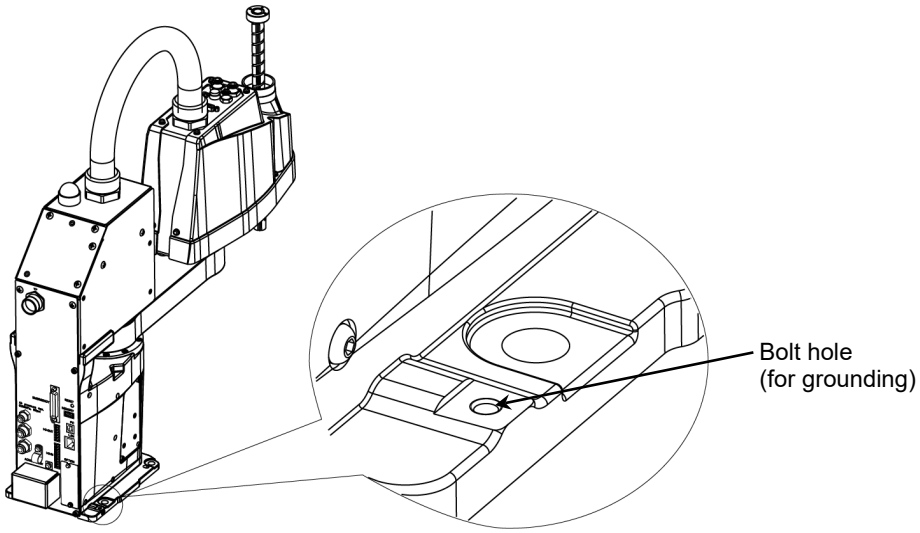
Item	Specification
AC power wire (2 cables)	Black
Ground wire	Green/Yellow
Cable length	5 m
Terminal	M4 round solderless terminal

When you attach to a plug, refer to the picture on the right.

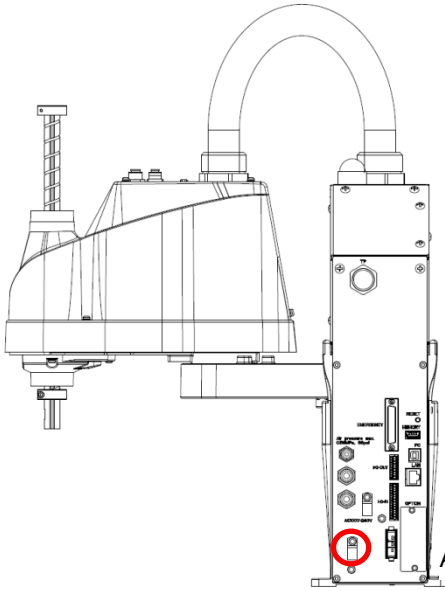


Directly connect the ground line to the Manipulator using bolt hole in the figure below.

It is recommended that the core size of the grounding wire be 5.5 mm^2 or more.



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



(Illustration: T3-B401S)

3.6.3 Breaker

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 set values.

Manipulator	Power	Rated electric current
T3-B	100VAC	10A
	200VAC	5A
T6-B	100VAC	20A
	200VAC	10A

If you install a circuit breaker, please select one that can handle the “inrush current” described in the following section.

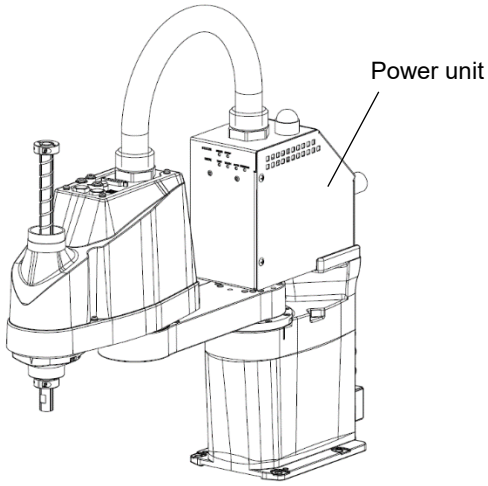
Reference: *3.6.1 Specifications*

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

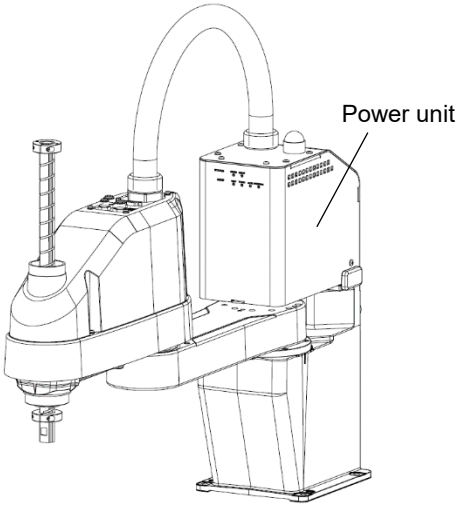
3.6.4 Power Unit

WARNING	■ Do not apply a load by applying weight to power unit. Doing so may result in deformation or damage of parts.
	■ NEVER connect deformed or damaged power unit to the Robot system or related equipment. It may result in the fire or electric shock.

T3-B



T6-B

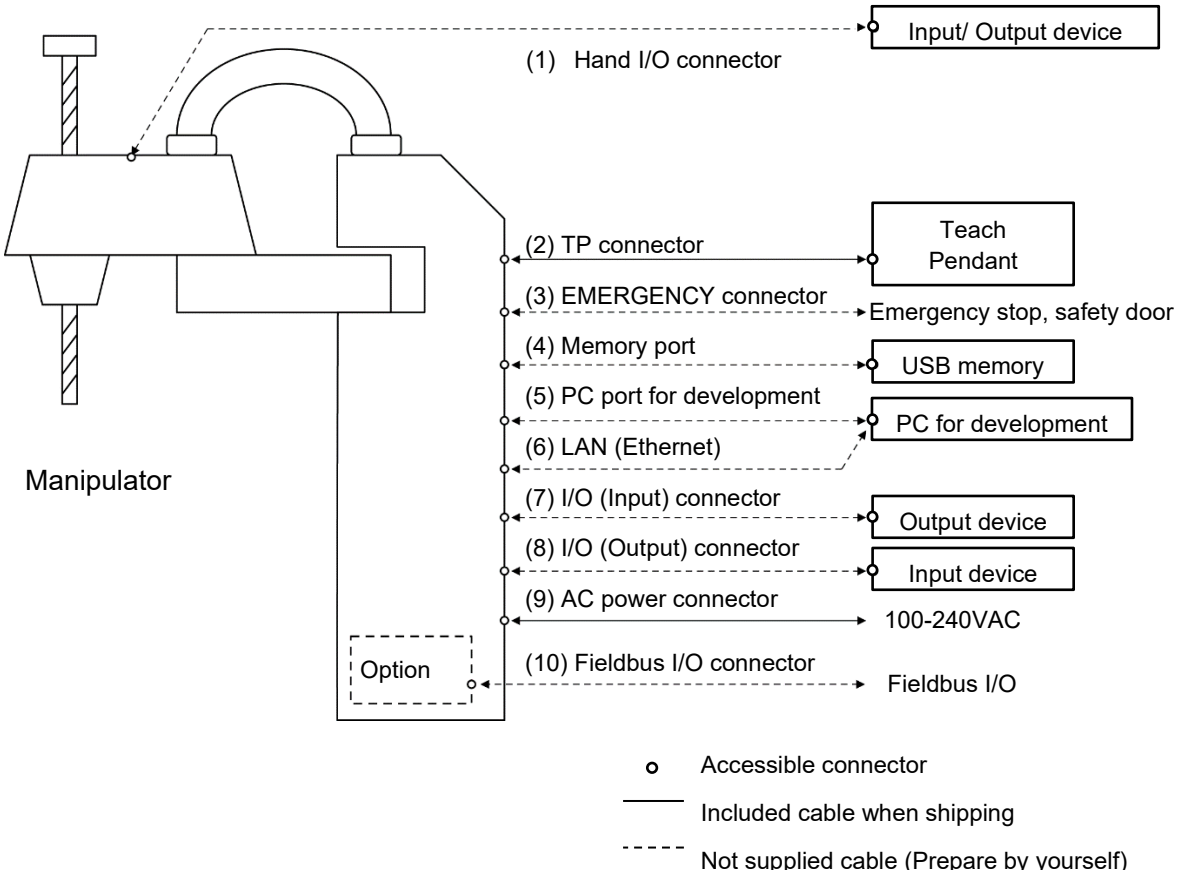


3.7 Connecting the Cables

WARNING	■ To shut off power to the robot system, disconnect the power plug from the power source. Be sure to connect the AC power cable to a power receptacle. DO NOT connect it directly to a factory power source. ■ Be sure to connect the cables properly. Use a tough cable cover to protect the cables. Do not allow unnecessary strain on the cables. (Do not put heavy objects on the cables. Do not bend or pull the cables forcibly.) The unnecessary strain on the cables may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system. ■ Grounding the manipulator is done by connecting with Power cable. Ensure that the Power cable and ground wire are correctly connected. If the ground wire is improperly connected to ground, it may result in the fire or electric shock.

CAUTION	■ Make sure that the serial numbers on each equipment match. Improper connection may not only cause improper function of the robot system but also serious safety problems. ■ 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.

3.7.1 Connection Example



(1) Hand I/O connector
Connect input/output devices of the users.
When there are input/output devices, use this connector.
Be careful about allowable current when using hand I/O connector.
For details, refer to "*13. Hand I/O connector*".

(2) TP connector
Connect the option Teach Pendant.
For details, refer to "*10.TP Port*".

(3) EMERGENCY
The EMERGENCY connector has inputs to connect the Emergency Stop switch and the Safety Door switch. For safety reasons, connect proper switches for these input devices.
For details, refer to "*11. EMERGENCY*".

(4) Memory port
Connect to USB memory.
For details, refer to "8. *Memory port*".

(5) PC for development
Connect the PC for development.
For details, refer to "*7. Development PC Connection Port*".

(6) LAN (EtherNet Communication)
Connect the EtherNet cable.
For details, refer to "*9. LAN (Ethernet Communication) Port*".

(7) I/O (Input) connector
This input connector is for output device of the user.
When there is output device, use this connector.
For details, refer to "*12. Standard I/O connector*".

(8) I/O (Output) connector
This output connector is for input device of the user.
When there is input device, use this connector.
For details, refer to "*12. Standard I/O connector*".

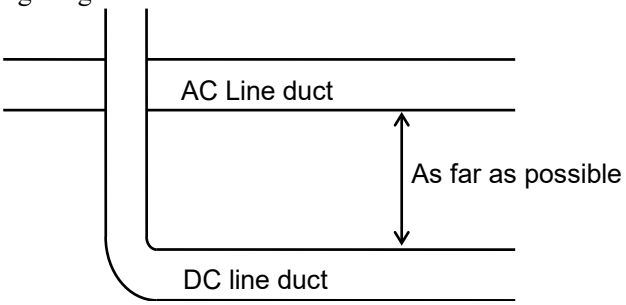
(9) AC power connector
Connector for AC power supply to the manipulator.

(10)Fieldbus I/O connector
If necessary, take EMC countermeasures for the Fieldbus I/O cable.
For details, refer to *3.7.2 Noise Countermeasures*.

3.7.2 Noise Countermeasures

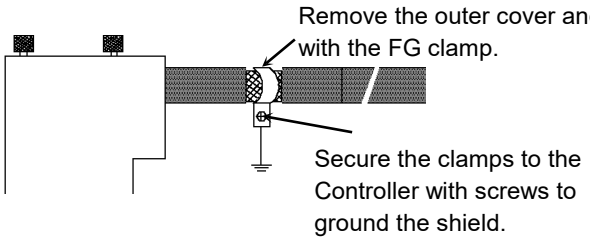
To minimize electrical noise conditions, the following items must be observed in the system's cable wiring:

- The earth wire of the power supply should be grounded. (Ground resistance: 100 Ω or less) It is important to ground the frame of Manipulator not only for prevention from electric shock, but also for reducing the influence of electric noise around the Manipulator. Therefore, be sure to connect the earth wire (yellow/green) of the Manipulator's power cable to the ground terminal of the factory power supply. For details about the plug and AC power cable, refer to "*3.6 Power Supply*".
- Do not tap power from a power line that connects to any equipment which may cause noise.
- Do not run AC power lines and DC power lines in the same wiring duct, and separate them as far as possible. For example, separate the AC motor power line and the Manipulator power line as far as possible from the sensor or valve I/O lines; and do not bundle both sets of wiring with the same cable tie. If more than one duct/cable must cross each other, they should cross perpendicularly. The preferable example is shown in the right figure.

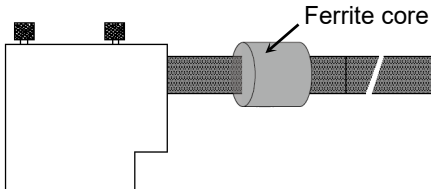


- Wire as short as possible to the I/O connector and EMERGENCY connector. Use a shielded cable and clamp the shield to the attached connector interior. Make sure to keep away from the peripheral noise source as far as possible.
- Make sure that the induction elements used to connect to the Manipulator's I/O (such as relays and solenoid valves) are noise suppression parts. If an induction element without protection against noise is used, make sure to connect a noise suppression part such as a diode located at the induction element in parallel with it. In selecting noise suppression parts, make sure that they can handle the voltage and current incurred by the induction load.
- As they are easily influenced by noise, keep cable such as USB, Ethernet, or fieldbus away from peripheral noise sources.

- Perform following EMC countermeasure for the Fieldbus I/O cable as necessary.
  - Put together the cable shield side.



  - Mount Ferrite core to the cable.



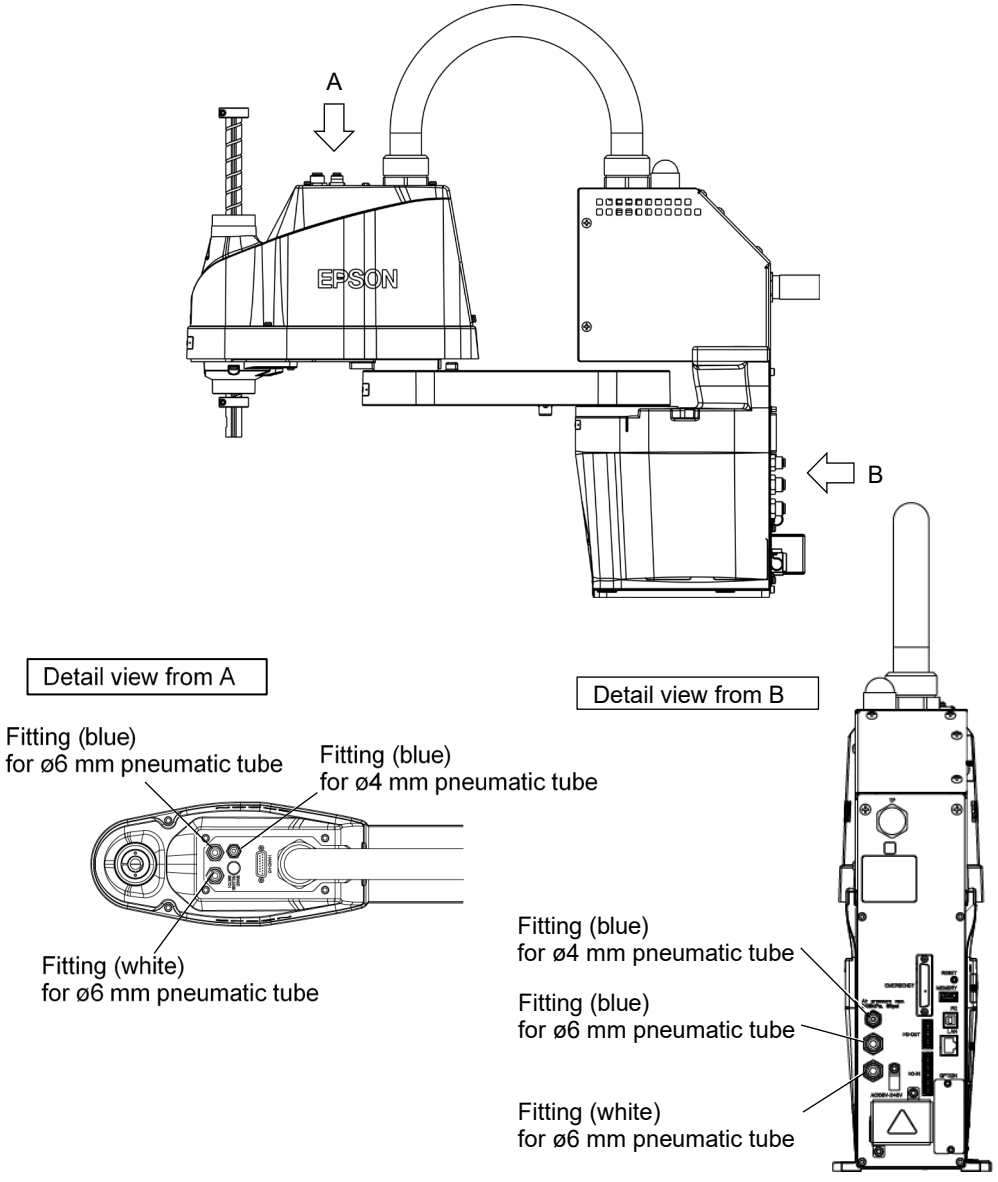
3.8 Pneumatic Tubes

Pneumatic tubes are contained in the cable unit.

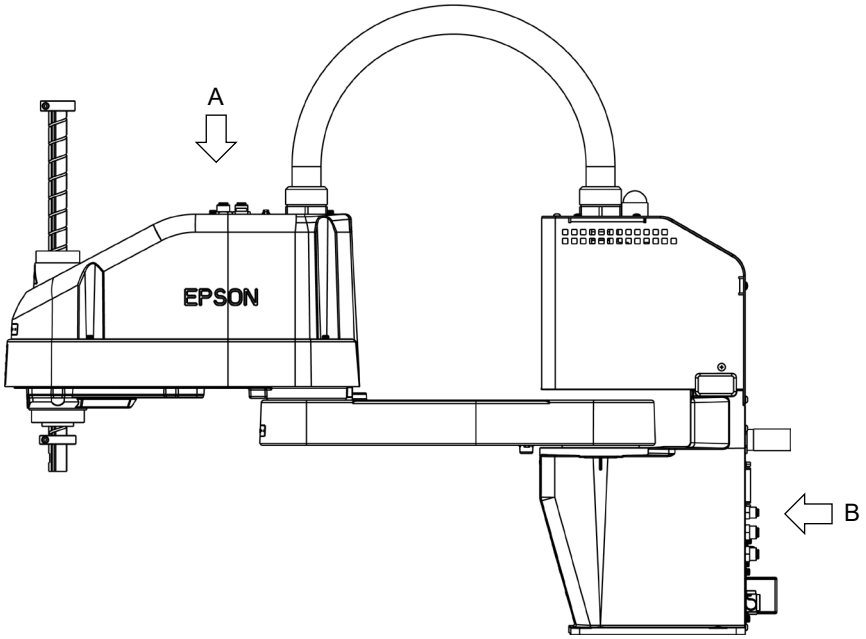
Max. Usable Pneumatic Pressure	Pneumatic Tubes	Outer Diameter × Inner Diameter
0.59 MPa (6 kgf/cm^2 : 86 psi)	2	ø 6 mm × ø 4 mm
	1	ø 4 mm × ø 2.5 mm

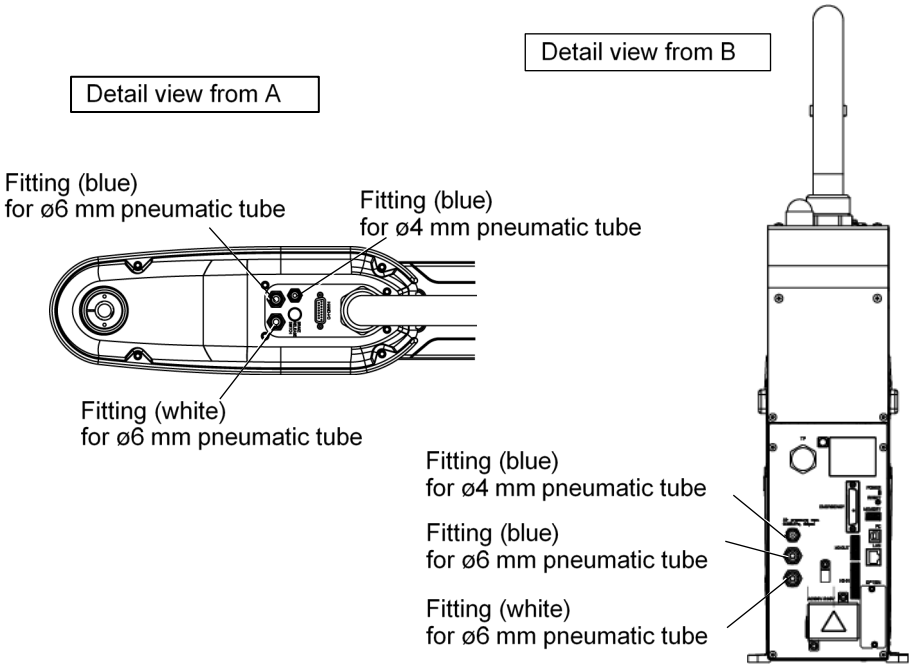
Fittings for ø6 mm and ø4 mm (outer diameter) pneumatic tubes are supplied on both ends of the pneumatic tubes.

T3-B



T6-B


A
EPSON
B


Detail view from A
Fitting (blue)
for ø6 mm pneumatic tube
Fitting (blue)
for ø4 mm pneumatic tube
Fitting (white)
for ø6 mm pneumatic tube
Detail view from B
Fitting (blue)
for ø4 mm pneumatic tube
Fitting (blue)
for ø6 mm pneumatic tube
Fitting (white)
for ø6 mm pneumatic tube

3.9 Relocation and Storage

3.9.1 Precautions for Relocation and Storage

Observe the following when relocating, storing, and transporting the Manipulators.

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

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

 CAUTION	■ Before relocating the Manipulator, fold the arm and secure it tightly with a sheet to prevent hands or fingers from being caught in the Manipulator. ■ When removing the anchor bolts, support the Manipulator to prevent falling. Removing the anchor bolts without support may result in a fall of the Manipulator, and then get hands, fingers, or feet caught. ■ To carry the Manipulator, have two or more people to work on it and secure the Manipulator to the delivery equipment or hold the bottom of Arm #1 and the bottom of the base by hand. When holding the bottom of the base by hand, be very careful not to get hands or fingers caught. ■ Stabilize the Manipulator with your hands when hoisting it. Unstable hoisting is extremely hazardous and may result in fall of the Manipulator.

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

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

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

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

Do not shock or shake the Manipulator during transport.

3.9.2 Relocation

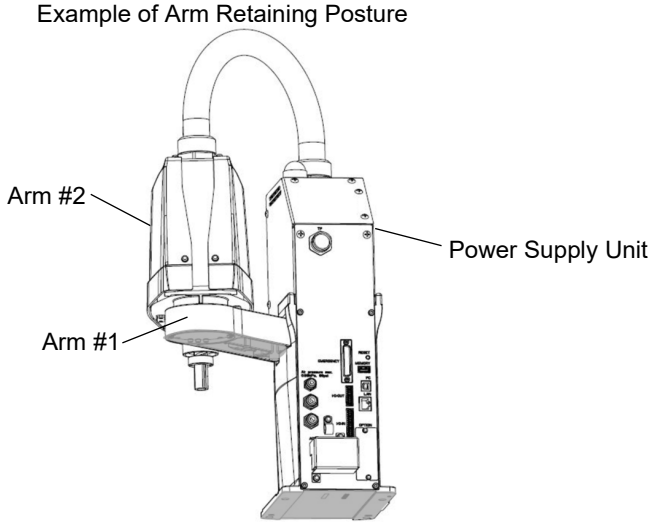
CAUTION	■ Install or relocate the Manipulator with two or more people. The Manipulator weights are as follows. Be careful not to get hands, fingers, or feet caught and/or have equipment damaged by a fall of the Manipulator. T3-B401S: Max.14kg: 31lbs. T6-B602S: Max.21kg: 46lbs.

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

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

(2) Cover the Arm #2 and Power Supply Unit with a sheet so that the arm will not be damaged.

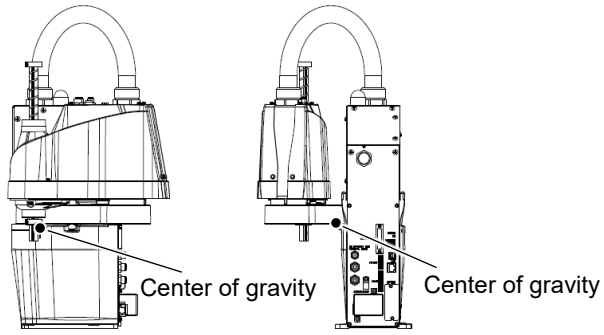
Example of Arm Retaining Posture



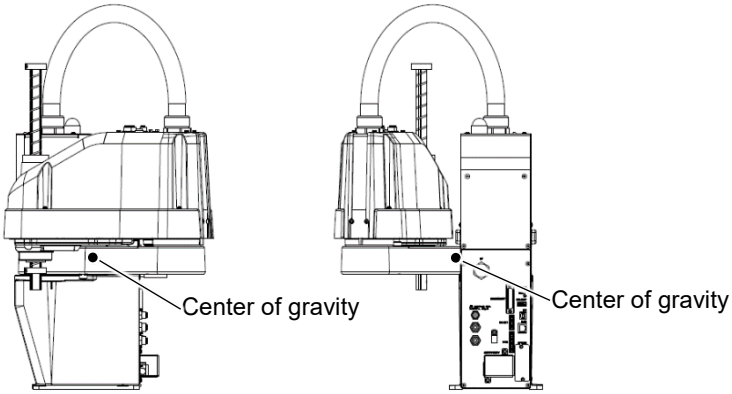
(Illustration: T3-B401S)

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

T3-B401S



T6-B602S



4. Setting of End Effectors

4.1 Attaching an End Effector

Create an end effector for your Manipulator. For details of attaching an end effector, refer to "*Hand Function Manual*"

Before attaching an end effector, observe these guidelines.

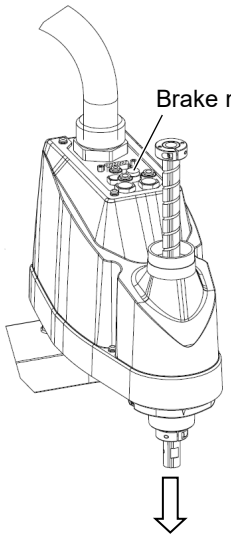
⚠ CAUTION	■ If you use an end effector equipped with a gripper or chuck, connect wires and/or pneumatic tubes properly so that the gripper does not release the work piece when the power to the robot system is turned OFF. Improper connection of the wires and/or pneumatic tubes may damage the robot system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

Shaft

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

Brake release switch

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



The shaft may be lowered by the weight of the end effector.

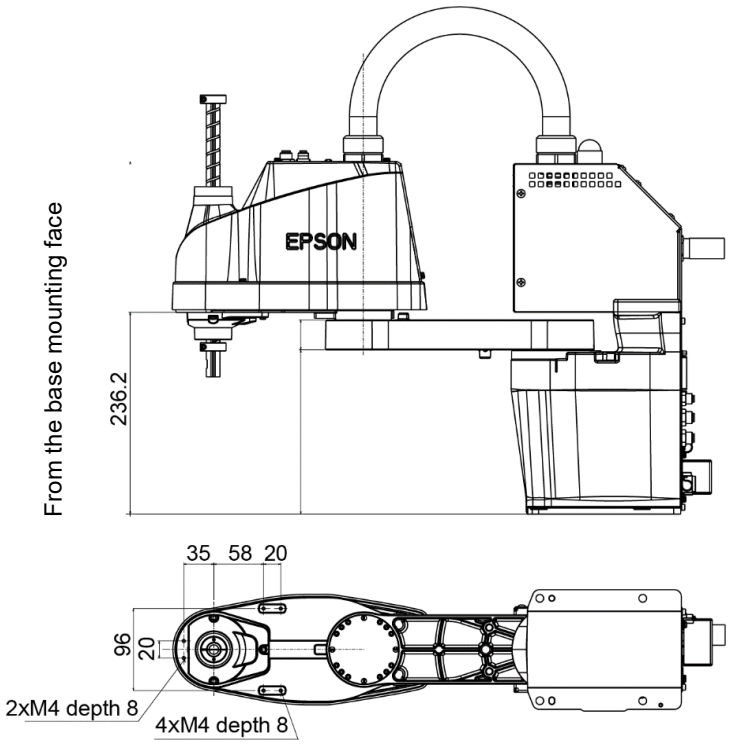
Layouts

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

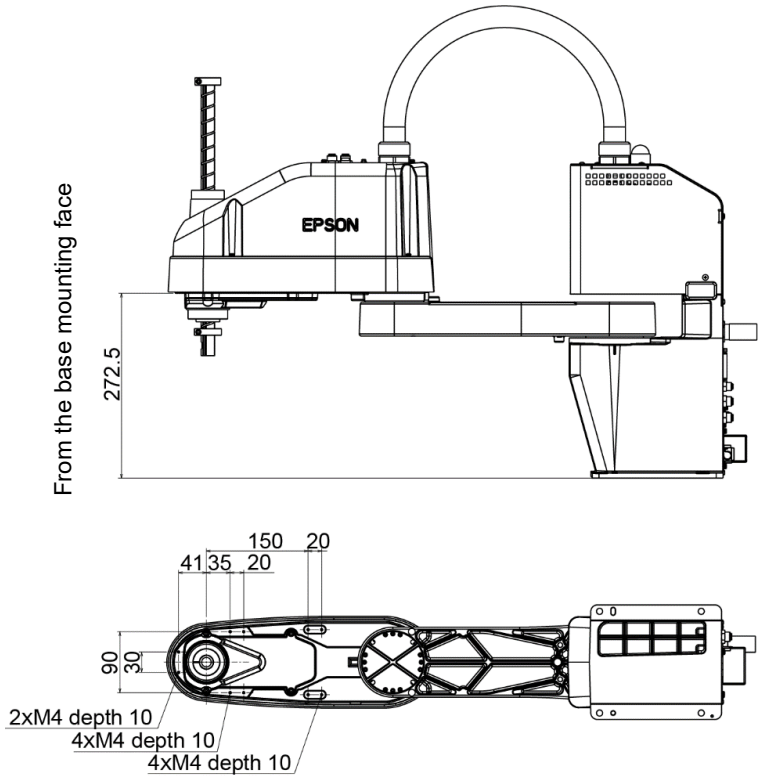
4.2 Attaching Cameras and Valves

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

T3-B



T6-B



4.3 Weight and Inertia Settings

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

EPSON RC+ 7.0 User's Guide
6.18.12 Weight, Inertia, and Eccentricity/offset Measurement Utility

4.3.1 Weight Setting

CAUTION	■ The total weight of the end effector and the work piece must not exceed T3-B: 3kg / T6-B: 6kg. The T-B series Manipulators are not designed to work with loads exceeding T3-B: 3kg / T6-B: 6kg. Always set the Weight parameters according to the load. Setting a value that is smaller than the actual load may cause errors, excessive shock and insufficient function of the Manipulator. Also, the life cycle of parts is shortened and positional gap due to belt tooth bumping occurs.

The acceptable weight capacity (end effector and work piece) in T-B series:

T3-B: default rating 1 kg, the maximum 3 kg
T6-B: default rating 2 kg, the maximum 6 kg

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

Load on the Shaft

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

EPSON RC+

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

Load on the Arm

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

Equivalent Weight Formula

When you attach the equipment to the rotation center of Joint #2: $W_M = M (L_1)^2/(L_1+L_2)^2$

When you attach the equipment to the end of Arm #2: $W_M = M (L_M)^2/(L_2)^2$

- W_M : equivalent weight
- M : weight of camera etc.
- L_1 : length of Arm #1
- L_2 : length of Arm #2
- L_M : distance from rotation center of Joint #2 to center of gravity of camera etc.

<Example>A "1 kg" camera is attached to the end of the T3-B series arm (225 mm away from the rotation center of Joint #2) with a load weight of "1 kg".

M=1

L_2=175

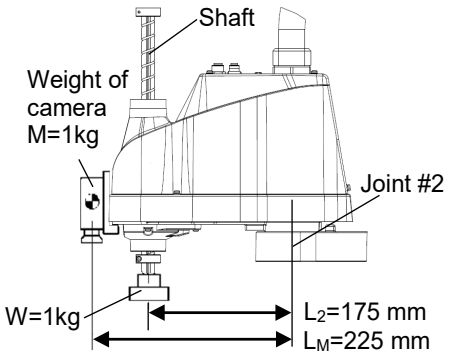
L_M=225

W_M=1×225²/175²

=1.653 → 1.7 (round up)

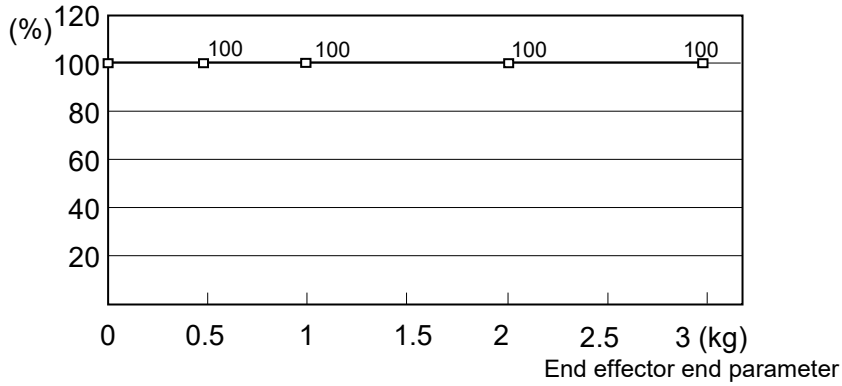
W+W_M=1+1.7=2.7

Enter "2.7" for the Weight Parameter.



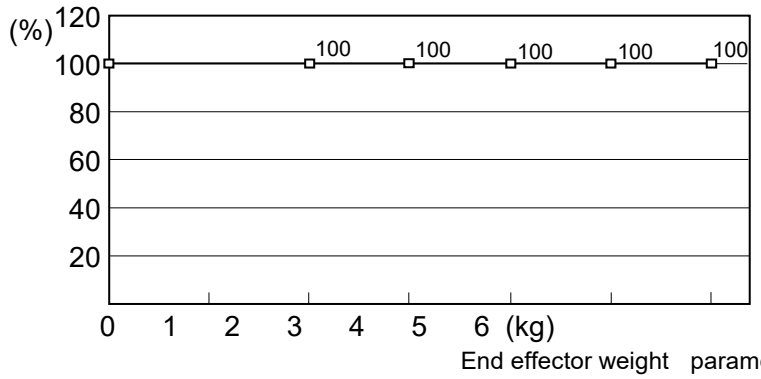
Automatic speed setting by Weight

T3-B



* The percentage in the graph is based on the speed at rated weight (1 kg) as 100%.

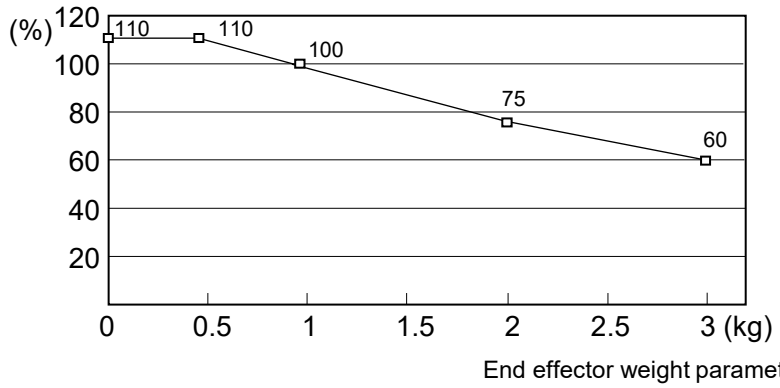
T6-B



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

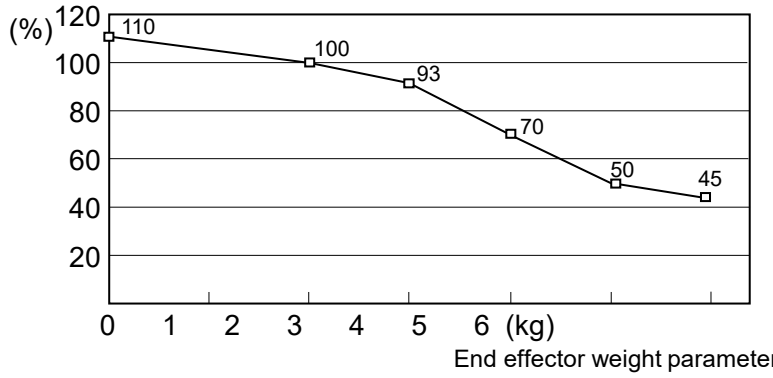
Automatic acceleration/deceleration setting by Weight

T3-B



* The percentage in the graph is based on the speed at rated weight (1 kg) as 100%.

T6-B



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

4.3.2 Inertia Setting

Moment of Inertia and the Inertia Setting

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

CAUTION	■ The moment of inertia of the load (weight of the end effector and work piece) must be T3-B: 0.01 kg·m^2 / T6-B: 0.08 kg·m^2 or less. The T-B series Manipulators are not designed to work with a moment of inertia exceeding T3-B: 0.01 kg·m^2 / T6-B: 0.08 kg·m^2. Always set the Weight parameters according to the load. Setting a value that is smaller than the actual load may cause errors, excessive shock and insufficient function of the Manipulator. Also, the life cycle of parts is shortened and positional gap due to belt tooth bumping occurs.

The acceptable moment of inertia of load for a T-B series Manipulator:

T3-B: default rating 0.003 kg·m^2, the maximum 0.01 kg·m^2
T6-B: default rating 0.01 kg·m^2, the maximum 0.08 kg·m^2

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

Moment of inertia of load on the shaft

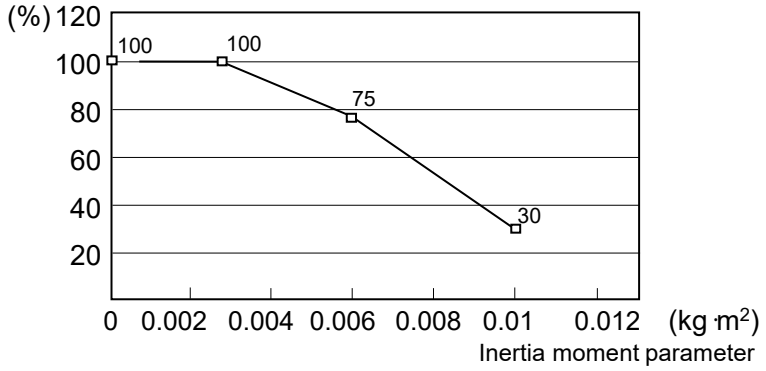
The moment of inertia of load (weight of the end effector and work piece) on the shaft can be set by the “moment of inertia” parameter of the Inertia command.

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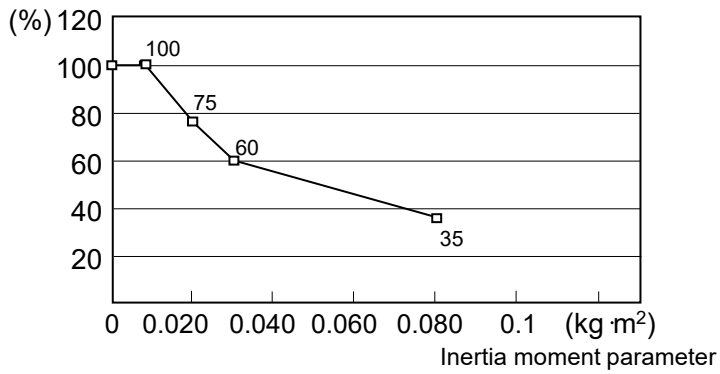
Enter a value into the [Load inertia:] text box on the [Inertia] panel ([Tools]-[Robot Manager]). (You may also execute the Inertia command from the [Command Window].)

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

T3-B



T6-B



Eccentric Quantity and the Inertia Setting

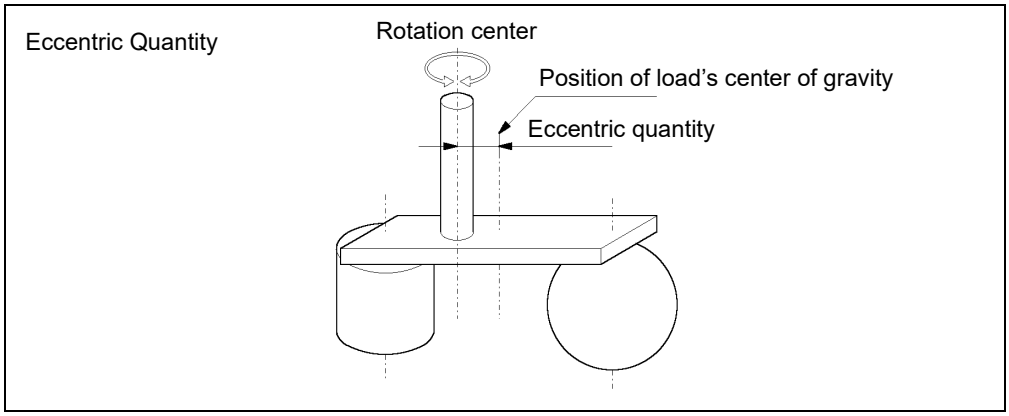
CAUTION	■ The eccentric quantity of load (weight of the end effector and work piece) must be T3-B: 100mm / T6-B: 150mm or less. The T-B series Manipulators are not designed to work with eccentric quantity exceeding T3-B: 100mm / T6-B: 150mm. Always set the Weight parameters according to the load. Setting a value that is smaller than the actual load may cause errors, excessive shock and insufficient function of the Manipulator. Also, the life cycle of parts is shortened and positional gap due to belt tooth bumping occurs.

The acceptable eccentric quantity of load in T-B series:

T3-B: default rating 0 mm, at the maximum: 100 mm

T6-B: default rating 0 mm, at the maximum: 150 mm

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



Eccentric quantity of load on the shaft

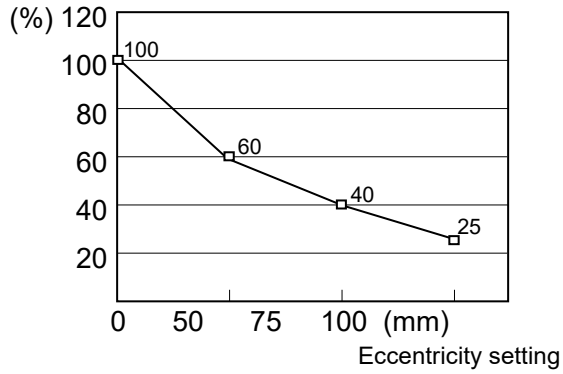
The eccentric quantity of load (weight of the end effector and work piece) on the shaft can be set by "eccentric quantity" parameter of Inertia command.

EPSON RC+

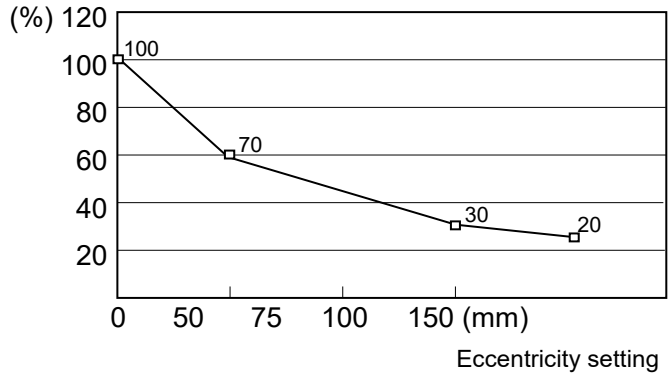
Enter a value into the [Eccentricity:] text box on the [Inertia] panel ([Tools]-[Robot Manager]). (You may also execute the Inertia command from the [Command Window].)

Automatic acceleration/deceleration setting by Inertia (eccentric quantity)

T3-B



T6-B

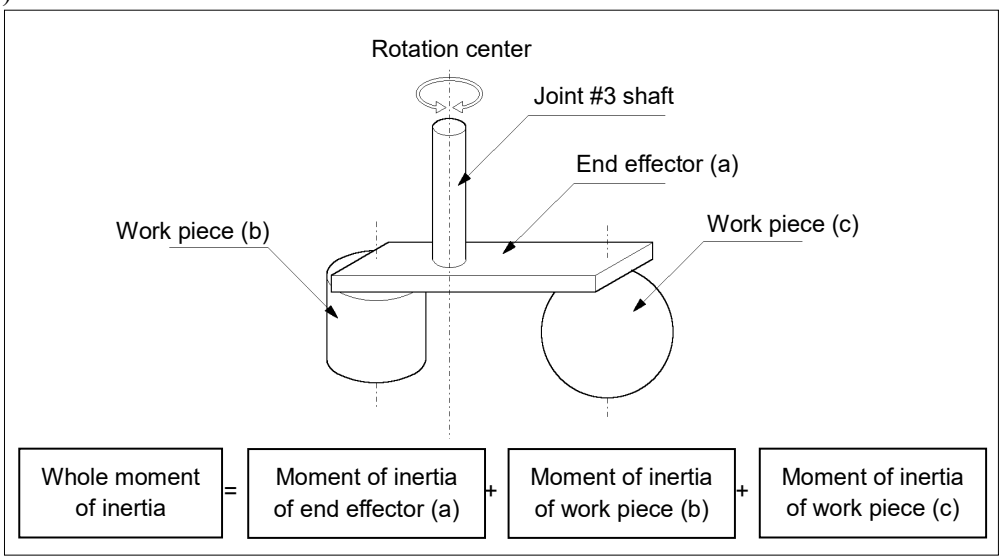


* The percentage in the graph is based on the acceleration / deceleration at rated eccentricity (0 mm) as 100%.

Calculating the Moment of Inertia

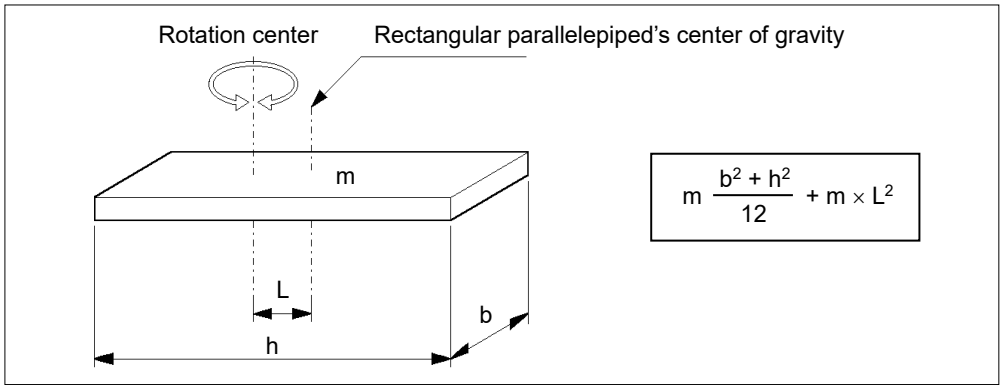
Refer to the following examples of formulas to calculate the moment of inertia of load (end effector with work piece).

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

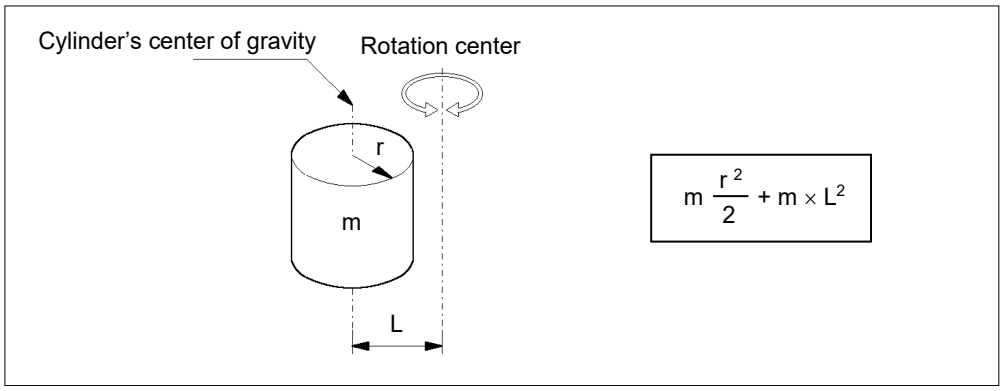


The methods for calculating the moment of inertia for (a), (b), and (c) are shown below. Calculate the total moment of inertia using the basic formulas.

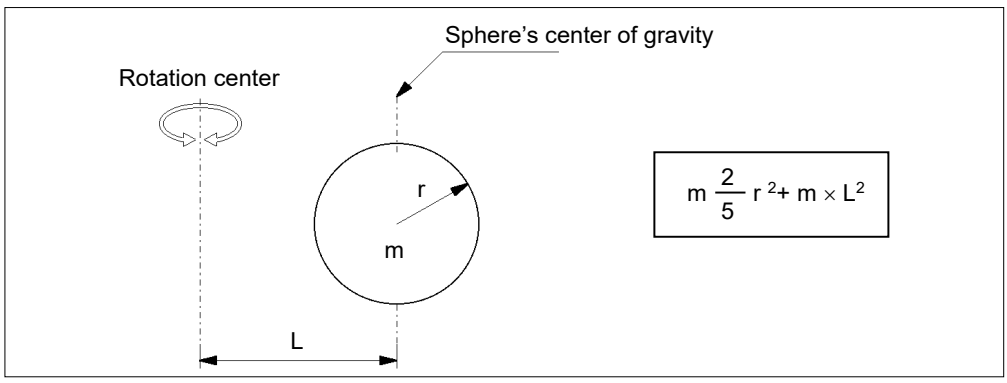
(a) Moment of inertia of a rectangular parallelepiped



(b) Moment of inertia of a cylinder



(c) Moment of inertia of a sphere

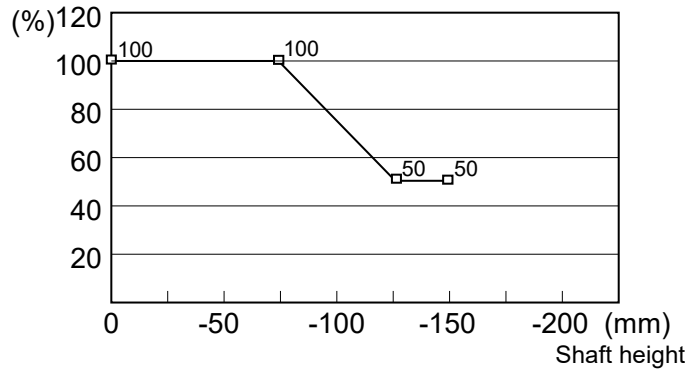


4.4 Precautions for Auto Acceleration/Deceleration of Joint #3

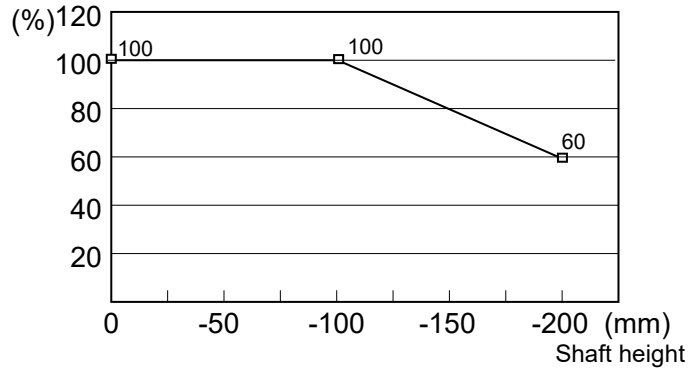
When you move the Manipulator in horizontal PTP motion with Joint #3 (Z) at a high position, the motion time will be faster.
When Joint #3 gets below a certain point, then auto acceleration/deceleration is used to reduce acceleration/deceleration. (Refer to the figures below) The higher the position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

Automatic acceleration/deceleration vs. Joint #3 position

T3-B



T6-B



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

NOTE

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

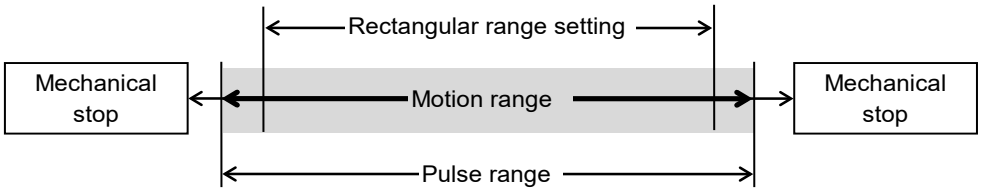
5. Motion Range

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

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

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

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



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

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

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

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

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

NOTE

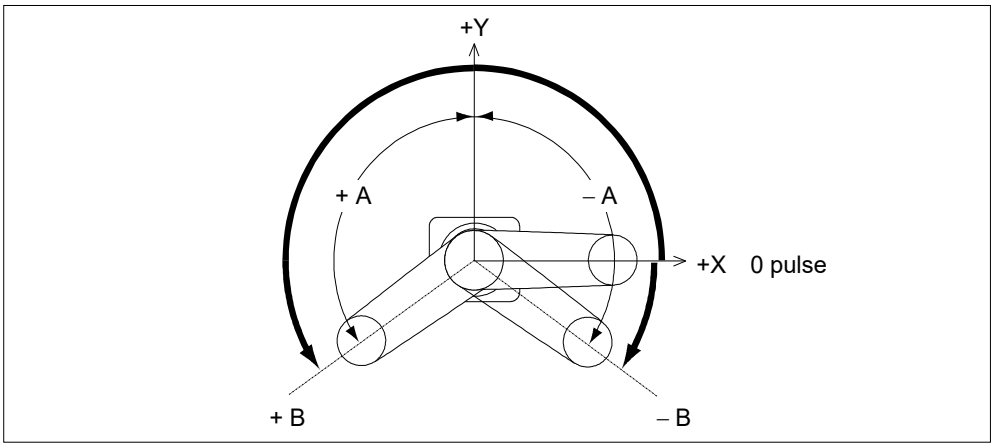
Once the Manipulator receives an operating command, it checks whether the target position specified by the command is within the pulse range before operating. If the target position is out of the set pulse range, an error occurs and the Manipulator does not move.

EPSON RC+

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

5.1.1 Max. Pulse Range of Joint #1

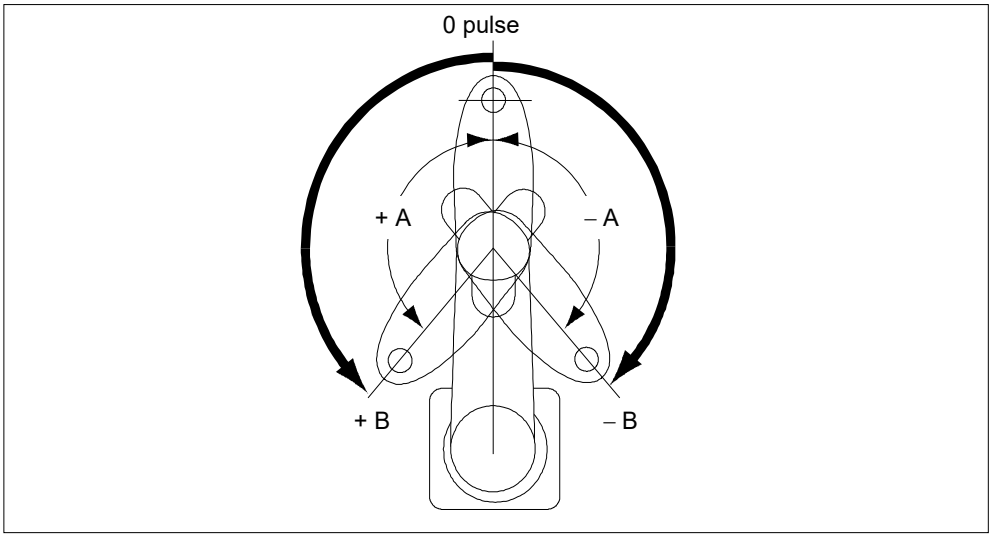
The 0 (zero) pulse position of Joint #1 is the position where Arm #1 faces toward the positive (+) direction on the X-coordinate axis.
When the 0 pulse is a starting point, the counterclockwise pulse value is defined as the positive (+) and the clockwise pulse value is defined as the negative (−).



	A: Max. Motion Range	B: Max. Pulse Range
T3-B	± 132°	– 95574 to 505174 pulse
T6-B		–152918 to 808278 pulse

5.1.2 Max. Pulse Range of Joint #2

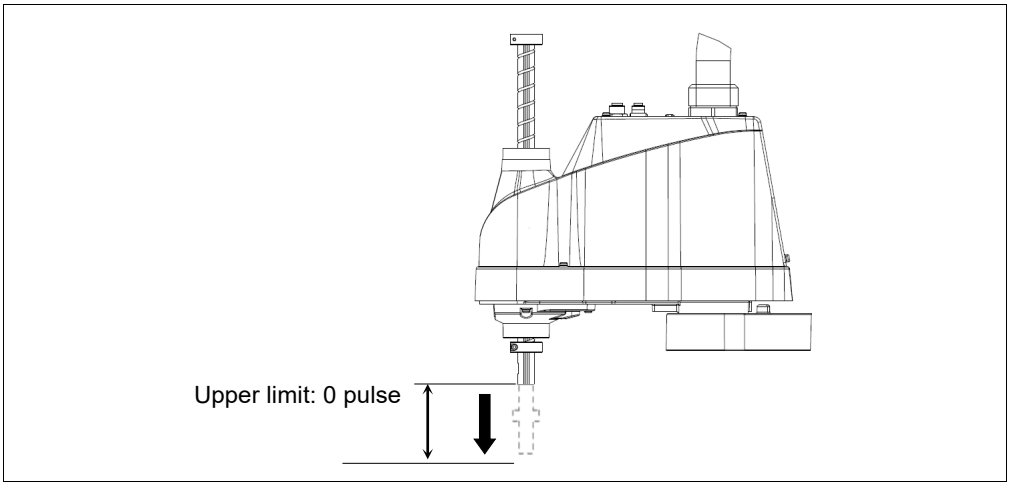
The 0 (zero) pulse position of Joint #2 is the position where Arm #2 is in-line with Arm #1.
With the 0 pulse as a starting point, the counterclockwise pulse value is defined as the positive (+) and the clockwise pulse value is defined as the negative (−).



	A: Max. Motion Range	B: Max. Pulse Range
T3-B	± 141°	± 320854 pulse
T6-B	± 150°	± 341334 pulse

5.1.3 Max. Pulse Range of Joint #3

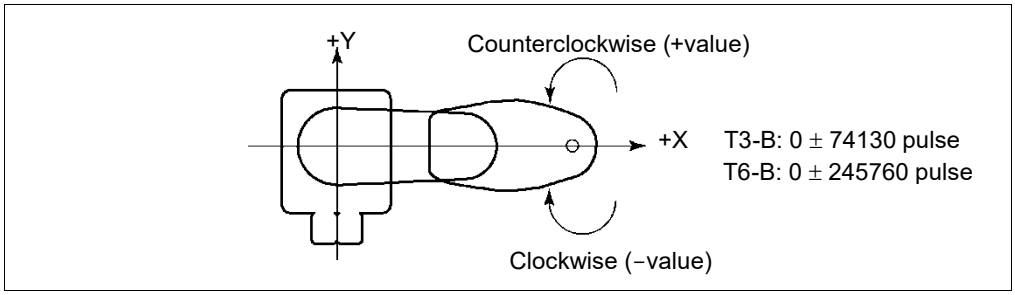
The 0 (zero) pulse position of Joint #3 is the position where the shaft is at its upper limit. The pulse value is always negative because Joint #3 always moves lower than the 0 pulse position.



	Joint #3 Stroke	Lower Limit Pulse
T3-B	150 mm	–187734 pulse
T6-B	200 mm	–245760 pulse

5.1.4 Max. Pulse Range of Joint #4

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

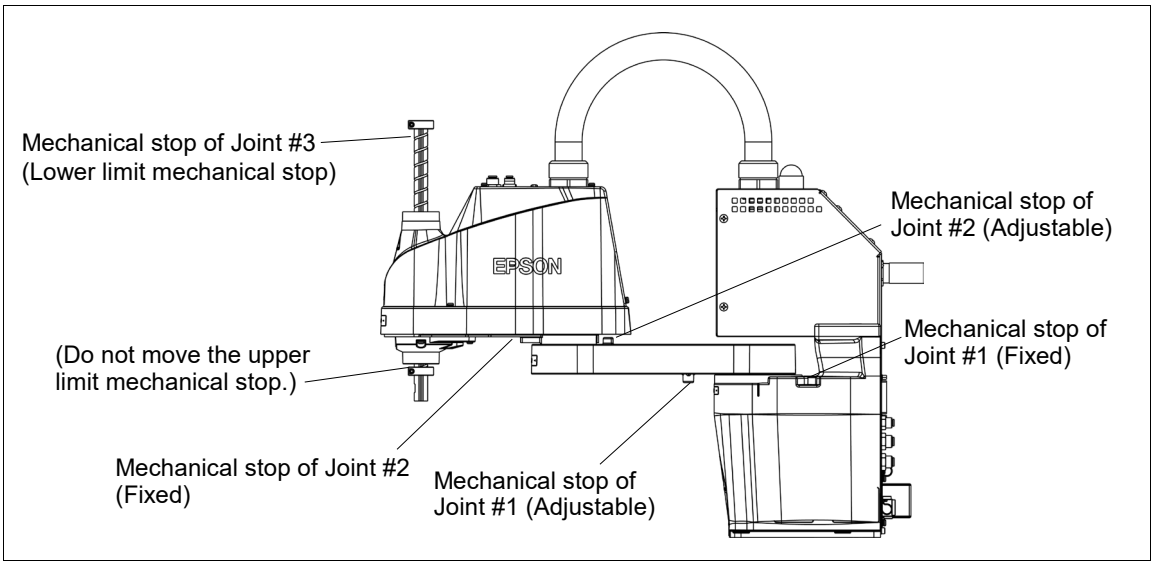


5.2 Motion Range Setting by Mechanical Stops

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

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

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

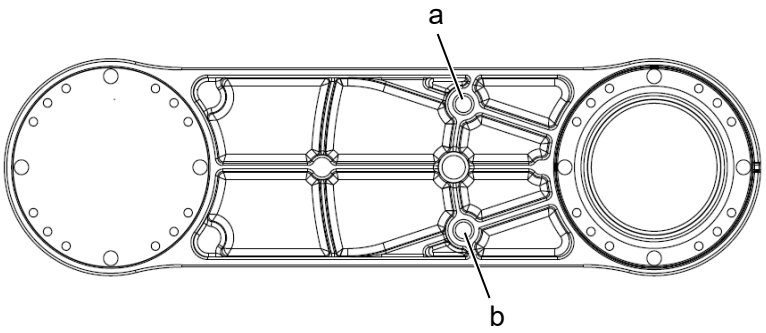


5.2.1 Setting the Mechanical Stops of Joints #1 and #2

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

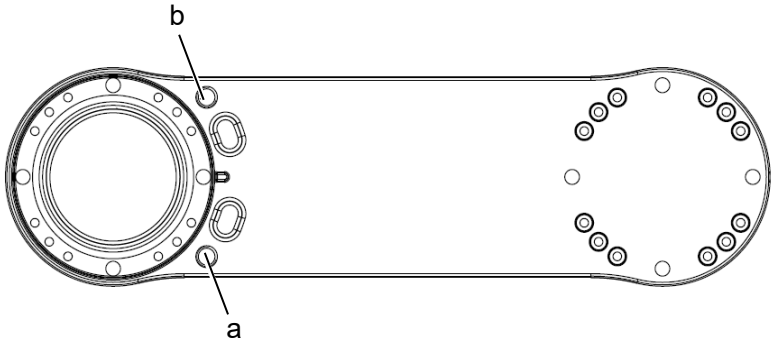
Install the bolts for the mechanical stop to the following position.

Joint #1 Mechanical Stops (Views from the bottom of Arm #1)



		a	b
T3-B	Setting Angle	110°	–110°
	Pulse Value	455112 pulse	–45512 pulse
T6-B	Setting Angle	115°	–115°
	Pulse Value	466489 pulse	–56889 pulse

Joint #2 Mechanical Stops (Views from the top of Arm #1)



		a	b
T3-B	Setting Angle	120°	–120°
	Pulse Value	273066pulse	–273066pulse
T6-B	Setting Angle	125°	–125°
	Pulse Value	284444pulse	–284444pulse

(1) Turn OFF the Manipulator.

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

T3-B Joint #2 only

Remove the user plate on the arm cover.

For details, refer to *T-B series Maintenance Manual* "*7. Cover*".

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

(3) Turn ON the Manipulator.

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

NOTE

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

Example: Using T3-B401S

The angle of Joint #1 is set from −110° to +110°.

The angle of Joint #2 is set from −120° to +120°.

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Execute the following commands from the [Command Window]

```
>JRANGE 1, -45512, 455112        ' Sets the pulse range of Joint #1
>JRANGE 2,- 273066, 273066       ' Sets the pulse range of Joint #2
>RANGE                           ' Checks the setting using Range
 -45512, 455112, -273066, 273066, -187734
    ,0, -74130, 74130
```

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

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

Example: Using T3-B401S
The angle of Joint #1 is set from −110° to +110°.
The angle of Joint #2 is set from −120° to +120°.

EPSON RC+

Execute the following commands from the [Command Window].

```
>MOTOR ON                          ' Turns ON the motor
>POWER LOW                         ' Enters low-power mode
>SPEED 5                           ' Sets at low speeds
>PULSE -45512,0,0,0                ' Moves to the min. pulse position of Joint #1
>PULSE 455112,0,0,0                ' Moves to the max. pulse position of Joint #1
>PULSE 204800,-273066,0,0          ' Moves to the min. pulse position of Joint #2
>PULSE 204800,273066,0,0           ' Moves to the max. pulse position of Joint #2
```

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

In this example, Joint #1 is moved to the center of its motion range (pulse value: 204800) when checking Joint #2.

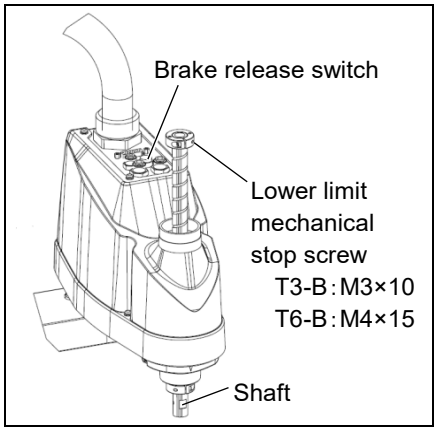
If the arm is hitting the mechanical stops or if an error occurs after the arm hits the mechanical stops, either reset the pulse range to a narrower setting or extend the positions of the mechanical stops within the limit.

5.2.2 Setting the Mechanical Stop of Joint #3

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

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

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



NOTE

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

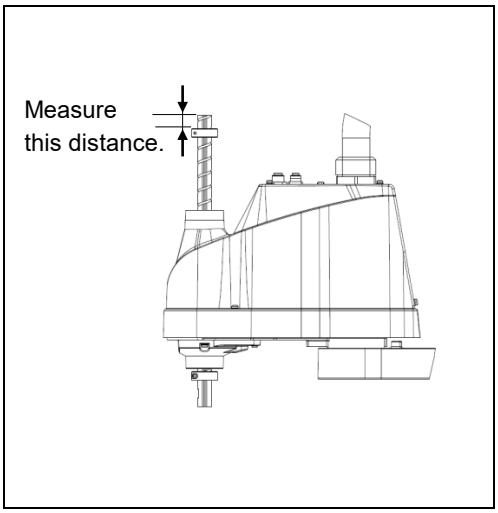
(3) Turn OFF the Manipulator.

(4) Loosen the lower limit mechanical stop screw (T3-B: M3×10, T6-B: M4×15).

NOTE


A mechanical stop is mounted on both the top and bottom of Joint #3. However, only the position of the lower limit mechanical stop on the top can be changed. Do not remove the upper limit mechanical stop on the bottom because the calibration point of Joint #3 is specified using the stop.

(5) The upper end of the shaft defines the maximum stroke. Move the lower limit mechanical stop down by the length you want to limit the stroke.
For example, when the lower limit mechanical stop is set at "150 mm" stroke, the lower limit Z coordinate value is "−150". To change the value to "−130", move the lower limit mechanical stop down "20 mm". Use calipers to measure the distance when adjusting the mechanical stop.



(6) Firmly tighten the lower limit mechanical stop screw (T3-B: M3×10, T6-B: M4×15).

Recommended tightening torque:
T3-B: 2.4±0.1 N·m
T6-B: 5.5±0.25 N·m

(7) Turn ON the Manipulator.

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

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

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

Lower limit of pulse (pulse) = lower limit Z coordinate value (mm) / Joint #3 resolution (mm/pulse)**

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

EPSON RC+

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

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

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

NOTE


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

EPSON RC+

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

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

(In this example, all pulses except those for Joint #3 are "0". Substitute these "0s" with the other pulse values specifying a position where there is no interference even when lowering Joint #3.)

5.3 Setting the Cartesian (Rectangular) Range in the XY Coordinate System of the Manipulator (for Joints #1 and #2)

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

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

EPSON RC+

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

5.4 Standard Motion Range

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

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

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

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

For the motion area figures, refer to "*3.3 Mounting Dimensions*".

6. Operation Mode & LED

6.1 Overview

The Robot system has three operation modes.

TEACH mode This mode enables point data teaching and checking close to the Manipulator using the Teach Pendant.
In this mode the Manipulator 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 Manipulators 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.

6.2 Switch Operation Mode

Change the operation mode using the mode selector key switch on the Teach Pendant.

TEACH mode Turn the mode selector key switch to “Teach” for TEACH mode.
Switching to TEACH mode pauses the program if it was running.
The operating manipulator stops by Quick Pause.

AUTO mode Turn the mode selector key switch to “Auto” and turn on the latch release input signal for AUTO mode.

TEST mode Turn the mode selector key switch to “Teach” for “TEACH” mode.
Push <F1> key-[Test Mode] in [Jog & Teach] dialog of TEACH mode. The mode will be changed to TEST

6.3 Program Mode (AUTO)

6.3.1 What is Program Mode (AUTO)?

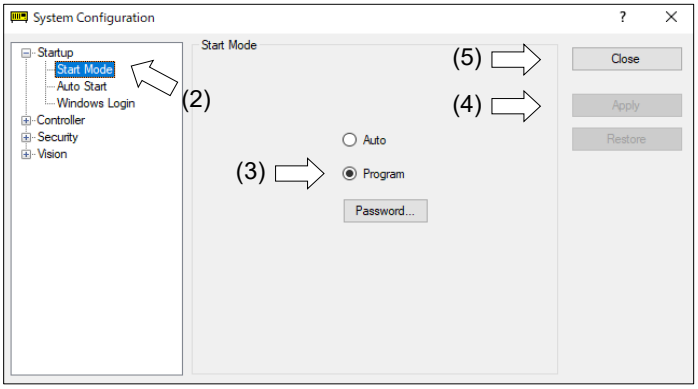
Program mode is for programming, debug, adjustment, and maintenance of the Robot system.

Follow the procedures below to switch to the Program mode.

6.3.2 Setup from EPSON RC+ 7.0

Switch the mode to Program mode from the EPSON RC+ 7.0.

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



(2) Select [Startup].

(3) Select [Start mode]-<Program> button.

(4) Click the <Apply> button.

(5) Click the <Close> button.

6.4 Auto Mode (AUTO)

6.4.1 What is Auto mode (AUTO)?

Auto mode (AUTO) is for automatic operation of the Robot system.

Procedures for switching to the Auto mode (AUTO) are the following.

A : Set the start mode of the EPSON RC+ 7.0 to “Auto” and start the EPSON RC+ 7.0.
(Reference: 6.3.2 *Setup from EPSON RC+ 7.0*)

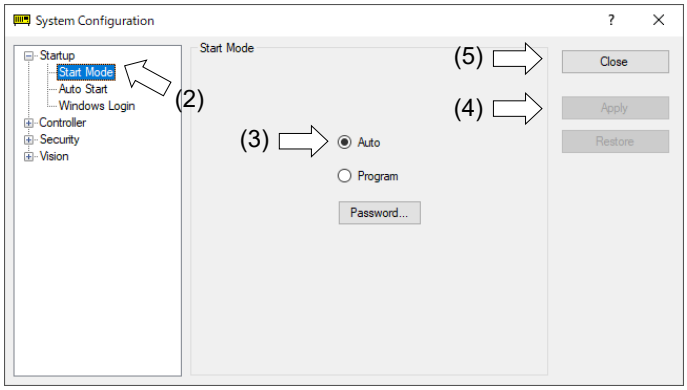
B : Offline the EPSON RC+ 7.0.

NOTE Execute and stop the program from the control device specified by the EPSON RC+ 7.0. (Reference: 6.4.3 *Setup Control Device*)

6.4.2 Setup from EPSON RC+ 7.0

Switch the mode to Auto mode (AUTO) from the EPSON RC+ 7.0.

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



(2) Select [Startup].

(3) Select [Start Mode]-<Auto> button.

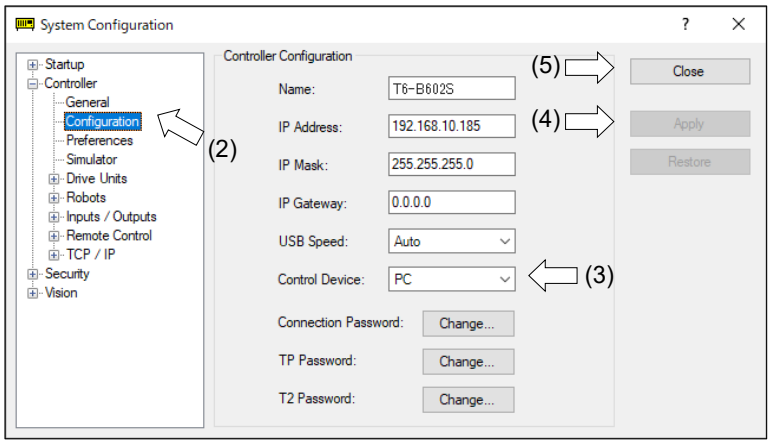
(4) Click the <Apply> button.

(5) Click the <Close> button.

6.4.3 Setup from Control Device

Set the control device from EPSON RC+ 7.0.

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



(2) Select [Controller]-[Configuration].

(3) Select [Control Device] to select the control device from the following two types.
- PC
- Remote (I/O)

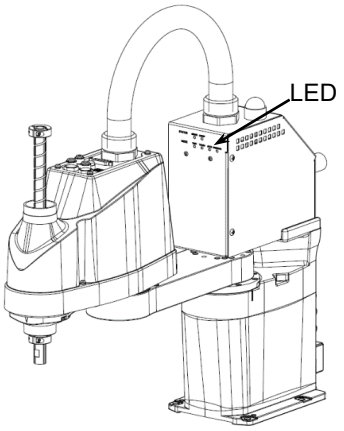
(4) Click the <Apply> button.

(5) Click the <Close> button.

6.5 LED

Six LEDs are located on the front panel of the Manipulator.

LEDs (ERROR, E-STOP, TEACH, TEST, AUTO, PROGRAM) turn ON according to the Controller status (error, Emergency Stop, TEACH mode, Auto mode, Program mode).

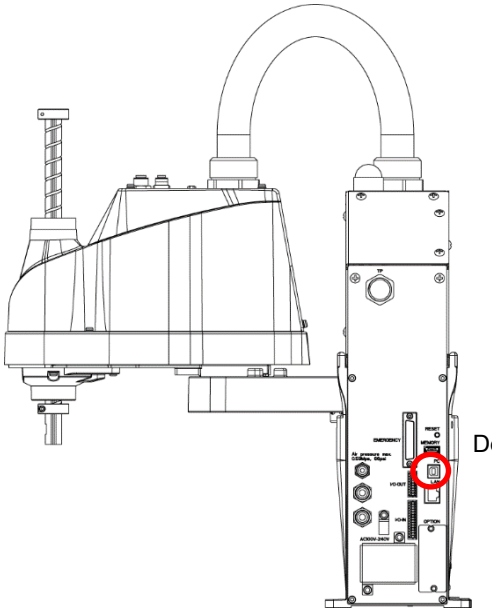


(Illustration: T3-B401S)

(Illustration: T3-B401S)

Controller status	LED display
Start up (Required time is different depending on the connection status of the device.)	1. TEST, TEACH, AUTO, and PROGRAM blink (15 seconds) 2. All turn OFF (10 seconds) 3. All turn ON (to 10 seconds) 4. All turn OFF (10-30 seconds) 5. Either of TEACH, AUTO, or PROGRAM turns ON
Execute Controller status storage function to the USB memory	TEACH AUTO, PROGRAM blink.
Complete Controller status storage to USB memory	TEACH, AUTO, PROGRAM turn ON (for 2 seconds). ERROR turns OFF even if an error occurs.
Failure of Controller status storage to USB memory	ERROR, TEACH, AUTO, PROGRAM turn ON (for 2 seconds).
Error	ERROR turns ON
Warning	ERROR blinks.
Emergency Stop	E-STOP turns ON.
TEACH mode	TEACH blinks.
Auto mode (AUTO mode)	AUTO blinks.
Program mode (AUTO mode)	PROGRAM blinks.
AC power supply drop	TEACH, AUTO turn ON.
TEST mode	TEST blinks.

7. Development PC Connection Port



(Illustration: T3-B401S)

NOTE

- For other details of development PC and Manipulator connection, refer to *EPSON RC+ 7.0 User's Guide 5.13.1 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.

7.1 What is Development PC Connection Port

The development PC connection port supports the following USB types.

- 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.

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

7.2 Precaution

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

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

7.3 Software Setup and Connection Check

Connection of the development PC and the Manipulator is indicated.

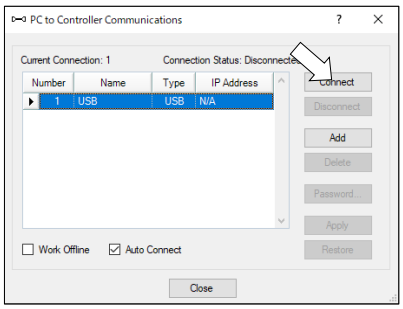
(1) Make sure that software EPSON RC+ 7.0 is installed to the Manipulator connected to the development PC.
(Install the software when it is not installed. Refer to "*EPSON RC+ 7.0 User's Guide*".

(2) Connect the development PC and the Manipulator using a USB cable.

(3) Turn ON the Manipulator.

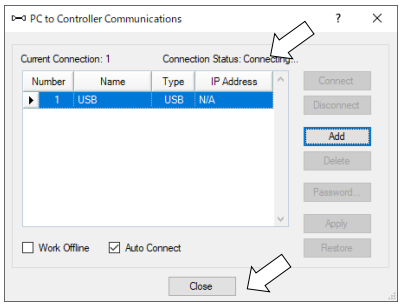
(4) Start EPSON RC+ 7.0.

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



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

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



The connection between the development PC and the Manipulator is completed. Now the robot system can be used from EPSON RC+ 7.0.

7.4 Disconnection of Development PC and Manipulator

Disconnection of the development PC and the Manipulator communication.

(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.
Communication between the Manipulator and the development PC is disconnected and the USB cable can be removed.

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

8. Memory Port

Connect a commercial USB memory to the Manipulator memory port to use the Controller status storage function to the USB memory.

8.1 What is Controller Status Storage Function?

This function saves various kinds of Manipulator data to the USB memory. Data saved in USB memory is loaded to EPSON RC+ 7.0 to get the status of the Manipulator and the program simply and accurately.

The saved data can also be used for restoring the Manipulator.
Unable to execute status storage to USB memory when operating the Manipulator.

8.2 Before Using Controller Status Storage Function

8.2.1 Precautions

 CAUTION	■ Controller status storage function is available at any time and in any Manipulator status after starting the Manipulator. However, operations form the console including stop and pause are not available while executing this function. Also, this function influences the Manipulator cycle time and the communication with EPSON RC+ 7.0. Other than only when it is necessary, do not execute this function when operating the Manipulator.

- Make sure that the USB port is used only for USB memory even though the port on the Manipulator is a universal USB port.
- Insert the USB memory directly into the Manipulator memory port. Connection with cables or hubs between the Manipulator and the USB memory is not assured.
- Make sure that the USB memory is inserted or removed slowly.
- Do not edit the saved files with an editor. Operation of the robot system after data restoration to the Manipulator is not assured.

8.2.2 Adoptable USB Memory

Use USB memory that meets following conditions.

- USB2.0 supported
- Without security function
  USB memory with password input function cannot be used.
- No installation of a driver or software is necessary for Windows 8, Windows 10, or Windows 11, Linux.
  (For supported operating systems for the EPSON RC+ 7.0, refer to "*2.4 System Example*".)

8.3 Controller Status Storage Function

8.3.1 Controller Status Storage

CAUTION	■ Controller status storage function is available at any time and in any Manipulator status after starting the Manipulator. However, operations form the console including stop and pause are not available while executing this function. Also, this function influences the Manipulator cycle time and the communication with EPSON RC+ 7.0. Other than only when it is necessary, do not execute this function when operating the Manipulator.

Use this procedure to save the status of the Manipulator to USB memory.

(1) Insert the USB memory into the memory port.
When the data transfer starts, the LED of TEACH, AUTO, and PROGRAM starts blinking. Wait until the LED status changes.
(The data transfer time varies according to the data size such as of the projects.)

(2) When the Manipulator status storage is completed successfully, the LED of TEACH, AUTO, and PROGRAM are turned ON for two seconds. Note that the LED of ERROR turns OFF even in the error status.
If it ends in failure, the LED of ERROR, TEACH, AUTO, and PROGRAM are turned ON for two seconds.

(3) Remove the USB memory from the Manipulator.

NOTE

- USB memory with LED is recommended to check the status changes.
- When storage is executed during Motor ON status, it may fail to store the status. Use another USB memory or execute the storage during Motor OFF status.

8.3.2 Load Data with EPSON RC+ 7.0

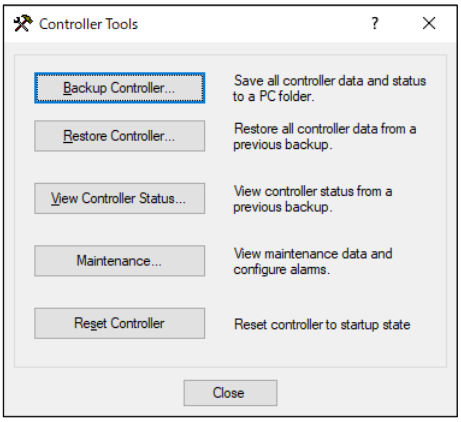
The following shows the procedure to load the data stored in the USB memory by EPSON RC+ 7.0 and display the Controller status.

(1) Insert the USB memory into the PC with EPSON RC+ 7.0.

(2) Make sure that the following folder is indicated in the USB memory.
BU_T_serial number_data status was saved
→ Example:BU_T_12345_2013-10-29_092951

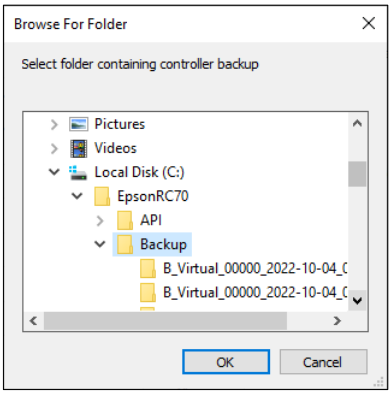
(3) Copy the folder confirmed in procedure (2) to the "\EpsonRC70\Backup" folder.

(4) Select the EPSON RC+ 7.0 menu-[Tools]-[Controller] to display the [Controller Tools] dialog.

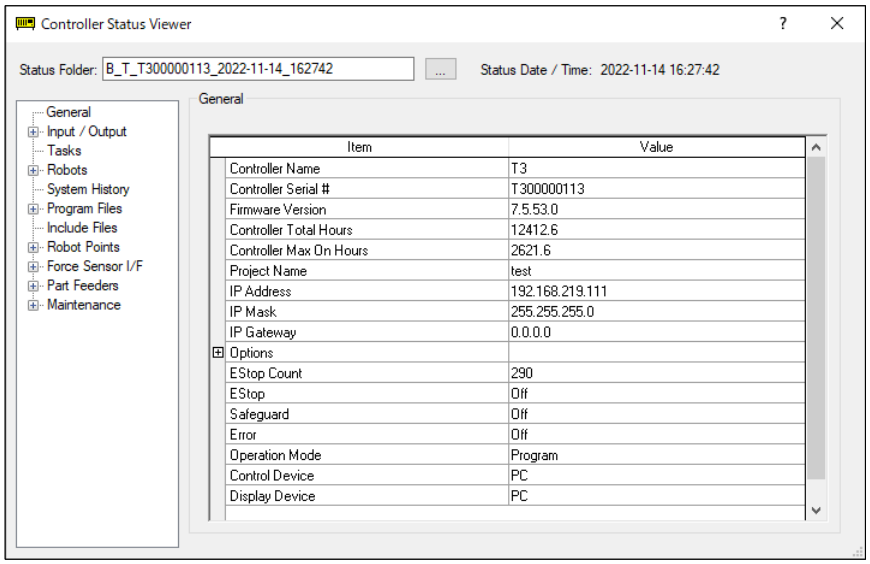


(5) Click the <View Controller Status…> button.

(6) [Browse For Folder] dialog appears. Select the folder copied in procedure (3) and click the <OK> button.



(7) [Controller Status Viewer] dialog appears to confirm the Controller status.
For details, refer to *View Controller Status* in *EPSON RC+ 7.0 User's Guide 5.12.8 Controller Command (Tools Menu)*.



8.3.3 Transfer with E-mail

Follow this procedure to transfer the data by e-mail that was saved to the USB memory.

(1) Insert the USB memory to a PC that supports sending of e-mail.

(2) Make sure that the USB memory has following folders.
BU_T_serial number_data status was saved
→ Example:BU_T_12345_2013-10-29_092951

(3) Send all the folders by e-mail.

NOTE

Delete files that do not relate to the project before transfer.

This function is used to send the data to the system director and EPSON from the end users for problem analysis.

8.4 Details of Data

The following data files are created by the Controller status storage function.

File Name	Outline	
Backup.txt	Information file for restore	File with information for Manipulator restore.
CurrentMnp01.PRM	Robot parameter	Saves information such as ToolSet.
CurrentStatus.txt	Save status	Saves program and I/O status.
ErrorHistory.csv	Error history	
InitFileSrc.txt	Initial setting	Saves various settings of the Controller.
MCSys01.MCD	Robot setting	Saves information of connected Manipulator.
SrcmcStat.txt	Hardware information	Saves installation information of hardware.
ProjectName.obj	OBJ file	Result of project build. Prg file is not included.
GlobalPreserves.dat	Global Preserve variables	Saves values of Global Preserve variables.
WorkQueues.dat	WorkQue information	Saves information of Queues information of the WorkQue.
MCSRAM.bin MCSYSTEMIO.bin MCTABLE.bin MDATA.bin SERVOSRAM.bin VXDWORK.bin	Inner information of Manipulator	
All files related to project except ProjectName.obj *1	Project	When [Include project files when status exported] check box is checked in EPSON RC+ 7.0 menu-[Setup]-[System Configuration]-[Controller]-[Preference], the project file is stored. Includes program files.

*1 Storage of “All files related to project except ProjectName.obj” can be specified by a setting.

9. LAN (Ethernet Communication) Port

NOTE

- Refer to *EPSON RC+ 7.0 User's Guide 5.13.1 [PC to Controller Communications] Command (Setup Menu)* for other details for the development PC and Manipulator connection.
- For Ethernet (TCP/IP) communication with robot application software, refer to *EPSON RC+ 7.0 Online Help* or *User's Guide 14. TCP/IP Communications*.

9.1 What is the LAN (Ethernet Communication) Port

Ethernet communication port supports 100BASE-TX / 10 BASE-T.

This port is used for two different purposes.

Connection with development PC

LAN (Ethernet communication) port is used for connection of the Manipulator and the development PC.

Equivalent operation is available to connect between the Manipulator and the development PC with the development PC connection port.

(Reference: *7. Development PC Connection Port*)

Connection with other Manipulator, Controller, or PC

The LAN (Ethernet communication) port can be used as an Ethernet (TCP/IP) communication port to communicate between multiple controllers from robot application software.

9.2 IP Address

From the following firmware version password authentication is required when connecting Controllers and PCs to a global accessible network.

F/W : Ver.7.4.58.x

NOTE

For details of setting password, refer to "*EPSON RC+ 7.0 User's Guide 1.9.1 Setting Password for PC Ethernet Controller Connection*".

Our robot system is provided on the assumption that customers use it in the closed local area networks. We considered the setting of the global IP address is access to the Internet and changed the specification to perform password authentication in order to secure the connections.

Password authentication is not performed in case of USB connections.

Be sure to use the following private IP addresses.

Private Address List

10.0.0.1	to	10.255.255.254
172.16.0.1	to	172.31.255.254
192.168.0.1	to	192.168.255.254

The following is the configuration of the controller Manipulator at delivery.

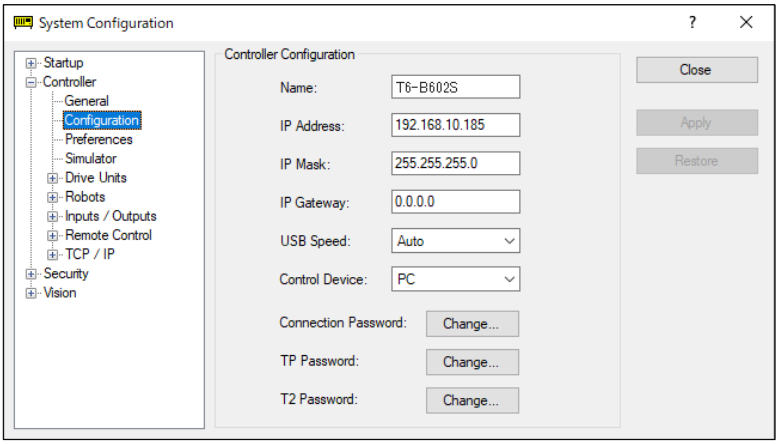
IP Address : 192.168.0.1
IP Mask : 255.255.255.0
IP Gateway : 0.0.0.0

9.3 Changing Manipulator IP Address

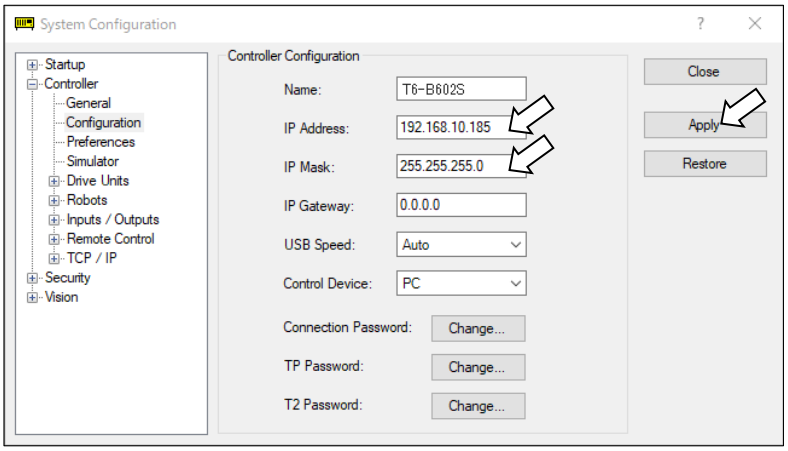
In this section, the procedure to change the Manipulator IP address when connecting Manipulator development PC connection port and the development PC by the USB cable is indicated.

(1) For connection between the development PC and the Manipulator.
Reference: *7. Development PC Connection Port*

(2) Select the EPSON RC+ 7.0 menu-[Setup]-[Controller] to display the following dialog.



(3) Select [Controller]-[Configuration].



(4) Enter the proper IP address and subnet mask and click the <Apply> button.

(5) Click the <Close> button. The Manipulator reboots automatically.
IP address configuration is completed and the Manipulator reboot dialog disappears.

NOTE

When the Manipulator and the development PC are connected via the Ethernet, the Manipulator IP address can also be changed. However, Manipulator and the development PC do not connect automatically after rebooting the Manipulator at Ethernet connection.

9.4 Connection of Development PC and Manipulator with Ethernet

Connection between the development PC and the Manipulator is shown below.

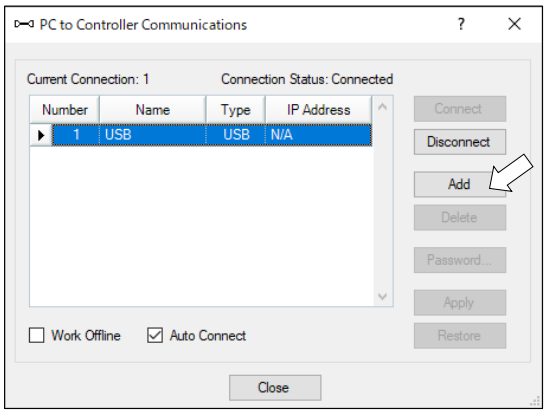
(1) Connect the development PC and the Manipulator using the Ethernet cable.

(2) Turn on the Manipulator.

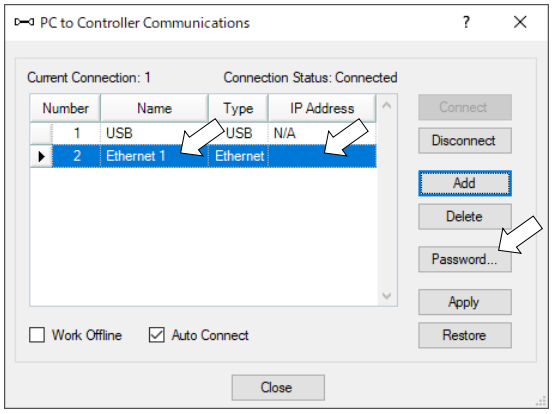
(3) Start EPSON RC+ 7.0.

(4) Display the [PC to Controller Communication] dialog from [Setup] in EPSON RC+ 7.0 menu.

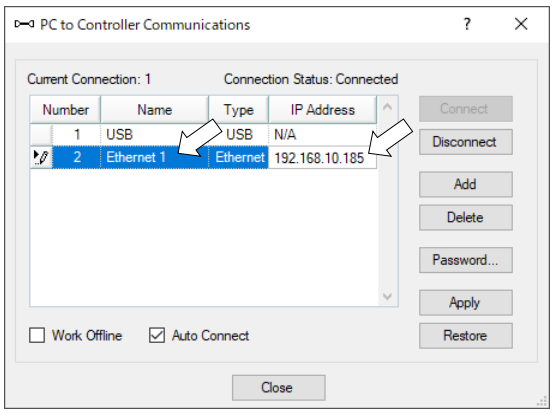
(5) Click the <Add> button.



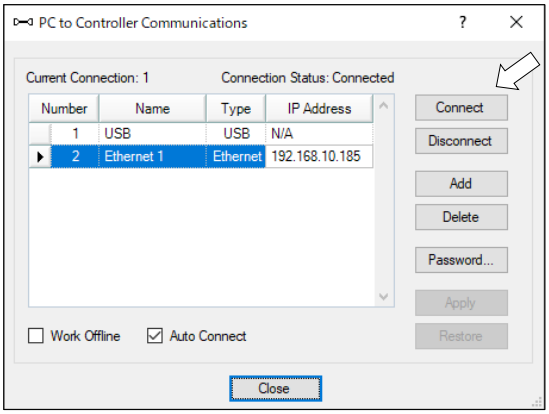
(6) Connection “No.2” is added. Set the following and click the <Apply> button.
Name : Valid value to identify the Manipulator to connect
IP Address : IP address for Manipulator to connect



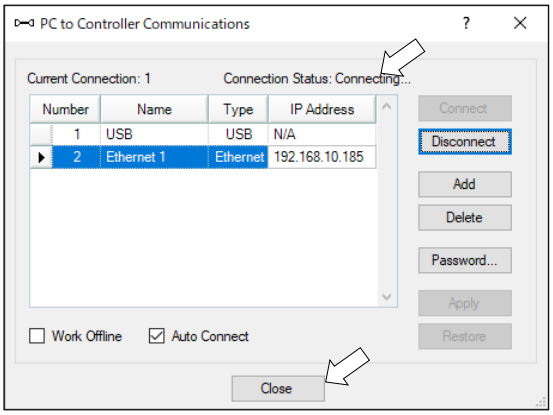
(7) [Name] and [IP Address] specified in procedure (6) is displayed.



(8) Make sure that “No.2” is selected, and click the <Connect> button.



(9) After the development PC and 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 between the development PC and the Manipulator is complete. Now the robot system can be used via an Ethernet connection from EPSON RC+ 7.0.

9.5 Disconnection of Development PC and Manipulator with Ethernet

Disconnection of the development PC and the Manipulator is shown below.

(1) Display [PC-Controller Connection] dialog from [Setup] in EPSON RC+ 7.0 menu.

(2) Click the <Disconnect> button.
Communication between the Manipulator and the development PC is disconnected and the Ethernet cable can be removed.

NOTE

If the Ethernet cable is removed when the Manipulator and the development PC is connected, Emergency Stop occurs and the Manipulator stops. Be sure to click the <Disconnect> button in the [PC to Controller Communications] dialog before the Ethernet cable is removed.

10. TP Port

10.1 What is the TP Port?

The TP port connects the Teach Pendant to the manipulator. You can connect the Teach Pendant (TP2, TP3).

Dedicated convert cable* is necessary if connecting TP2 to T-B series manipulator. Contact the supplier of your region if only convert cable is necessary.

* TP Exchange Cable: R12NZ900L6

NOTE

When nothing is connected to the TP port, Emergency Stop status occurs in the Manipulator. When the Teach Pendant is not connected, connect the TP bypass plug.

Store the removed TP in place so that it can be distinguished from the TP connected to the controller.

Do not connect the devices except TP2, TP3 to the TP port. Connecting these devices may result in malfunction of the device since the pin assignments are different.

External enable switch cannot be connected to the TP port. Use the enable switch provided with the TP.

10.2 Teach Pendant Connection

A dedicated cable is attached to the Teach Pendant. Connect this cable connector to the TP port.
Communication is set automatically. Enable the Teach Pendant by one of the following procedures.

- Insert the Teach Pendant connector to the Manipulator and turn ON the Manipulator.
- Insert the Teach Pendant connector while the Manipulator is turned ON.

NOTE

Teach Pendant connection and disconnection from the Controller are allowed when the Manipulator power is ON.

When the Teach Pendant connector is removed from the Manipulator with the mode selector key switch of the Teach Pendant in the “Teach” position, the operation mode will remain in the TEACH mode. The operation mode cannot be switched to AUTO mode. Be sure to remove the Teach Pendant after switching the operation mode to “Auto” mode.

The administrator supervises the removal and storage of the Teach Pendant. Only the personnel who is allowed can touch it. Store it so that you can see the Teach Pendant is not connected to the controller.

For details, refer to manual

Robot Contoroller Option Teach Pendant TP2.
Robot Contoroller Option Teach Pendant TP3.

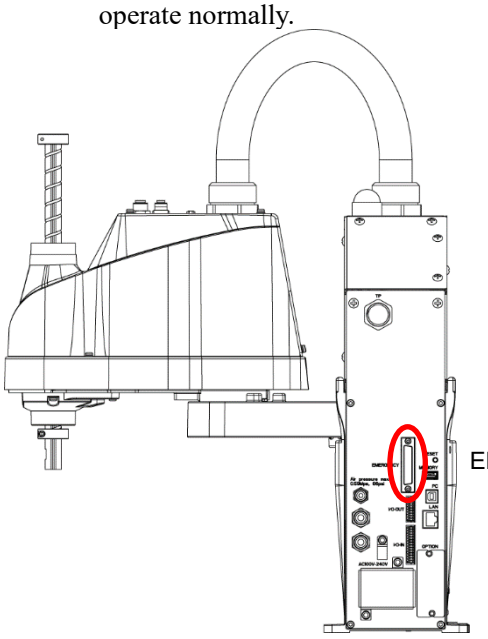
11. EMERGENCY

NOTE

The details of safety requirements for this section are described in *EPSON RC+ 7.0 User's Guide 2. Safety*. Please refer to them to keep the robot system safe.

WARNING	■ Make sure that emergency stop or safeguard 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.

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



(Illustration: T3-B401S)

11.1 Safeguard Switch and Latch Release Switch

The EMERGENCY connector has input terminals for the Safeguard 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 (cable side) D-Sub 25 pin male (board side)

* The E-STOP BOX, EMERGENCY connector cable, terminal block, and EMERGENCY connector kit are offered as options.

11.1.1 Safeguard Switch

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

In order to maintain a safe working zone, a safeguard must be erected around the Manipulator. The safeguard must have an interlock switch at the entrance to the working zone. The Safeguard that is described in this manual is one of the safeguards and an interlock of the Safeguard is called a Safeguard switch. Connect the Safeguard switch to the Safeguard input terminal on the EMERGENCY connector.
The Safeguard switch has safety features such as temporary hold-up of the program or the operation-prohibited status that are activated whenever the Safeguard is opened.

Observe the following in designing the Safeguard switch and the Safeguard.

- For the Safeguard switch, select a switch that opens as the Safeguard opens, and not by the spring of the switch itself.
- The signal from the Safeguard (Safeguard input) is designed to input to two redundant signals. If the signals at the two inputs differ by two seconds or more, the system recognizes it to be a critical error. Therefore, make sure that the Safeguard switch has two separate redundant circuits and that each connects to the specified pins at the EMERGENCY connector on the Manipulator.
- Make sure to design the safeguard to prevent the door from closing accidentally.

11.1.2 Latch Release Switch

The controller software latches these conditions:

- The safeguard is open.
- The operation mode is set to “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 safeguard is open or the operation mode is “TEACH”.

Closed : The latch release switch releases the latched conditions.

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

11.1.3 Checking Latch Release Switch Operation

After connecting the safeguard 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 Manipulator while the safeguard is open in order to boot the controller software.

(2) Make sure that “Safety” is displayed on the main window status bar.

(3) Close the safeguard, 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 safeguard is open can be latched by software based on the latch release input condition. To cancel the condition, close the safeguard, and then close the safeguard latch release input.

Open : The latch release switch latches the condition that the safeguard is open.

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

NOTE The latch release input also functions to acknowledge the change of to TEACH mode. In order to change the latched condition of TEACH mode, turn the mode selector key switch on the Teach Pendant to “Auto”. Then, close the latch release input.

11.2 Emergency Stop Switch Connection

11.2.1 Emergency Stop Switch

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

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 that each circuit connects to the specified pins on the EMERGENCY connector at the Manipulator. Refer to “*11.4 Circuit Diagrams*”.
Give the emergency stop function to all the equipment which have executable token.

11.2.2 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 on the main window.

(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.

11.2.3 Recovery from Emergency Stop

To recover from the emergency stop condition, follow the procedure of safety check as required by the system.

After safety check, the operations below are required to recover from the emergency stop condition.

- Release the Emergency Stop Switch
- Execute the RESET command

11.3 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	Safeguard Latch Release
6	Not Used	*1	19	SDLATCH2	Safeguard Latch Release
7	SD11	Safeguard input (1) *2	20	SD21	Safeguard input (2) *2
8	SD12	Safeguard input (1) *2	21	SD22	Safeguard 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 Safeguard 1 and Safeguard 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 Emergency Stop rated input current	+24 V ±10% 37.5 mA ±10% /+24 V input	3-4, 16-17 pin
Safeguard rated input voltage range Safeguard rated input current	+24 V ±10% 10 mA/+24 V input	7-8, 20-21 pin
Latch Release rated input voltage range Latch Release rated input current	+24 V ±10% 10 mA/+24 V input	18-19 pin

NOTE

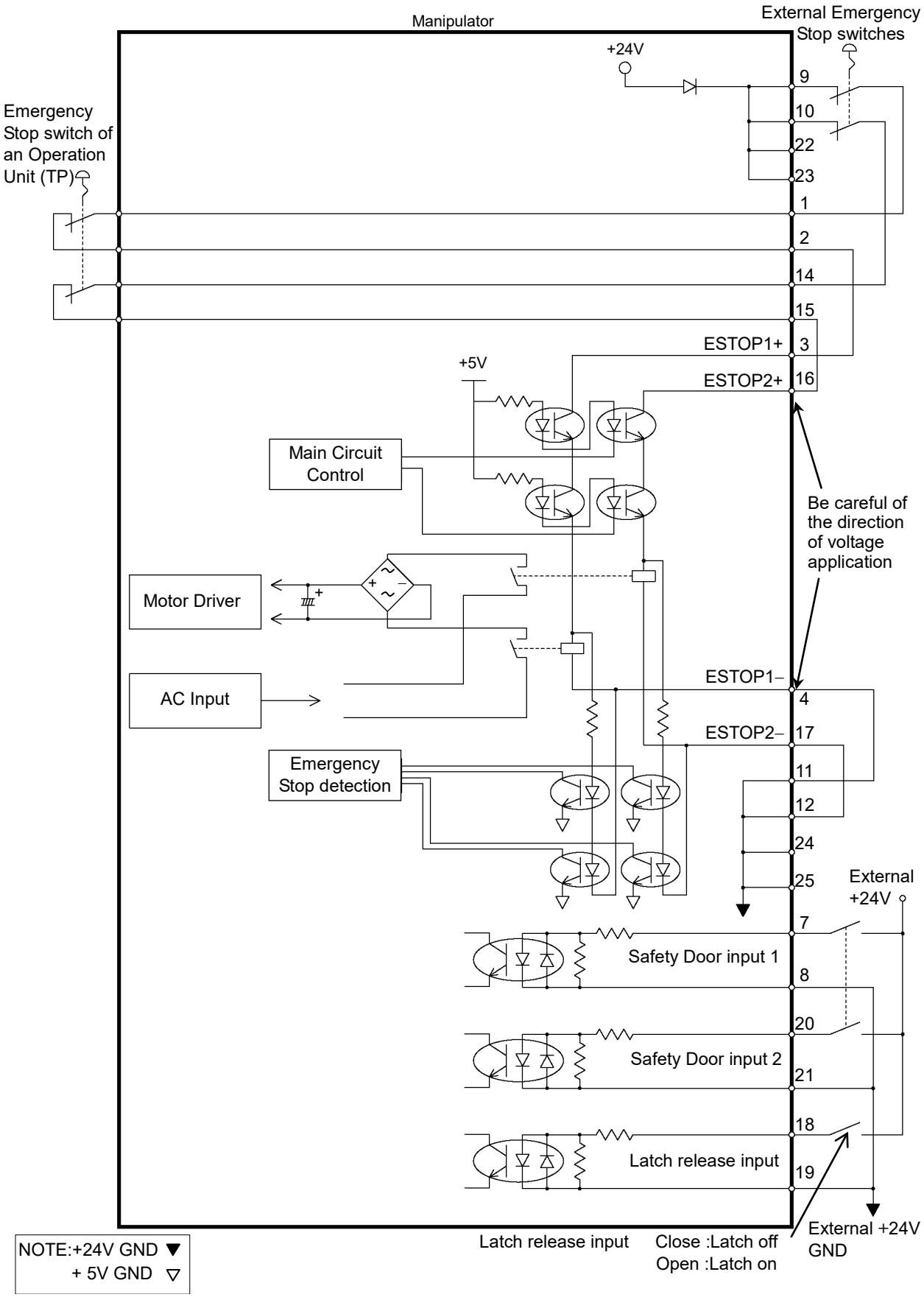
The total electrical resistance of the Emergency Stop switches and their circuit should be 1 Ω or less.

CAUTION

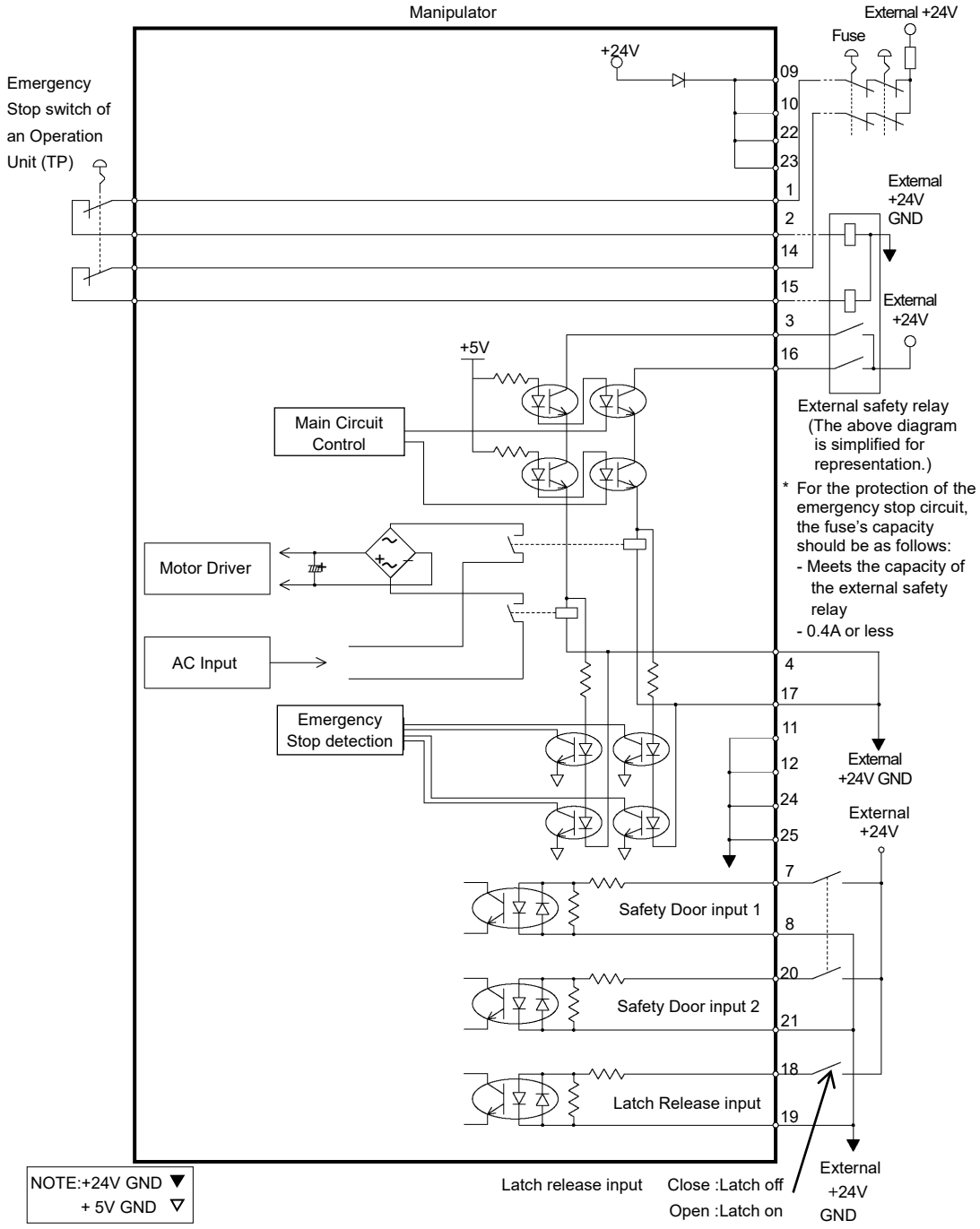
- The 24 V output is for emergency stop. Do not use it for other purposes. Doing so may result in system malfunction.
- Do not apply reverse voltage to the Emergency Stop circuit. Doing so may result in system malfunction.

11.4 Circuit Diagrams

11.4.1 Example 1: External emergency stop switch typical application



11.4.2 Example 2: External safety relay typical application



12. Standard I/O Connector

CAUTION	■ Be careful not to exceed rated current range or rated current which are defined in manual. If exceeding rated current, the Manipulator may now operate at worst.

Standard I/O Connector is a connector mounted on back side of the Manipulator for connecting your input/output equipment to the system.

Connector name	Pins	Bit number
I/O (Input) Connector	18	0-17
I/O (Output) Connector	12	0-11

For cable wiring, refer to "*3.7.2 Noise Countermeasures*" in order to prevent noise.

Remote function is initially assigned to both input and output from 0 to 8. For further details, refer to "*14. I/O Remote Settings*".

Also, for details of hand I/O, refer to "*13.Hand I/O Connector*".

12.1 Input Circuit

Input Voltage Range : +12 to 24 V ±10%

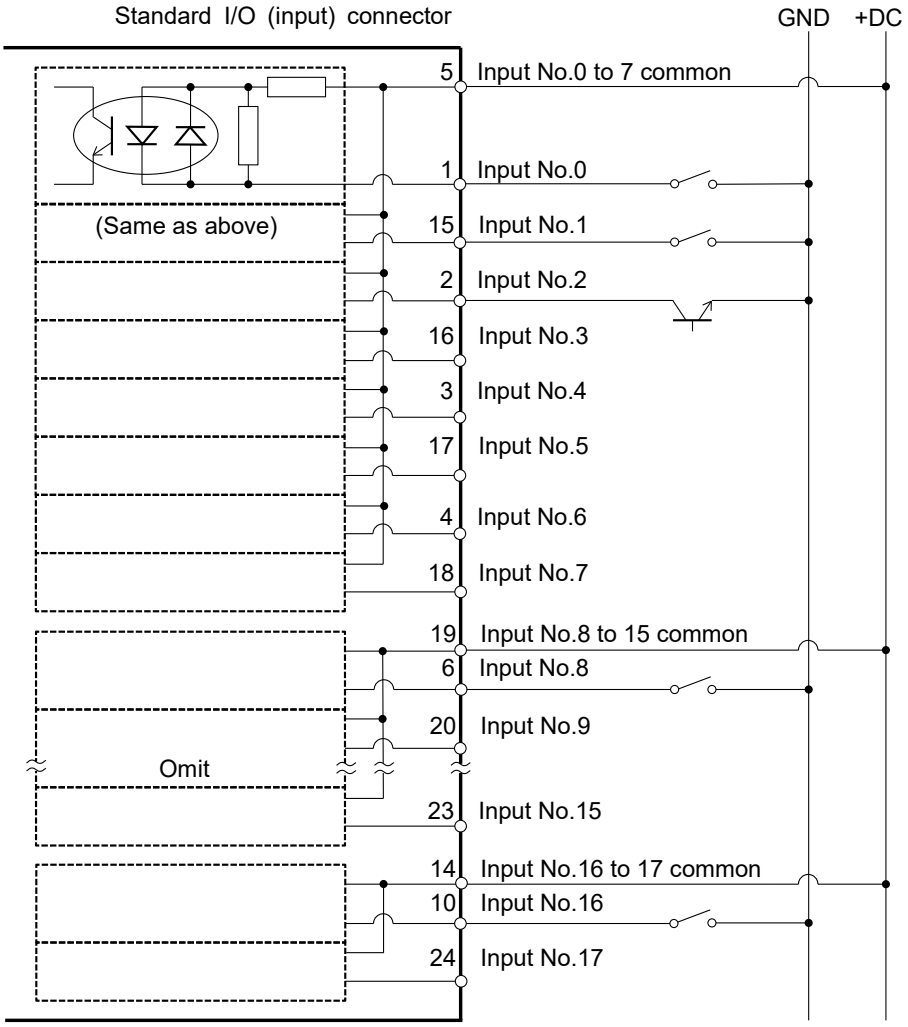
ON Voltage : +10.8 V (min.)

OFF Voltage : +5 V (max.)

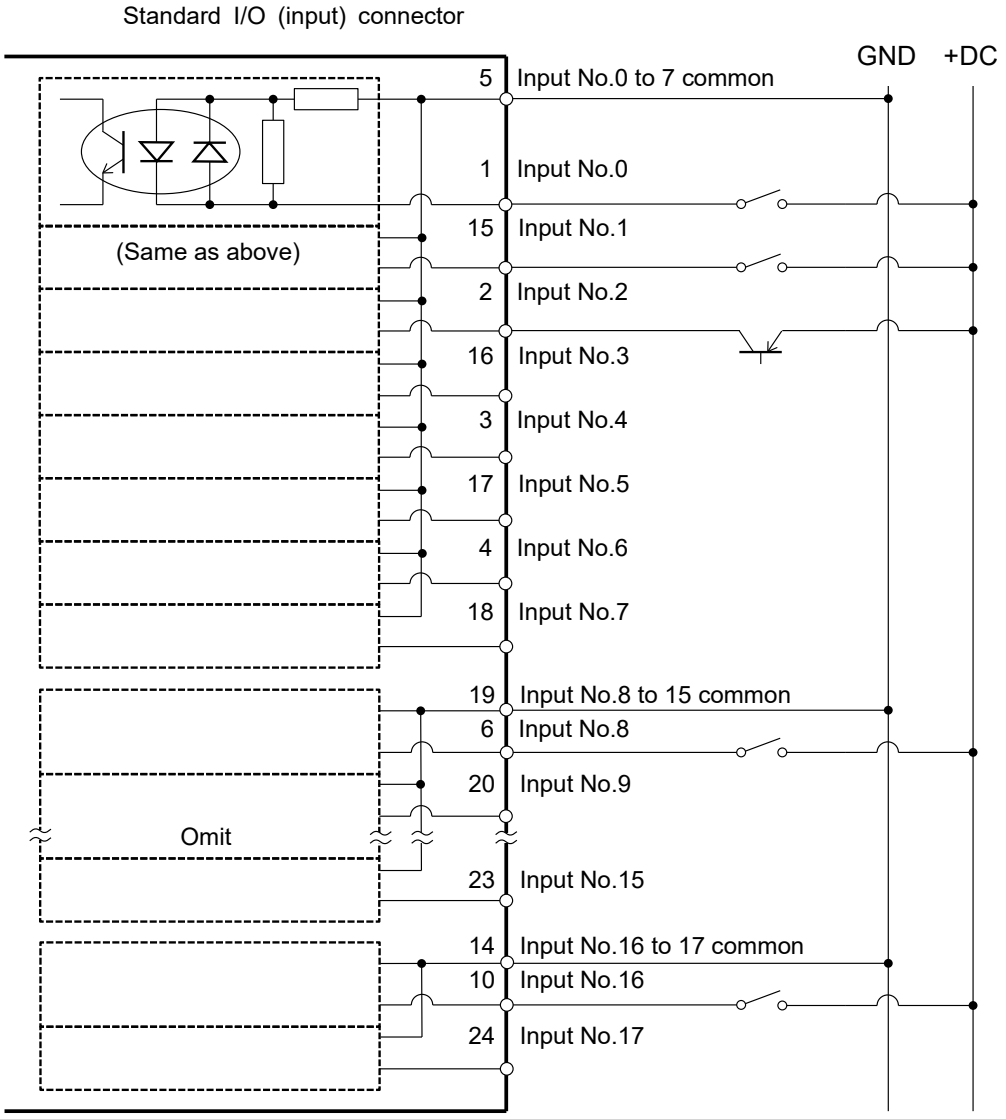
Input Current : 10 mA (TYP) at +24 V input

Two types of wiring are available for use with the two-way photo coupler in the input circuit.

12.1.1 Typical Input Circuit Application 1



12.1.2 Typical Input Circuit Application 2



12.1.3 Pin Assignments of Input Circuit

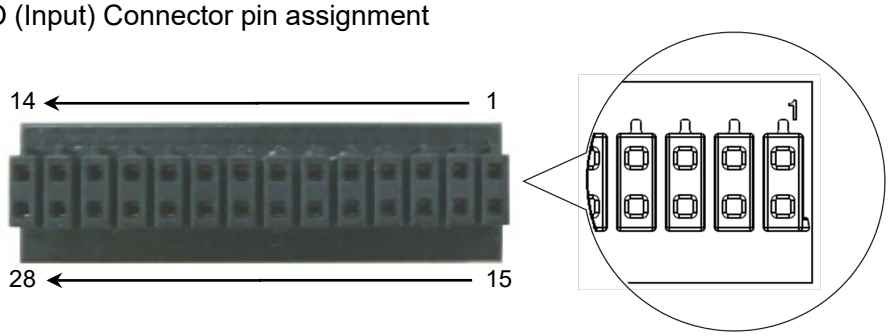
Pin No.	Signal Name	Pin No.	Signal Name
1	Input No. 0 (Start)	15	Input No. 1 (SelProg1)
2	Input No. 2 (SelProg2)	16	Input No. 3 (SelProg4)
3	Input No. 4 (Stop)	17	Input No. 5 (Pause)
4	Input No. 6 (Continue)	18	Input No. 7 (Reset)
5	Input common No. 0 to 7	19	Input common No. 8 to 15
6	Input No. 8	20	Input No. 9
7	Input No. 10	21	Input No. 11
8	Input No. 12	22	Input No. 13
9	Input No. 14	23	Input No. 15
10	Input No. 16	24	Input No. 17
11	Not Used	25	Not Used
12	Not Used	26	Not Used
13	Not Used	27	Not Used
14	Input common No. 16 to 17	28	Not Used

Remote function inside ( ) in the table above is initially assigned to input from 0 to 7. For further details, refer to "*14. I/O Remote Settings*".

Connector	Connector model
I/O (Input) Connector	DMC 0,5/14-G1-2,54 P20THR R72 (Board side) DFMC 0,5/14-ST-2,54 (Cable side) (PHOENIX CONTACT)

* I/O connector is included with shipment.

I/O (Input) Connector pin assignment



12.2 Output Circuit

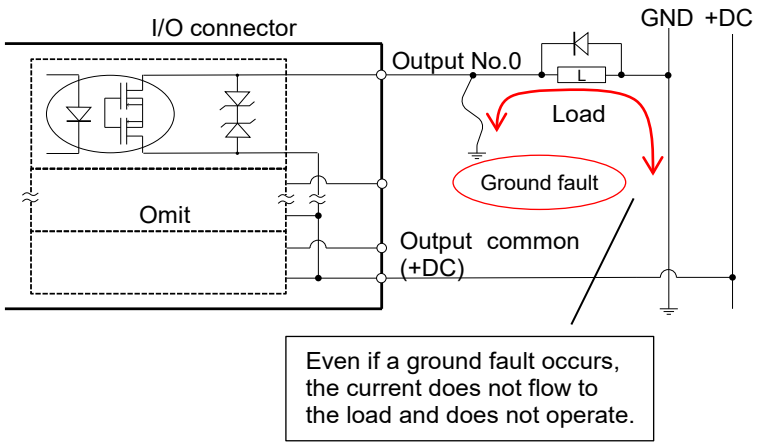
Rated Output Voltage	: +12 V to +24 V ±10%
Maximum Output Current	: TYP 100 mA/1 output
Output device	: PhotoMOS relay
ON resistance	: Less than 0.7 Ω

The following two wirings are available since non-polar PhotoMOS relay is used for output circuit.

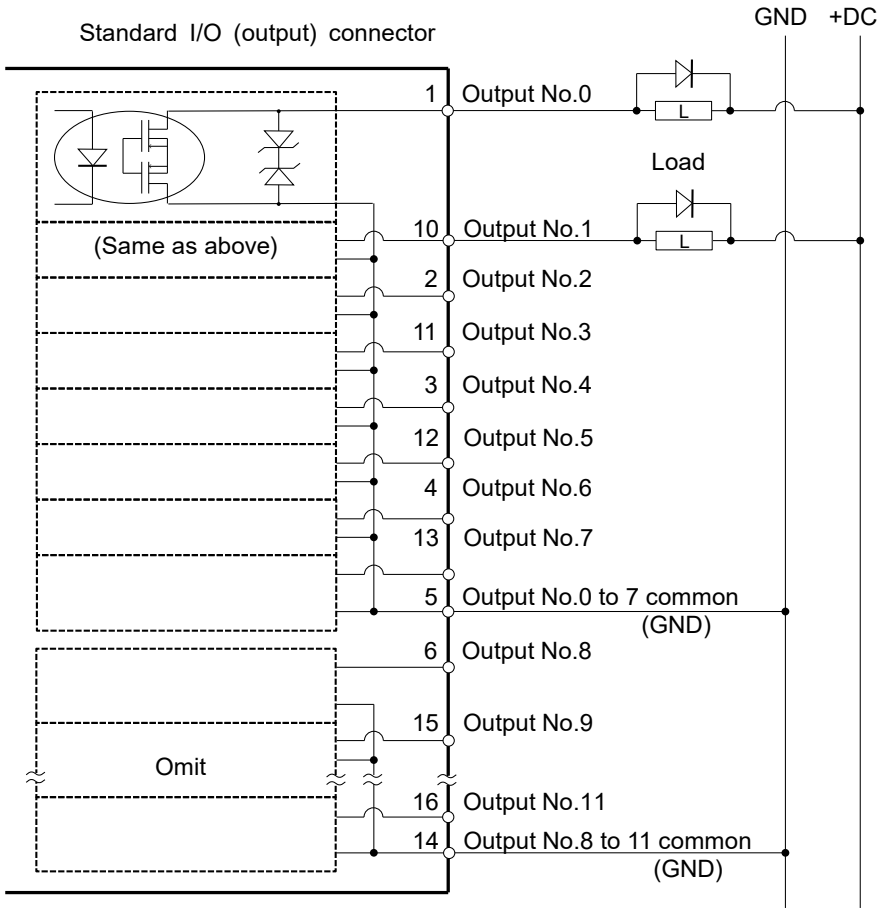
CAUTION

- Be sure to wire the output circuit properly because it has no protection circuitry for short-circuit and reverse-connection. Improper wiring may cause malfunction of the parts on the board and then improper function of the robot system.
- To comply with European Machinery Directive, use plus common (PNP) to prevent the load from unintended operation in the event of a ground fault in the wiring between the controller and the load.

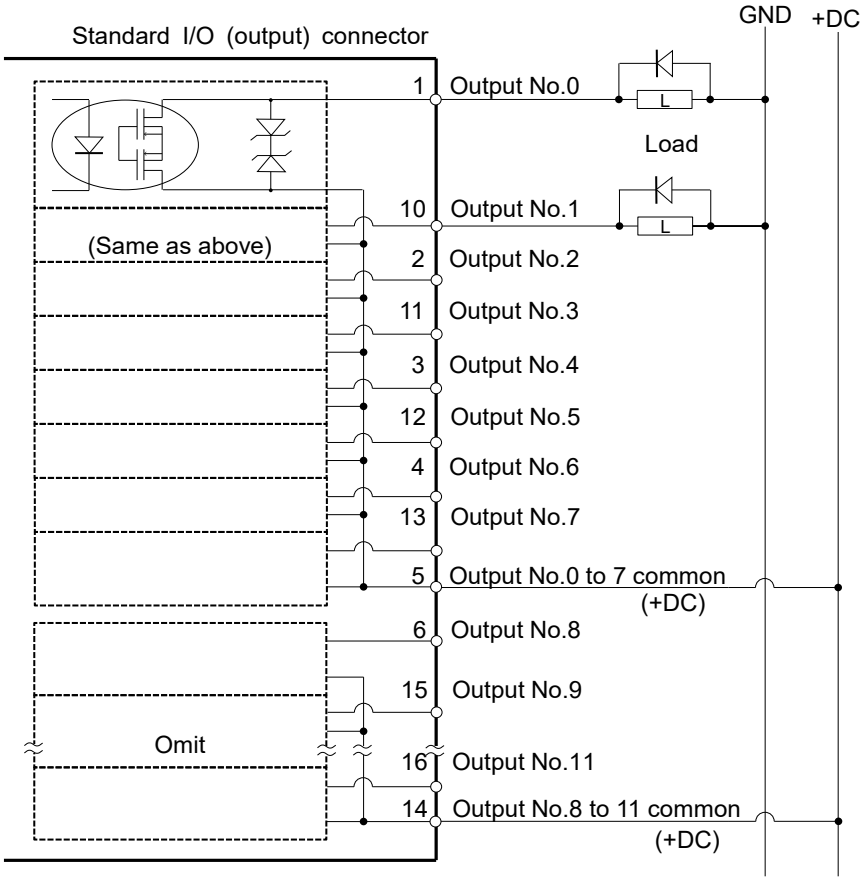
■ Plus common (PNP) connection



12.2.1 Typical Output Circuit Application 1: Sink Type (NPN)



12.2.2 Typical Output Circuit Application 2: Source Type (PNP)



12.2.3 Pin Assignments of Output Circuit

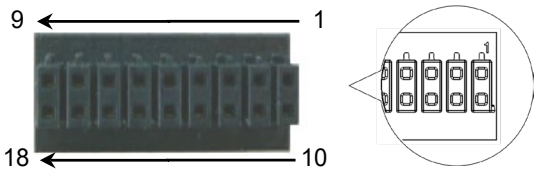
Pin No.	Signal Name	Pin No.	Signal Name
1	Output No. 0 (Ready)	10	Output No.1 (Running)
2	Output No.2 (Paused)	11	Output No.3 (Error)
3	Output No.4	12	Output No.5 (SafeguardOn)
4	Output No.6 (SError)	13	Output No.7 (Warning)
5	Output common No. 0 to 7	14	Output common No. 8 to 11
6	Output No. 8 (EstopOff)	15	Output No. 9
7	Output No.10	16	Output No.11
8	Not Used	17	Not Used
9	Not Used	18	Not Used

Remote function inside ( ) in the table above is initially assigned to output from 0 to 8. For further details, refer to "*14. I/O Remote Settings*".

Connector	Connector model
I/O (Output) Connector	DMC 0,5/9-G1-2,54 P20THR R44 (Board side) DFMC 0,5/ 9-ST-2,54 (Cable side) (PHOENIX CONTACT)

* I/O connector is included with shipment.

I/O (Output) Connector pin assignment



12.3 I/O Cable Product Procedure

The following describes I/O cable product procedure for connecting user's input/output devices.

12.3.1 I/O Cable Connecting Method

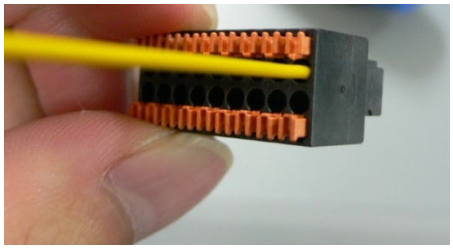
(1) Prepare for I/O connector and cable which are included with shipment.

Adaption cable:

Electric wire capacity: 0.14 to 0.5mm^2

Wire type: single wire, stranded wire, stranded wire with rod terminal.

(2) Push the edge of cable into wire insertion slot.



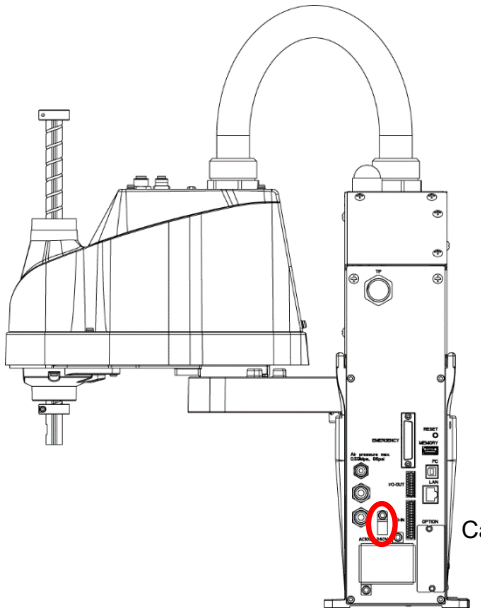
For single wire and stranded wire, peel off the covering of the cable.

NOTE

- If using a twisted wire or finer single wire, insert it while pushing orange colored open button.
- Orange push pins are easy to come off. Be careful during operation.
- There is a cable check hole above the open button. You can check cables using tester.

12.3.2 How to Fix the I/O Cable

You can fix the I/O cables using cable clamp on the back of the manipulator.



(Illustration: T3-B401S)

NOTE

Fixing cables with I/O cable clamp, wiring of I/O cables is difficult to disconnect.

13. Hand I/O Connector

CAUTION	■ Be careful not to exceed rated current range or rated current which are defined in manual. If exceeding rated current, the Manipulator may now operate at worst.

Hand I/O connector is a connector for connecting your input/output equipment to the system. It is mounted on upper of Arm #2.

Connector name	Polarity	Pins	Bit number
Hand I/O connector	Input	6	18-23
	Output	4	12-15

For cable wiring, refer to "*3.7.2 Noise Countermeasures*" in order to prevent noise.

Also, for details of standard I/O mounted on back side of the manipulator, refer to "*12 Standard. I/O Connector*".

13.1 Power Supply Specifications

Hand I/O connector has a power supply which user can use. Enable to use this power supply to operate external devices.
Be careful not to exceed allowable current when using power supply.

Voltage: 24V ±5%
Allowable current: T3-B: 500mA
T6-B: 700mA

13.2 Input Circuit

Input Voltage Range : +12 to 24 V ±10%

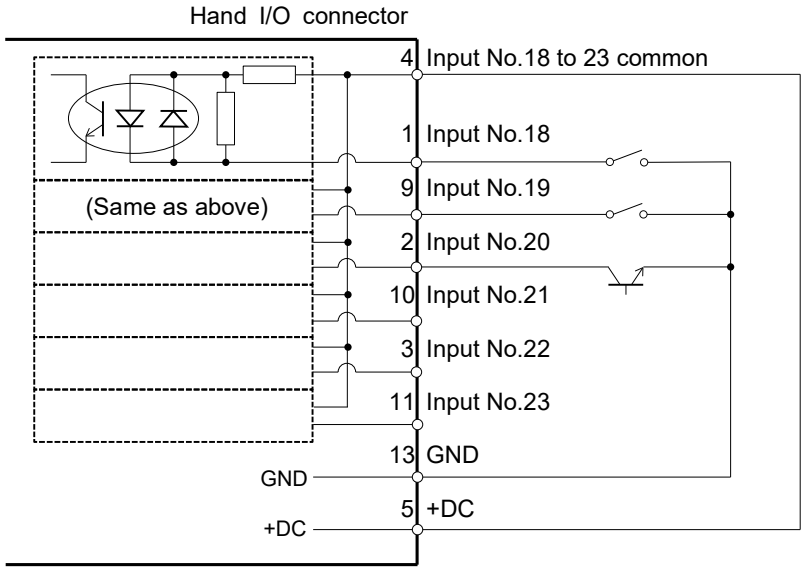
ON Voltage : +10.8 V (min.)

OFF Voltage : +5 V (max.)

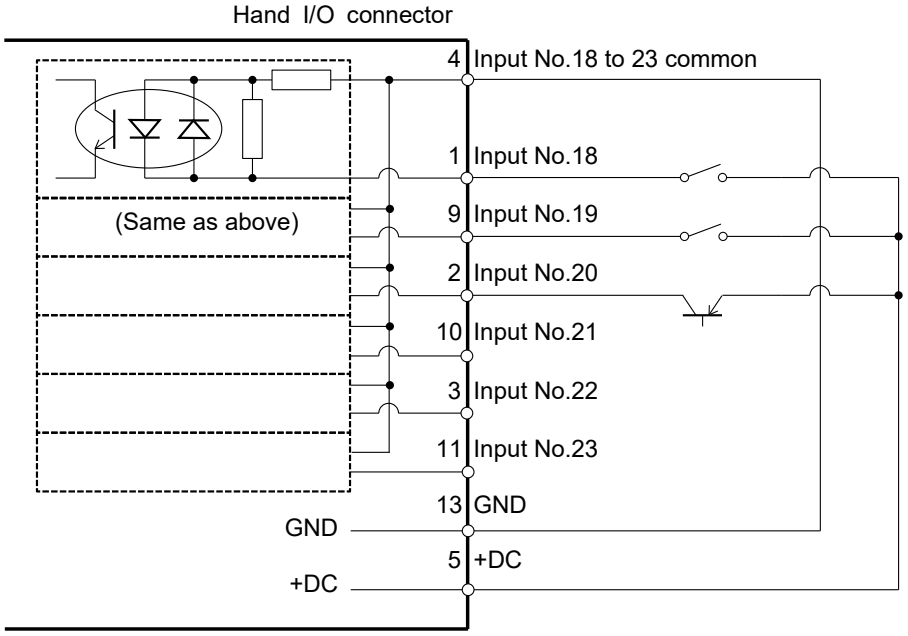
Input Current : 10 mA (TYP) at +24 V input

Two types of wiring are available for use with the two-way photo coupler in the input circuit.

13.2.1 Typical Input Circuit Application 1: Source Type



13.2.2 Typical Input Circuit Application 2: Sink Type



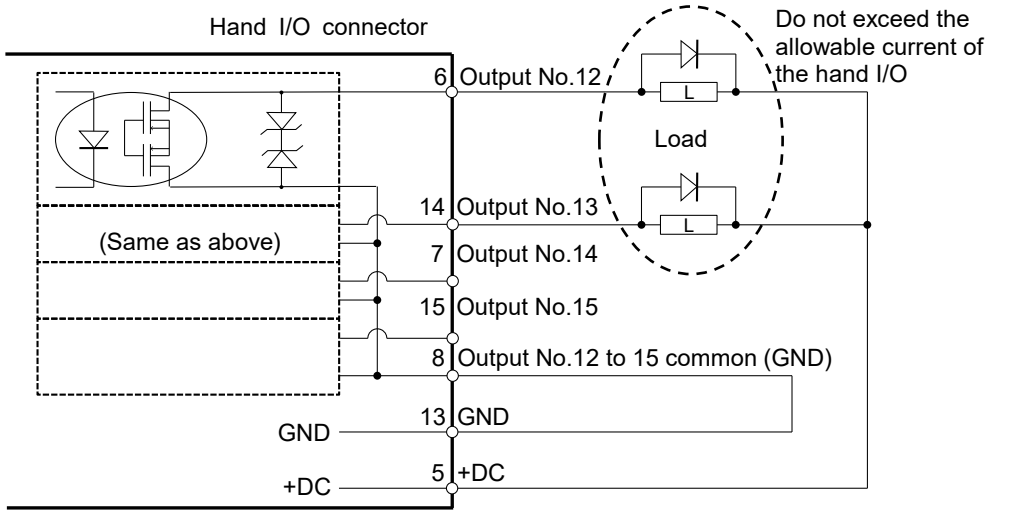
13.3 Output Circuit

Rated Output Voltage	: +12 V to +24 V ±10%
Maximum Output Current	: TYP 100 mA/1 output
Output device	: PhotoMOS relay
On resistance	: Less than 0.7 Ω

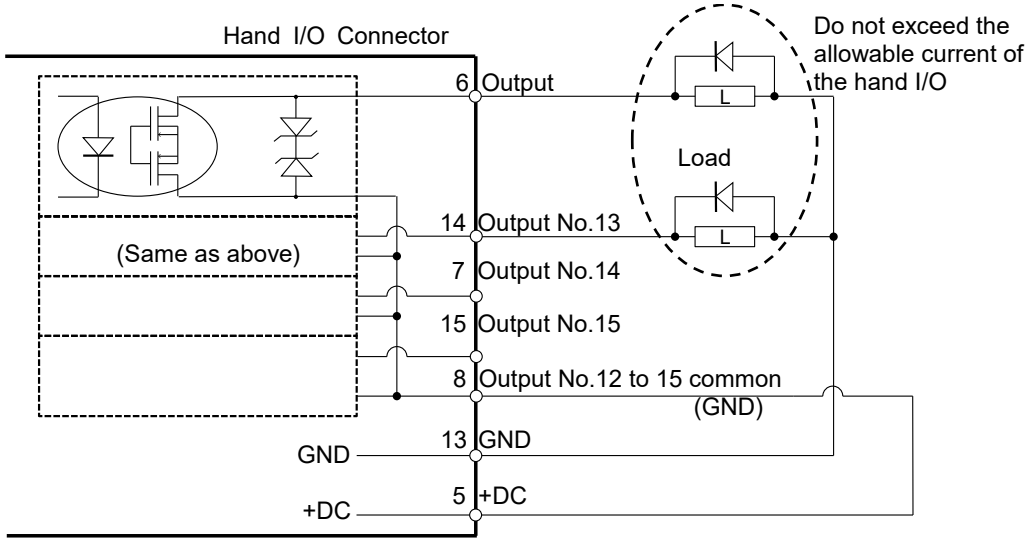
The following two wirings are available since non-polar PhotoMOS relay is used for output circuit.

CAUTION	■ Be sure to wire the output circuit properly because it has no protection circuitry for short-circuit and reverse-connection. Improper wiring may cause malfunction of the parts on the board and then improper function of the robot system.

13.3.1 Typical Output Circuit Application 1: Sink Type (NPN)



13.3.2 Typical Output Circuit Application 2: Source Type (PNP)



13.4 Pin Assignments

The following is pin assignments of Hand I/O connector (D-sub 15 pin male).

Pin No.	Signal Name	Pin No.	Signal Name
1	Input No.18	9	Input No.19
2	Input No.20	10	Input No.21
3	Input No.22	11	Input No.23
4	Input common No.18 to 23	12	Not Used
5	+24V	13	GND
6	Output No.12	14	Output No.13
7	Output No.14	15	Output No.15
8	Output common No.12 to 15		

Connector	Standard
Hand I/O connector	D-Sub 15 pin female (manipulator side) D-Sub 15 pin male (cable side)

* I/O connector is included with shipment.

13.5 How to Control Hand I/O

T-B series has I/O (Input: 6 bit, Output: 4 bit) for hand control I/O.

Input bit port: 18, 19, 20, 21, 22, 23

Output bit port: 12, 13, 14, 15

How to operate

Hand I/O is only supported for bit port operation commands. Byte or word commands are not supported.

Available commands

Command	Function
Sw	Input bit port I/O.
SetSw	Set an input of virtual I/O.
On	Turn ON the output bit.
Off	Turn OFF the output bit.

Restriction 1: Remote I/O

Hand I/O cannot be set in Remote I/O.

Restriction 2: Input/Output by byte port or word port

There are restrictions to operate input/output of standard I/O by byte or word port since hand I/O is included in byte port and word port.

Input: Always “0” is read for bit of hand I/O.

Output: Execute error occurs when specifying “1” for bit of hand I/O.

Input example:

When operating byte input by following conditions

Input hand I/O23: ON

Input standard I/O bit: 16=OFF, 17=ON

```
In(2)---> 0x02 (0000 0010B)
```

Output example:

When operating byte output by following conditions

Output standard I/O bit port 11＝ON,10~8=OFF

```
Out  1,'H08
```

Error output example:

When operating byte output by following conditions

Output standard I/O bit port 11＝ON,10~8=OFF

```
Out  1,'H18 <---  Error since hand I/O bit is ON
```

	Byte port		Word port	
	Port	Description	Port	Description
Input	2	“0” is read for upper 6 bits 0000 00xx	1	“0” is read for upper 6 bits 0000 00xx xxxx xxxx
Output	1	Always specify “0” for upper 4 bits. 0000 xxxx	0	Always specify “0” for upper 4 bits. 0000 xxxx xxxx xxxx

14. I/O Remote Settings

This section describes the functions and timings of input and output signals.

The remote functions may be assigned to your standard I/O board(s), or fieldbus I/O board(s) to enhance robot system control - either from an operational unit of your choice or a sequencer.

Remote function is initially assigned to both input and output from 0 to 8.

To accept external remote inputs, assign the remote function and the control device is remote. For further details, refer to the section, *Remote Control Software Configuration* in *EPSON RC+ 7.0 User's Guide - Remote Control*.

The user defines the I/O number that a remote function is assigned to using software configuration. For further details, refer to the section, *Remote Control Software Configuration* in *EPSON RC+ 7.0 User's Guide - Remote Control*.

For details about I/O cable connection, refer to sections "*12: Standard I/O Connector*", "*13. Hand I/O Connector*" and "*17. Fieldbus I/O*".

For details about communication with external equipment, refer to *EPSON RC+ 7.0 User's Guide -12. Remote Control*.

CAUTION	■ When using remote I/O, always make sure of the following. Using the robot system under unsatisfactory conditions may cause malfunction of the system and/or safety problems. - This signal is not safety signal. Do not this use for safety functions. - Assign remote functions to inputs/outputs correctly and wire correctly when setting up remote I/O signals. - Make sure that the functions correspond to the correct input/output signals before turning ON the system. When verifying the robot system operation, prepare for failures with initial settings or wiring. If the Manipulator functions unusually by the failures with initial settings or wiring, press the Emergency Stop switch immediately to stop the Manipulator.

Remote function is available when virtual I/O is enabled.

NOTE

When you set up a remote I/O signal, please either keep a written record of the settings or store the data in a file for later reference.

When you set up a fieldbus I/O signal to the remote function, response depends on the baud rate of the fieldbus. For details of fieldbus response, refer to *Robot Controller Option Fieldbus I/O.*

Hand I/O connecter cannot be set in remote signal.

14.1 I/O Signal Description

Remote function is initially assigned to both input and output from 0 to 8.

To change the function assignment from the initial setting, use EPSON RC+ 7.0.

To use all signals, you will need to add Fieldbus I/O module.

14.1.1 Remote Input Signals

Remote inputs are used to control the Manipulators and start programs. Certain conditions must be met before inputs are enabled, as shown in the table below.
To accept external remote inputs, assign the remote function and set remote to the control device. When external remote input is available, “AutoMode output” turns ON.
Except “SelProg”, the signals execute each function when the signal starts in input acceptance condition. The function executes automatically. Therefore, no special programming is needed.

NOTE ☞ When an error occurs, you must execute a “Reset” to clear the error condition before any other remote input commands can be executed. Use the “Error output” and “Reset input” to monitor the error status and clear error conditions from the remote device.

Name	Initial	Description	Input Acceptance Condition (*1)
Start	0	Execute function selected at SelProg. (*2) (*13)	Ready output ON Error output OFF EStopOn output OFF SafeguardOn output OFF EStopOff output ON Pause input OFF Stop input OFF
SelProg1 SelProg2 SelProg4 SelProg8 SelProg16 SelProg32	1 2 3 Not Set Not Set Not Set	Specify the executing Main function number. (*2)	
Stop	4	All tasks and commands are stopped.	
Pause	5	All tasks are paused. (*3)	Running output ON
Continue	6	Continue the paused task.	Paused output ON Pause input OFF Stop input OFF
Reset	7	Reset emergency stop and error. (*4)	Ready output ON
Shutdown	Not set	Terminates the system	
ForcePowerLow	Not Set	Operates as the forced low power function. The manipulator is operated in the low power mode. Power High control from the command is not accepted. Executes the following according to the manipulator preferences. Stops or temporarily stops all the tasks and commands. (*12)	Any time This input is acceptable even AutoMode output is OFF.
SelRobot	Not Set	Changes the output condition of MotorsOn, AtHome, PowerHigh, and MCalReqd.(*9)	

Name	Initial	Description	Input Acceptance Condition (*1)
SelRobot1 SelRobot2 SelRobot4 SelRobot8 SelRobot16	Not set	Specify the number of manipulator which executes a command. (*5)	
SetMotorsOn	Not set	Turn ON manipulator motors. (*5) (*6)	Ready output ON EStopOn output OFF SafeguardOn output OFF EStopOff output ON SetMotorOff input OFF
SetMotorsOff	Not set	Turn OFF manipulator motors. (*5)	Ready output ON
SetPowerHigh	Not set	Set the manipulator power mode to High (*5)	Ready output ON EStopOn output OFF SafeguardOn output OFF EStopOff output ON SetPowerLow input OFF
SetPowerLow	Not set	Set the manipulator power mode to Low. (*5)	Ready output ON
Home	Not set	Move the manipulator Arm to the home position defined by the user.	Ready output ON Error output OFF EStopOn output OFF SafeguardOn output OFF EStopOff output ON MotorsOn output ON Pause input OFF Stop input OFF
MCal	Not set	Execute MCal (*5) (*7)	Ready output ON Error output OFF EStopOn output OFF SafeguardOn output OFF EStopOff output ON MotorsOn output ON Pause input OFF Stop input OFF
Recover	Not set	After the safeguard is closed, recover to the position where the safeguard is open.	Paused output ON Error output OFF EStopOn output OFF SafeguardOn output OFF EStopOff output ON RecoverReqd output ON Pause input OFF Stop input OFF
ResetAlarm	Not Set	Cancel the alarm (*11)	
SelAlarm1 SelAlarm2 SelAlarm4 SelAlarm8	Not Set	Specify the alarm number to cancel (*10)	

Name	Initial	Description	Input Acceptance Condition (*1)
ALIVE	Not Set	Input signal for alive monitoring of the manipulator. Same signal as the input will be output to ALIVE output. The master equipment can perform alive monitoring of the manipulator by switching the input periodically and checking the output signal.	
ExtCmd_0-15	Not Set	For extended remote I/O command. For details, refer to the following manual. *Remote Control Reference* *4. Remote I/O to Be Used*	
ExtCmd_16-31	Not Set		
ExtCmd_32-47	Not Set		
ExtCmd_48-63	Not Set		
ExtCmd_64-79	Not Set		
ExtCmd_80-95	Not Set		
ExtCmd_96-111	Not Set		
ExtCmd_112-127	Not Set		

(*1) "AutoMode output" ON is omitted from the table. This is an input acceptance condition for all functions.

(*2) "Start input" executes Function specified by the following six bits: SelProg 1, 2, 4, 8, 16, and 32.

Function name	SelProg1	SelProg2	SelProg4	SelProg8	SelProg16	SelProg32
Main	0	0	0	0	0	0
Main1	1	0	0	0	0	0
Main2	0	1	0	0	0	0
Main3	1	1	0	0	0	0
		⋮				
Main60	0	0	1	1	1	1
Main61	1	0	1	1	1	1
Main62	0	1	1	1	1	1
Main63	1	1	1	1	1	1

0=OFF, 1=ON

(*3) "NoPause task" and "NoEmgAbort task" do not pause.
For details, refer to *EPSON RC+ 7.0 Online Help* or *Pause* in *SPEL+ Language Reference*.

(*4) Turns OFF the I/O output and initializes the manipulator parameter.
For details, refer to *EPSON RC+ 7.0 Online Help* or *Reset* in *SPEL+ Language Reference*.

(*5) The values specified by "SelRobot1, 2, 4, 8, and 16" correspond to the robot numbers, when multiple robots are connected to the controller.

Robot number	SelRobot1	SelRobot2	SelRobot4	SelRobot8	SelRobot16
0 (All)	0	0	0	0	0
1	1	0	0	0	0
2	0	1	0	0	0
3	1	1	0	0	0
			⋮		
13	1	0	1	1	0
14	0	1	1	1	0
15	1	1	1	1	0
16	0	0	0	0	1

0=OFF, 1=ON

(*6) Initializes the manipulator parameter.
For details, refer to *EPSON RC+ 7.0 Online Help* or *Motor* in *SPEL+ Language Reference*.

(*7) For details, refer to *EPSON RC+ 7.0 Online Help* or *MCal* in *SPEL+ Language Reference*.

(*8) This is for experienced users only. Make sure that you fully understand the input specification before using.
CmdRunning output and CmdError output will not change for this input.
"NoEmgAbort task" will not stop by this input.
When the input changes from ON to OFF, all tasks and commands will stop.

(*9) This function changes the output condition of MotorsOn, AtHome, PowerHigh, and MCalReqd.

By setting this signal with the condition selected using SelRobot1 - SelRobot16, you can switch the output condition.
Once you select the condition, it will be kept until you change it or turn off / restart the Controller. All manipulators are selected as default.

(*10) The values specified by "SelAlarm1, 2, 4, and 8" correspond to the alarm numbers.

Alarm #	Target	SelAlarm1	SelAlarm2	SelAlarm4	SelAlarm8
1	Controller battery	1	0	0	0
2	-	0	1	0	0
3	Manipulator grease	1	1	0	0
4	-	0	0	1	0
5	-	1	0	1	0
6	-	0	1	1	0
7	-	1	1	1	0
8	-	0	0	0	1
9	-	1	0	0	1

0=OFF, 1=ON

The following parts are subject to grease up.

Ball screw spline unit on the Joint # 3

(*11) The specified alarm can be canceled by selecting the conditions using SelAlarm1-SelAlarm8 and setting this signal.

(*12) Operation of all tasks and commands, power mode of the manipulator, and PowerHigh command by the setting of the manipulator preferences.

Preferences (1): “Motor power low when ForcePowerLow signal OFF”

Preferences (2): “ForcePowerLow signal change pauses all tasks”

For details of the manipulator preferences, refer to *EPSON RC+ 7.0 User’s Guide [Setup]-[System Configuration]-[Controller]-[Preferences] in 5.12.2 [System Configuration] Command (Setup Menu)*.

Preferences (1)	Preferences (2)	ForcePowerLow	All tasks and commands	Power mode	PowerHigh
0	0	1→0	Stop	Low only	Accept
0	0	0→1	Stop	Low only	Not accept
0	1	1→0	Continue	High/Low	Accept
0	1	0→1	Temp. stop	Low only	Not accept
1	0	1→0	Stop	Low only	Not accept
1	0	0→1	Stop	Low only	Accept
1	1	1→0	Temp. stop	Low only	Not accept
1	1	0→1	Continue	High/Low	Accept

(*13) Do not execute the Restart command of the SPEL+ program and the Start signal of the remote input at the same time. Error 2503 may occur when the programs are executed at the same time.

14.1.2 Remote Output Signals

Remote output is a function to output a status of the Manipulator or operation mode.

Remote outputs provide the assigned function using with any control device The outputs execute automatically. Therefore, no special programming is needed.

Name	Initial	Description
Ready	0	Turns ON when the manipulator startup completes and no task is running.
Running	1	Turns ON when task is running. However, turns OFF when “Paused output” is OFF.
Paused	2	Turns ON when pause task exists.
Error	3	Turns ON when an error occurs. Use “Reset input” to recover from the error. (*13)
EStopOn	Not set	Turns OFF except in Emergency Stop. Turns ON in Emergency Stop. Turns OFF when the controller power is OFF (*11)
SafeguardOn	5	Turns ON when the safeguard is open.
SError	6	Turns ON when critical error occurs. When a critical error occurs, “Reset input” does not function. Reboot the controller to recover. (*13)
Warning	7	Turns ON when warning occurs. The task runs as normal with the warning. However, be sure to eliminate the cause of the warning as soon as possible. (*13)
EStopOff	8	Turns ON except in Emergency Stop. Turns OFF in Emergency Stop. Turns OFF when the controller power is OFF
MotorsOn	Not set	Turns ON when the manipulator motor is ON. (*5)
AtHome	Not set	Turns ON when the manipulator is in the home position. (*5)
PowerHigh	Not set	Turns ON when the manipulator’s power mode is High. (*5)
MCalReqd	Not set	Turns ON when the manipulator hasn’t executed MCal. (*5)
RecoverReqd	Not set	Turns ON when at least one manipulator is waiting for Recover after the safeguard is closed.
RecoverInCycle	Not set	Turns ON when at least one manipulator is executing Recover.
WaitingRC	Not set	Turns ON when the controller waits for RC+ to connect.
CmdRunning	Not set	Turns ON when an input command is executing.
CmdError	Not set	Turns ON when an input command cannot be accepted.
CurrProg1 CurrProg2 CurrProg4 CurrProg8 CurrProg16 CurrProg32	Not set	Indicates the running or the last main function number (*1)
AutoMode	Not set	Turns ON in remote input acceptable status. (*2)
TeachMode	Not set	Turns ON in TEACH mode.
TestMode	Not set	Turns ON in TEST mode.
EnableOn	Not set	Turns ON when the enable switch is ON.

Name	Initial	Description
ErrorCode1 ⋮ ErrorCode8192	Not set	Indicates the error number.
InsideBox1 ⋮ InsideBox15	Not set	Turns ON when the manipulator is in the approach check area. (*3)
InsidePlane1 ⋮ InsidePlane15	Not set	Turns ON when the manipulator is in the approach check plane. (*4)
Alarm	Not set	Turns ON when any of the alarms is occurring. (*9)
Alarm1	Not set	Turns ON when a battery alarm of the manipulator is occurring. (*12)
Alarm2	Not set	Turns ON when a battery alarm of the manipulator connected to CU is occurring. (*12)
Alarm3	Not set	Turns ON when a grease alarm of the manipulator connected to CU is occurring. (*10) (*12)
Alarm4	Not set	Turns ON when a battery alarm of the manipulator connected to DU1 is occurring. (*12)
Alarm5	Not set	Turns ON when a grease alarm of the manipulator connected to DU1 is occurring. (*10) (*12)
Alarm6	Not set	Turns ON when a battery alarm of the manipulator connected to DU2 is occurring. (*12)
Alarm7	Not set	Turns ON when a grease alarm of the manipulator connected to DU2 is occurring. (*10) (*12)
Alarm8	Not set	Turns ON when a battery alarm of the manipulator connected to DU3 is occurring. (*12)
Alarm9	Not set	Turns ON when a grease alarm of the manipulator connected to DU3 is occurring. (*10) (*12)
PositionX	Not set	Outputs current X coordinate in the World coordinate system (*6) (*7)
PositionY	Not set	Outputs current Y coordinate in the World coordinate system (*6) (*7)
PositionZ	Not set	Outputs current Z coordinate in the World coordinate system (*6) (*7)
PositionU	Not set	Outputs current U coordinate in the World coordinate system (*6) (*7)
PositionV	Not set	Outputs current V coordinate in the World coordinate system (*6) (*7)
PositionW	Not set	Outputs current W coordinate in the World coordinate system (*6) (*7)
Torque1	Not set	Outputs the current torque value of Joint #1 (*6) (*7)
Torque2	Not set	Outputs the current torque value of Joint #2 (*6) (*7)
Torque3	Not set	Outputs the current torque value of Joint #3 (*6) (*7)
Torque4	Not set	Outputs the current torque value of Joint #4 (*6) (*7)
Torque5	Not set	Outputs the current torque value of Joint #5 (*6) (*7)
Torque6	Not set	Outputs the current torque value of Joint #6 (*6) (*7)
CPU	Not set	Outputs the CPU load factor of the user program (*8)
ESTOP	Not set	Outputs how many times emergency stops have been executed.
ALIVE	Not set	Output signal for alive monitoring of the manipulator. The signal input by ALIVE input will be output. The master equipment can perform alive monitoring of the manipulator by switching the input periodically and checking the output signal.

Name	Initial	Description
ForceControlOn	Not set	Turns ON when the manipulator operating force control function. (*5)
ExtCmdGet	Not set	For extended remote I/O command. For details, refer to the following manual. *Remote Control Reference 4. Remote I/O to Be Used*
ExtRespSet	Not set	
ExtCmdResult	Not set	
ExtError	Not set	
ExtResp_0-15	Not set	
ExtResp_16-31	Not set	
ExtResp_32-47	Not set	
ExtResp_48-63	Not set	
ExtResp_64-79	Not set	
ExtResp_80-95	Not set	
ExtResp_96-111	Not set	
ExtResp_112-127	Not set	

(*1) Outputs the current or the last function number of CurrProg1, 2, 4, 8, 16, or 32.

Function name	CurrProg1	CurrProg2	CurrProg4	CurrProg8	CurrProg16	CurrProg32
Main	0	0	0	0	0	0
Main1	1	0	0	0	0	0
Main2	0	1	0	0	0	0
Main3	1	1	0	0	0	0
			⋮			
Main60	0	0	1	1	1	1
Main61	1	0	1	1	1	1
Main62	0	1	1	1	1	1
Main63	1	1	1	1	1	1

0=OFF, 1=ON

(*2) Remote function is available in the following conditions.

- The setting is Auto mode and the control device is remote.
- The setting is Program mode and Remote I/O is enabled.

(*3) For details, refer to *EPSON RC+ 7.0 Online Help* or *Box* in *SPEL+ Language Reference*.

(*4) For details, refer to *EPSON RC+ 7.0 Online Help* or *Plane* in *SPEL+ Language Reference*.

(*5) Manipulator status is output as follows, according to the condition selected in SelRobot.

Wait at least 40 ms before inputting the signal after changing the condition in SelRobot.

Name	(SelRobot1- SelRobot16) condition when inputting SelRobot	
	0: All robots are selected	1 - 16: Particular robot number is selected
MotorsOn	Turns ON when at least one manipulator motor is ON.	Turns ON when the motor of the selected manipulator is ON.
AtHome	Turns ON when all manipulators are in the home position.	Turns ON when the selected manipulator is in the home position.
PowerHigh	Turns ON when at least one manipulator's power mode is High.	Turns ON when the selected manipulator's power mode is High.
MCalReqd	Turns ON when at least one manipulator hasn't executed MCal.	Turns ON when the selected manipulator hasn't executed MCal.

(*6) Outputs information of the selected robot when SelRobot1, SelRobot2, SelRobot4, SelRobot8, and SelRobot16 are set. If not, information of Robot 1 will be output.

(*7) Outputs information in Real format.

(*8) Outputs the total load factor of the user created tasks. For details on the CPU load factor, refer to the task manager.

(*9) The signal turns on when the alarm occurs in the manipulator alarm information.

(*10) For details about the target of grease up, refer to the following.

"Regular Inspection 1.3 Greasing"

(*11) It is not recommended that EStopOn does not match the output with emergency stop state and controller off state. To output the state of emergency stop, assign EStopOff.

(*12) The occurrence of battery alarm and grease alarm is monitored every 5 minutes.
The alarm occurrence and output timing of the controller are different.
It may be output up to 5 minutes after the controller alarm occurs.

"Alarm" will on when battery alarm or grease alarm of Controller or Manipulator occurs with "Robot maintenance" enabled. For details of Robot maintenance, refer to "Alarm" section of maintenance manual.

(*13) Following shows status number/error number of output (Error, SError, Warning).

Name	Error Number
Error	1000 to 8000s
SError	9000s
Warning	410 to 900s

For more information of status number/error number, refer to following manual.

"Status Code / Error Code List" manual

14.2 Timing Specifications

14.2.1 Precautions for Remote Input Signals

The following charts indicate the timing sequences for the primary operations of the Controller.

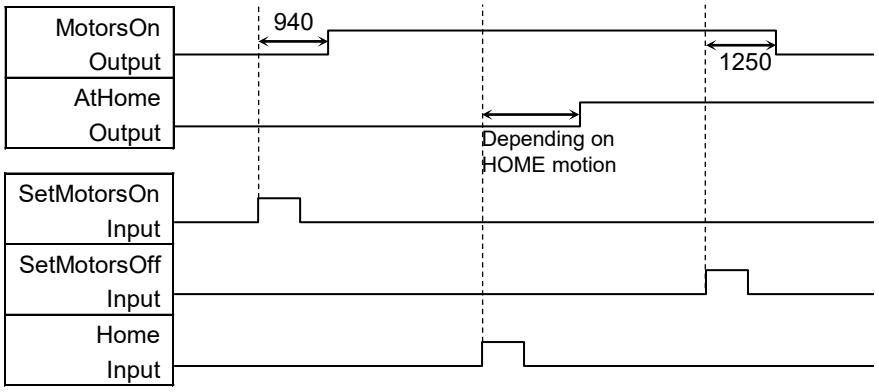
The indicated time lapses (time durations) should be referred to only as reference values since the actual timing values vary depending on the number of tasks running, as well as CPU speed of the Manipulator. Check carefully and refer to the following charts for the timing interrelation when you enter an input signal.

During system design, make sure that you actuate only one remote input operation at a time, otherwise an error will occur.

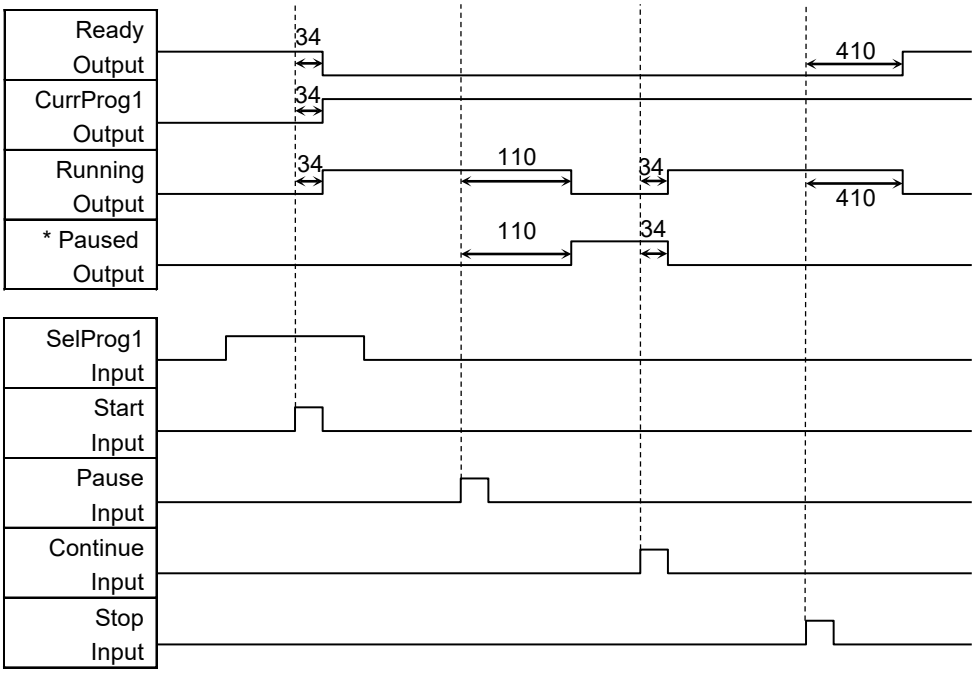
The pulse width of an input signal must be 25 or more milliseconds to be detected.

[Unit: ms]

14.2.2 Timing Diagram for Operation Execution Sequence

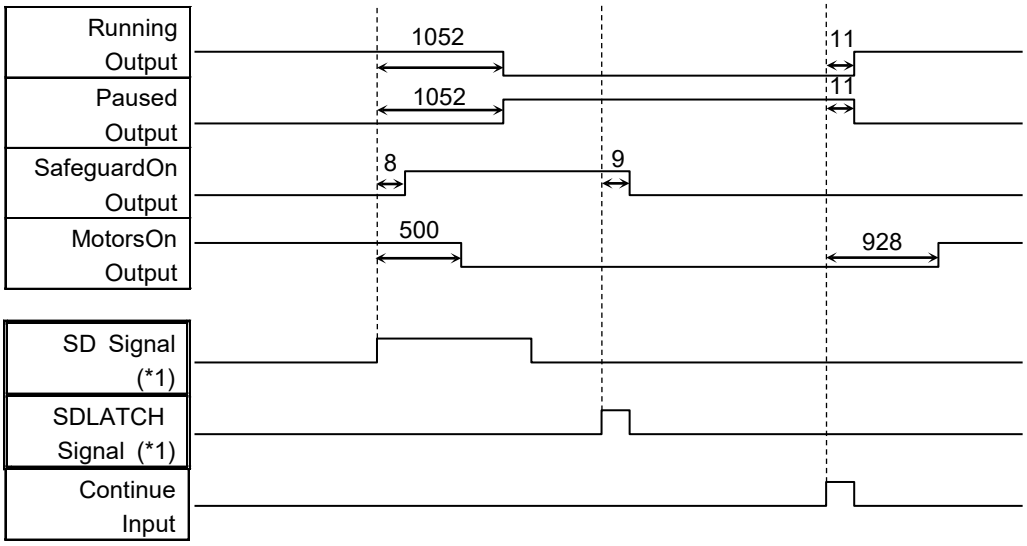


14.2.3 Timing Diagram for Program Execution Sequence



* The duration varies depending on the Quick Pause (QP) setting and the program's operating status at the time of Pause input

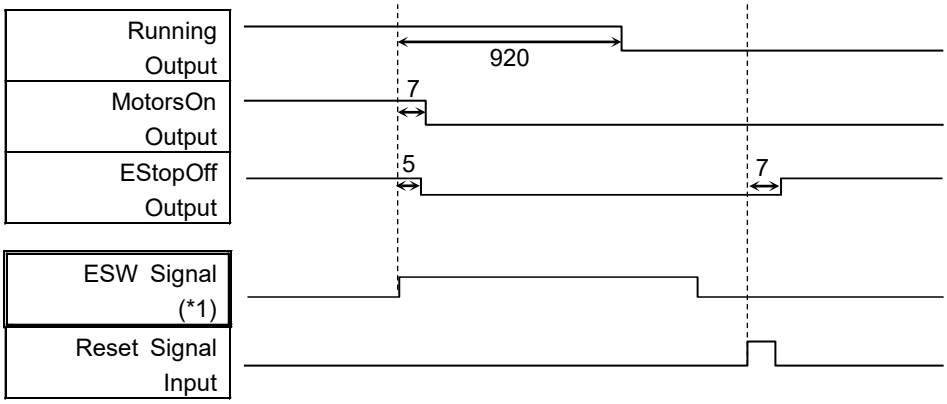
14.2.4 Timing Diagram for Safety Door Input Sequence



[Unit: msec]

(*1) A logical signal to explain the timing of internal processing of the controller.
For details about input signals name and operating conditions, refer to the *11.3 Pin Assignments.*

14.2.5 Timing Diagram for Emergency Stop Sequence

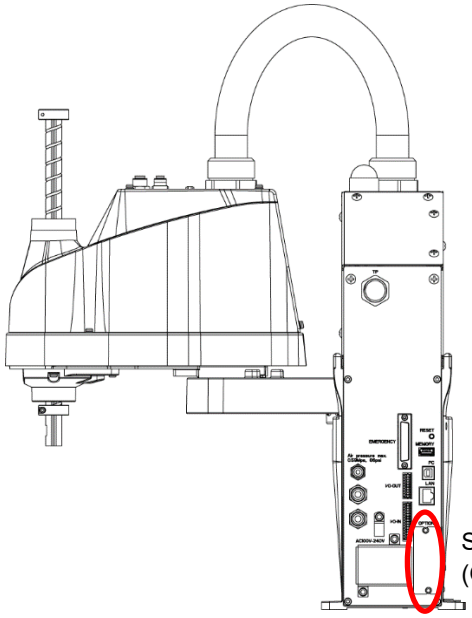


[Unit: msec]

(*1) A logical signal to explain the timing of internal processing of the controller.
For details about input signals name and operating conditions, refer to the *11.3 Pin Assignments.*

15. SD Card Slots

⚠ CAUTION	■ Do not use any SD card other than accessories. If using other SD card, system may not operate properly. ■ SD card is only available for robot system. SD card is written only for robot system. Unable to use for reading/writing data. If you write data on SD card, robot system may not operate properly. ■ Replacing SD card should be performed by a person who has taken proper training. For details, refer to “Safety Manual Training”.



(Illustration: T3-B401S)

SD card slot is a slot for inserting SD card.
Firmware to operate the manipulator is written on SD card.

Reference: *T-B series Maintenance Manual 14.3 Replacement of SD card*

NOTE

The SD card insertion direction differs depending on the product shipment time.

16. Fieldbus I/O

Fieldbus I/O of the T-B series supports the following model.

DeviceNet™	CC-Link
PROFIBUS-DP	PROFINET
EtherNet/IP™	EtherCAT®
Modbus	

For details, refer to the following manuals.

Robot Controller Option Fieldbus I/O

EPSON RC+ 7.0 User's Guide 11.7 Fieldbus Slave I/O

For installing method of Fieldbus I/O module, refer to the following manual.

T-B series Maintenance Manual 14.6 Fieldbus I/O

17. Restrictions

For T-B series manipulator, there are commands with restrictions or may cause an error if executing. However, error does not occur when building a program.
Also, some functions have restrictions.

17.1 Commands Cannot Use

The following commands/ functions are not available.

AbortMotion	Aborts a motion command and puts the running task in error status.
Toff	Turns off execution line display on the LCD.
Ton	Specifies a task which shows an execution line on the LCD.
ShutDown	Shuts down EPSON RC+ and optionally shuts down or restarts Windows.
WindowsStatus	Returns the Windows startup status.

17.2 Commands Cause Motion Error If Specifying RS-232C

If specifying RS-232C port of the controller, the following commands/ functions cause motion error.

Input #	Allows string or numeric data to be received from a file, communications port, or database and stored in one or more variables.
Print #	Outputs data to the specified file, communications port, database, or device.
Line Input #	Reads data of one line from a file, communication port, database, or the device.
Lof	Checks whether the specified RS-232 or TCP/IP port has any lines of data in its buffer.
Read	Reads characters from a file or communications port.
ReadBin	Reads binary data from a file or communications port.
Write	Writes characters to a file or communication port without end of line terminator.
WriteBin	Writes binary data to a file or communications port.

17.3 Commands Cause Error

17.3.1 6-axis Robot Command

If executing the 6-axis robot command, motion error occurs.

17.3.2 Conveyor Tracking Commands

If executing conveyor tracking commands/functions, motion error occurs.

Cnv_AbortTrack	Aborts tracking motion to a conveyor queue point.
Cnv_Accel Function	Returns acceleration and deceleration for the conveyor
Cnv_Accel	Sets acceleration and deceleration for the conveyor
Cnv_AccelLim	Sets limit of acceleration and deceleration after the conveyor tracked.
Cnv_AccelLim Function	Returns limit of acceleration and deceleration after the conveyor tracked.
Cnv_Adjust	Sets whether to retrieve the tracking delay offset of the conveyor.
Cnv_AdjustClear	Clears the tracking delay offset of the conveyor.
Cnv_Adjust	Get Function Returns the tracking delay offset of the conveyor.
Cnv_AdjustSet	Sets the tracking delay offset of the conveyor.
Cnv_Downstream Function	Returns the downstream limit for the specified conveyor.
Cnv_Downstream	Sets the downstream limit for the specified conveyor.
Cnv_Fine Function	Returns the current Cnv_Fine setting.
Cnv_Fine	Sets the value of Cnv_Fine for one conveyor.
Cnv_Flag Function	Returns the tracking state for the tracking abort line.
Cnv_Mode Function	Returns the setting mode value of the conveyor
Cnv_Mode	Sets the setting mode value of the conveyor
Cnv_Name$ Function	Returns the name of the specified conveyor.
Cnv_Number Function	Returns the number of a conveyor specified by name.
Cnv_OffsetAngle	Sets the offset value for the conveyor queue data.
Cnv_OffsetAngle Function	Returns the offset value of the conveyor queue data.
Cnv_Point Function	Returns a robot point in the specified conveyor's coordinate system derived from sensor coordinates.
Cnv_PosErr Function	Returns deviation in current tracking position compared to tracking target.
Cnv_PosErrOffset	Sets an offset value to correct the deviation in current tracking position compared to tracking target.
Cnv_Pulse Function	Returns the current position of a conveyor in pulses.
Cnv_QueAdd	Adds a robot point to a conveyor queue.
Cnv_QueGet Function	Returns a point from the specified conveyor's queue.
Cnv_QueLen Function	Returns the number of items in the specified conveyor's queue.
Cnv_QueList	Displays a list of items in the specified conveyor's queue.
Cnv_QueMove	Moves data from upstream conveyor queue to downstream conveyor queue.
Cnv_QueReject	Sets and displays the queue reject distance for a conveyor.
Cnv_QueReject Function	Returns the current part reject distance for a conveyor.
Cnv_QueRemove	Removes items from a conveyor queue.
Cnv_QueUserData	Sets and displays user data associated with a queue entry.
Cnv_QueUserData Function	Returns the user data value associated with an item in a conveyor queue.

Cnv_RobotConveyor Function	Returns the conveyor being tracked by a robot.
Cnv_Speed Function	Returns the current speed of a conveyor.
Cnv_Trigger	Latches current conveyor position for the next Cnv_QueAdd statement.
Cnv_Upstream Function	Returns the upstream limit for the specified conveyor.
Cnv_Upstream	Sets the upstream limit for the specified conveyor.

17.3.3 PG Commands

If executing PG commands, motion error occurs.

PG_FastStop	Stops the PG axes immediately.
PG_LSpeed	Sets the pulse speed of the time when the PG axis starts accelerating and finishes decelerating.
PG_Scan	Starts the continuous spinning motion of the PG robot axes.
PG_SlowStop	Stops slowly the PG axis spinning continuously.

17.3.4 R-I/O Commands

If executing R-I/O commands/functions, motion error occurs.

LatchEnable	Enable/Disable the latch function for the robot position by the R-I/O input.
LatchState Function	Returns the latch state of robot position using the R-I/O.
LatchPos Function	Returns the robot position latched using the R-I/O input signal.
SetLatch	Sets the latch function of the robot position using the R-I/O input.

17.3.5 Force Sensing Commands

If executing force sensing commands/functions, motion error occurs.

Force_Calibrate	Sets zero offsets for all axes for the current force sensor.
Force_ClearTrigger	Clears all trigger conditions for the current force sensor.
Force_GetForces	Returns the forces and torques for all force sensor axes in an array.
Force_GetForce Function	Returns the force for a specified axis.
Force_Sensor	Sets the current force sensor for the current task.
Force_Sensor Function	Returns the current force sensor for the current task.
Force_SetTrigger	Sets the force trigger for the Till command.

17.3.6 Robot Control Commands

ROTOK Function	Returns whether an ROT modifier parameter can be added when issuing a move command to a destination.
DiffToolOrientation Function	Returns the angle between the coordinate axes of Tool coordinate systems. * When COORD_ALL is specified, an error will occur. When a command except for COORD_ALL is specified, the operation will be executed.
DiffPoint Function	Returns the difference between two specified points.

17.3.7 Other (FineDist)

You cannot use the command: FineDist

Robot determines the position by set value of Fine even if using FineDist.

Fine	Specifies and displays the positioning error limits. (Unit: pulse)
FineDist	Specifies and displays the positioning error limits (Unit: mm)

17.3.8 Other (HealthCalcPeriod)

You cannot use the command: HealthCalcPeriod
A period of parts consumption commands information to calculate “remaining months” is one day and unable to change.

HealthCalcPeriod	Set the calculation period of parts consumption commands.
HealthCalcPeriod Function	Returns the calculation period of parts consumption commands.

17.3.9 Other (ChDisk)

You cannot specify USB option to the command: ChDisk.

17.4 Restrictions of Functions

Some of the following functions are not available.

17.4.1 TP3

You cannot use build of the program. An error occurs to finish the program if executing it. Other functions are available.

17.4.2 Loop Processing

If the created robot control program is consisted of the multi-tasking and also there are some task with infinite loop, the system may become unstable and the connection with EPSON RC+ is disconnected.

The controller detects infinite loop tasks. If the possibilities to affect the system are detected, the following error occurs and stops the program.
If the error occurs, modify the program and make sure not to set infinite loop.

Error code	: 2556
Error message	: An excessive loop was detected. Please reduce the number of looped tasks or set Wait
Remedy	: Do not perform any processing such as infinite loop or any other similar processing as much as possible. Execute Wait command or similar command in the loop processing and avoid occupying the CPU if performing calculation which required loop or waiting for I/O signals.

There is no problem if executing commands with Wait in the loop such as Wait command, robot operating command, Print command, and NetWait command.

NOTE: Infinite loop is performed in the following case
When commands are created only with command without Wait in the loop such as operation instruction, assignment command, and I/O check command.

Example 1: Turns ON output port “2” when Input port “0” turned ON

Example of program that may cause errors

```
Do
   If Sw(0) = On Then
      On(2)
      Exit Do
   EndIf
Loop
```

Correction example

```
Wait Sw(0) = On
On(2)
```

Example 2: When performing the large amount of calculation with a loop structure.

Example of program that may cause errors

```
For i = 0 To 10000
   For j = 0 To 10000
      a = a + 1
   Next
Next
```

Correction example

```
For i = 0 To 10000
   For j = 0 To 10000
      a = a + 1
   Next
   Wait 0.01      ' Execute Wait to avoid occupying the CPU
Next
```

17.4.3 Camera Searching by CV1/CV2

You may not be able to use Camera searching by T-B series Manipulator if CV1/CV2 is used and the following two conditions are fulfilled.

- When connecting PC and T-B series Manipulator by USB connection
- When the configuration of default gateway of T-B series Manipulator is None, or “0.0.0.0”.

Type IP address for CV1/ CV2 manually when you cannot use Camera researching.

For more details of Camera researching, refer to the following.

Vision Guide 7.0 Hardware & Setup
Setup: 2.3.2 CV1/CV2 Camera Configuration

17.4.4 Restore the Data of Backup Controller Function

Backup controller function that acquired by virtual controller cannot be restored to T-B series Manipulator.

NOTE : Backup controller function that acquired by actual equipment can be restored to T-B series Manipulator.

18. Error Code List

For the error number, refer to the following manual.

Status Code/Error Code List

Regular Inspection

Performing inspection properly is essential to prevent trouble and ensure safety.
This volume describes the inspection schedule and contents.
Inspect according to the schedule.

1. Regular Inspection for T3-B T6-B Manipulator

This chapter describes maintenance inspection procedures. Performing maintenance inspection properly is essential to prevent trouble and ensure safety.
Be sure to perform the maintenance inspections in accordance with the schedule.

1.1 Inspection

1.1.1 Schedule for Inspection

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

	Inspection Point					
	Daily inspection	Monthly inspection	Quarterly inspection	Biannual inspection	Annual inspection	Overhaul (replacement)
1 month (250 h)	Inspect every day	√				
2 months (500 h)		√				
3 months (750 h)		√	√			
4 months (1000 h)		√				
5 months (1250 h)		√				
6 months (1500 h)		√	√	√		
7 months (1750 h)		√				
8 months (2000 h)		√				
9 months (2250 h)		√	√			
10 months (2500 h)		√				
11 months (2750 h)		√				
12 months (3000 h)		√	√	√	√	
13 months (3250 h)		√				
⋮	⋮	⋮	⋮	⋮	⋮	⋮
20000 h						√

h = hour

1.1.2 Inspection Point

Inspection Item

Inspection Point	Inspection Place	Daily	Monthly	Quarterly	Biannual	Annual
Check looseness or backlash of bolts/screws.	End effector mounting bolts	√	√	√	√	√
	Manipulator mounting bolts	√	√	√	√	√
Check looseness of connectors.	External connectors on Manipulator (on the connector plates etc.)	√	√	√	√	√
Visually check for external defects. Clean up if necessary.	External appearance of Manipulator	√	√	√	√	√
	External cables	-	√	√	√	√
Check for bends or improper location. Repair or place it properly if necessary.	Safeguard etc.	√	√	√	√	√
Check the brake operation	Arm #3	√	√	√	√	√
Check whether unusual sound or vibration occurs.	Whole	√	√	√	√	√
Check the power supply behavior.	Controller	-	-	-	-	√
Check behavior of the emergency stop button and safeguard.	Emergency stop button	-	-	-	-	√
	Safeguard	-	-	-	-	√

Inspection Method

Inspection Point	Inspection Method
Check looseness or backlash of bolts/screws.	Use a hexagonal wrench to check that the end effector mounting bolts and the Manipulator mounting bolts are not loose. When the bolts are loose, refer to "*1.4 Tightening Hexagon Socket Head Bolts*" and tighten them to the proper torque.
Check looseness of connectors.	Check that connectors are not loose. When the connectors are loose, reattach it not to come off.
Visually check for external defects. Clean up if necessary.	Check the appearance of the Manipulator and clean up if necessary. Check the appearance of the cable, and if it is scratched, check that there is no cable disconnection.
Check for bends or improper location. Repair or place it properly if necessary.	Check that the safeguard, etc. are located properly. If the location is improper, place it properly.
Check the brake operation	Check that the shaft does not fall when in MOTOR OFF. If the shaft falls when in MOTOR OFF and the brake is not released, contact the supplier.
Check whether unusual sound or vibration occurs.	Check that there is no unusual sound or vibration when operating. If there is something wrong, contact the supplier.
Check the power supply behavior.	Turn OFF and ON the power supply, and check that it starts without any error.
Check behavior of the emergency stop button	Operate emergency stop switch with the motor energized, then check the LED lamp on the top of the power unit lights off and the ESTOP LED on the Controller lights up. If EPSON RC+ is connected, make sure to check "EStop" is displayed in red on the status bar.
Check behavior of the safeguard.	Operate safeguard with the motor energized, then check the LED lamp on the top of the power unit lights off. If EPSON RC+ is connected, make sure to check "Safety" is displayed in blue on the status bar.

1.2 Overhaul (Parts Replacement)

Overhaul (replacement) shall be performed by personnel who has taken a proper training.
For details, refer to "*Safety Manual Training*".
For details on overhaul, refer to the "*Maintenance Manual"*.

1.3 Greasing

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

CAUTION	■ Keep enough grease in the Manipulator. Operating the Manipulator with insufficient grease will damage sliding parts and/or result in insufficient function of the Manipulator. Once the parts are damaged, a lot of time and money will be required for the repairs.

CAUTION	■ If grease gets into your eyes, mouth, or on your skin, follow the instructions below. If grease gets into your eyes : Flush them thoroughly with clean water, and then see a doctor immediately. If grease gets into your mouth : If swallowed, do not induce vomiting. See a doctor immediately. : If grease just gets into your mouth, wash out your mouth with water thoroughly. If grease gets on your skin : Wash the area thoroughly with soap and water.

	Greasing part	Greasing Interval	Notice
Joint #1	Reduction gear units	Overhaul timing	Greasing shall be performed by personnel who has taken a proper training. For details, "*T-B series Maintenance Manual*"
Joint #2			

	Greasing part	Greasing Interval	Grease	How to grease
Joint #3	Ball screw spline unit	At 100 km of operation (50 km for first greasing)	AFB	*Greasing the Ball Screw Spline Unit* *(See below)*

Joint #3 Ball screw spline unit

The recommended greasing interval is at 100 km of operation. However, greasing timing also can be checked from the grease condition. Perform greasing if the grease is discolored or becomes dry.



Normal grease



Discolored grease

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

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

Reference: *T-B series Maintenance Manual 4. Alarm*

Greasing the Ball Screw Spline Unit

	Name	Quantity	NOTE
Grease	For Ball Screw Spline Unit (AFB grease)	Proper quantity	
Tools	Wiping cloth	1	For wiping grease (Spline shaft)

NOTE
Cover the surrounding area such as the end effector and peripheral equipment in case the grease drips.

(1) Turn ON the Manipulator.

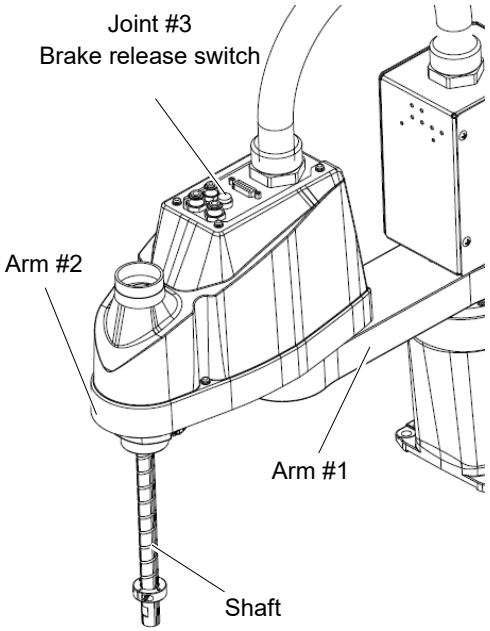
(2) Move the shaft to its lower limit in one of the following methods.

- Move the shaft to its lower limit manually while pressing the brake release switch.

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

- Move the shaft to its lower limit from EPSON RC+ 7.0 [Tools]-[Robot Manager]-[Jog & Teach].

NOTE Make sure that the hand does not interfere with peripheral equipment.

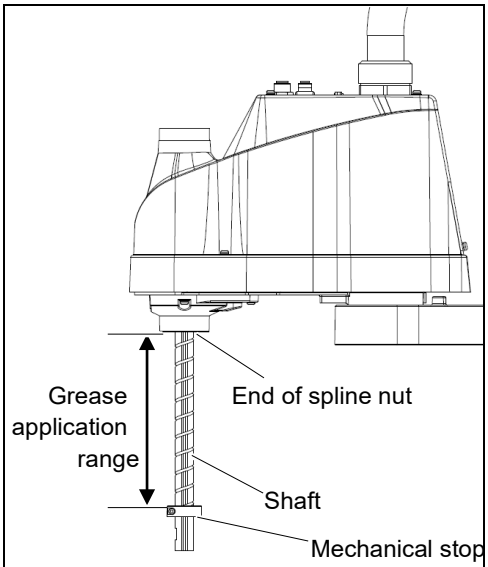


(Illustration T3-B401S)

(3) Turn OFF the Manipulator.

(4) Wipe off the old grease from the shaft, and then apply new grease to it.

Grease application range is from the end of the spline nut to mechanical stop.



(Illustration T3-B401S)

(5) Apply grease evenly to the spiral groove of the ball screw spline unit and the vertical groove so that the groove is filled.



Grease application example

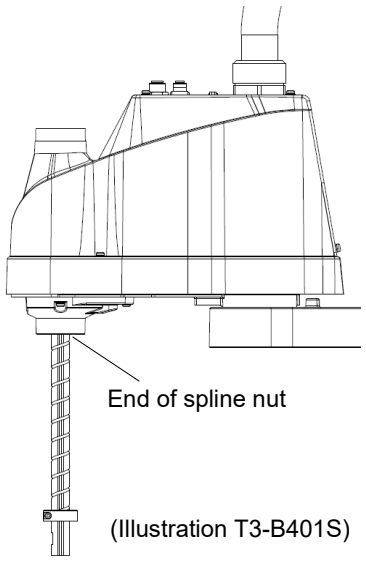
(6) Turn ON the Manipulator.

(7) Start the robot manager and move the shaft to the origin position. Be careful not to hit peripheral equipment.

(8) After moving to the origin position, reciprocate the shaft. The reciprocating operation is a low power mode operation program that performs from the upper limit to the lower limit. Run for about 5 minutes to spread the grease over the shaft.

(9) Turn OFF the Manipulator.

(10) Wipe off excess grease on the end of the spline nut and mechanical stop.



(Illustration T3-B401S)

1.4 Tightening Hexagon Socket Head Cap Bolts

Hexagon socket head cap bolts (herein after referred to as bolt) are used in places where mechanical strength is required. These bolts are fastened with the tightening torques shown in the following table.

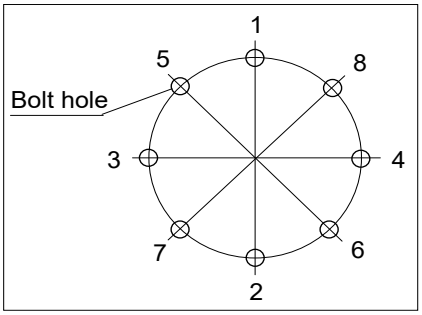
When it is necessary to refasten these bolts in some procedures in this manual (except special cases as noted), use a torque wrench so that the bolts are fastened with the appropriate tightening torques as shown below.

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.

Appendix

This volume describes the specifications table for each model and detailed data of stopping time and stopping distance.

Appendix A: Specifications

T3-B Specifications

Item		T3-B401S
Arm length	Arm #1, #2	400 mm
	Arm #1	225 mm
	Arm #2	175 mm
Weight (cables not included)		Approx. 14 kg: 31 lbs.
Driving method	All joints	AC servo motor
Max. operating speed*1	Joints #1, #2	3700 mm/s
	Joint #3	1000 mm/s
	Joint #4	2600 °/s
Repeatability	Joints #1, #2	± 0.02 mm
	Joint #3	± 0.02 mm
	Joint #4	± 0.02°
Max. motion range	Joint #1	± 132°
	Joint #2	± 141°
	Joint #3	150 mm
	Joint #4	± 360°
Max. pulse range	Joint #1	– 95574 ~ 505174
	Joint #2	± 320854
	Joint #3	– 187734 ~ 0
	Joint #4	± 74130
Resolution	Joint #1	0.000439°/pulse
	Joint #2	0.000439°/pulse
	Joint #3	0.000799 mm/pulse
	Joint #4	0.004857°/pulse
Motor rated capacity	Joint #1	200 W
	Joint #2	100 W
	Joint #3	100 W
	Joint #4	100 W
Payload (Load)	Rated	1 kg
	Max.	3 kg
Joint #4 allowable moment of inertia*2	Rated	0.003 kg·m^2
	Max.	0.01 kg·m^2
Hand	Shaft diameter	ø 16 mm
	Through hole	ø 11 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
		4-M8
Environmental requirements	Ambient temp.	5 to 40 °C *3
	Ambient relative humidity	20 to 80% (no condensation)
Noise level *4		L_{Aeq} = 70 dB (A) or under

Item			T3-B401S
Assignable value ( ) Default value	Speed		1 ~ (5) ~ 100
	Accel *5		1 ~ (10) ~ 120
	SpeedS		0.1 ~ (50) ~ 2000
	AccelS		0.1 ~ (200) ~ 10000
	Fine		0 ~ (1250) ~ 65535
	Weight		0,175 ~ (1,175) ~ 3,175
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, Error, SafeguardOn, SError, Warning, EStopOff
		Hand I/O (Upper side of Arm #2)	Input: 6 points Output: 4 points Non-polar, Supported for both Sink and Source
			Power: 24V Max. 500mA
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 resetting of system
Display	Mode display LED		TEACH, AUTO, PROGRAM, TestMode, Error, E-STOP

Item	T3-B401S
Controller status save	Save to USB memory Save in RC+ (PC)
Voltage	100 V to 240 VAC
Phase	Single phase
Frequency	50 / 60 Hz
Momentary power interrupt	Less than 10 ms
Power consumption	660 VA
Inrush current (When AC power is turned ON)	Max. 30A (Less than 2 ms.)
Short-circuit current rating	5.0 kA
Max. load current	3.3 A
Leak current	Max. 10 mA
Ground resistance	Less than 100Ω
Safety standard	CE Marking EMC Directive, Machinery Directive, RoHS Directive UKCA Marking EMC Regulations, Machinery Regulations, RoHS Regulations KC Marking, KCs Marking

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

*4: Conditions of Manipulator during measurement as follows:

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

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

*5: 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.

T6-B Specifications

Item		T6-B602S
Arm length	Arm #1, #2	600 mm
	Arm #1	325 mm
	Arm #2	275 mm
Weight (cables not included)		Approx. 21 kg: 46 lbs.
Driving method	All joints	AC servo motor
Max. operating speed*1	Joints #1, #2	4180 mm/s
	Joint #3	1000 mm/s
	Joint #4	1800 °/s
Repeatability	Joints #1, #2	± 0.04 mm
	Joint #3	± 0.02 mm
	Joint #4	± 0.02°
Max. motion range	Joint #1	± 132°
	Joint #2	± 150°
	Joint #3	200 mm
	Joint #4	± 360°
Max. pulse range	Joint #1	– 152918 ~ 808278
	Joint #2	± 341334
	Joint #3	– 245760 ~ 0
	Joint #4	± 245760
Resolution	Joint #1	0.000275°/pulse
	Joint #2	0.000439°/pulse
	Joint #3	0.000814 mm/pulse
	Joint #4	0.001465°/pulse
Motor rated capacity	Joint #1	300 W
	Joint #2	200 W
	Joint #3	100 W
	Joint #4	100 W
Payload (Load)	Rated	2 kg
	Max.	6 kg
Joint #4 allowable moment of inertia*2	Rated	0.01 kg·m^2
	Max.	0.08 kg·m^2
Hand	Shaft diameter	ø 20 mm
	Through hole	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		150 × 150 mm
		4-M8
Environmental requirements	Ambient temp.	5 ~ 40 °C *3
	Ambient relative humidity	20 ~ 80 % (no condensation)
Noise level *4		L_{Aeq} = 70 dB (A) or under

Item			T6-B602S
Assignable value ( ) Default value	Speed		1 ~ (5) ~ 100
	Accel *5		1 ~ (10) ~ 120
	SpeedS		0.1 ~ (40) ~ 2000
	AccelS		0.1 ~ (200) ~ 10000
	Fine		0 ~ (1250) ~ 65535
	Weight		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, Error, SafeguardOn, SError, Warning, EStopOff
		Hand I/O (Upper side of Arm #2)	Input: 6 points Output: 4 points Non-polar, Supported for both Sink and Source
			Power: 24V Max. 700mA
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 resetting of system
Display	Mode display LED		TEACH, AUTO, PROGRAM, TestMode, Error, E-STOP

Item	T6-B602S
Controller status save	Save to USB memory Save in RC+ (PC)
Voltage	100 V to 240 VAC
Phase	Single phase
Frequency	50 / 60 Hz
Momentary power interrupt	Less than 10 ms
Power consumption	1,200 VA
Inrush current (When AC power is turned ON)	Max. 60A (Less than 2 ms.)
Short-circuit current rating	5.0 kA
Max. load current	6.0 A
Leak current	Max. 10 mA
Ground resistance	Less than 100Ω
Safety standard	CE Marking EMC Directive, Machinery Directive, RoHS Directive UKCA Marking EMC Regulations, Machinery Regulations, RoHS Regulations KC Marking, KCs Marking

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

*4: Conditions of Manipulator during measurement as follows:

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

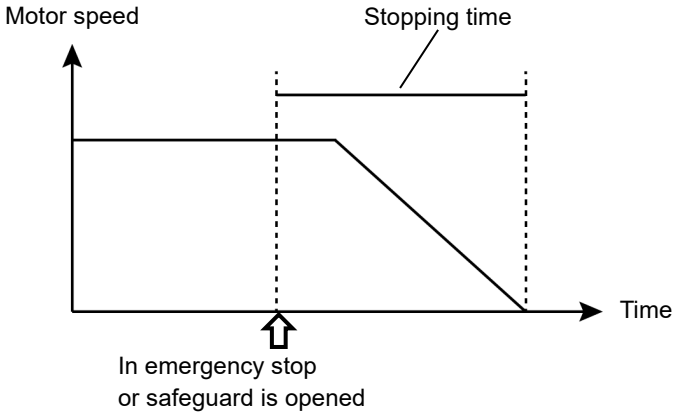
Measurement point : Rear of the Manipulator, 1000 mm apart from the motion range, 50 mm above the base-installed surface.

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

Appendix B: Stopping time and Stopping distance in Emergency

The stopping time and stopping distance in emergency stop are shown in a graph for each model.

The stopping time is “Stopping time” in the figure below. Be sure to confirm that safety is ensured according to the installation environment and operation of the robot.



Condition:

The stopping time and stopping distance vary depending on the parameters (setting value) set for the robot. In this chapter, the time and distance are shown with the following parameters.

Accel : 100 ,100
Other : Default

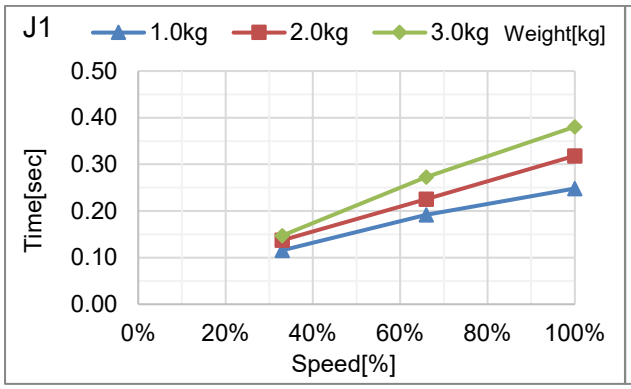
Description of legend:

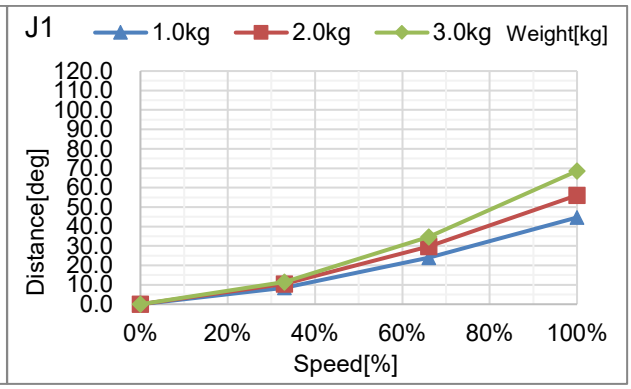
The graph is shown for each Weight value (rated value, 100%, about 66%, and about 33% of the maximum payload).

Horizontal axis	: Arm speed (Speed value)
Vertical axis	: Stopping time and stopping distance in each arm speed
Time [sec]	: Stopping time
Distance [deg]	: Stopping distance of J1 and J2
Distance [mm]	: Stopping distance of J3

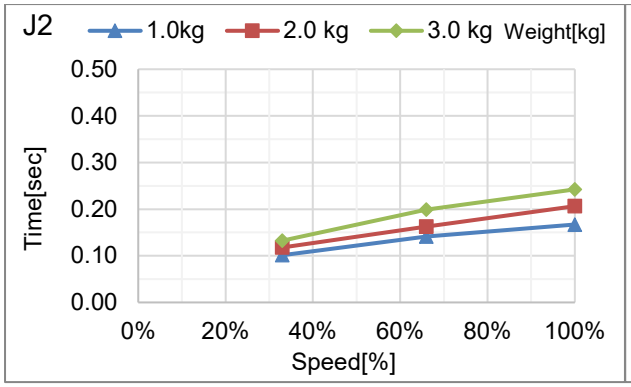
T3-B Stopping time and Stopping distance in Emergency

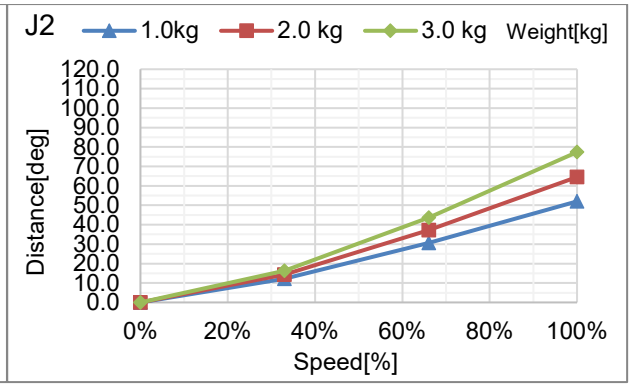
T3-B401S: J1



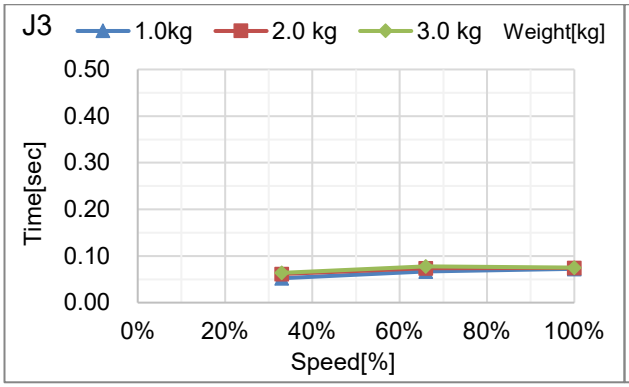


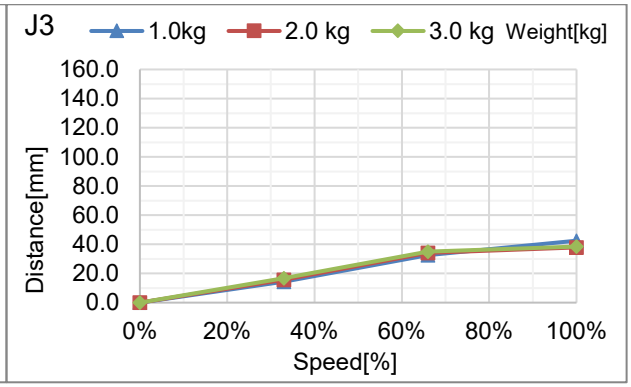
T3-B401S: J2





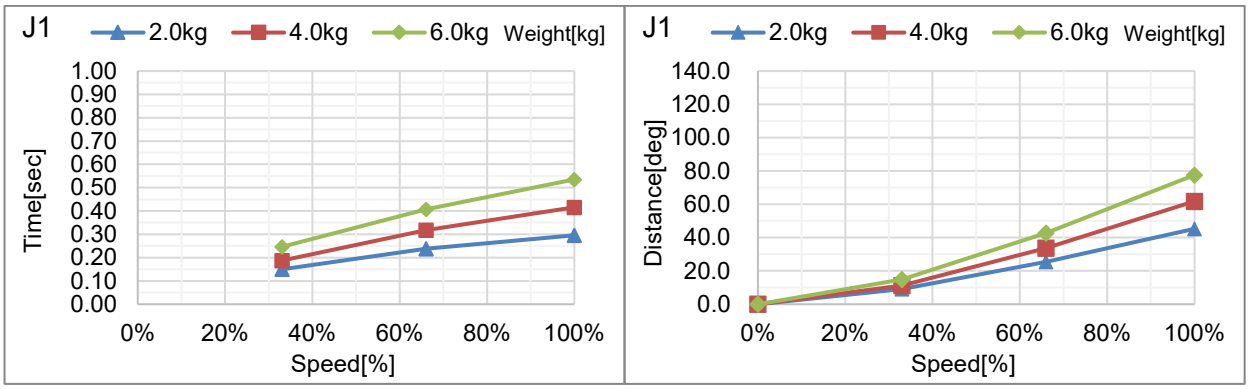
T3-B401S: J3



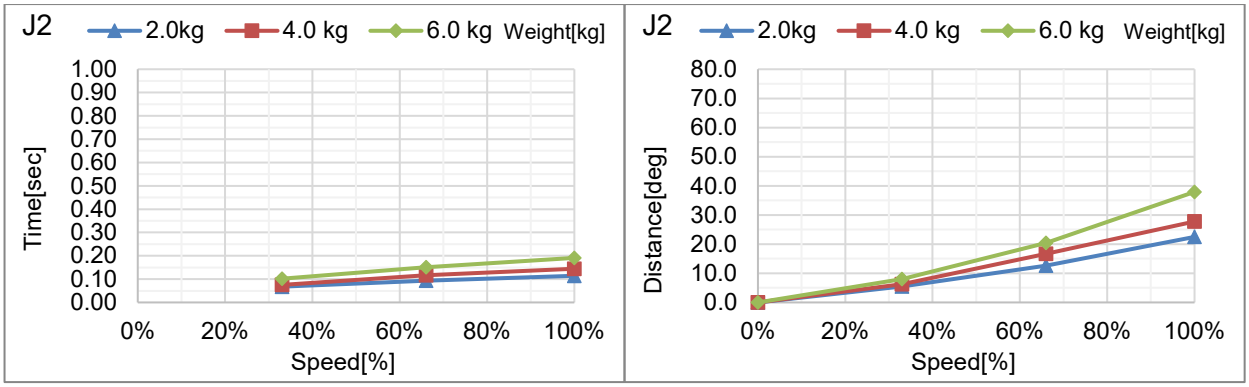


T6-B Stopping time and Stopping distance in Emergency

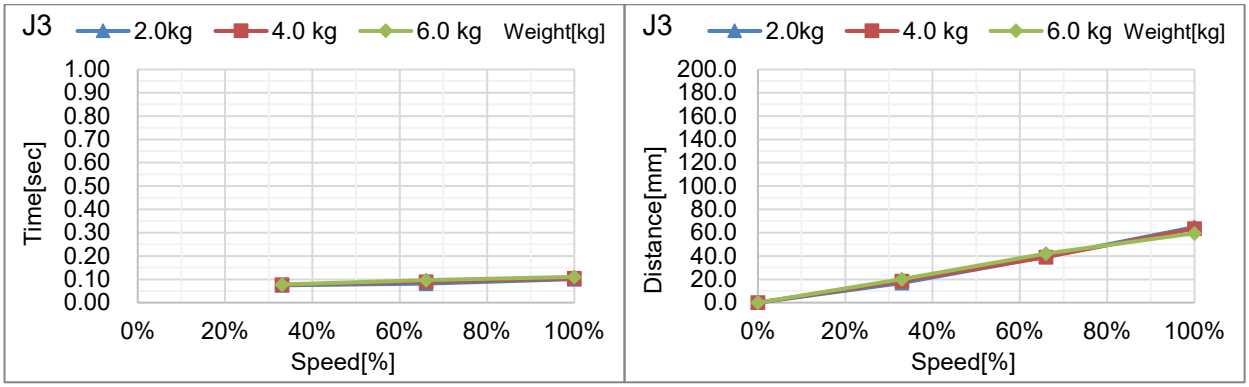
T6-B602S: J1



T6-B602S: J2



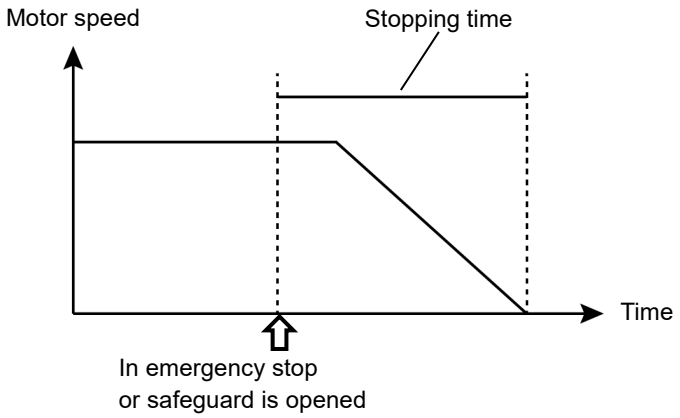
T6-B602S: J3



Appendix C: Stopping time and Stopping distance When Safeguard Is Opened

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

The stopping time is “Stopping time” in the figure below. Be sure to confirm that safety is ensured according to the installation environment and operation of the robot.



Condition:

The stopping time and stopping distance vary depending on the parameters (setting value) set for the robot. In this chapter, the time and distance are shown with the following parameters.

Accel : 100 ,100
Other : Default

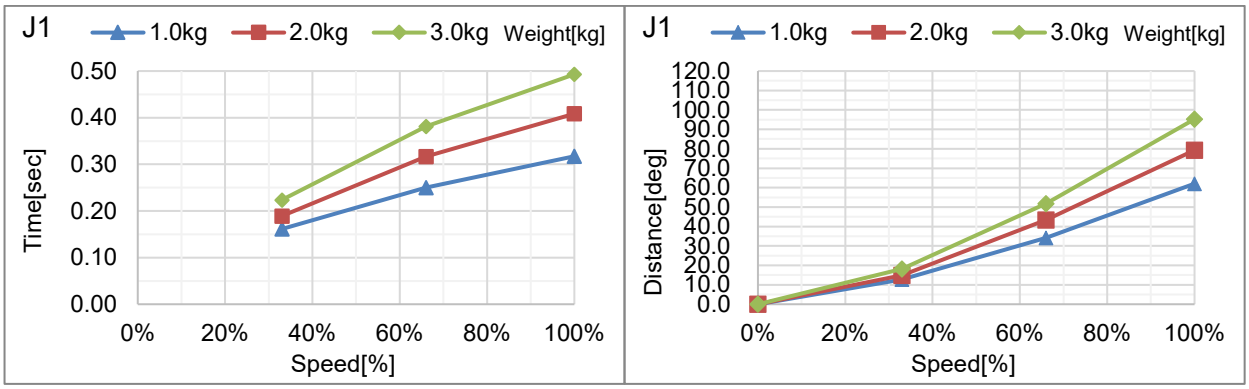
Description of legend:

The graph is shown for each Weight value (rated value, 100%, about 66%, and about 33% of the maximum payload).

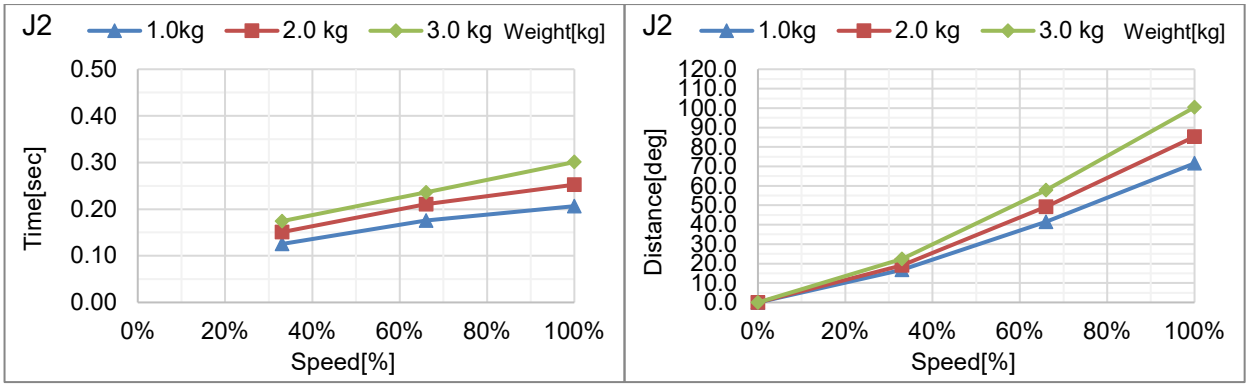
Horizontal axis	: Arm speed (Speed value)
Vertical axis	: Stopping time and stopping distance in each arm speed
Time [sec]	: Stopping time
Distance [deg]	: Stopping distance of J1 and J2
Distance [mm]	: Stopping distance of J3

T3-B Stopping time and Stopping distance When Safeguard Is Opened

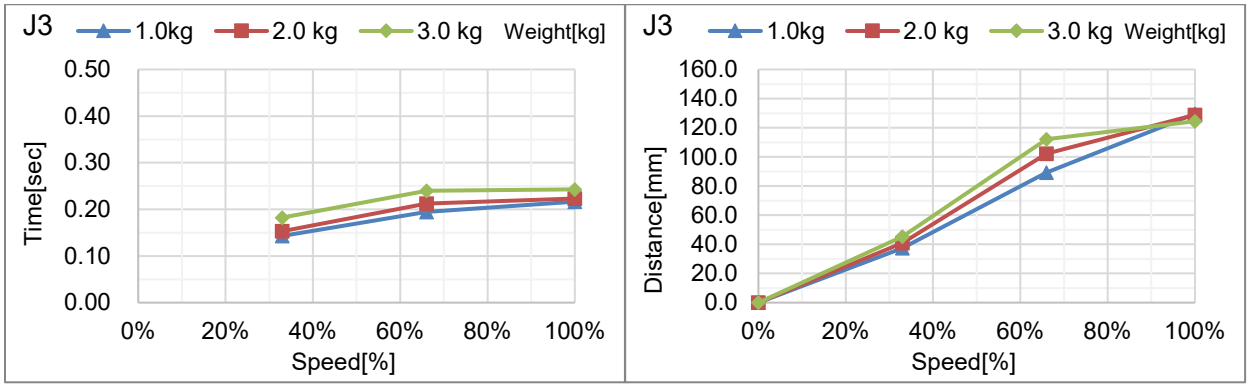
T3-B401S: J1



T3-B401S: J2

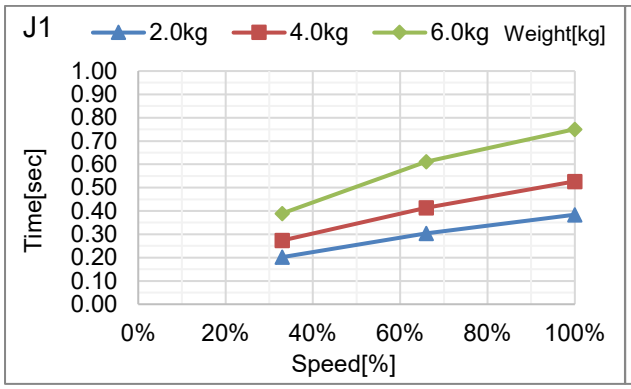


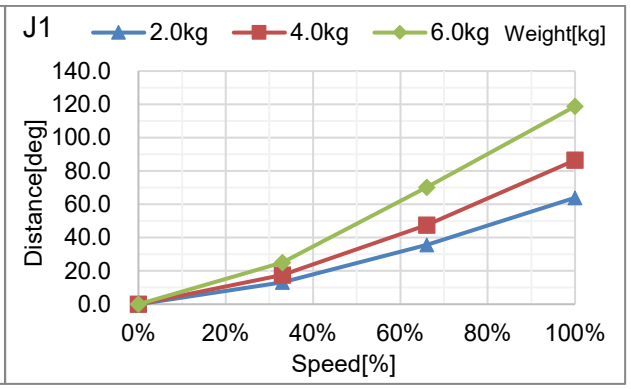
T3-B401S: J3



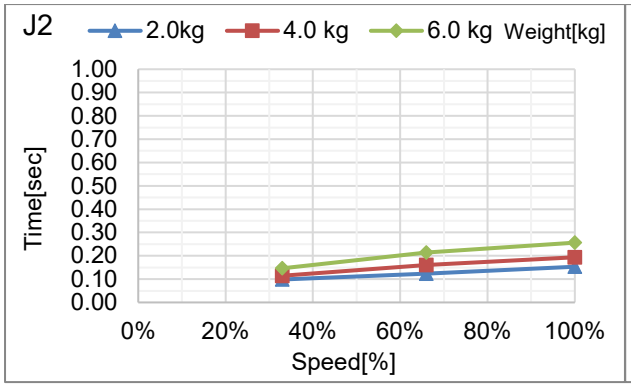
T6-B Stopping time and Stopping distance When Safeguard Is Opened

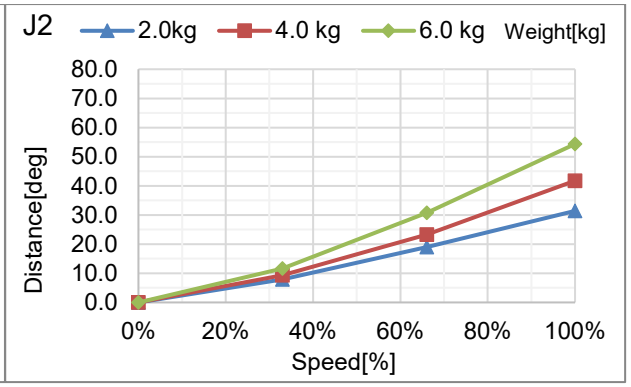
T6-B602S: J1



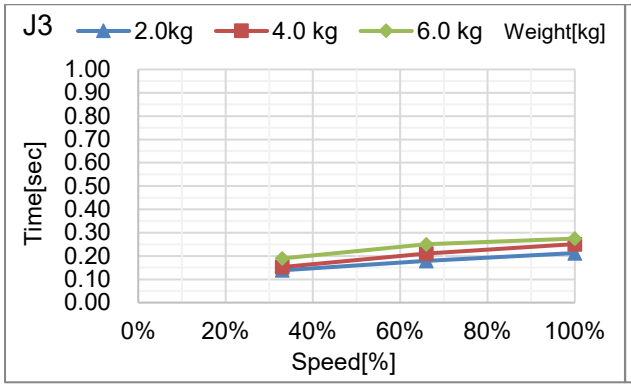


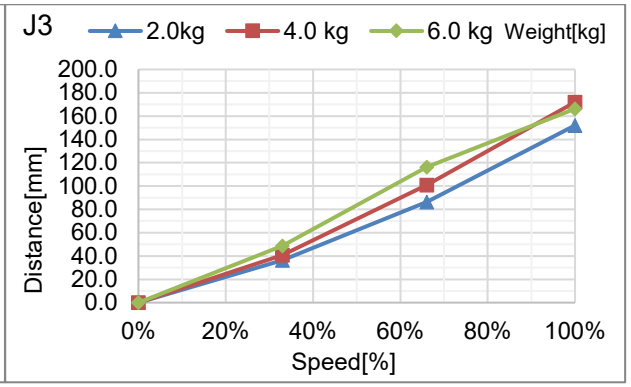
T6-B602S: J2





T6-B602S: J3





Appendix D: Open Source Software License

(for T-B series)

(1) The T-B series product includes open source software programs listed in Section (9) according to the license terms of each open source software program.

(2) We provide the source code of the Open Source Programs (each is defined in Section (9)) until five (5) years after the discontinuation of same model of this option product. If you desire to receive the source code above, please contact the "SUPPLIER" in the first pages of *Safety Manual*. You shall comply with the license terms of each open source software program.

(3) The open source software programs are WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. See the license agreements of each open source software program for more details, which are described on Section (10).

(4) OpenSSL toolkit
The T-B series product includes software developed by the OpenSSL project for use in the OpenSSL Toolkit (http://www.openssl.org/).
This product includes cryptographic software written by Eric Young (eay@cryptsoft.com).

(5) cJSON
This library is available under the MIT License.
Copyright (c) 2009-2017 Dave Gamble and cJSON contributors
https://opensource.org/licenses/mit-license.php

(6) Libxml2
This library is available under the MIT License.
Copyright (C) 1998-2012 Daniel Veillard. All Rights Reserved.
https://opensource.org/licenses/mit-license.php

(7) OPC UA Stack
This module is released under the RCL Licence.
Portions copyright (C) by OPC Foundation, Inc. and licensed under the Reciprocal Community License (RCL)
https://opcfoundation.org/license/rcl.html

(8) The license terms of each open source software program are described on Section (10).

(9) The list of open source software programs which the T-B series product includes are as follows.

bash	dash	libc-bin	libc6
libcomerr2	libdevmapper 1.02.1	libgcc1	libstdc++6
libudev1	login	Logrotate	makedev
mount	mountall	net-tools	netbase
rsyslog	ssh	sudo	tzdata
ubuntu-minimal	udev	Linux	Xenomai

(10)For the each open source license, please refer to the URLs as follows.

bash	http://tiswww.case.edu/php/chet/bash/bashtop.html
dash	http://packages.ubuntu.com/ja/precise/dash
libc-bin	http://www.eglibc.org/home
libc6	http://www.eglibc.org/home
libcomerr2	http://packages.ubuntu.com/ja/precise/libcomerr2
libdevmapper1.02.1	ftp://sources.redhat.com/pub/lvm2/
libgcc1	ftp://gcc.gnu.org/pub/gcc/releases/
libstdc++6	ftp://gcc.gnu.org/pub/gcc/releases/
libudev0	http://packages.ubuntu.com/ja/precise/libudev0
login	http://packages.ubuntu.com/ja/precise/login
logrotate	https://fedorahosted.org/logrotate/
makedev	ftp.redhat.com
mount	ftp://ftp.us.kernel.org/pub/linux/utils/util-linux-ng/
mountall	http://packages.ubuntu.com/ja/precise/mountall
net-tools	https://developer.berlios.de/projects/net-tools/
netbase	http://packages.ubuntu.com/ja/precise/netbase
rsyslog	http://www.rsyslog.com
ssh	http://www.openssh.com/ftp.html
sudo	http://www.sudo.ws/
tzdata	http://www.iana.org/time-zones
ubuntu-minimal	http://packages.ubuntu.com/ja/precise/ubuntu-minimal
udev	http://packages.ubuntu.com/ja/precise/udev
Linux	http://www.kernel.org/
Xenomai	http://www.xenomai.org/