EPSON

Industrial Robot: 6-Axis Robots

VT series

Manual

Rev.10   ENM256R7499F

Original instructions

VT series　Manual Rev.10

Industrial Robot: 6-Axis Robots

VT series *Manual*

Rev.10

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" and "VT series" described in this manual are the following models.

VT6L series

NOTE ☞ VT series Manipulators can use the Teach Pendant (TP2, TP3, TP4). Do not connect the other devices to TP port except TP bypass plug, TP2, TP3 and TP4. Connecting other devices may result in malfunction of the device since the pin assignments are different.

NOTE ☞ Concerning the security support for the network connection:

The network connecting function (Ethernet) on our products assumes the use in the local network such as the factory LAN network. Do not connect to the external network such as Internet.

In addition, please take security measure such as for the virus from the network connection by installing the antivirus software.

NOTE ☞ Security support for the USB memory:

Make sure the USB memory is not infected with virus when connecting to the Controller.

Features of VT series Manipulators

The VT series Manipulators are Controller integrated Manipulators.

Structure of Robot System

The VT series Manipulators can be used with the following combinations of software.

EPSON RC+7.0:

	Controller Firmware
VT6-A901S, VT6-A901C, VT6-A901P	Ver.7.4.56.2 or later
VT6-A901S-DC	Ver.7.4.57.1 or later

EPSON RC+ 7.0	Before Ver.7.4.6	!!!
	Ver.7.4.7 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 following version or later.   Display or control may not be operated properly.

Epson RC+8.0:

	Controller Firmware	
	Before Ver.7.5.53.x	Ver.7.5.54.x or later
Epson RC+ 8.0	N/A	OK

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

N/A: Not Available   An error will be shown.

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

EPSON RC+ 7.0	Epson RC+ 8.0

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

The Manuals of This Product

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

Safety Manual

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

Read this manual first.

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

VT series Manual

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

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

Status Code/Error Code List

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

VT series Maintenance Manual

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

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

Epson RC+ User's Guide

This manual describes general information about program development software.

Epson RC+ SPEL+ Language Reference

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

Other Manual

Manuals for each option are available.

Installation

VT6L Manipulator

Regular Inspection

Appendix

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 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.

2. Installation

2.1   System Example
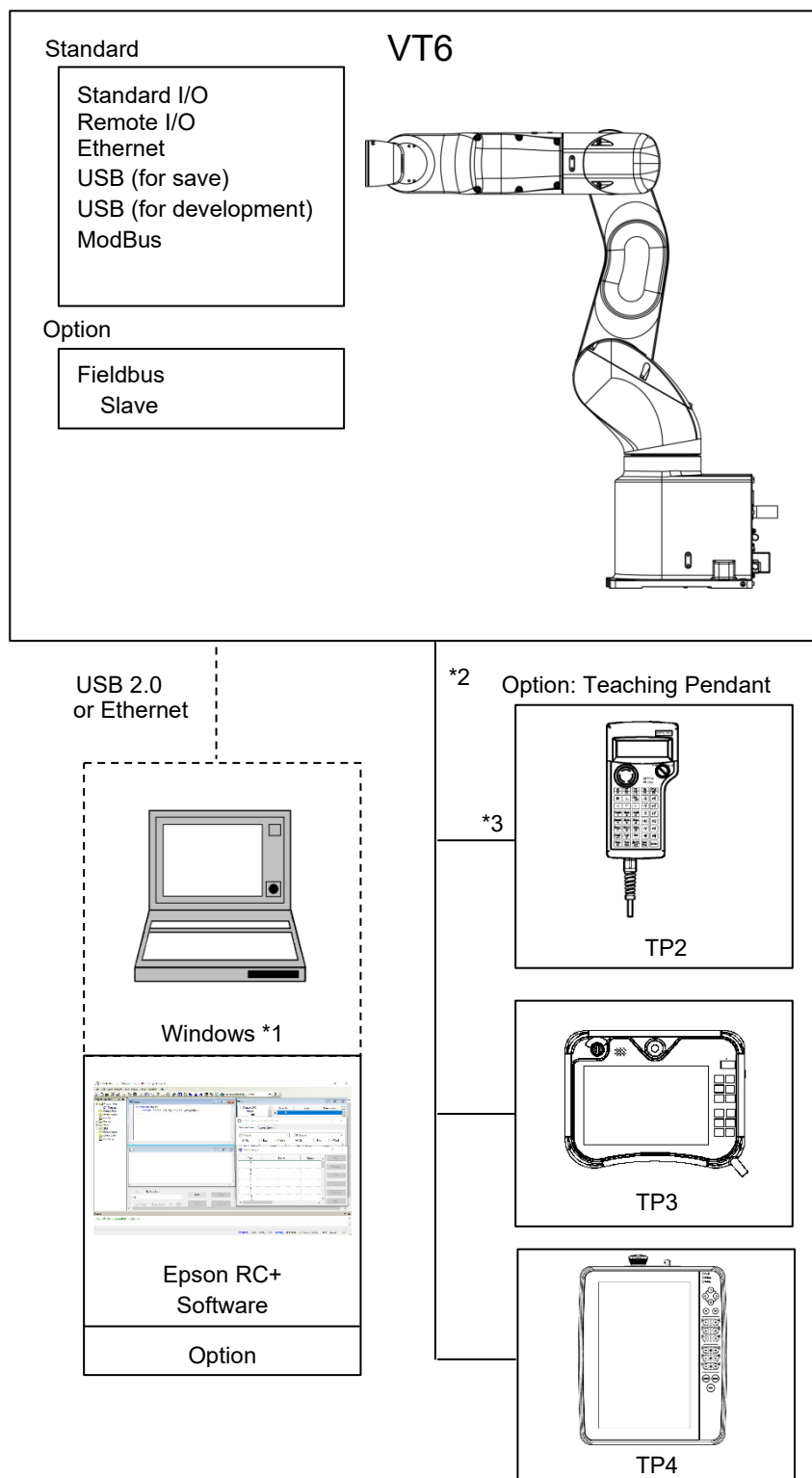
Standard

Standard I/O
Remote I/O
Ethernet
USB (for save)
USB (for development)
ModBus

Option

Fieldbus
   Slave

VT6

USB 2.0
or Ethernet

Windows *1

Epson RC+
Software

Option

*2   Option: Teaching Pendant

*3

TP2

TP3

TP4

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

*2   Either teaching pendant is available.

*3   When connecting to VT series Manipulators, specified 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: Except for prohibited part to hold
The number of people to transport: At least two
Prohibited part to hold: Bottom of base (the shaded area in the figure)
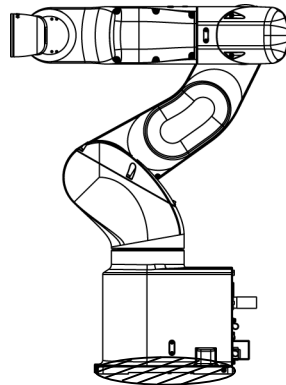
2.4   Environments and Installation

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 "*VT6L 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 *VT series manual* "*VT6L Manipulator   12. 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 "*VT6L 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 AUTO 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.

⚠ WARNING	Turning off the Manipulator before the AUTO LED starts blinking may cause the Controller to malfunction.
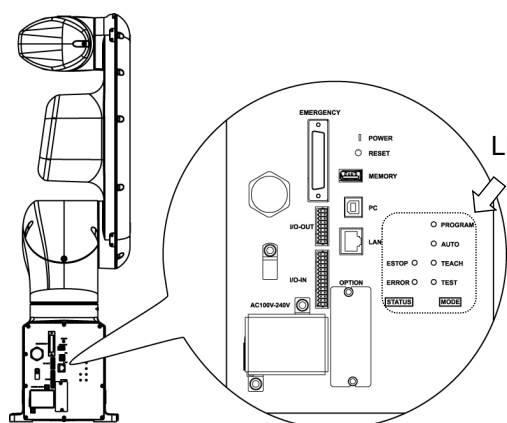
Standard, Cleanroom model
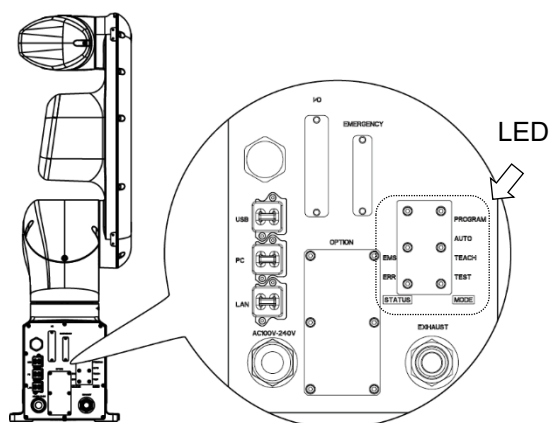
Protection model

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+ Software

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

For the software installation procedure, refer to the following manual.
   Epson RC+ User's Guide

4.2   Development PC and Manipulator Connection

Connect the development PC and the development PC connection port for connection.
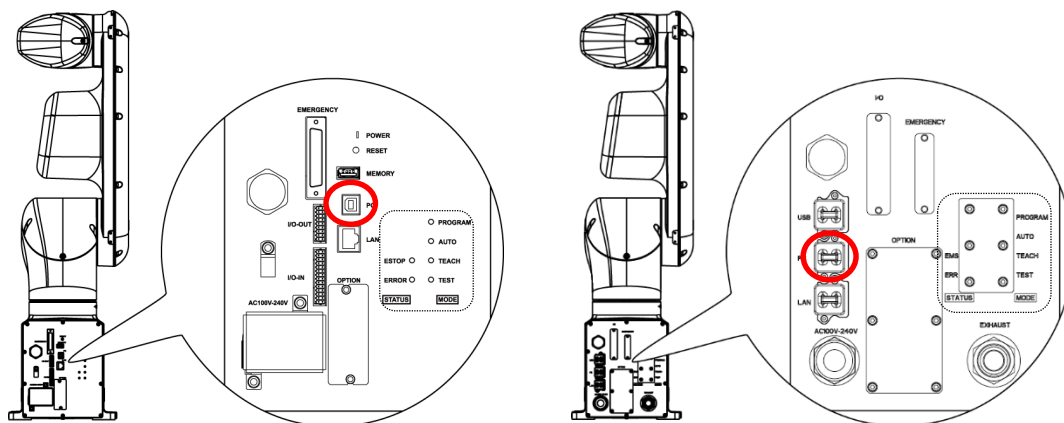
Standard, Cleanroom model   Protection model

NOTE
☞

- For other details of development PC and Manipulator connection, refer to *Epson RC+ User's Guide* "*[PC to Controller Communications Command] (Setup Menu)*".

- Be sure to install the Epson RC+ 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+ 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+ 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+ 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+.

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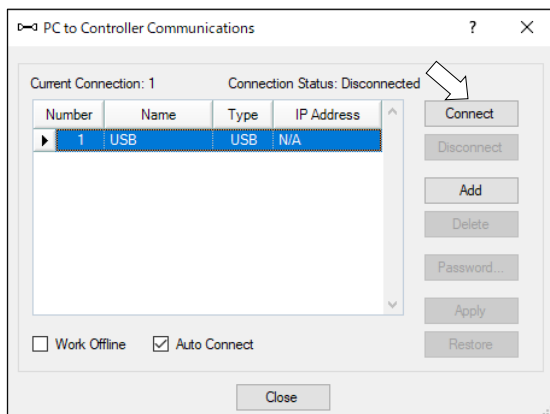
EPSON
RC+ 7.0

Epson
RC+ 8.0
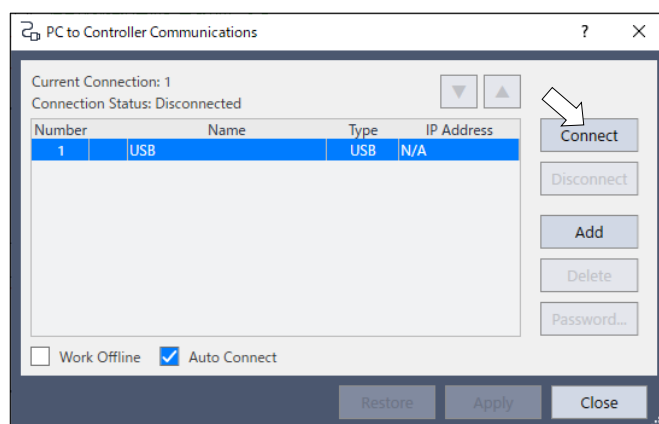
(6) Select the "No.1 USB" and click the <Connect> button.

(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.

EPSON
RC+ 7.0
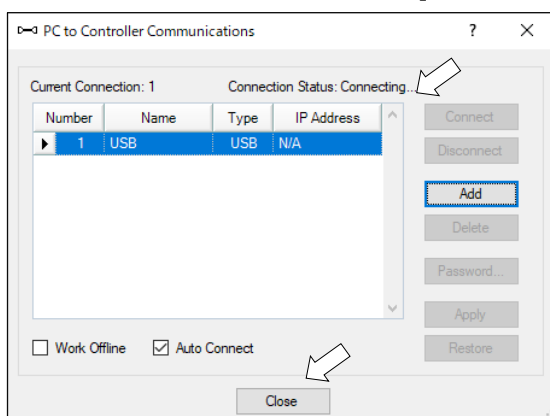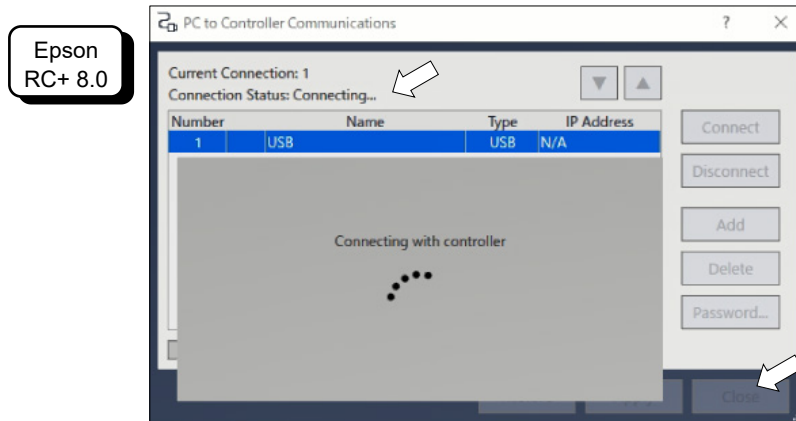
Epson RC+ 8.0

Connection of the development PC and the Manipulator is completed. Now robot system can be used from Epson RC+.

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+ 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 the Manipulator manually by releasing the solenoid brake from the command window of the Epson RC+.

For details, *"VT6L Manipulator 1.6.2 Release the Brake by the Software"*.

⚠ CAUTION	■ Normally, release the brake of joints one by one. Take extra care if you need to release the brakes of two or more joints simultaneously. Releasing the brakes of two or more joints simultaneously may 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 using the software, be sure to keep the emergency stop switch in an easily accessible location so that you can immediately press it if necessary. 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+.
       Double click the <Epson RC+> icon on the desktop.
  (2) Open the command window.
       Epson RC+ menu-[Tool]-[Command Window]
  (3) Execute the following command in [Command Window].
       `>Reset`
       `>Brake Off,`[Arm # (1 to 6) whose brake will be released]
       Execute the following command to turn on the brake again.
       `>Brake On,`[Arm # (1 to 6) whose brake will be turned on]

B: Command execution from the Epson RC+

Move the 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+.
Double click the <Epson RC+> icon on the desktop or select it from the Windows menu.

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

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

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

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

C: Jog motion from the Epson RC+

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

(1) Start the Epson RC+.
Double click the <Epson RC+> icon on the desktop or select it from the Windows menu.

(2) Create a new project.
1. Select [New] from the [Project] Menu. The [New Project] dialog box will be displayed.

EPSON
RC+ 7.0
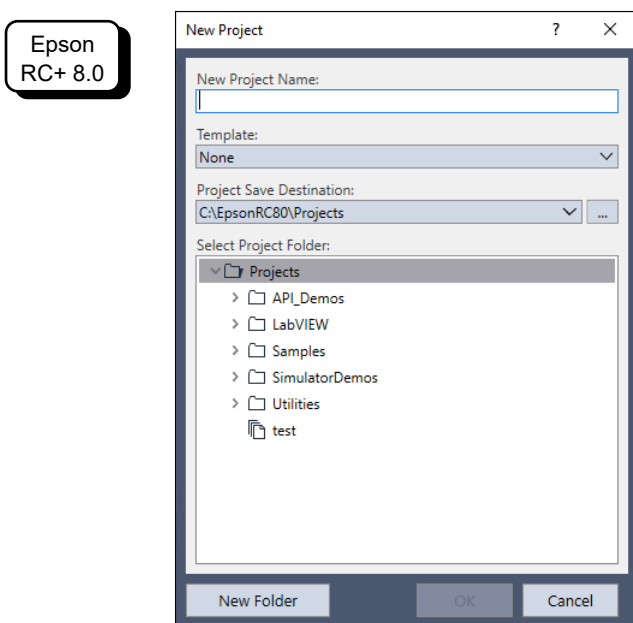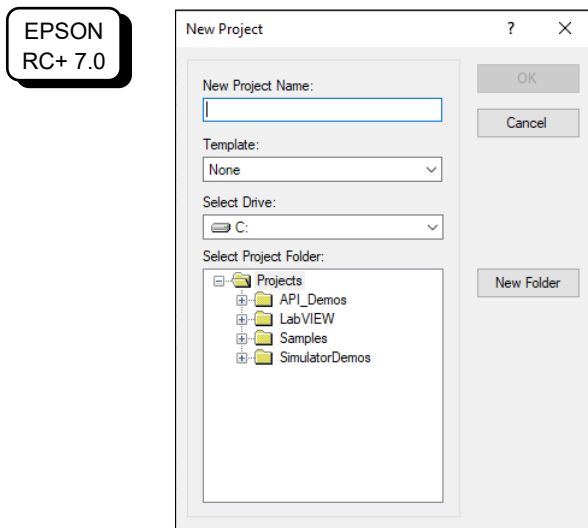
Epson
RC+ 8.0

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+ menu-[Tools]-[Robot Manager].

(4) Turn ON the motors.
Check that the [Control Panel] tab is open. Click the <MOTOR ON> button.
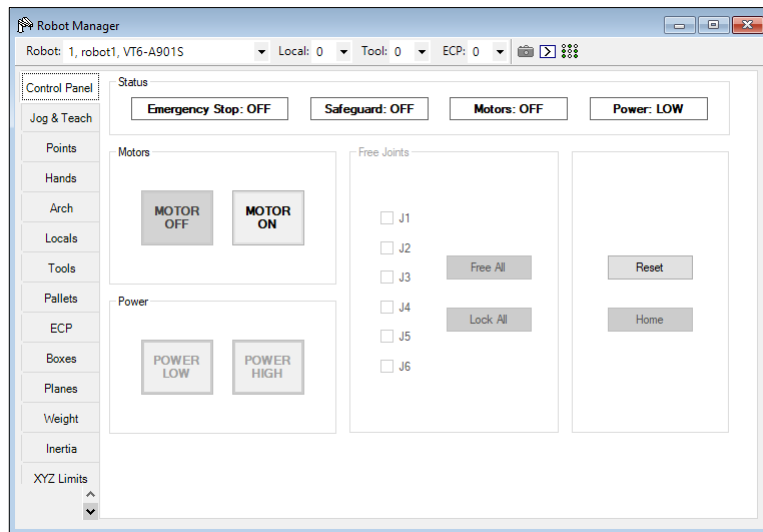
EPSON
RC+ 7.0

Epson
RC+ 8.0

Click the <Motor: Off> button.
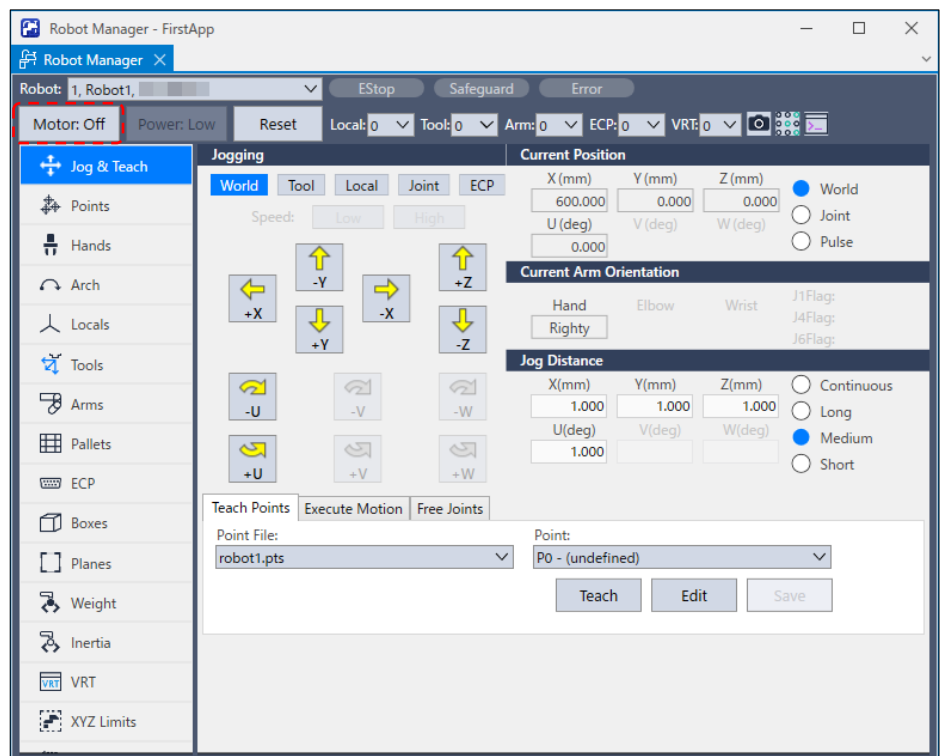
(5) Move the Manipulator with Jog motion.

    1. Select [Jog & Teach] tab.
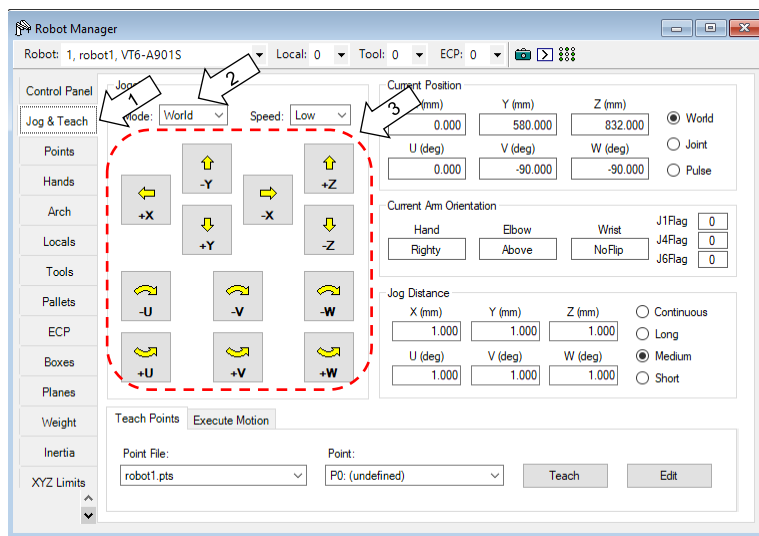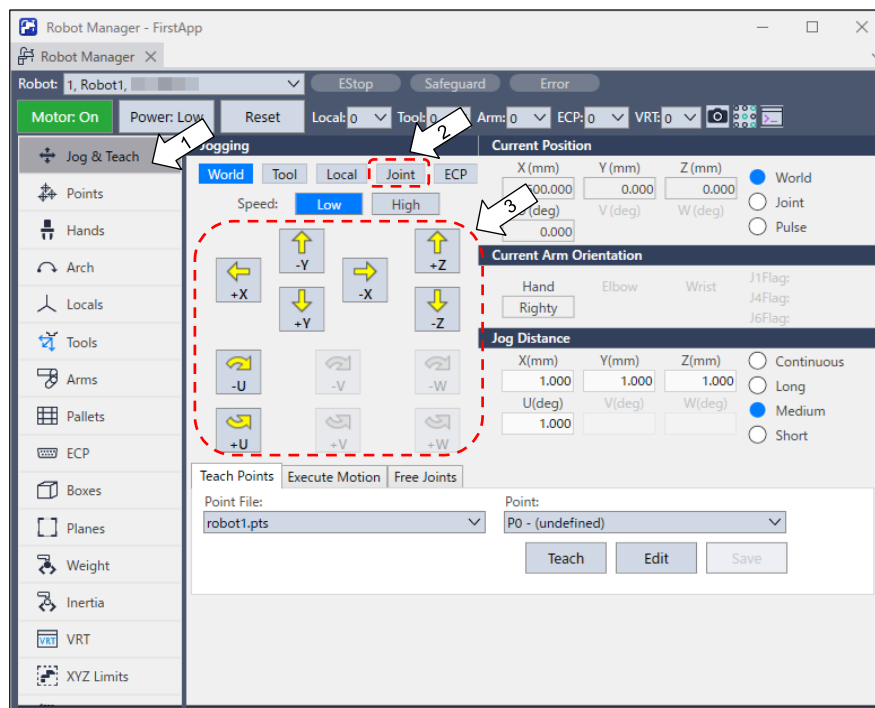
    2. EPSON RC+ 7.0: Select "Joint" in [Jogging]-<Mode>.
        Epson RC+ 8.0: Select "Joint" in [Jogging].

    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+ 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+ development environment.

1. Start Epson RC+
    Double-click the Epson RC+ icon on the desktop.
2. Create a new project
    (1) Select [New] from the [Project] Menu. The [New Project] dialog box will be displayed.
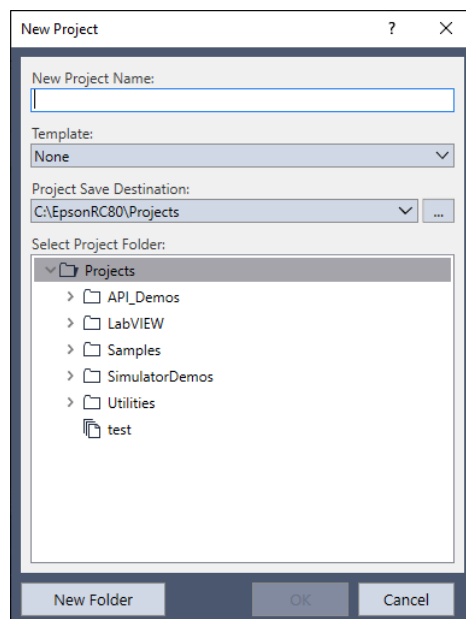
(2) Type a project name in the [New Project Name] box. (e.g. FirstApp)

(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
```


EPSON
RC+ 7.0
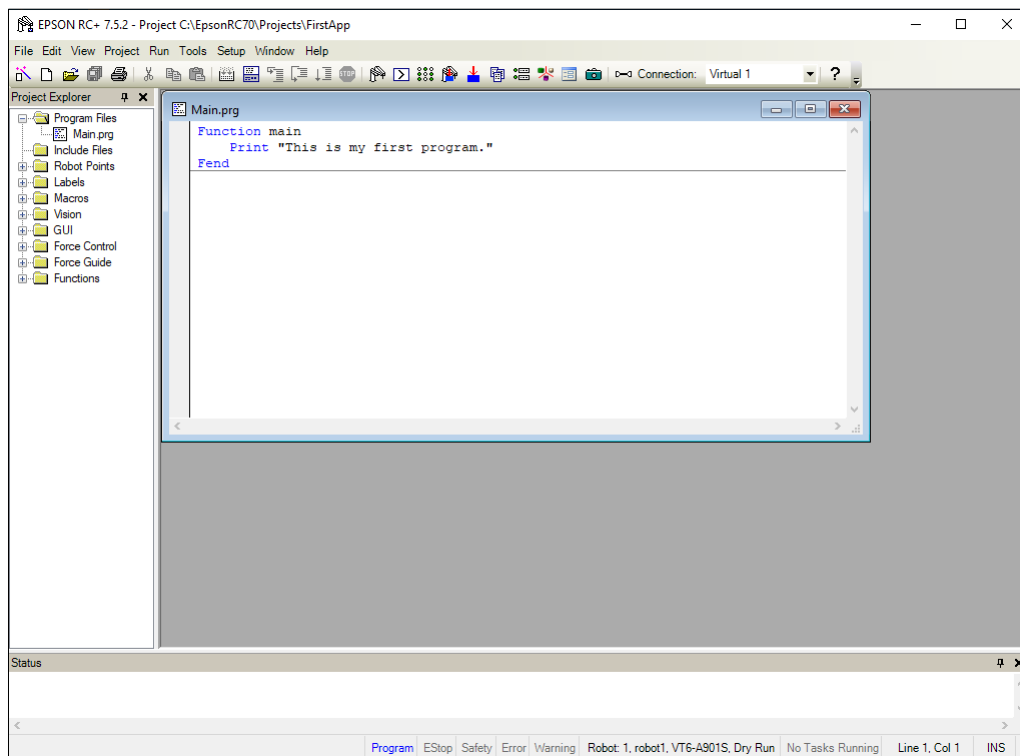
Epson
RC+ 8.0
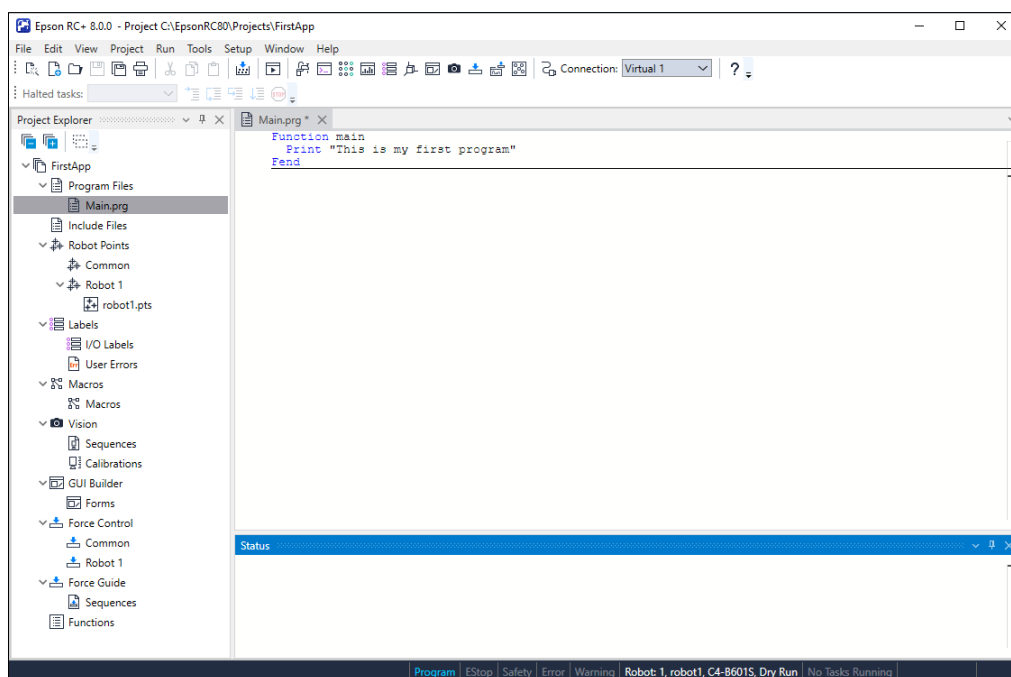
4. Run the program

   (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.

EPSON
RC+ 7.0
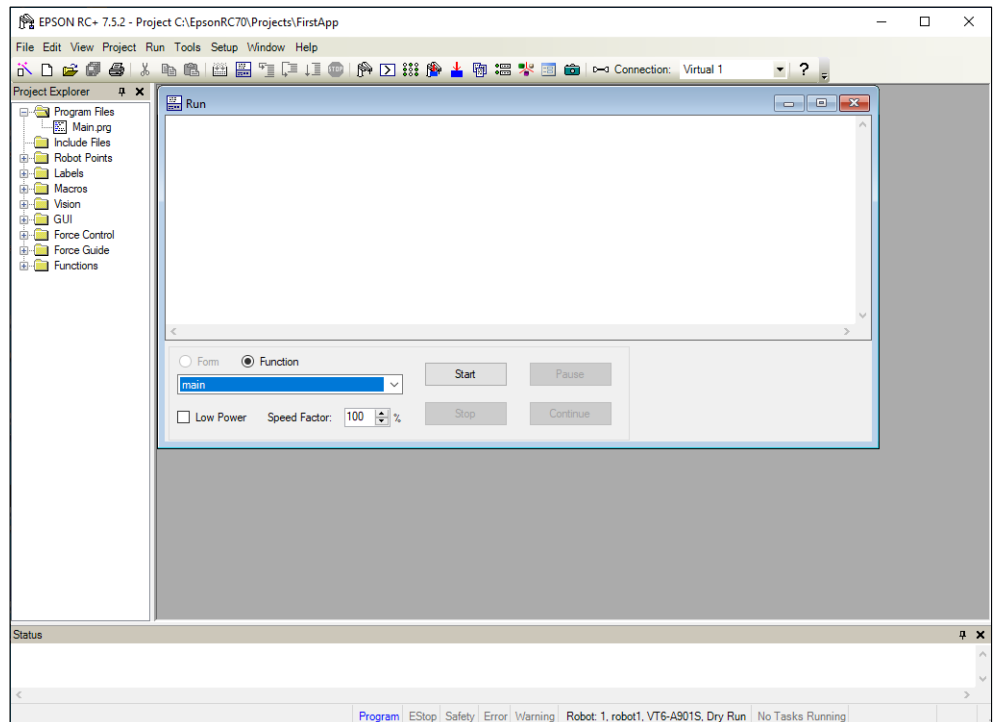
Epson
RC+ 8.0
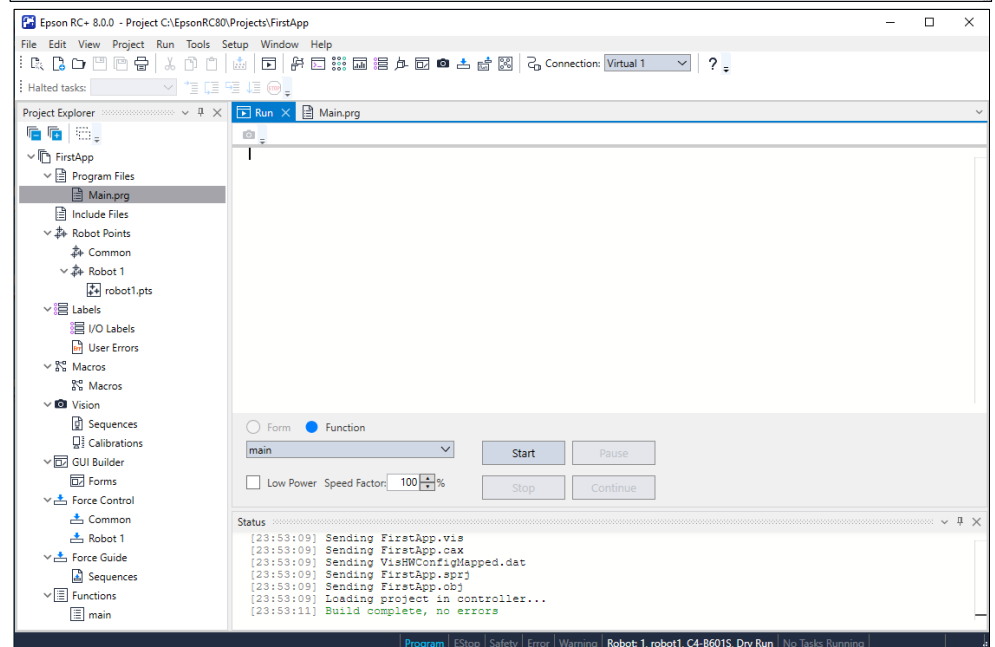
   (3) Click the <Start> button on the Run window to run the program.

   (4) The tasks like the following will be displayed in the status window.

```
Task main started
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 robot. Click the <Robot Manager> button on the toolbar to display the [Robot Manager] window.

    (2) Turn ON the motors.

EPSON
RC+ 7.0

Click the [Control Panel] tab. Then, click the <Motor On> button.
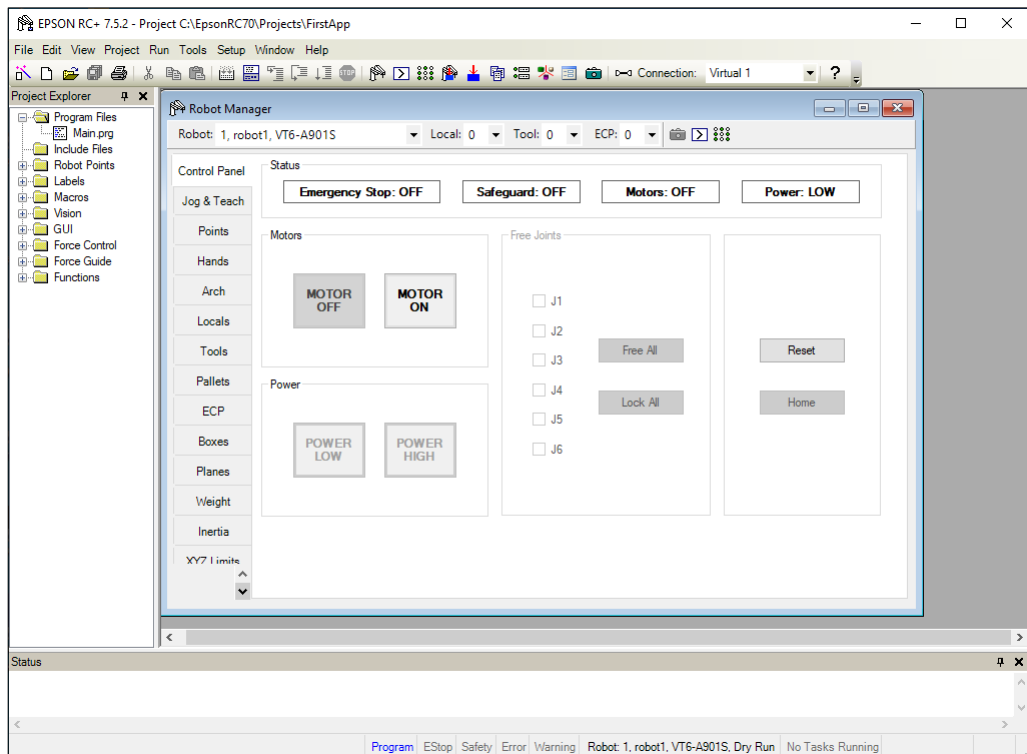
Epson
RC+ 8.0

Click the <Motor: Off> button.
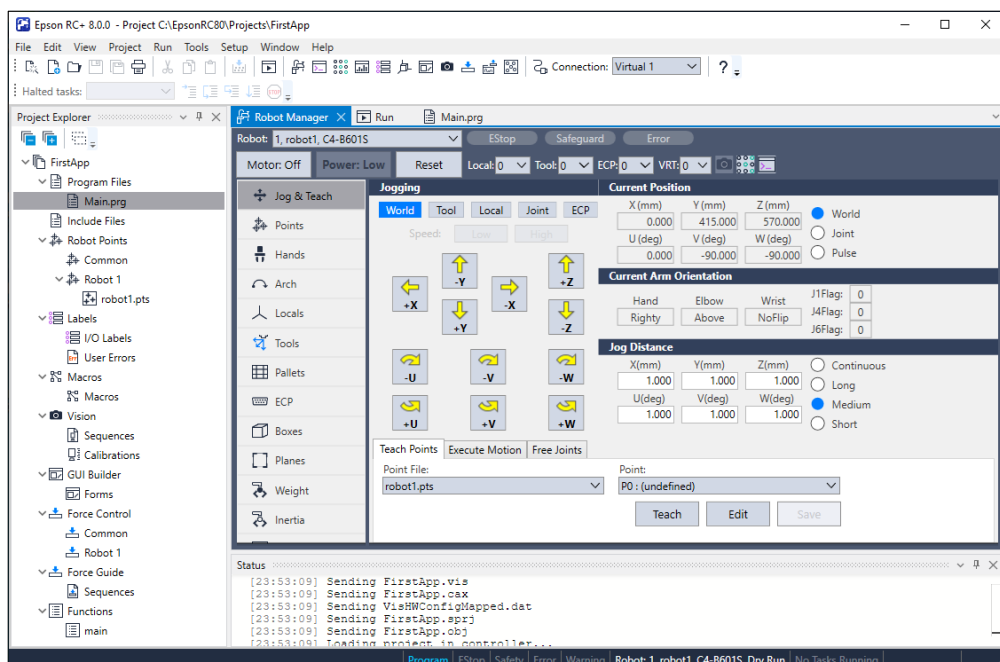
You will be prompted to confirm the operation.

(3) Click the <Yes> button to continue.

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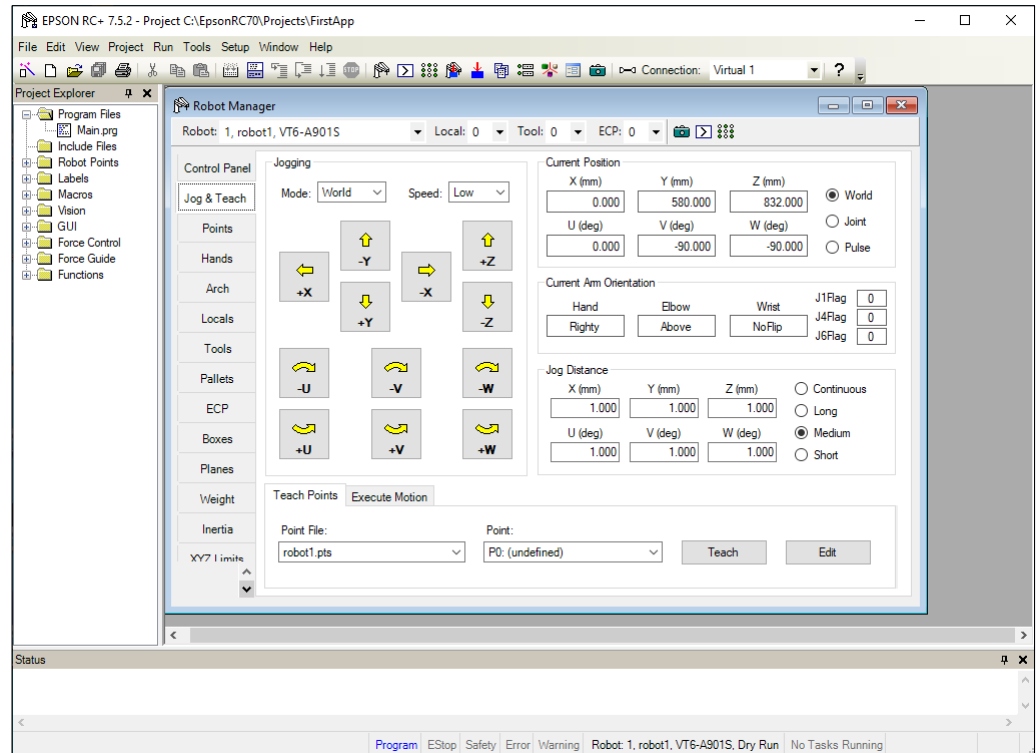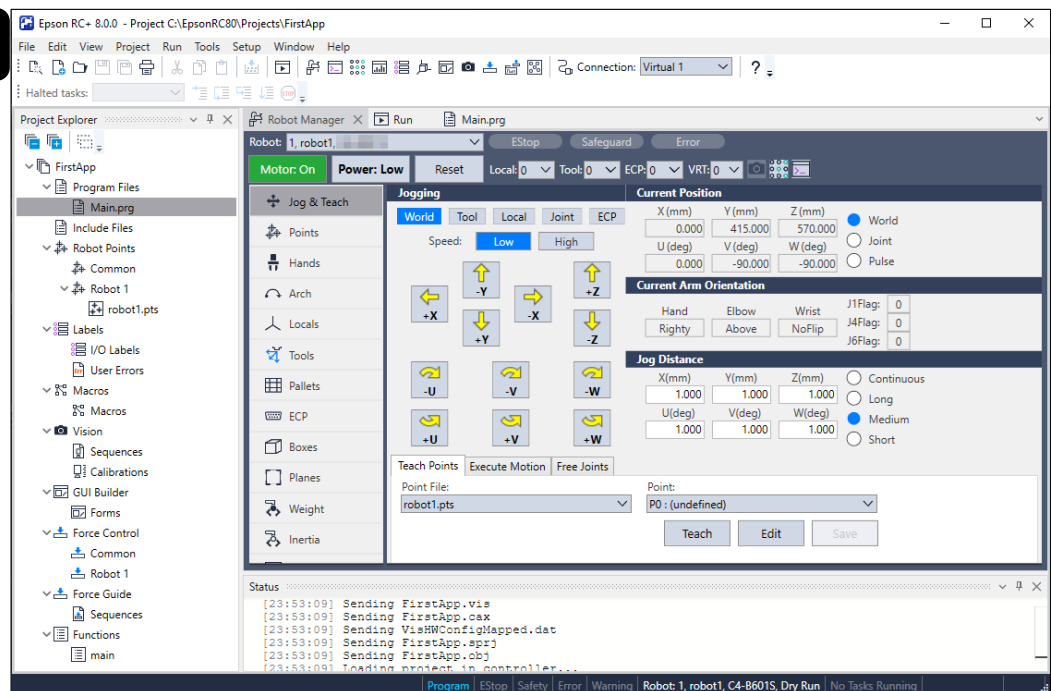
(5) Click the <Teach> button in the lower right corner to teach point P0. You will be prompted for a point label and description.

(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+. 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+ 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+ 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+ User's Guide "Remote Control"
VT6L Manipulator "14. I/O Remote Set Up"

I/O
EPSON RC+ User's Guide "I/O Setup"
VT6L Manipulator "13. Standard I/O Connector"

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

5.1.2   Ethernet

Epson RC+ User's Guide
   "Security for Controller Ethernet Connection"
   "Security for Compact Vision CV2-A Ethernet Connection"
   "Security for Feeder Ethernet Connection"
   "Ethernet Communication"
VT6L Manipulator "9. LAN (Ethernet) Port"

5.2   Ethernet Connection of Development PC and Manipulator

Epson RC+ User's Guide
   "Security for Controller Ethernet Connection"
   "Security for Compact Vision CV2-A Ethernet Connection"
   "Security for Feeder Ethernet Connection"
   "Ethernet Communication"
VT6L Manipulator "9. LAN (Ethernet) Port"

5.3   Connection of Option Teaching Pendant

VT6L Manipulator "10. TP Port"
ROBOT CONTROLLER Option Teach Pendant TP2
   "Function & Installation: Installation"
ROBOT CONTROLLER Option Teach Pendant TP3
   "Function & Installation: Installation"
ROBOT CONTROLLER Option Teach Pendant TP4
   "Installation"

VT6L Manipulator

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

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.

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. ■ If mounting Manipulator on the mobile platform and pressing Emergency Stop switch to stop Manipulator, be sure to design the system that the mobile platform also stops. If the mobile platform does not stop and it keeps moving, it is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system, and may cause serious safety problems. ■ Do not operate Manipulator when the mobile platform is moving. When using Manipulator, it must be surrounded by the safeguards. Operating Manipulator while the mobile platform is moving 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. ■ When using DC specification Manipulator, do not connect to AC power source. Connecting to AC power source is extremely hazardous and may result in electric shock and/or malfunction of the robot system. ■ When using DC specification Manipulator and connecting to DC power source such as battery, be careful of polarity. If connecting Manipulator cable to wrong polarity, it may result in malfunction of the robot system. For details on connection, refer to "*3.6.2 Power Cable*".

	■ 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.
	
	■ Each Joint:
	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 30 degrees for about once an hour.
	
	■ Vibration (resonance) may occur continuously depending on the combination of robot motion speed, Arm orientation, and end effector load. Vibration arises from natural vibration frequency of the Arm and can be controlled by following measures.
	
	  Changing Manipulator speed
	
	  Changing the teach points
	
	  Changing the end effector load
	
	■ 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.
	
	■ When mounting Manipulator on the mobile platform, be sure to stop Manipulator while the mobile platform is in operation. Manipulator stops when motors on all axes are turned OFF (servo free status). If you cannot turn OFF the motor, set power mode to "Low" and perform exclusive control of mobile platform and Manipulator so that they do not move simultaneously.

⚠ CAUTION	

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 "*12. 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 "*VT series Maintenance Manual 19. 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.
- When Emergency Stop switch is pressed, a great force is applied to the base table. When mounting Manipulator on the mobile platform, be sure to design the system that the system does not turnover and Manipulator does not fall over.

NOTE

☞

To check brake problems, refer to "*Regular Inspection 1. Regular Inspection for VT6L Manipulator*".

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

Stopping distance in emergency

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

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

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

1.5   Safeguard

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

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

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

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

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

NOTE

☞

For the safeguard, do not use the E-STOP circuit.
For details of wiring instructions, refer to "*12. EMERGENCY*".

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

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

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

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

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

1.6   How to Move Arms with the Electromagnetic Brake

When the electromagnetic brake is operating such as an emergency status, all arms cannot be moved.

For procedures to release the electromagnetic brake, refer to the following section.
When the electromagnetic brake is released, the arms can be moved by hand.

1.6.2 Release the Brake by the Software
(When the software is available)

NOTE
☞
In an emergency situation such as you cannot /do not want to turn ON the power, you can forcibly move the robot arm by pushing or pulling it with strong force.
A measure of force: 500N (near Arm #6)
However, if moving the robot forcibly, the joints may get damage. Be sure to do this only in an emergency situation.

1.6.1   Arm Motions

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

1.6.2 Release the Brake by the Software

(When the software is available)

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

Epson RC+

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

```
>Reset
>Brake Off,[the Arm (#1 to #6) whose brake will be turned OFF]
```

Execute the following command to turn ON the brake again.

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

1.7 Precaution for Operation in Low Power Status

In the low power status, the Manipulator operates at low speed and low torque.

If in close proximity to the Manipulator, operate the Manipulator carefully. Otherwise, your hands or fingers may get caught during operation. The Manipulator may also collide with peripheral equipment and cause equipment damage or malfunction of the Manipulator.

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

VT6-A901* (Table top mounting), VT6-A901SR (Ceiling mounting)

Joint	#1	#2	#3	#4	#5	#6
Joint Torque	100.57	274.29	94.22	31.83	31.53	31.92

VT6-A901SW (Wall mounting)

Joint	#1	#2	#3	#4	#5	#6
Joint Torque	210.29	274.29	94.22	31.83	31.53	31.92

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

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 may get your hand or fingers caught when bringing your hand close to moving parts.
E		When releasing the brakes, be careful of the arm falling due to its own weight.
F		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.

Location	Warning Label	NOTE
H	注意 CAUTION / 注意 ATTENTION / 注意 ATENCIÓN / 주의 CUIDADO / ОСТОРЖНО / 小心起吊 LIFT WITH CARE / 小心起吊 SOULEVEZ AVEC SOIN / 持ち上げ注意 LEVANTAR CON CUIDADO / 주의해서 들어 올리십시오 LEVANTE COM CUIDADO / ПОДНИМАЙТЕ ОСТОРОЖНО 注意 CAUTION / 注意 ATTENTION / 注意 ATENCIÓN / 주의 CUIDADO / ОСТОРЖНО / TP以外禁止接线 CONNECT ONLY TP / TP以外禁止接線 CONNECTER UNIQUEMENT TP / TP以外接続禁止 CONECTAR SOLO TP / TP만 연결 CONECTAR SOMENTE O TP / ПОДКЛЮЧИТЬ ТОЛЬКО TP	Do not connect the followings to the TP port of the controller 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

VT6-A901S/C

VT6-A901P
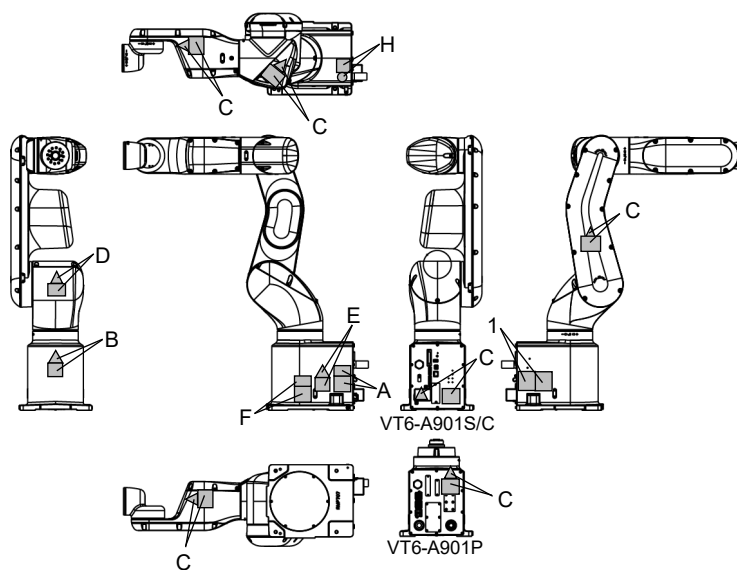
1.9   Response for Emergency or Malfunction

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   How to Move Arms with the Electromagnetic Brake*".

2. Specifications

2.1   Model Number

VT6-A90 1 ☐ ☐-☐

Power supply

| ☐ | : AC specification Manipulator |
| DC | : DC specification Manipulator |

Mounting type

☐	: Table Top mounting
R	: Ceiling mounting*1 (AC specification, Standard model only)
W	: Wall mounting (AC specification, Standard model only)

Environment

S	: Standard model
C	: Cleanroom model (AC specification Manipulator only)
P	: Protection model (IP67) (AC specification Manipulator only)

Brake equipment

| 1 | : Brakes on all joints |

Arm length

| 90 | : 920 mm |

Payload

| 6 | : 6 kg |

*1 Manipulators are set to "Table Top mounting" at shipment. To use the Manipulators as "Ceiling mounting", you need to change the model settings.
For details on how to change the model settings, refer to *"5.5 Changing the Robot"*, and *"Epson RC+ User's Guide - Robot Configuration"*.

For details on the specifications, refer to "*Appendix A: VT6L Specifications*".

2.2   Part Names
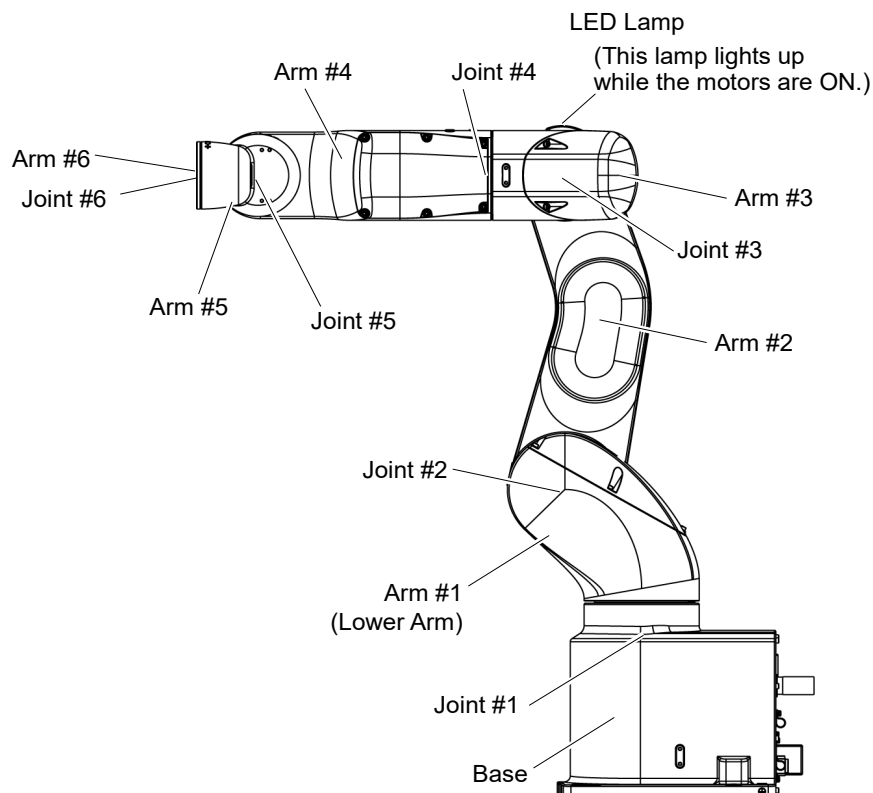
NOTE   When the LED lamp is lighting or the Controller power is ON, current is being applied to the Manipulator. (The LED lamp may not be seen depending on the Manipulator's posture. Be very careful.)

Performing any work with the power ON is extremely hazardous and it may result in electric shock and/or improper function of the robot system. Make sure to turn OFF the Controller power before the maintenance work.

Standard model

EMERGENCY Connector

TP Port

I/O (Output) Connector

I/O (Input) Connector

RESET switch

MEMORY Port

Port of PC for development

LAN (Ethernet) Connector

OPTION Cover
(OPTION connector inside)

Power Supply Cover
(Power connector inside)

Cleanroom model

EMERGENCY Connector

TP Port

I/O (Output) Connector

I/O (Input) Connector

RESET switch

MEMORY Port

Port of PC for development

LAN (Ethernet) Connector

Exhaust port
Fitting for ø12 mm pneumatic tube

Power Supply Cover
(Power connector inside)

OPTION Cover
(OPTION connector inside)

Protection model

I/O Connector

TP Port

MEMORY Port

Port of PC for development

LAN (Ethernet) Connector

Power cord

EMERGENCY
Connector

OPTION Cover
(OPTION connector inside)

2.3   Outer Dimensions

Detail A

123.3

10
20

2×M4
depth 7

Viewed from T

2×M4
depth 7

2×M4
depth 7

20
8.7

106.3

20
5.4

106.3

Viewed from Z

Viewed from U

119

61

61

Y

U

Z

X

150

2×M4
depth 7

20

50

45

2×M4
depth 7

8.7
20

106.3

Viewed from Y

106.3

2×M4
depth 7

5.4
20

Viewed from X

[Unit: mm]

2.4   Standard Motion Range

[Unit: mm]
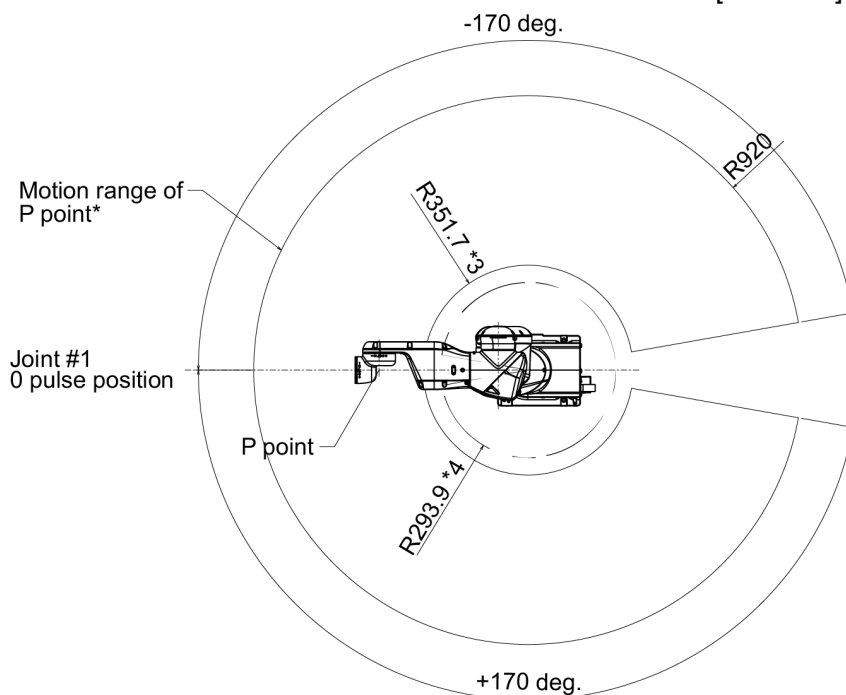
Top View

Front View
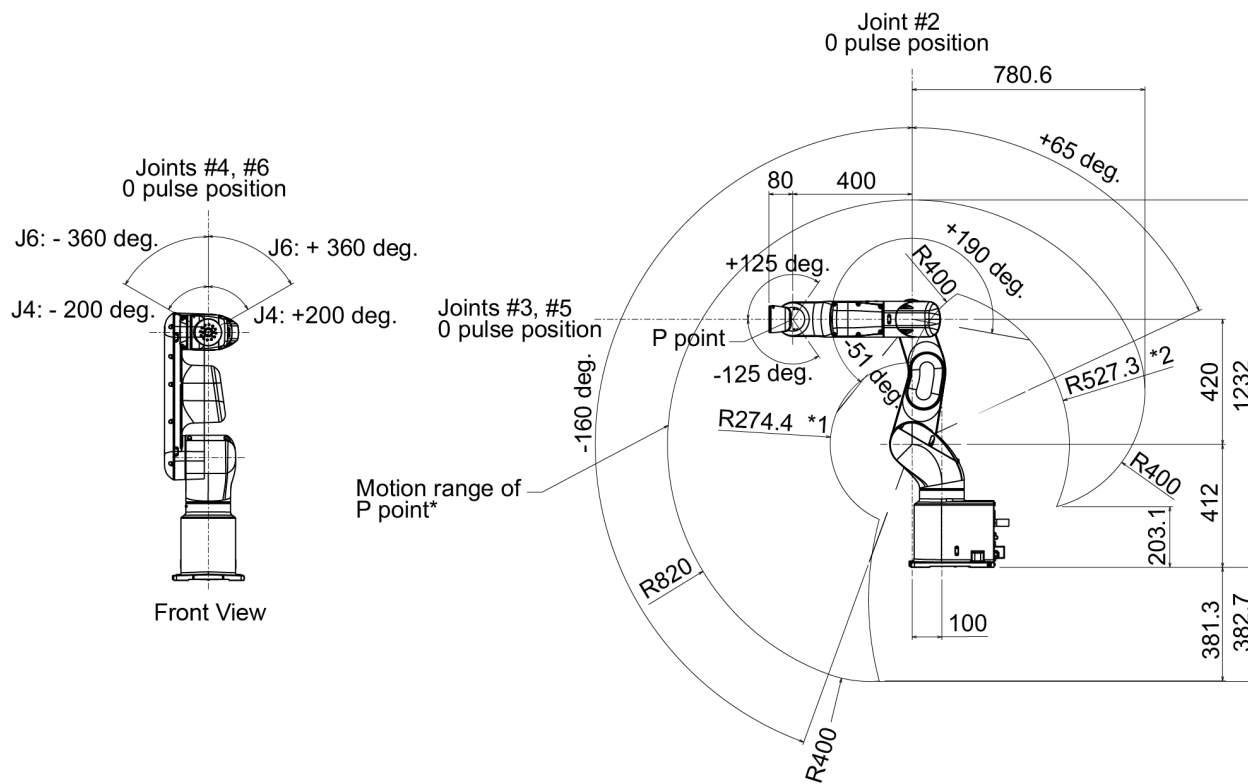
Lateral view

(deg.=°)

* P point: Intersection of the rotation centers for Joints #4, #5, and #6
*1   : P point from top with Joint #3 declining −51° (Joint #2 center − P point center)
*2   : P point from top with Joint #3 tilting up +190° (Joint #2 center − P point center)
*3   : P point from lateral with Joint #3 declining +190° (Joint #1 center − P point center)
*4   : P point from lateral with Joint #3 tilting up −51° (Joint #1 center − P point center)

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

2.5   System Example
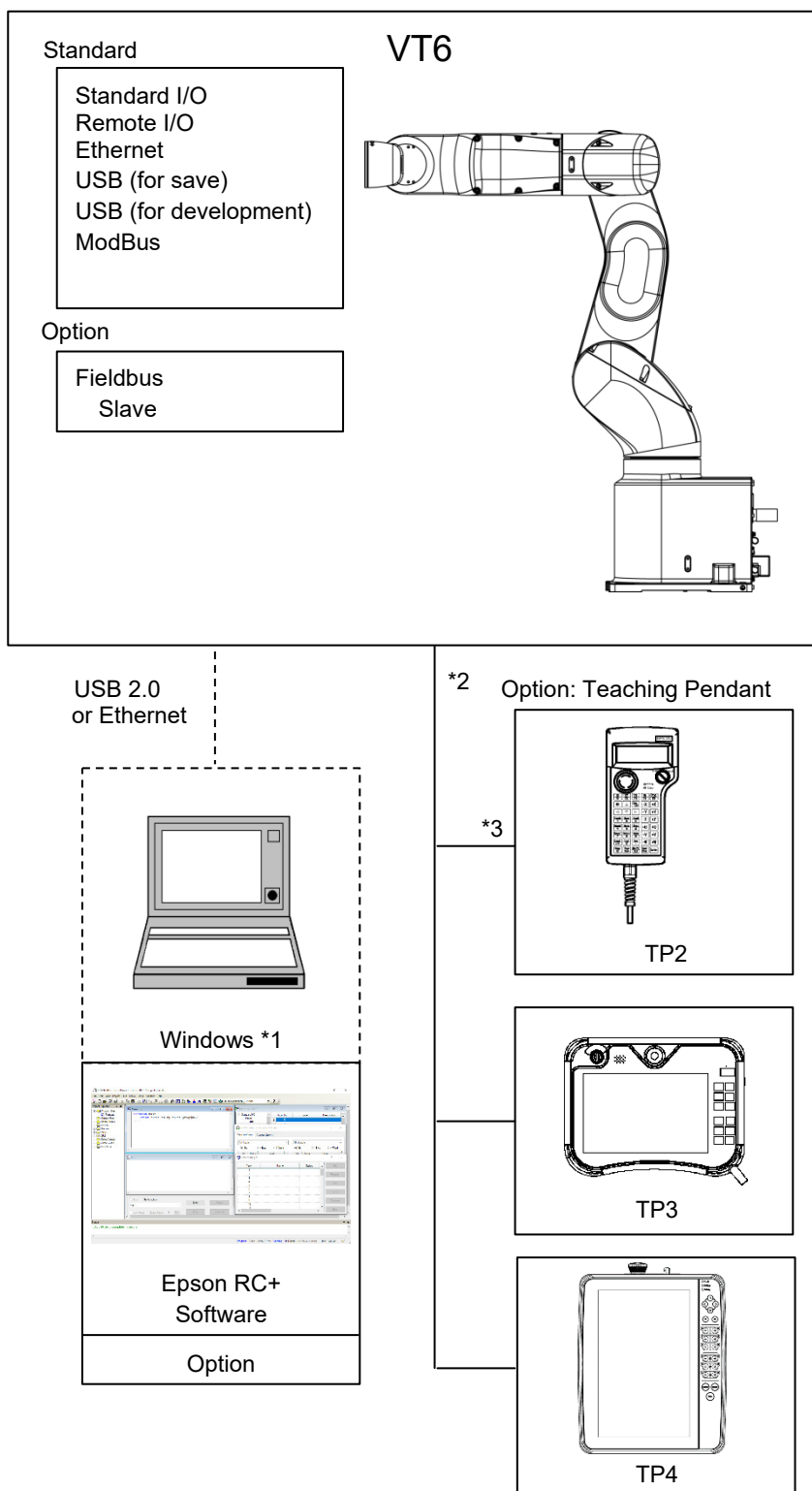
*1   For system requirements, refer to the following manual:
Epson RC+ User's Guide

*2   Either teaching pendant is available.

*3   When connecting to VT series Manipulators, specified convert cable is necessary.

2.6   Specifications

For the specifications of each model, refer to "*Appendix A: VT6L Specifications*".

2.7   How to Set the Model

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

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

NOTE
☞

If the custom specifications number (MT***) or (X***) is described on the signature label (S/N label), the Manipulator has custom specifications.

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

The Manipulator model can be set from software.
Refer to the following manual.
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	10 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.

For the Protection model Manipulator, be sure to install the robot system in an environment that also meets the following conditions:

Item	Conditions
Environment	- Install indoors
	- Keep away from direct sunlight
	- Keep away from salinity or other contaminants
	- Keep away from flammable or corrosive solvents (including water) *1 and gases
	- Keep away from organic solvents, acids, alkalis, and chlorine cutting fluids
	- Do not use in water
	- Keep away from shock or vibration
	- Keep away from sources of electric noise
	- Available under the environment with dust, oily smoke, and metal *2
	- Keep away from explosive area
	- Keep away from a large quantity of radiation

*1 The Manipulator is mainly made of iron and aluminum. It is not rust-proofed.
Do not use the Manipulator under conditions where it can be exposed to water or any other corrosive liquid (including water).

*2 Any contaminants that can deteriorate sealing performance of nitrile rubber oil sealing, O-rings, packing seals and liquid gasket should be avoided.

Special Environmental Conditions
The protective seals are attached on the Protection model Manipulator to prevent dust, water, etc. from the outside. Follow the precautions in use environment described below.

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.

When mounting Manipulator on the mobile platform, be sure to use mobile platform in low acceleration. If using the mobile platform in high acceleration, it may cause Manipulator to make a safety stop.

⚠ WARNING	■ Use an earth leakage breaker on the power cable of the Manipulator to avoid electric shock and circuit breakdown caused by short circuit. ■ For DC specification Manipulator, use a circuit protector to avoid electric shock and/or malfunction of the robot system.

⚠ 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 fastest speed. Provides enough beams to give sufficient strength.

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

	VT6-A901*
Max. Reaction torque on the horizontal plate	500 N·m
Max. Horizontal reaction force	500 N
Max. Vertical reaction force	3100 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 mounting Manipulator on the mobile platform, be sure to use mobile platform in low acceleration. If using the mobile platform in high acceleration, it may cause Manipulator to make a safety stop.

Be sure to design the mounting position of Manipulator so that the center of gravity is always within the mobile platform when Manipulator grasps a workpiece by using a tool. For operation pose, create operation program so that the center of gravity of Manipulator is always within the mobile platform. If the center of gravity is not within the mobile flatform, Manipulator may fall over.

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.

NOTE
☞ Adjust the holes of the base table with the shell size to be used.

Standard model, Cleanroom model

TP connector

ø29

37

11

I/O(input)connector

24

11

I/O(output)connector

28

9

DC power connector

54

13

EMERGENCY connector

34

9

AC power connector

(Unit: mm)

Protection model

TP connector

ø29

67

15.35

I/O connector

53.05

12.55

EMERGENCY connector

(Unit: mm)

⚠ 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

Mounting Area

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

Space for teaching points
Space for maintenance and inspections
(Ensure a space to open the covers and plates for maintenance.)
Space for cables

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

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

[Unit: mm]
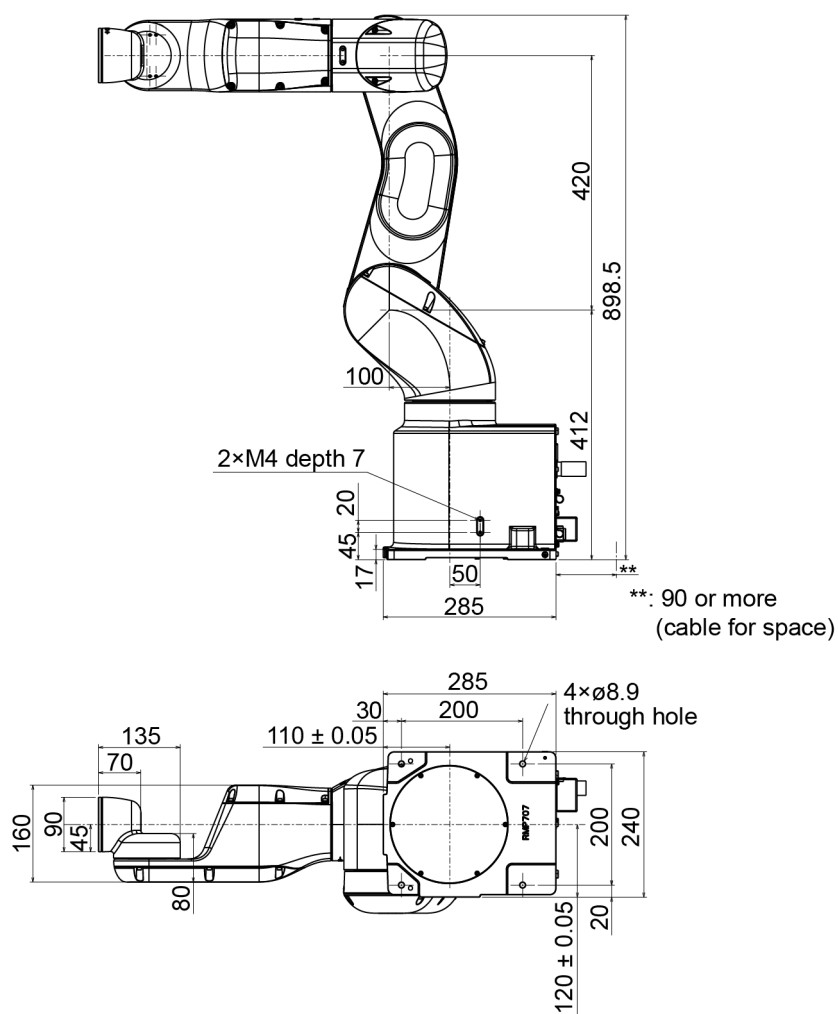
3.4   Unpacking and Transportation

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, and transportation 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. ■ To transport the Manipulator, secure it to the delivery equipment or have at least 2 people to hold it by hand. Also, do not hold the bottom of the base (the shaded area in the figure). Holding the area by hand is extremely hazardous and may cause your hands and fingers caught. DO NOT hold the bottom of the base by hand. ■ Manipulator weight <table><tr><td></td><td>VT6-A901**</td></tr><tr><td>Standard, Cleanroom</td><td>Approx. 40 kg: 89 lbs.</td></tr><tr><td>Protection</td><td>Approx. 42 kg: 92 lbs.</td></tr></table> ■ When transporting the Manipulator, avoid excessive vibration or shock. Excessive vibration or shock may cause equipment damage and/or malfunction of the Manipulator. ■ When transporting the Manipulator for a long distance, secure it to the delivery equipment directly so that the Manipulator never falls over. If necessary, pack the Manipulator in the same style as it was delivered.
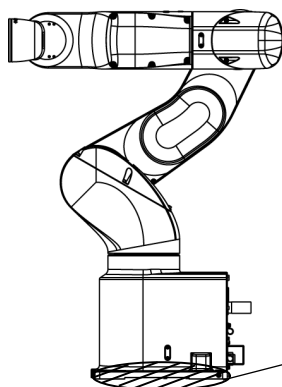
3.5   Installation Procedure

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.

⚠ WARNING	■ To ensure safety, a safeguard must be installed for the robot system. For details on the safeguard, refer to the *1.5 Safeguard*. ■ Install the Manipulator in a location with sufficient space so that a tool or a work piece does not touch a wall or a safeguard when the Manipulator extends its arm fully while holding a work piece. Installing the Manipulator at a location with insufficient space is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system as a tool or a work piece may collide with a wall or a safeguard. ■ Anchor the Manipulator before turning ON the power or operating the Manipulator. Turning ON the power or operating the Manipulator that is not anchored is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system as the Manipulator may fall down. ■ Before installing and operating the Manipulator, make sure that all parts of the Manipulator are in place and have no external defects. Missing or defective parts may cause improper operation of the Manipulator. Improper operation of the Manipulator is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system. ■ This Manipulator is not a collaborative robot. Be sure to perform risk assessment and take safety measures such as safeguard and emergency stop switch. Operating Manipulator without taking safety measures is extremely hazardous, may result in serious bodily injury and/or severe equipment damage to the robot system, and may cause serious safety problems.

⚠ CAUTION	■ The Manipulator must be installed to avoid interference with structures, utilities, other machines and equipment that may create a trapping hazard or pinch points. ■ Vibration (resonance) may occur during operation depending on rigidity of the installation table. If the vibration occurs, improve rigidity of the table or change the speed or acceleration and deceleration settings. ■ When mounting Manipulator on the mobile platform, there is a risk that Manipulator falls over. Be careful of the following items and take measures to prevent falls. 　Stiffness of the connection between mobile platform and Manipulator 　Acceleration of mobile platform and Manipulator 　Motion range of Manipulator ■ Be sure to design the mounting position of Manipulator so that the center of gravity is always within the mobile platform when Manipulator grasps a workpiece by using a tool. For operation pose, create operation program so that the center of gravity of Manipulator is always within the mobile platform. If the center of gravity is not within the mobile flatform, Manipulator may fall over.

⚠ CAUTION	■ Install the Table Top Mounting Manipulator with two or more people. The Manipulator weight are as follows. Be careful not to get hands, fingers, or feet caught and/or have equipment damaged by a fall of the Manipulator. VT6-A901**: Standard, Cleanroom model: Approx. 40 kg: 89 lbs. Protection model: Approx. 42 kg: 92 lbs.

Mounting bolt

For the dimensions, refer to *"3.3 Mounting Dimensions"*.

There are four threaded holes for the Manipulator base.

NOTE
☞

Use M8 mounting bolts conforming to the strength of ISO898-1 property class 10.9 or 12.9.

Tightening torque:
32.0 ± 1.6 N·m (314 ± 16 kgf·cm)

4-M8×35
Spring Washer
Plain Washer
17 mm
Screw Hole (depth 18 mm or more)
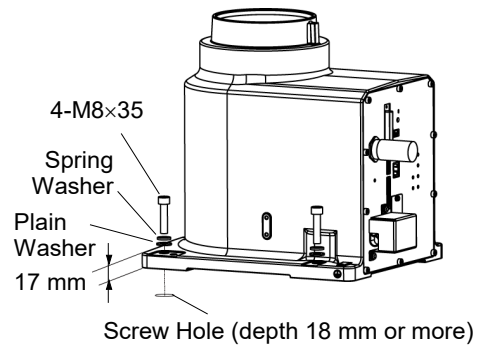
Cleanroom Model

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

(1) Unpack the Manipulator outside of the cleanroom.

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

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

(4) Transport the Manipulator into the cleanroom.

(5) Secure the Manipulator to the base table.

3.6   Power Supply

	■ There is no power switch on the Manipulator. Right after inserting power plug to power, the Robot System turns ON.
WARNING	Be careful about electric shock when inserting power plug.

3.6.1   Specifications

AC specification Manipulator:

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	1,200VA
Short-circuit Current Rating	5kA
Maximum Load Current	6.0A (Case of 200V) 12.0A (Case of 100V)
Inrush Current (When AC power is turned ON)	Max. 60A (Less than 2 ms)
Leak Current	Max. 10 mA
Ground Resistance	TN ground (100 Ω or less)

DC specification Manipulator:

Ensure that the available power meets following specifications.

Item	Specifications
Voltage	48 VDC
Available voltage	43 to 60 VDC
Absolute Maximum Ratings	72 VDC (Be careful not to exceed the above value when voltage rises.)
Inrush Current (When DC power is turned ON)	Max. 40A (less than 10 ms)
Rated Capacity	1200 W
Maximum Load Current	25A
Grounding	Ground wire and DC power wire (−) are connected.

3.6.2　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. ■ Be sure to connect brown wire of DC power cable to "+" and blue wire to "−". Connecting to wrong polarity will result in malfunction of Manipulator. ■ Always use a plug or a disconnecting device for power connecting cable. Never connect the Controller 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 Power 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.

AC specification Manipulator

Item	Specifications
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.

DC specification Manipulator

Item	Specifications
DC power wire (+)	Brown
DC power wire (−)	Blue
Cable length	2 m
Terminal	M4 round solderless terminal

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

For DC specification Manipulator, connect the ground and DC power wire (–).

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

Bolt hole M4
(for grounding)

4
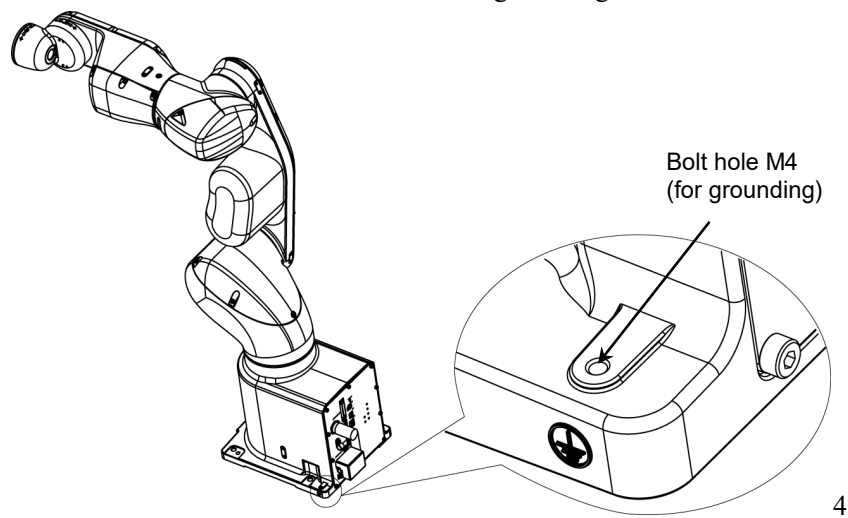
Use cable clamp on rear side of the Manipulator to fix power cable.

(Only for Standard model, Cleanroom model)

Power Cable Clamp
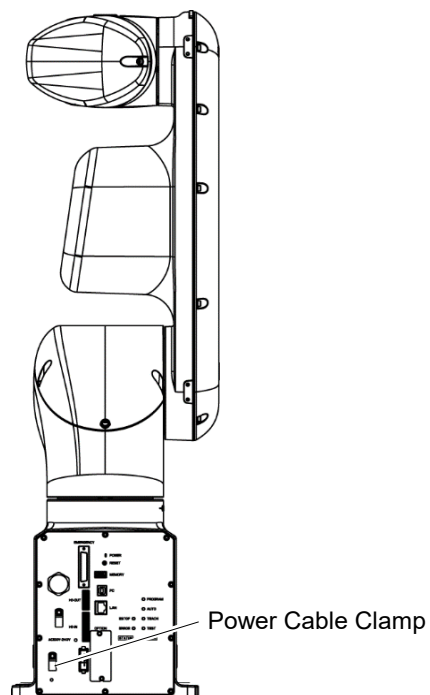
3.6.3 Breaker

AC power line:

Install an earth leakage circuit breaker or a circuit breaker.

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

VT6L	Power	Rated electric current
AC specification	100VAC	20A
	200VAC	10A

DC power line:

Install a circuit protector.

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

VT6L	Power	Rated electric current
DC specification	48VDC	40A

If you install a circuit protector, please select one that is described in the following section and can handle the "inrush current".

3.6.1 Specifications

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

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 power cable to a power plug. 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 between the Manipulator and Controller 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

Standard model, Cleanroom model

o   Detachable connector

⎯⎯   Supplied cable

- - - - -   Not supplied cable (Prepare by yourself)

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

(2) 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 "*12. EMERGENCY*".

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

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

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

(6) 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 "*13. Standard I/O connector*".

(7) 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 "*13. Standard I/O connector*".

(8) Power connector
Connector for supplying AC power source (AC specification Manipulator) or DC power source (DC specification Manipulator) to the Manipulator.

NOTE
☞
When sharing the power source of DC specification Manipulator with equipment such as mobile platform which generates regenerative power, connect overvoltage protection circuit (e.g. regenerative absorption circuit) outside and make sure that input voltage does not exceed absolute maximum ratings of Manipulator.

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

For the Cleanroom model Manipulator, an exhaust system is necessary. For details, refer to "*Appendix A: VT6L Specifications*".

Protection model

     o   Detachable connector

    ——   Supplied cable

    - - - - -   Not supplied cable (Prepare by yourself)

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

(2) 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 "*12. EMERGENCY*".

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

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

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

(6) I/O connector
This is a connector for connecting input and output devices of the user.
When there is input or output device, use this connector.
For details, refer to "*13. Standard I/O connector*".

(7) AC power connector
Connector for AC power supply to the Manipulator.
This is connected at shipment.

(8) 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.

AC Line duct

As far as possible

DC line duct
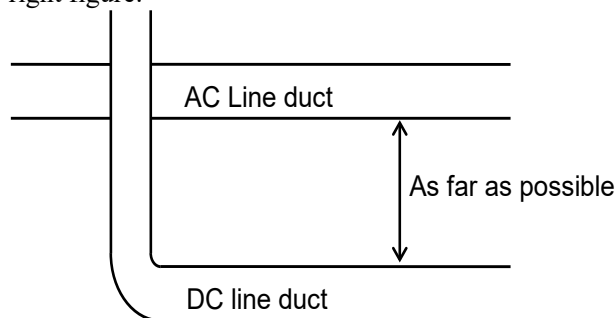
- Wire as short as possible to the I/O connector and EMERGENCY connector. Use a shielded cable and clamp the shield to the attached connector interior. Make sure to keep away from the peripheral noise source as far as possible.

- 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.

Remove the outer cover and fix with the FG clamp.

Secure the clamps to the Controller with screws to ground the shield.
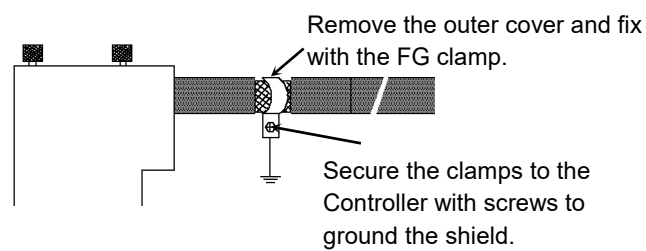
- Mount Ferrite core to the cable.

Ferrite core
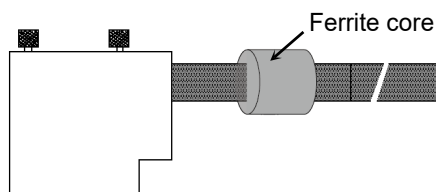
3.8   Relocation and Storage

3.8.1   Precautions for Relocation and Storage

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

Transportation, and installation 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	■ When removing the anchor bolts, support the Manipulator to prevent falling over. Removing the anchor bolts without supporting the Manipulator may get hands, fingers, or feet caught as the Manipulator may fall over. ■ To transport the Manipulator, secure it to the delivery equipment or have at least 2 people to hold it by hand. Also, do not hold the bottom of the base (the screened parts in the figure). Holding these parts by hand is extremely hazardous and may cause your hands and fingers caught.
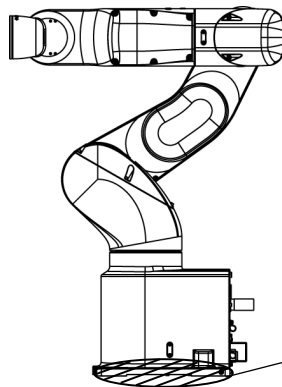
DO NOT hold the bottom of the base by hand.

Manipulator weight

	VT6-A901**
Standard, Cleanroom	Approx. 40 kg: 89 lbs.
Protection	Approx. 42 kg: 92 lbs.

■ Make sure not to hold the power unit when transporting the Manipulator.
Also, avoid excessive vibration or shock during Manipulator transporting.
Excessive vibration or shock may cause equipment damage and/or malfunction of the Manipulator.

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

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

Item	Conditions
Ambient temperature	-20 to 60 °C
Ambient relative humidity	10 to 90 % (no condensation)

During unpacking and relocation, avoid applying external force to the arms and motors of the Manipulator.

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.

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

3.8.2   Relocation

⚠ CAUTION	■ Install or relocate the Manipulator with two or more people. The Manipulator weight are as follows. Be careful not to get hands, fingers, or feet caught and/or have equipment damaged by a fall of the Manipulator. Standard, Cleanroom: Approx. 40 kg :89 lbs. Protection: Approx. 42 kg :92 lbs.

(1)   Position the Manipulator as shown in the figure.

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

Recommend : Joint #2 +52°
Joint #3 −51°

DO NOT hold the bottom of the base by hand.
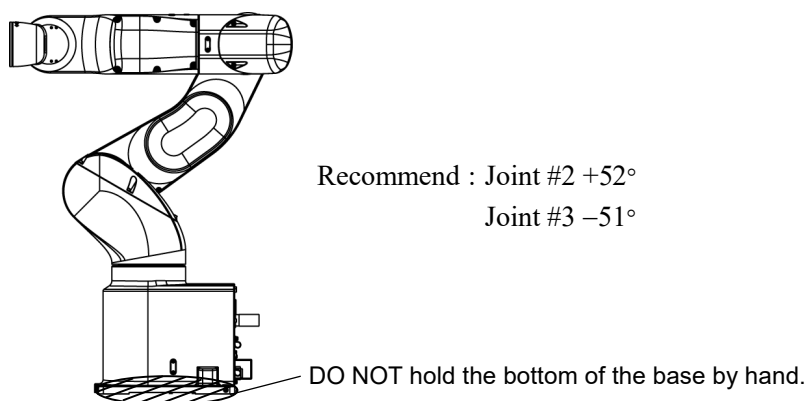
Manipulator weight

	VT6-A901**
Standard, Cleanroom	Approx. 40 kg: 89 lbs.
Protection	Approx. 42 kg: 92 lbs.

(2)   Turn OFF the power on all devices.

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

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

(4)   Then, secure the Manipulator to the delivery equipment or have at least 2 people to transport the Manipulator.

Using Eyebolt

Check that the eyebolts are securely fastened before transporting the Manipulator.

After transporting the Manipulator, remove the eyebolts and keep them for future use.

The eyebolts and wire must be strong enough to withstand the weight (See the figures below).

If you use the eyebolts to lift up the Manipulator, make sure to put hands on it to keep the balance. The Manipulator may fall if the balance is lost and this is extremely hazardous.

To prevent damage on the covers and arms, it is recommended to protect the contacting parts of the wire and arm with a cloth.
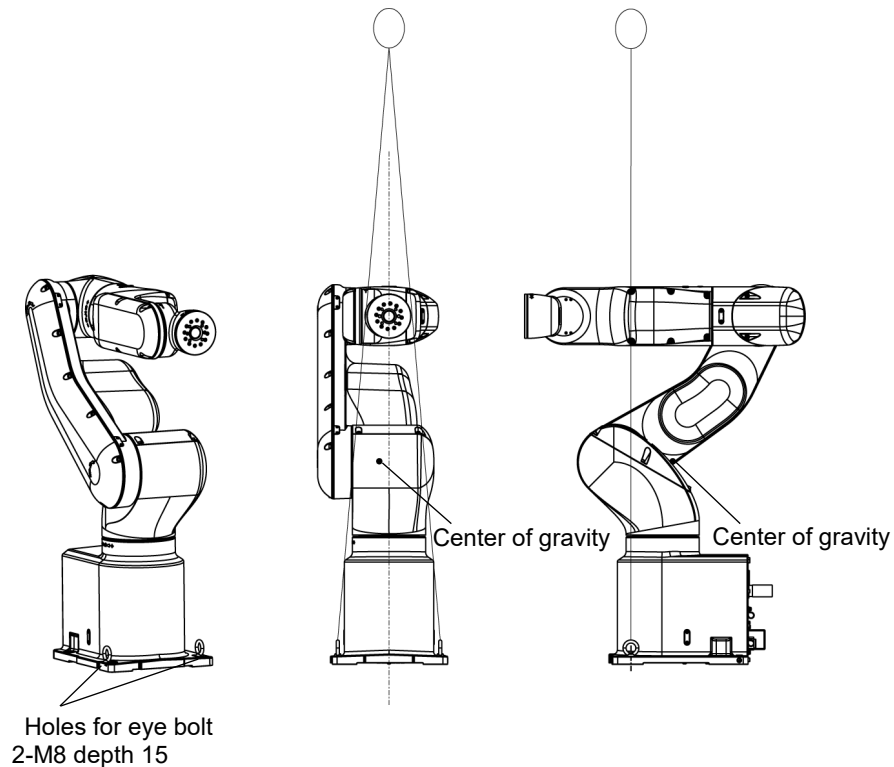
Center of gravity   Center of gravity

Holes for eye bolt
2-M8 depth 15

Manipulator weight

	VT6-A901**
Standard, Cleanroom	Approx. 40 kg: 89 lbs.
Protection	Approx. 42 kg: 92 lbs.

⚠ CAUTION	■ Remove the eyebolts from the Manipulator after transportation/relocation is completed.
	If the Manipulator is operated with the eyebolts left on it, the arm may collide with the eyebolts and it may cause equipment damage and/or malfunction of the Manipulator.

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.

3.9   Checking the Basic Orientation

After installing the Manipulator and setup the operating environment, move the Manipulator to the origin position and check if it moves to the basic orientation properly.

Follow the following procedures, set the basic orientation of the Manipulator shown below as the origin position.

  (1) Start Epson RC+.
    Double-click the <Epson RC+> icon on your desktop.

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

  (3) On [Command Window], execute the following commands.

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

If the Manipulator cannot be in the basic orientation shown in the figure, please contact the supplier of your region.
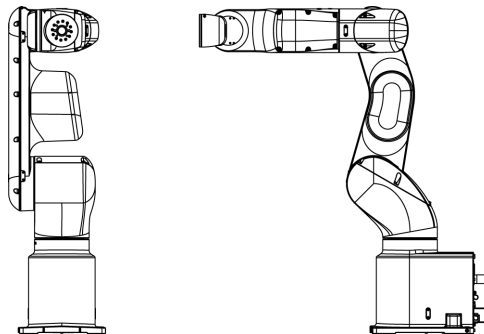
3.10   Origin Position Label

12 origin position labels (6 labels + spare) are included in the robot at shipment   See the figures below and attach labels on each axis.

By attaching labels on the arms in basic orientation or any orientation, you can use them as a mark when the original positions are misaligned.

If origin position is misaligned after replacing motors, reduction gear units, or belts due to a malfunction, look the origin position labels to align positions roughly.

| Arm #1 | Arm #2 | Arm #3, 4 | Arm #5, 6* |
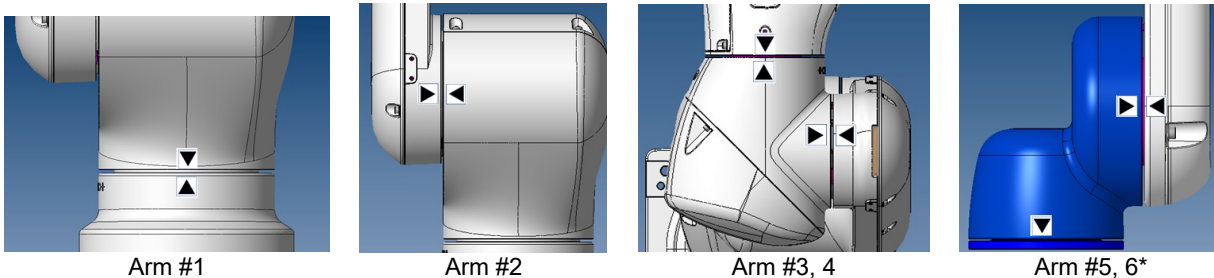
 * Arm #6: There is no space for attaching origin position labels. Please attach the label on the end effector.

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*".

Flange dimensions of the wrist attached to the end of Arm #6 is as below.

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

Wrist Flange

Detail A

Arm #6

Attach an end effector to the end of the Arm #6 using the M5 bolts.

Layouts

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

Compatibility with ISO flange:

To install the end effector whose mounting dimensions are designed for the ISO flange, we provide the optional "Tool Adapter (ISO flange)". For details, refer to "*11. Options*".

4.2   Attaching Cameras and Air Valves

Decks are equipped to Arms #4 and #5 to enable the easy installation of air valve.

To mount the camera, the camera plate unit is necessary.
We provide the optional "Camera Plate Unit". For details, refer to "*11. Options*".
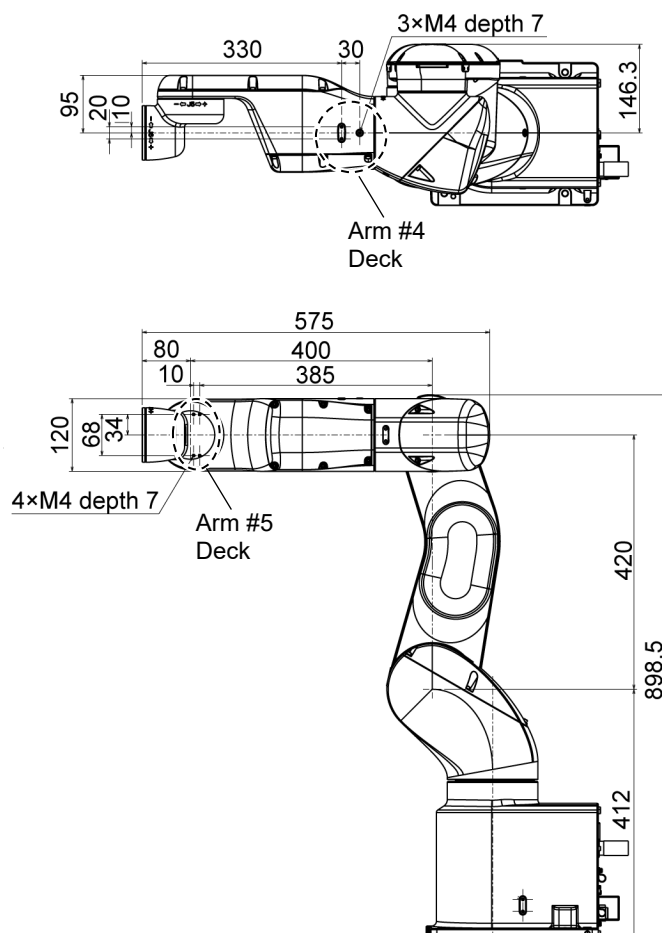
4.3   Weight and Inertia Settings

The WEIGHT and INERTIA (inertia moment and eccentricity) commands are for setting the load parameters of the Manipulator. These settings optimize the Manipulator motion.

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

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

To ensure optimum Manipulator performance, make sure that the load (weight of the end effector and work piece) and inertia moment of the load are within the maximum rating for the Manipulator, and that Arm #6 does not become eccentric.

If the load or the inertia moment exceeds the ratings or if the load becomes eccentric, follow the steps in "*4.3.1 WEIGHT Setting*" and "*4.3.2 INERTIA Setting*", to set parameters.

Setting parameters makes the operation of the Manipulator optimal, reduces vibration to shorten the operating time, and improves the capacity for larger loads. In addition, it reduces persistent vibration produced when the inertia moment of the end effector and work piece is bigger.

You can also set by following "Weight, Inertia, and Eccentricity/offset Measurement Utility". The following manual describes the details.

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

The allowable load for VT series Manipulators is 6 kg at the maximum.

Due to the limitations of the moment and inertia moment shown in the table below, the load (end effector weight + work piece weight) should also meet these conditions.

Allowable Load

Joint	Allowable Moment	GD2/4 Allowable Moment of Inertia
Joint #4	12.0 N·m (1.22 kgf·m)	0.3 kg·m^2
Joint #5	12.0 N·m (1.22 kgf·m)	0.3 kg·m^2
Joint #6	7.0 N·m (0.71 kgf·m)	0.1 kg·m^2

Moment

The moment indicates amount of torque applied on the joint in order to support the gravity on the load (end effector + work piece).

The moment increases as weight of the load and amount of eccentricity increase. As this also increases the load applied on the joint, make sure to keep the moment within the allowable value.

Inertia moment

The inertia moment indicates how difficult the load (end effector + work piece) to rotate when the Manipulator joint starts to rotate (amount of inertia). The inertia moment increases as weight of the load and amount of eccentricity increase. As this also increase the load applied on the joint, make sure to keep the inertia moment within the allowable value.

The moment M (Nm) and inertia moment I (kgm^2) when the volume of the load (end effector + work piece) is small can be obtained by the following formula.

$$M\ (N·m) = m(kg) \times L\ (m) \times g\ (m/s^2)$$
$$I\ (kgm^2) = m(kg) \times L^2\ (m^2)$$

m : Weight of load (kg)
L : Eccentric quantity of load (m)
g : Gravitational acceleration (m/s^2)
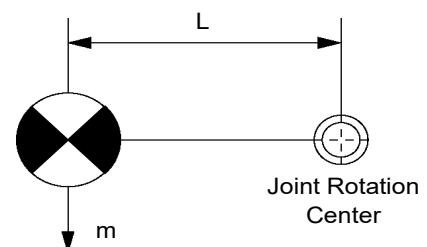
The figure below shows distribution of the center of gravity when the volume of the load (end effector + work piece) is small.

Design the end effector so that the center of gravity is within the allowable moment.

If the volume of the load is large, calculate the moment and inertia moment by referring to "*4.3.2 INERTIA setting*" – "*Calculating the Inertia Moment*".
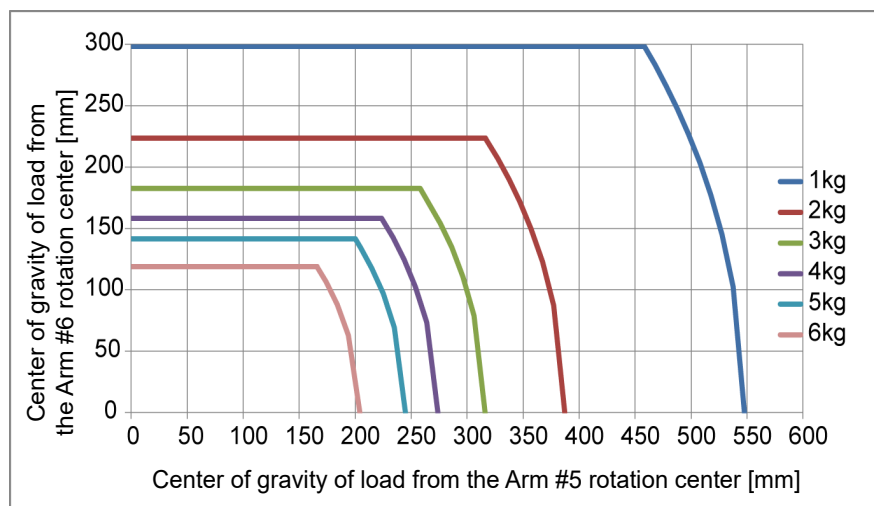
Max. Eccentric Quantity of Load
(Distance between the joint rotation center and the load's center of gravity)

Joint	1 kg	2 kg	3 kg	4 kg	5 kg	6 kg
#4	548 mm	387 mm	316 mm	274 mm	245 mm	204 mm
#5	548 mm	387 mm	316 mm	274 mm	245 mm	204 mm
#6	300 mm	224 mm	183 mm	158 mm	141 mm	119mm

When calculating the critical dimension of the load using the allowable moment and inertia moment, the calculated value represents a distance from the Arm #5 rotation center, not the distance from the flange. To calculate the distance from the flange to the load's center of gravity, subtract the distance from the center of the Arm #5 rotation center to the flange (=80 mm) as shown in the example below.

Example: Calculation of the critical dimension of the load (a) when the load is 6 kg.

Center of gravity by the allowable moment control:

12.0 N·m/(6 kg×9.8 m/s^2) = 0.204 m = 204 mm

Center of gravity by the allowable inertia moment control:

(0.3 kgm2/6 kg)1/2 = 0.223 m = 223 mm

Due to the allowable moment control, center of gravity for the load limit is 204 mm from the Arm #5 rotation center.

Distance (a) from the flange to the center of gravity for the load limit
= 204 mm－80 mm = 124 mm

Critical Dimension of Load

[Unit: mm]
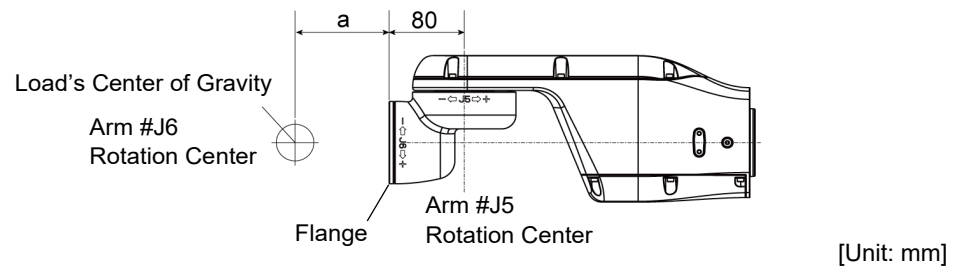
4.3.1 Weight Setting

⚠ CAUTION	■ Set the total weight of the end effector and the work piece smaller than the maximum payload. The VT series Manipulators can operate without limitations on the condition unless and until the load exceeds this maximum payload. Always set the Weight parameters of the WEIGHT command according to the load. Setting a value that is smaller than the actual load may cause errors, excessive shock, insufficient function of the Manipulator, and/or shorten the life cycle of parts/mechanisms.

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

Rated	Maximum
3 kg	6 kg

Change the setting of the Weight parameter according to the load.

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

Setting method of Weight parameters

Epson RC+

Select [Tools]-[Robot Manager]-[Weight] panel and set the value in [Weight:].

You may also execute the Weight command from [Command Window].

Load on the Manipulator
Mounting location of the load

Arm #4
Deck

Load on the fore
end of Arm #6

Arm #5
Deck
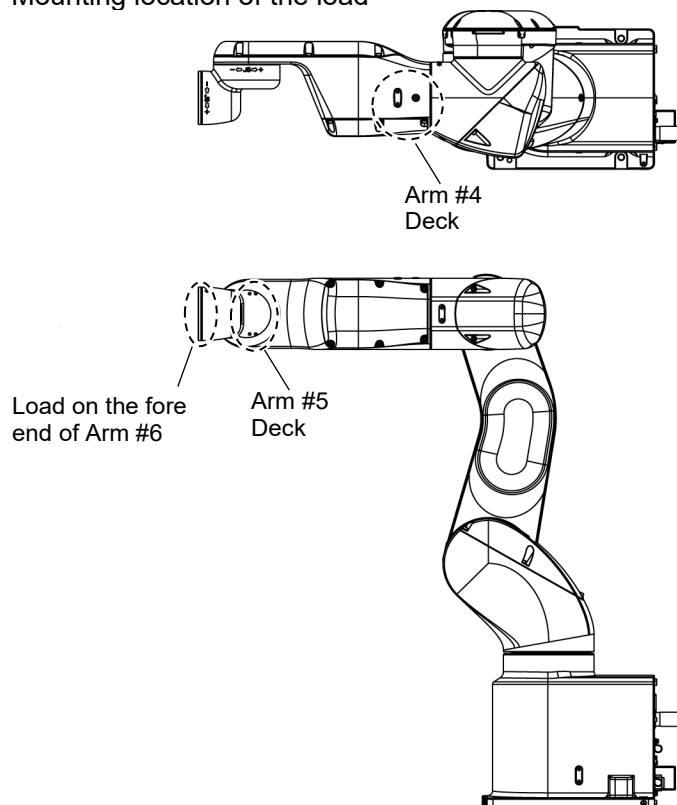
When you attach the equipment to the decks on the upper arm, convert its weight into equivalent weight assuming that the equipment is attached to the end of the Arm #6. Then, this equivalent weight added to the load will be a Weight parameter.

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

Weight Parameter Formula

Weight parameter $= M_w + W_a + W_b$

M_w : Load on the fore end of Arm #6 (kg)

W_a : Equivalent weight of the Arm #4 deck (kg)

W_b : Equivalent weight of the Arm #5 deck (kg)

$W_a = M_a(L_a)^2/(L)^2$

$W_b = M_b(L_b)^2/(L)^2$

M_a : Weight of the air valve on the Arm #4 deck

M_b : Weight of the camera on the Arm #5 deck

L : Length of the upper arm (480 mm)

L_a : Distance between the Joint #3 and the center of gravity of the air valve on the Arm #4 deck (mm)

L_b : Distance between the Joint #3 and the center of gravity of the camera on the Arm #5 deck (mm)
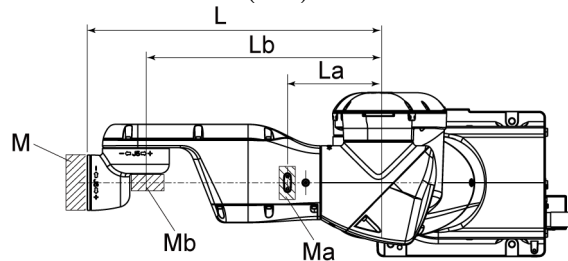
<Example> The fore end of the Arm #6 is 480mm (L) away from the Joint #3 of VT6-A901S* (VT6L).

Load on the fore-end of Arm #6 is 5 kg (M_w).

Load on the Arm #4 deck is 1.5 kg (M_a).

The deck is 150 mm (L_a) away from Joint #3.

Load on the Arm #5 deck is 1.0 kg (M_b).

The deck is 390 mm (L_b) away from the Joint #3.

$W_a = 1.5 \times 150^2/480^2 = 0.15 \rightarrow 0.2$ (round up)

$W_b = 1.0 \times 390^2/480^2 = 0.66 \rightarrow 0.7$ (round up)

$M_w + W_a + W_b = 5 + 0.2 + 0.7 = 5.9$

Enter "5.9" for the Weight parameter.

Automatic speed setting by Weight

The percentages in the graphs are based on the speed at rated weight (3 kg) as 100%.
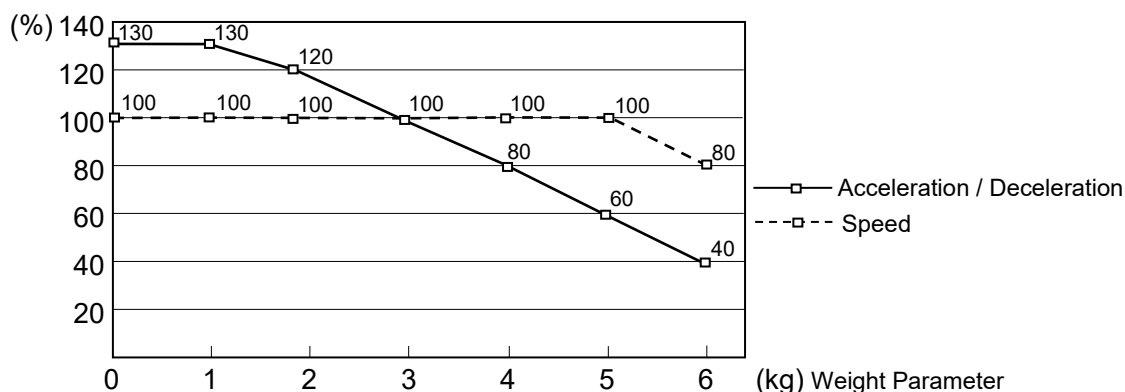
Weight parameter (kg)	Acceleration / Deceleration	Speed
0	130	100
1	130	100
2	120	100
3	100	100
4	80	100
5	60	100
6	40	80

NOTE Maximum AccelS setting value varies depending on Weight setting value. For more details, refer to "*Appendix A Specifications*".

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.

	■ The moment of inertia of the load (weight of the end effector and work piece) must be 0.1 kg·m^2 or less. The VT series Manipulators are not designed to work with a moment of inertia exceeding 0.1 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.
⚠ CAUTION	

The acceptable inertia moment of load for VT series Manipulators is 0.03 kg·m^2 nominal rating and 0.1 kg·m^2 maximum. Change the setting of the inertia moment according to the inertia moment of the load using the INERTIA command. After the setting has been changed, the maximum acceleration/deceleration speed of Arm #6 responding to "inertia moment" is set automatically.

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

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

Eccentric Quantity and the INERTIA Setting

⚠ CAUTION

■ The eccentric quantity of the load (weight of the end effector and work piece) must be 300 mm or less. The VT series Manipulators are not designed to work with eccentric quantity exceeding 300 mm.
Always set the eccentric quantity parameter according to the eccentric quantity. Setting a value that is smaller than the actual eccentric quantity may cause errors, excessive shock, insufficient function of the Manipulator, and/or shorten the life cycle of parts/mechanisms.

The acceptable eccentric quantity of the load for VT series Manipulators is 50 mm at nominal rating and 300 mm at maximum. Depends to the eccentric quantity of load, change the setting of eccentric quantity parameter using the INERTIA command. After changing the setting, the maximum acceleration/deceleration speed of Manipulator corresponding to "eccentric quantity" is set automatically.

Rotation Center

a

Flange

a, b = Eccentric Quantity (300 mm or less)

To set the parameter, enter the larger value of "a" or "b".

Position of Load's Center of Gravity

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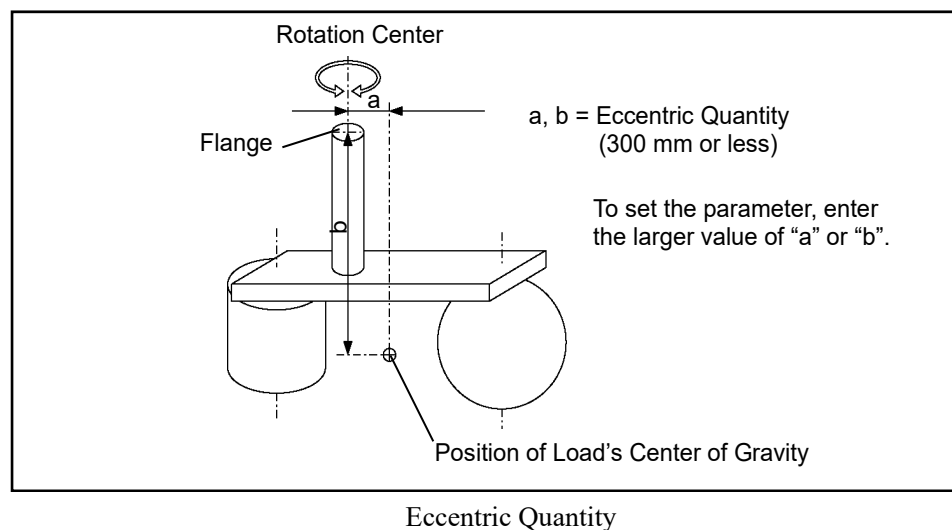
Eccentric quantity of load on Arm #6
The eccentric quantity of the load (weight of the end effector and work piece) on the Arm #6 can be set by the "eccentric quantity" parameter of the INERTIA command.
Enter the larger value of either "a" or "b" in the figure above to [Eccentricity].

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

Automatic acceleration/deceleration setting by INERTIA (eccentric quantity)

The percentage in the graph is based on the acceleration/ deceleration at rated eccentricity (0.03 kg·m2) as 100%.
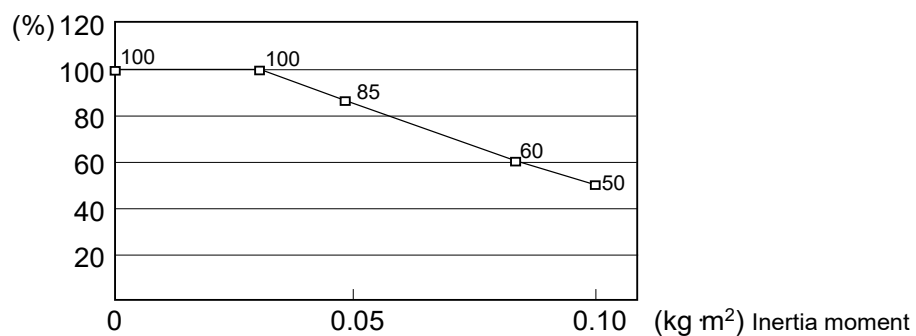
Moment of inertia setting (kg·m²)	Automatic acceleration/deceleration setting by Inertia (moment of inertia) (%)
0	100
0.03	100
0.05	85
0.08	60
0.1	50

Automatic setting by eccentricity setting
The percentage in the graph is based on the acceleration/ deceleration at rated eccentricity (50 mm) as 100%

Eccentricity setting
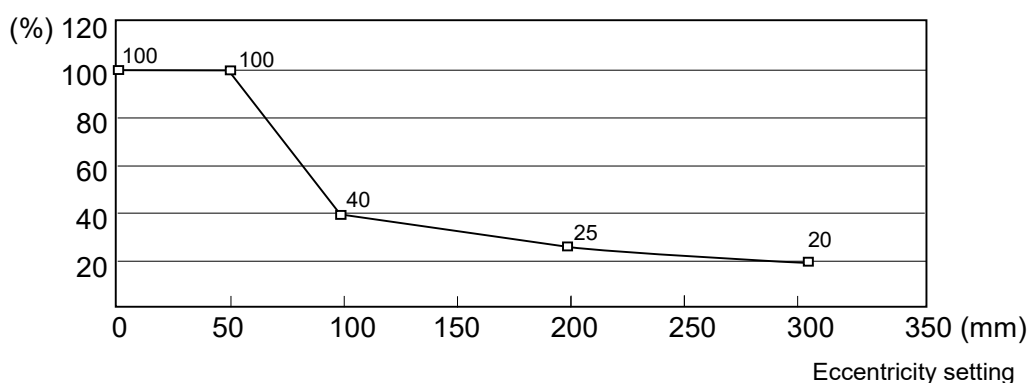
Eccentric quantity parameter (mm)	Automatic acceleration/deceleration setting by Inertia (eccentric quantity) (%)
0	100
50	100
100	40
200	25
300	20

Calculating the Inertia Moment

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

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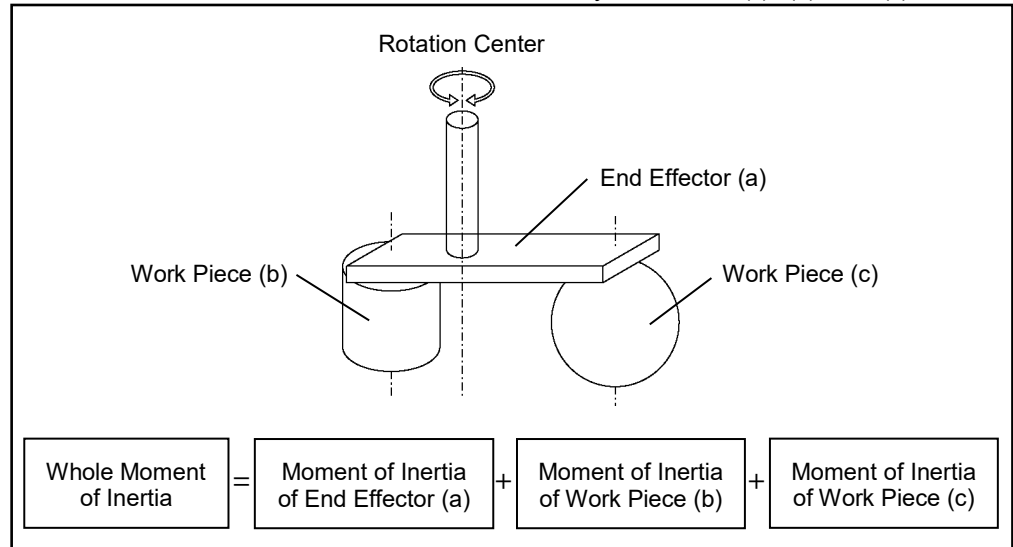
The methods for calculating the inertia moment for (a), (b), and (c) are shown in this and the next page. Figure out the whole inertia moment using the basic formulas below.

(a) Inertia moment of a rectangular parallelepiped

$$m \frac{b^2 + h^2}{12} + m \times L^2$$
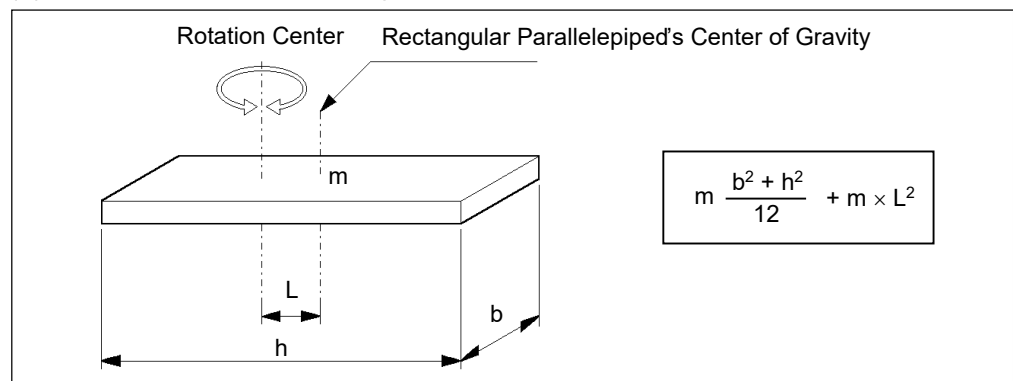
(b) Inertia moment of a cylinder

$$m \frac{r^2}{2} + m \times L^2$$
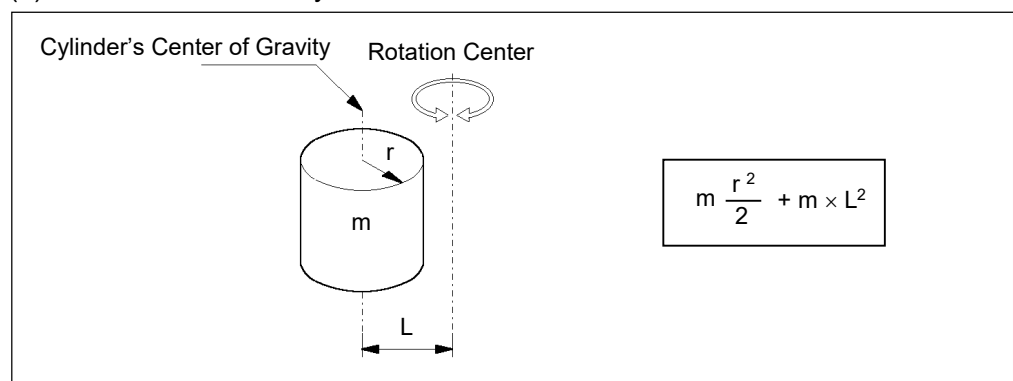
(c) Inertia moment of a sphere
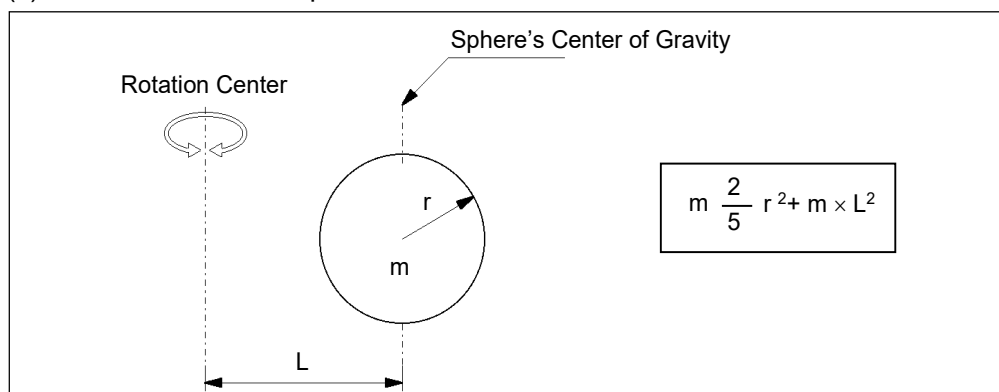
4.4   Precautions for Auto Acceleration/deceleration

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

WEIGHT Setting

The speed and acceleration/deceleration of the Manipulator are controlled according to the load weight set by the WEIGHT command.

The more the load weight increases, the more the speed and acceleration/deceleration are reduced to prevent residual vibration.

INERTIA Setting

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

Auto Acceleration/Deceleration According to Manipulator's Posture

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

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

5. Motion Range

⚠ CAUTION	■ When setting up the motion range for safety, both the pulse range and mechanical stops must always be set at the same time. Failure to do so may cause serious safety problems.

The motion range is preset at the factory as explained in "*2.4 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

3. Setting the Cartesian (rectangular) range in the X, Y coordinate system of the Manipulator
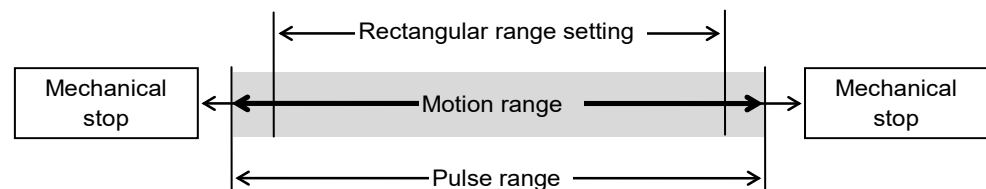
When the motion range is changed due to layout efficiency or safety, follow the descriptions in *5.1* to *5.3* to set the range.

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 (the lower limit and the upper limit) of each axis.
Pulse values are read from the encoder output of the servo motor.
The pulse range should be set within the mechanical stop range.

NOTE ☞   The Arms #4 and #6 do not have a mechanical stop.

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

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

5.1.1   Max. Pulse Range of Joint #1

Pulse values in counterclockwise direction are positive （＋） and values in clockwise direction are negative （－）.
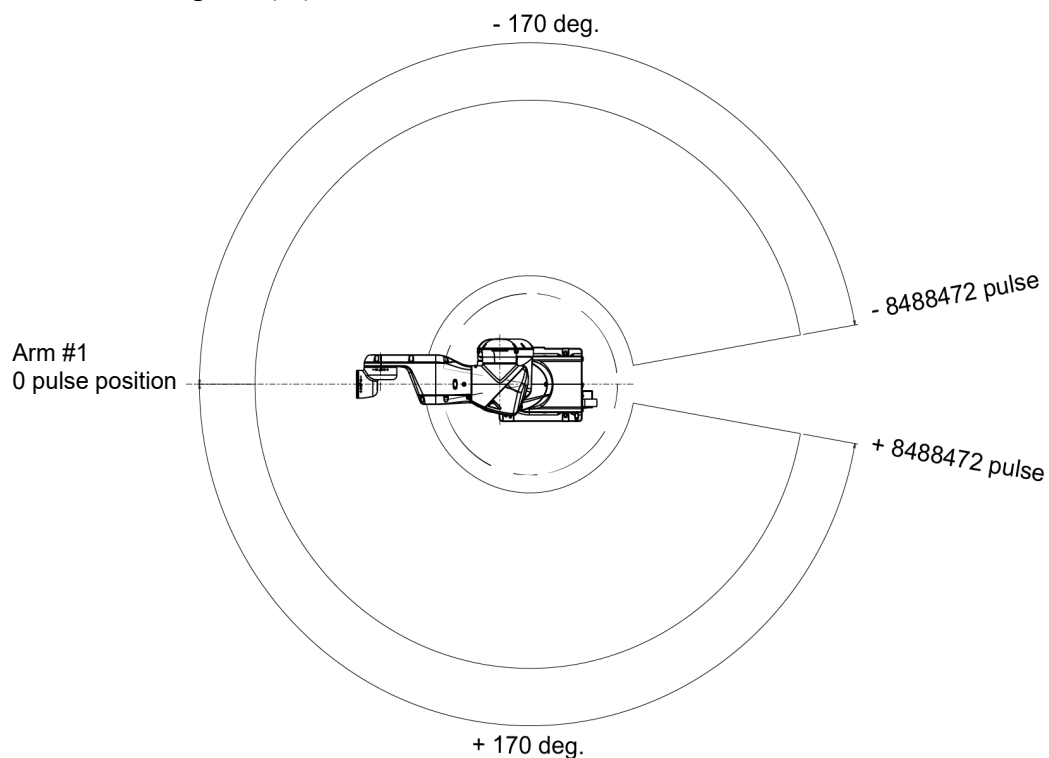
5.1.2   Max. Pulse Range of Joint #2

Pulse values in clockwise direction are positive （＋） and values in counterclockwise direction are negative （－）.
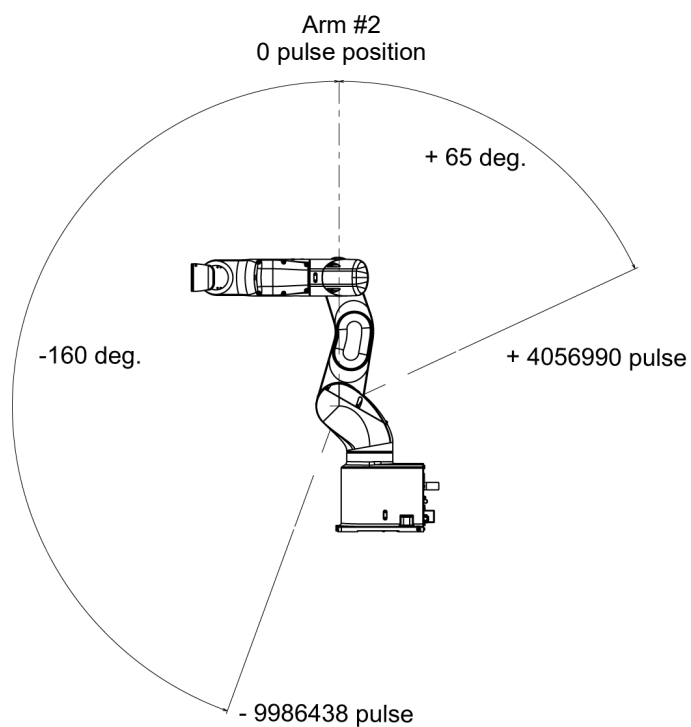
5.1.3   Max. Pulse Range of Joint #3

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

Arm #3
0 pulse position

+190 deg.

- 51 deg.

+ 8816759 pulse

- 2366604 pulse
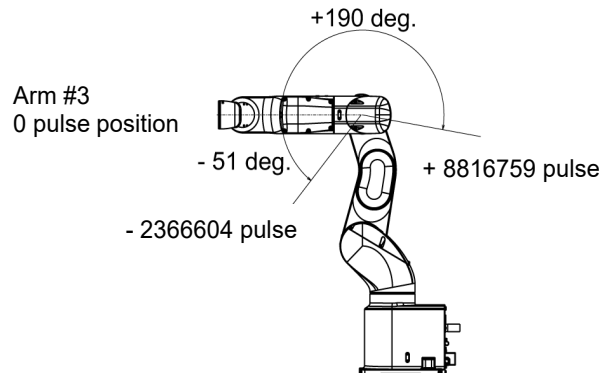
5.1.4   Max. Pulse Range of Joint #4

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

Arm #4
0 pulse position

- 200 deg.   + 200 deg.

- 8128764 pulse   + 8128764 pulse
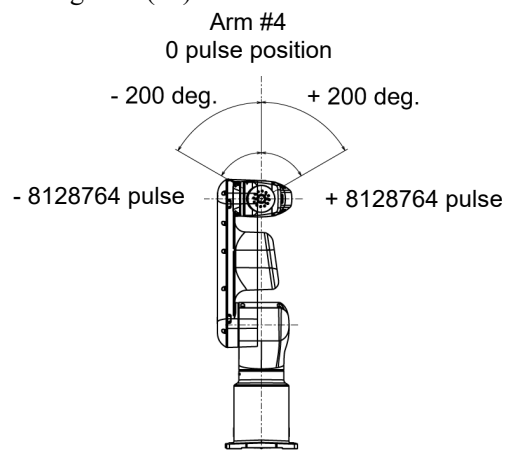
5.1.5   Max. Pulse Range of Joint #5

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

+ 4599018 pulse

Arm #5
0 pulse position

+ 125 deg.
- 125 deg.

- 4599018 pulse
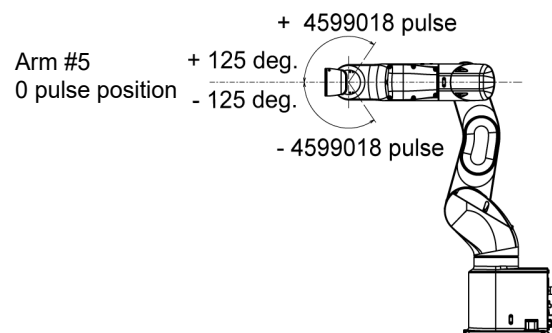
5.1.6   Max. Pulse Range of Joint #6

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

Arm #6
0 pulse position

- 360 deg.   + 360 deg.

- 13410735 pulse   + 13410735 pulse
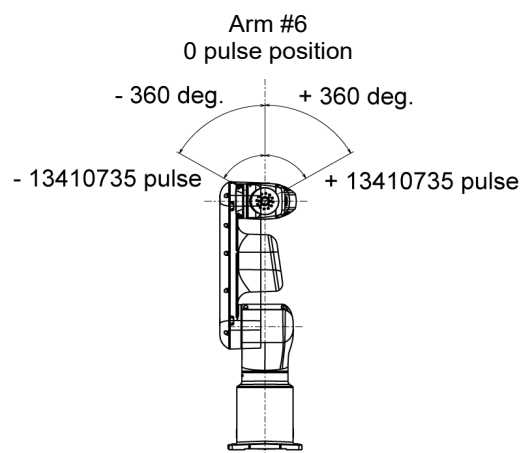
5.2   Motion Range Setting by Mechanical Stops

Using the adjustable mechanical stops (option) physically limits the absolute area that the Manipulator can move.

Be sure to turn OFF the Manipulator in advance.

Use bolts conforming to the specified length and surface processing (ex: nickel plating) with high corrosion resistance.

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

For details on the pulse range setting, refer to the following section.
5.1 Motion Range Setting by Pulse Range (for All Arms).

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

NOTE
☞   For details about how to install the adjustable mechanical stops, contact the supplier of your region.

5.2.1   Motion Range Setting of Joint #1

Install the adjustable mechanical stop (J1) to the threaded hole corresponding to the angle you want to set.)

Hexagon socket head cap bolt	M4 × 28 (1 bolt)
Strength	Equivalent to ISO898-1 property class 10.9 or 12.9
Tightening torque	4.0 ± 0.2 N·m (41 ± 2 kgf·cm)

a   b
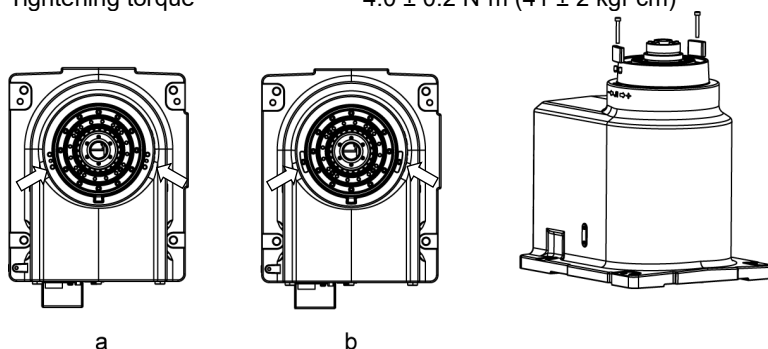
	a	b
Angle (°)	±170	−170 to +84 or −84 to +170
Pulse (pulse)	±8488472	− 8488472 to +4194304, or − 4194304 to +8488472
Adjustable mechanical stop (J1)	Not applied (standard)	Applied

5.2.2   Motion Range Setting of Joint #2

Install the adjustable mechanical stop (J2) to the threaded hole corresponding to the angle you want to set.)

Hexagon socket head cap bolt	M4 × 16 (1 bolt)
Strength	Equivalent to ISO898-1 property class 10.9 or 12.9
Tightening torque	4.0 ± 0.2 N·m (41 ± 2 kgf·cm)
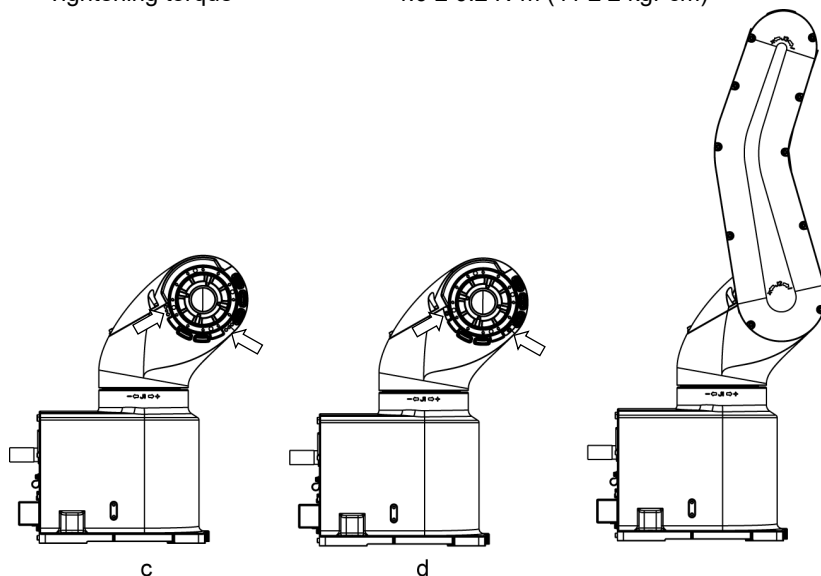
	c	d
Angle (°)	−160, +65	−160 to +43, or −148 to +65
Pulse (pulse)	−9986438 +4056990	−9986438 to +2683855, or −9237455 to +4056990
Adjustable mechanical stop (J2)	Not applied (standard)	Applied

5.2.3   Motion Range Setting of Joint #3

Install the adjustable mechanical stop (J3) to the threaded hole corresponding to the angle you want to set.)

Hexagon socket head cap bolt   M4 × 16 (1 bolt)

Strength   Equivalent to ISO898-1 property class 10.9 or 12.9

Tightening torque   4.0 ± 0.2N·m (41 ± 2 kgf·cm)
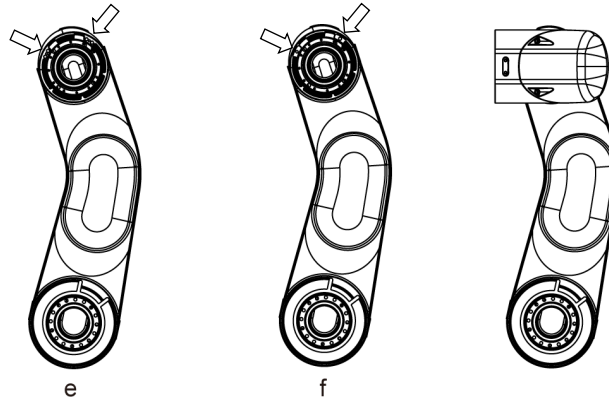
	e	f
Angle (°)	−51, +190	−34 to +190, or −51 to +173
Pulse (pulse)	−2366604 +8816759	−1577736 to +8816759 or −2366604 to +8027891
Adjustable mechanical stop (J3)	Not applied (standard)	Applied

5.3   Restriction of Manipulator Operation by Joint Angle Combination

To prevent the arms of the Manipulator from interfering each other, the Manipulator operation is restricted in the specified motion range according to the joint angle combination of the Joints #1, #2, and #3.

The Manipulator operation is restricted and the Manipulator stops when the joint angles of the Arm are within the colored areas in the following figures. In addition, the determination whether inside and outside of the colored area may differ depending on a position due to calculation error on the boundary line between the colored area and the white area as shown below.

The restriction to Manipulator operation is enabled:

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

The restriction to the Manipulator operation is disabled:

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

Combination of Joint #2 and #3

Joint#1: −110 deg. to 110 deg.
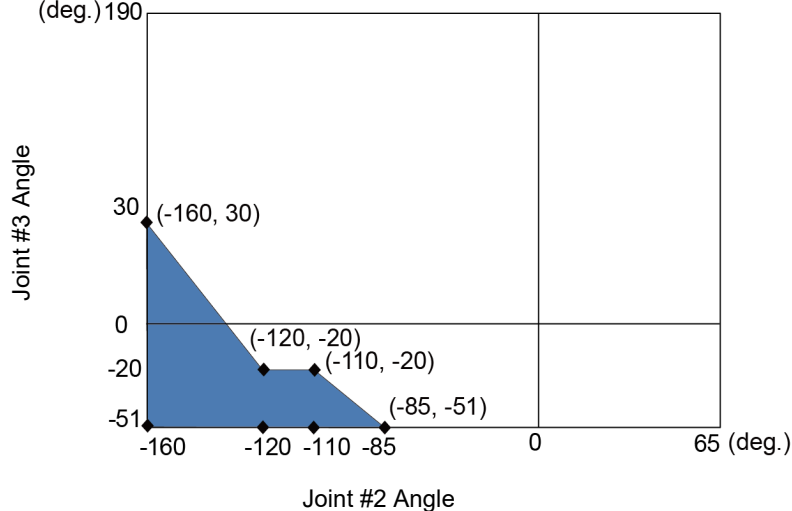
Joint#1: −110 deg. to −170 deg. or 110 deg. to 170 deg.

(deg.= °)
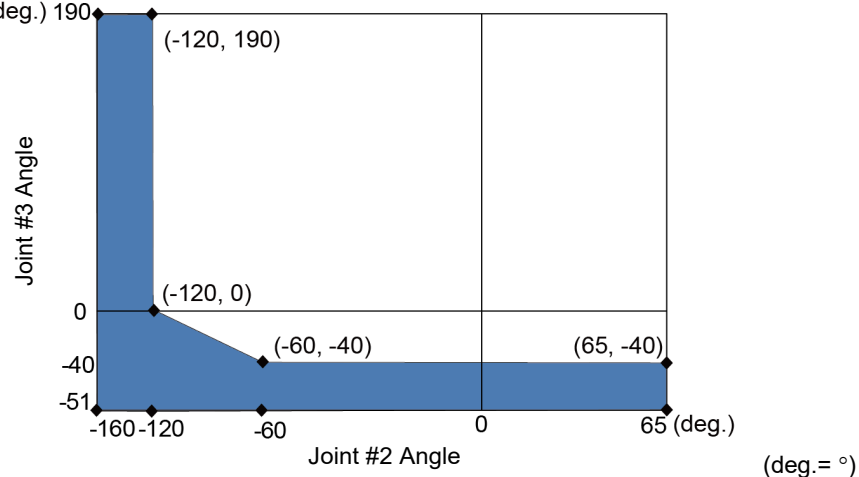
5.4   Coordinate System

The origin point is where the Manipulator's installation face intersects with the rotation axis of Joint #1.

For details on the coordinate system, refer to the *Epson RC+ User's Guide manual*.
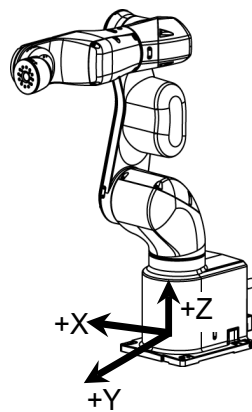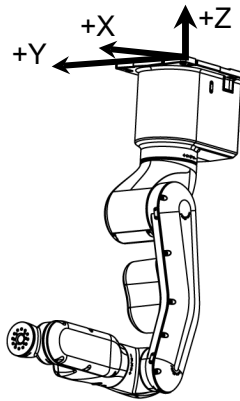
Table Top mounting   Ceiling mounting*   Wall mounting*
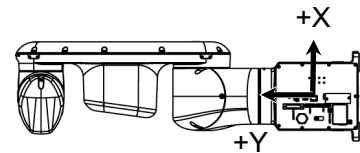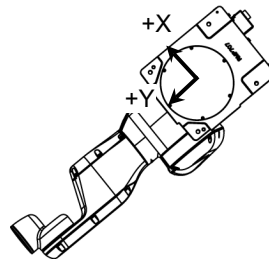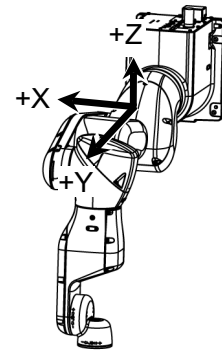
*: Only for Standard model, AC specification Manipulator

5.5   Changing the Robot

This section describes how to change the Manipulator model on Epson RC+.

⚠ CAUTION	■ Changing the Manipulator should be done with great caution. It initializes the robot calibration parameters (Hofs, CalPls), additional axis information, and PG parameter data. Before changing the robot, make sure to save the calibration data by following the procedure below. (1) Select the Epson RC+ menu-[Setup]-[System Configuration]. (2) Select [Robot]-[Robot**]-[Calibration] from the tree list. Then, click <Save>.

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

(2) Select [Robot]-[Robot**] from the tree list.
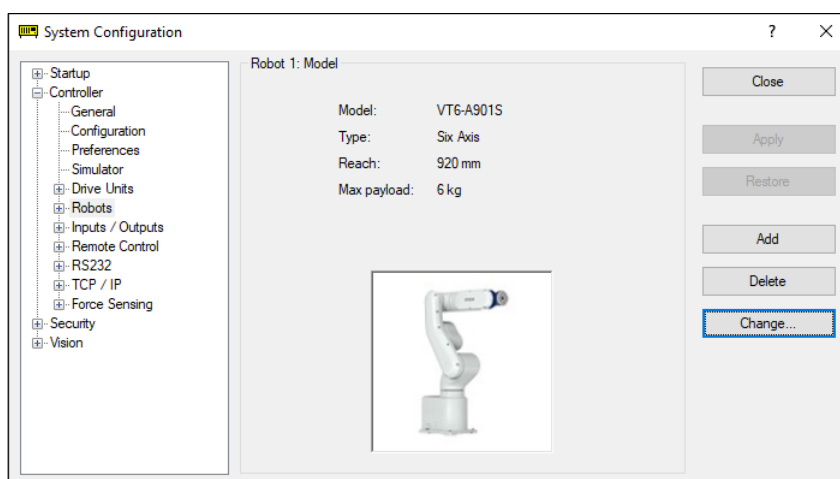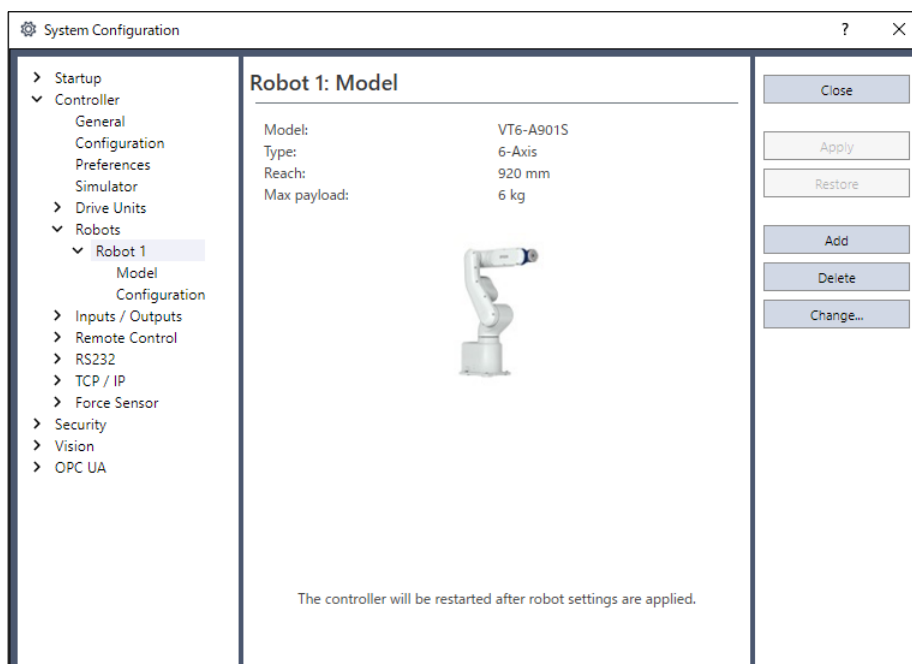
(3) Click the <Change…> button. The following dialog box will be displayed.

EPSON
RC+ 7.0

Epson
RC+ 8.0

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

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

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

(7) Select the robot model in the [Model] box. Available robots will be displayed according to the format of the currently installed motor driver. When [Dry run] is used, all the Manipulators of the series selected in Step 6 will be displayed.

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

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

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

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

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

Epson
RC+

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

6. 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 box 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+

Switch the mode to Program mode from the Epson RC+.

(1) Select Epson RC+ menu-[Setup]-[System Configuration] to display the [System Configuration] dialog box.
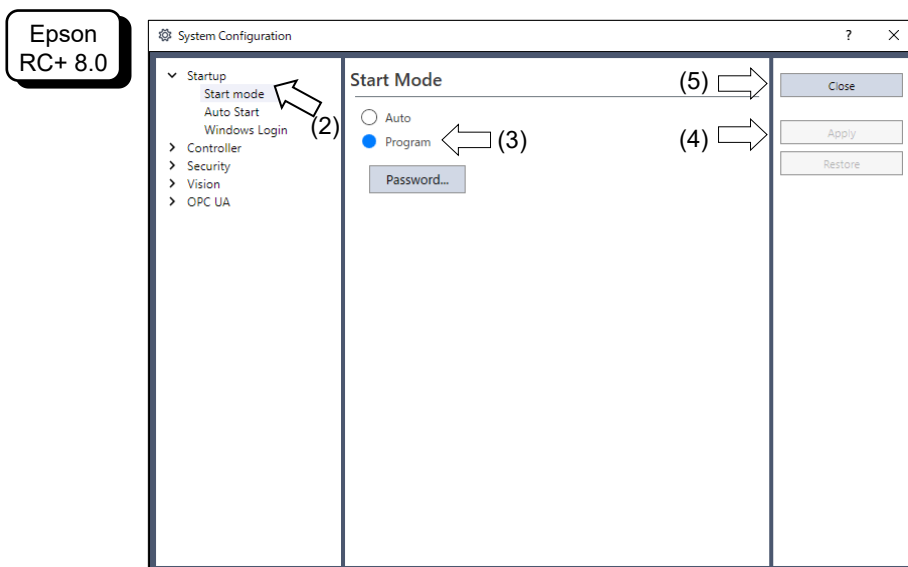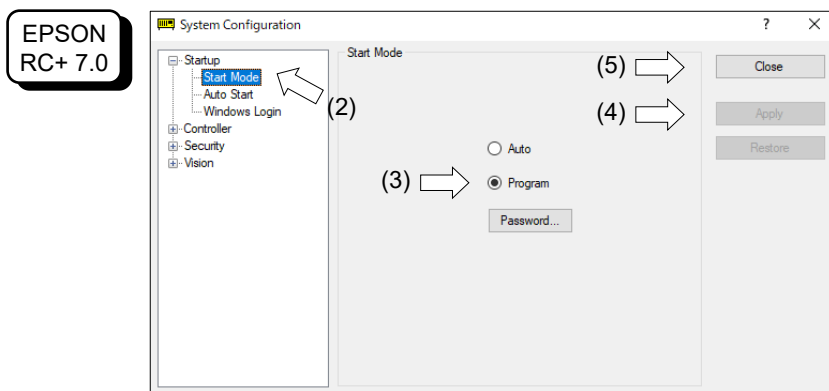
(2) Select [Startup].

(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+ to "Auto" and start the Epson RC+.
(Reference: *6.3.2 Setup from Epson RC+*)

B： Offline the Epson RC+.

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

6.4.2   Setup from Epson RC+

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

(1) Select Epson RC+ menu-[Setup]-[System Configuration] to display the [System Configuration] dialog box.
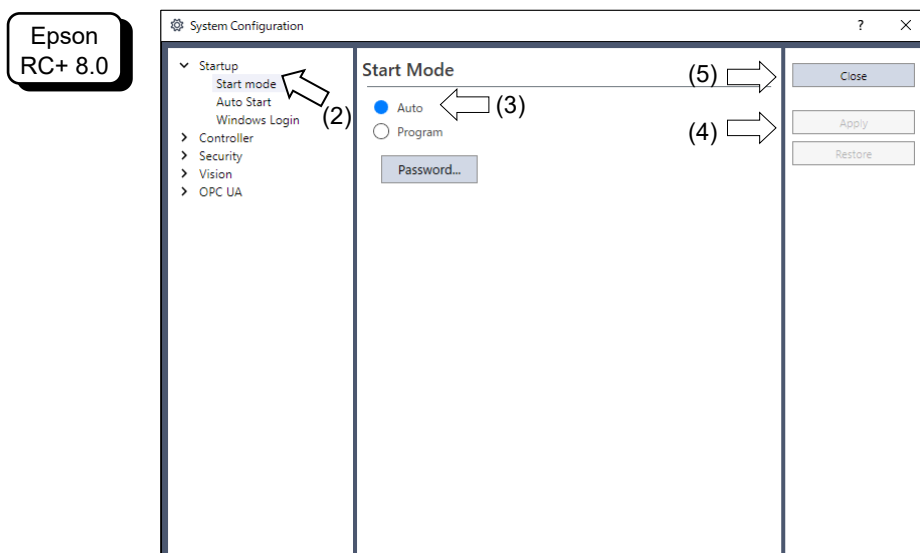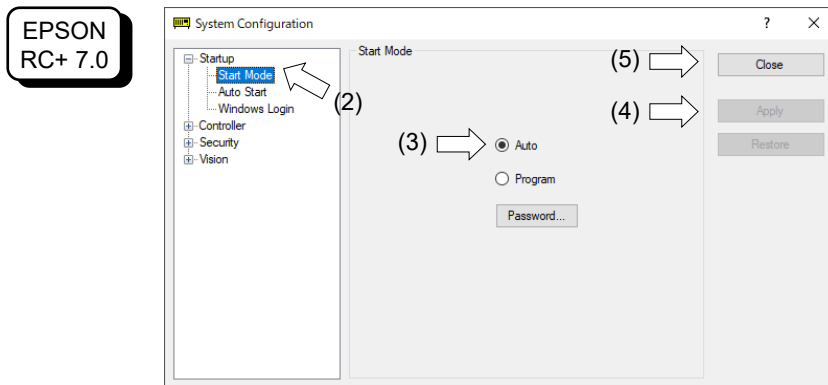
(2) Select [Startup].

(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+.

(1) Select Epson RC+ menu-[Setup]-[System Configuration] to display the [System Configuration] dialog box.
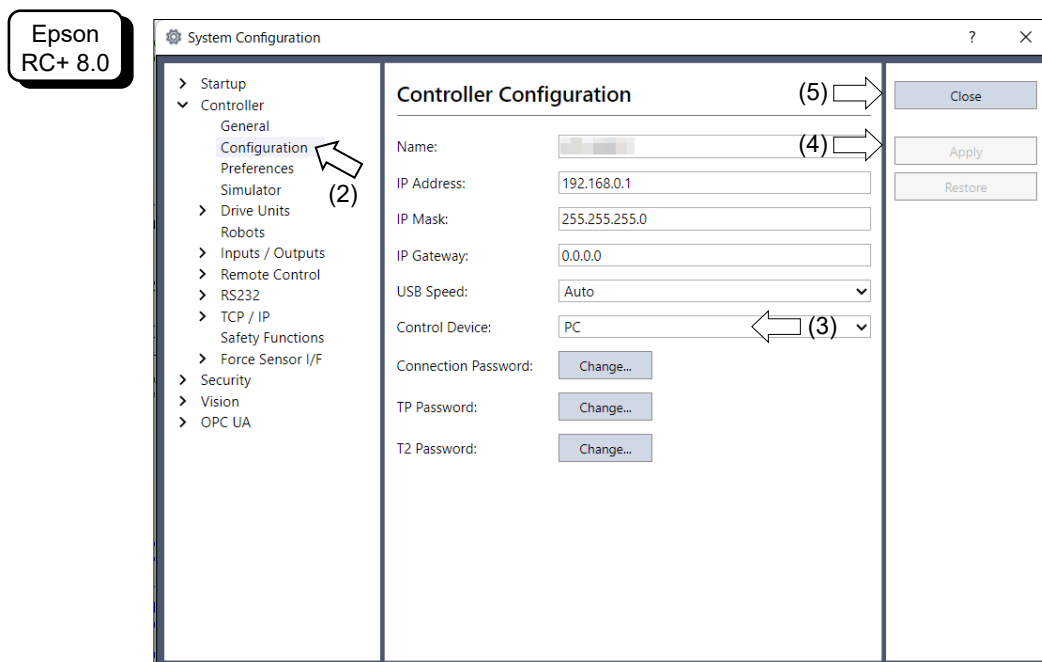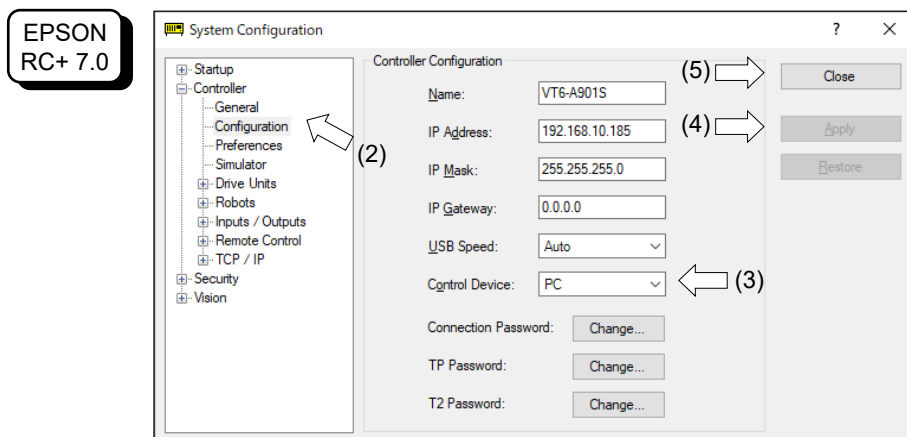
(2) Select [Controller]-[Configuration].

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

(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).
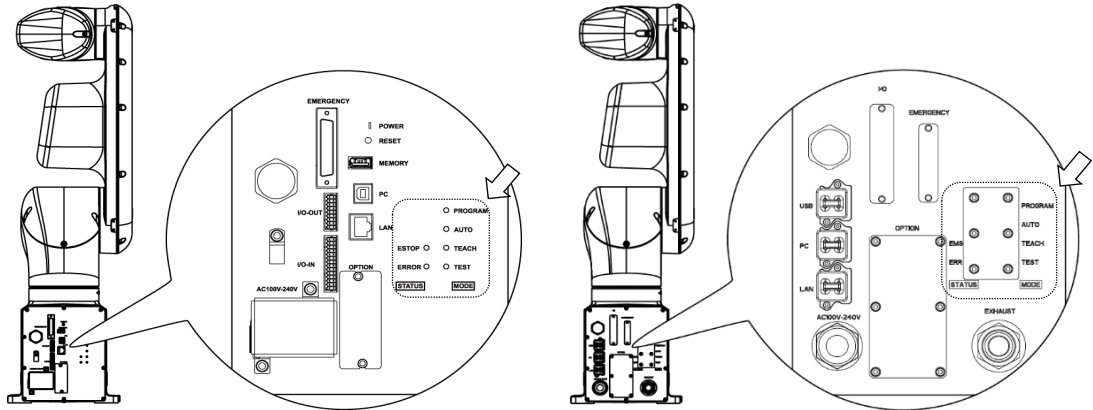
Standard, Cleanroom model   Protection model

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 (for 15 seconds) 2. All turn OFF (10 seconds) 3. All turn ON (to 10 seconds) 4. All turn OFF (10 to 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.
Power supply drop	TEACH, AUTO turn ON.
TEST mode	TEST blinks.

7. Development PC Connection Port

Standard, Cleanroom model   Protection model
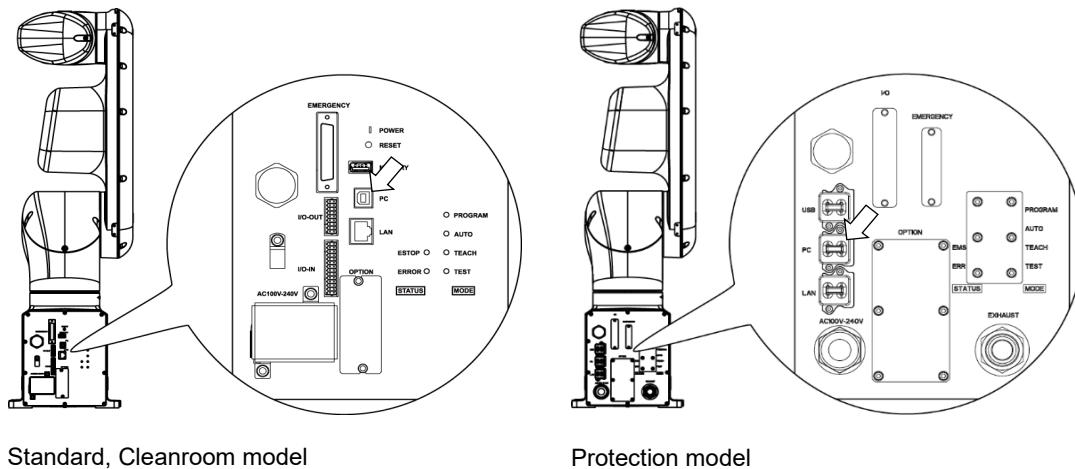
NOTE
☞

- For other details of development PC and Manipulator connection, refer to the following manual.

    Epson RC+ User's Guide
        - [PC to Controller Communications] Command (Setup Menu).

- Be sure to install the Epson RC+ 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+ 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+ 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+ is installed to the Manipulator connected to the
development PC.
(Install the software when it is not installed. Refer to *Epson RC+ User's Guide.*)

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

(3)   Turn ON the Manipulator.

(4)   Start Epson RC+.

(5)   Select the Epson RC+ menu-[Setup]-[PC to Controller Communications] to display
the [PC to Controller Communications] dialog box.
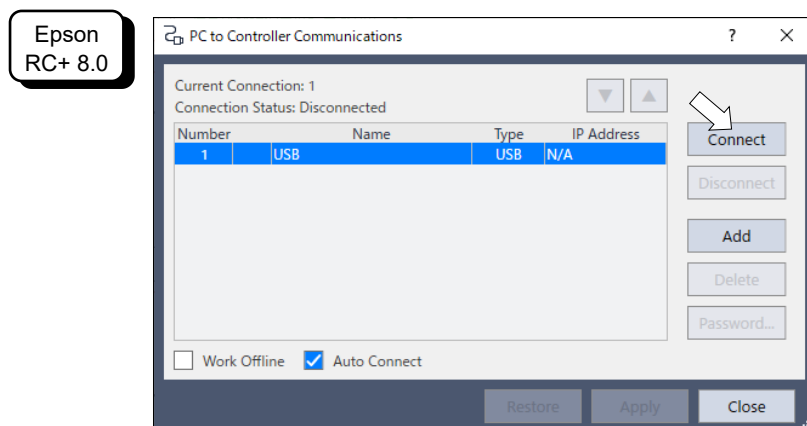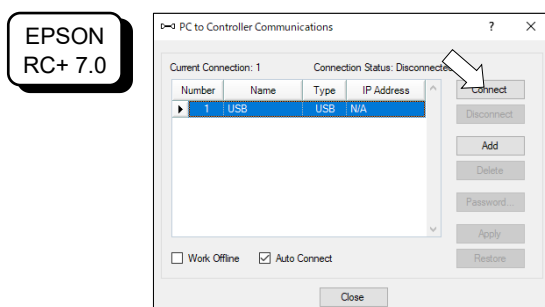
(6)   Select "No.1 USB" and click the <Connect> button.

(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 box.
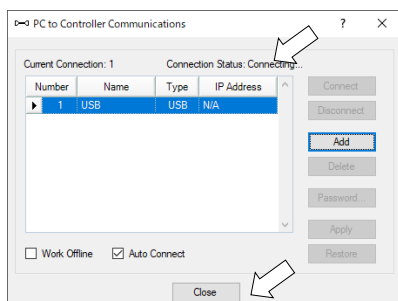
EPSON RC+ 7.0
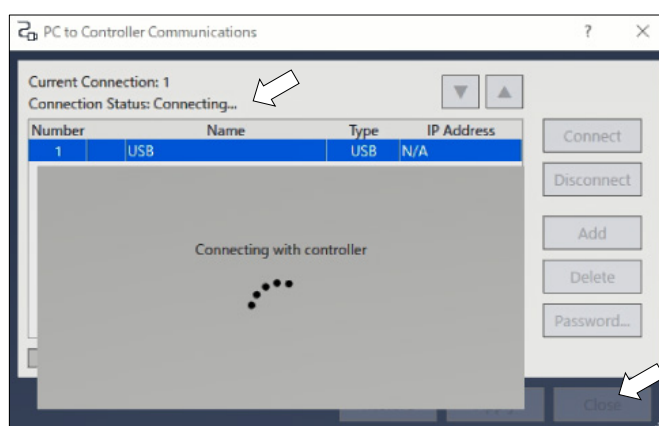
Epson RC+ 8.0

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

7.4   Disconnection of Development PC and Manipulator

Disconnection of the development PC and the Manipulator communication.

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

(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 box 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.
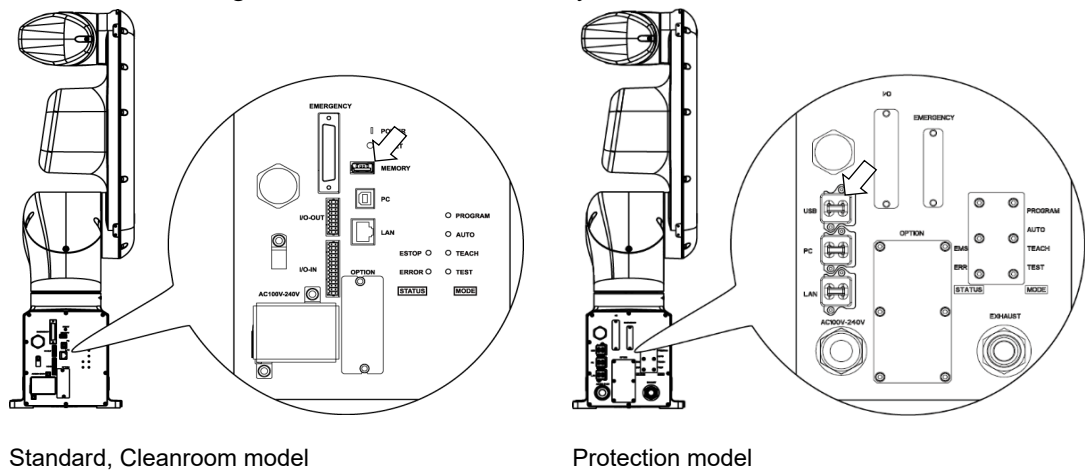
Standard, Cleanroom model   Protection model

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+ 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+. 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 Controller 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, Windows 11, or Linux.
  (For supported operating systems for the Epson RC+, refer to *Epson RC+ User's Guide*.)

- FAT32 format

- MBR format

  * By using Microsoft's "Media Creation Tool", the USB memory will be in GPT format. Therefore, you will need to convert it to MBR format.

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+. 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+

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

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

(2) Make sure that the following folder is indicated in the USB memory.
BU_VT_serial number_data status was saved
→ Example: BU_VT_12345_2013-10-29_092951

(3) Select the Epson RC+ menu-[Tools]-[Controller] to display the [Controller Tools] dialog box.

EPSON
RC+ 7.0

Controller Tools

Backup Controller...　Save all controller data and status to a PC folder.

Restore Controller...　Restore all controller data from a previous backup.

View Controller Status...　View controller status from a previous backup.

Maintenance...　View maintenance data and configure alarms.

Reset Controller　Reset controller to startup state

Close

Epson
RC+ 8.0

Controller Tools

Backup Controller...　Save all controller data and status to a PC folder.

Restore Controller...　Restore all controller data from a previous backup.

View Controller Status...　View controller status from a previous backup.

Maintenance...　View maintenance data and configure alarms.

Reset Controller　Reset controller to startup state

Close

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

(5) [Browse For Folder] dialog box appears. Select the folder from the USB memory which checked in step (2) and click the <OK> button.

Browse For Folder

Select folder containing controller backup

> Pictures
> Videos
∨ Local Disk (C:)
　∨ EpsonRC70
　　> API
　　∨ Backup
　　　B_Virtual_00000_2022-10-04_0
　　　B_Virtual_00000_2022-10-04_0

OK　Cancel
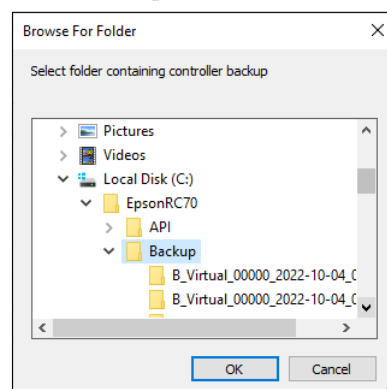
(6) [Controller Status Viewer] dialog box appears to confirm the Controller status.

For details, refer to *View Controller Status* in *Epson RC+ User's Guide - Controller Command (Tools Menu)*.

EPSON RC+ 7.0

Item	Value
Controller Name	VT6-A901S
Controller Serial #	VT60T20003
Firmware Version	7.4.58.3
Controller Total Hours	208.4
Controller Max On Hours	100.3
Project Name	C4_sample
IP Address	192.168.10.185
IP Mask	255.255.255.0
IP Gateway	0.0.0.0
Options	
EStop Count	0
EStop	Off
Safeguard	Off
Error	On
Operation Mode	Program
Control Device	PC
Display Device	PC
Controller Preferences	

Status Folder: B_VT_VT60T20003_2022-10-04_194622 Status Date / Time: 2022-10-04 19:46:22

Epson RC+ 8.0

Item	Value
Controller Name	
Controller Serial #	
Firmware Version	
Controller Total Hours	12412.6
Controller Max On Hours	2621.6
Project Name	test
IP Address	192.168.219.111
IP Mask	255.255.255.0
IP Gateway	0.0.0.0
Options	
ECP	Yes
API	Yes
PC Vision	No
OCR	Yes
Conveyor Tracking	No
GUI Builder	Yes
Fieldbus Master	No
Legacy Force Sensing	No
VRT	No

Status Folder: B_ Select Status Date / Time: 2022-11-14 16:27:47

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_VT_serial number_data status was saved

→ Example: BU_VT_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+ 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+ User's Guide - [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+ Help* or *User's Guide - TCP/IP Communications*.
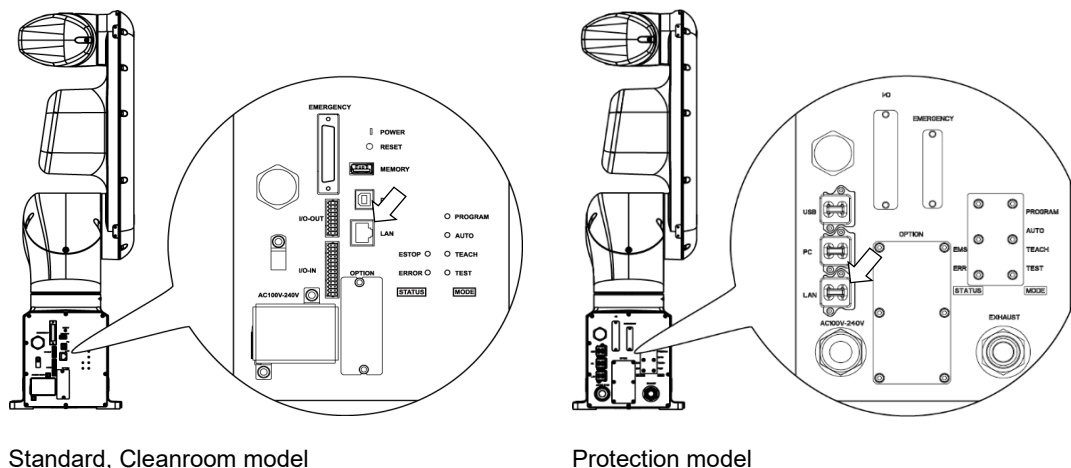
Standard, Cleanroom model   Protection model

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.

(Refer to *Setup & Operation 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+ User's Guide - 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+ menu-[Setup]-[Controller] to display the [System Configuration] dialog box.

(3) Select [Controller]-[Configuration].
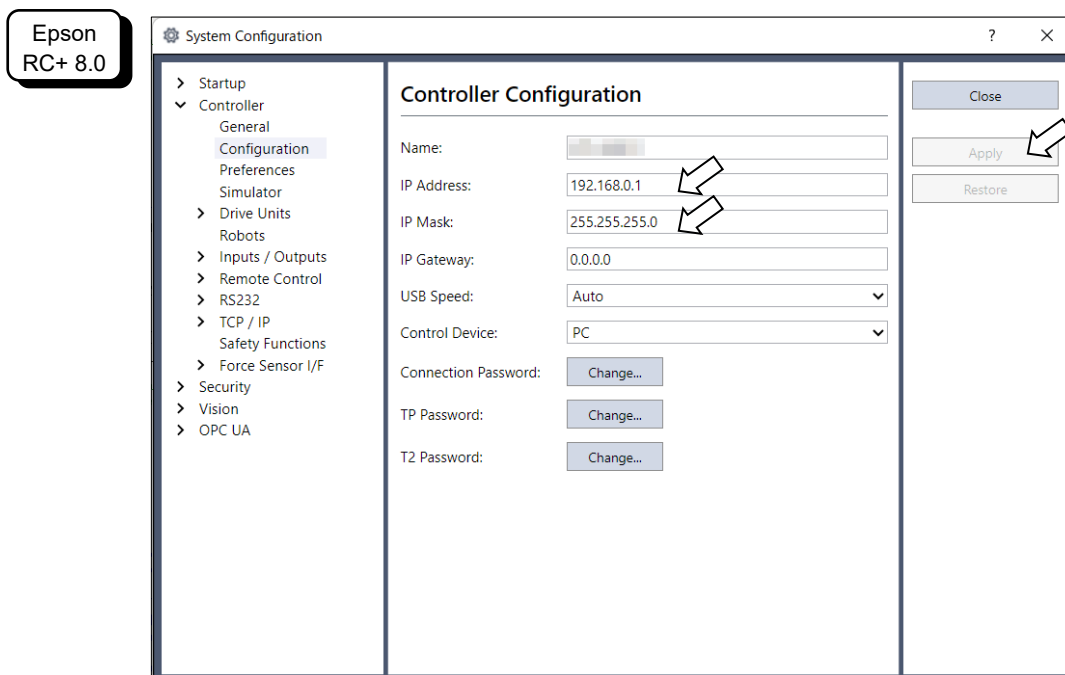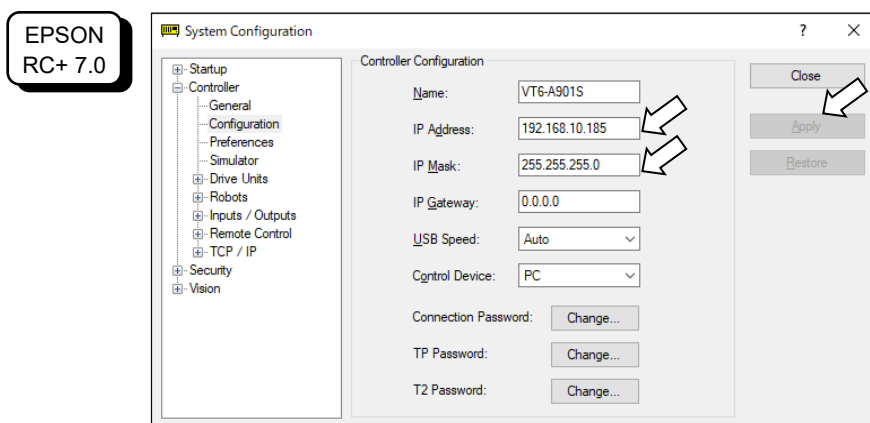
(4) Enter the proper IP address and subnet mask and click the <Apply> button.

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

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

(5) Click the <Add> button.

EPSON
RC+ 7.0
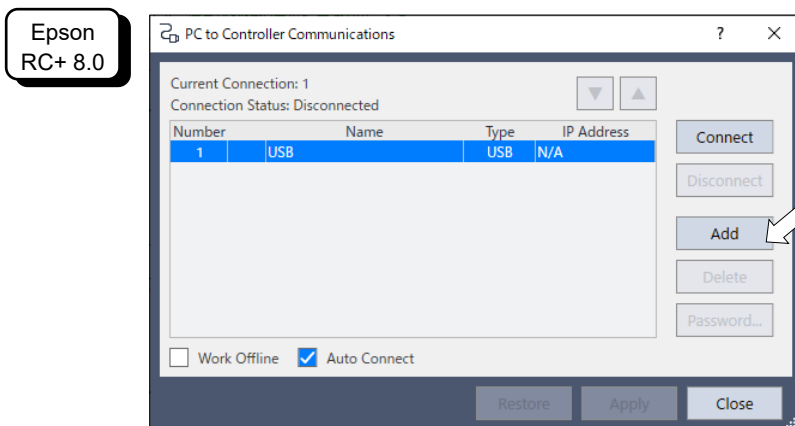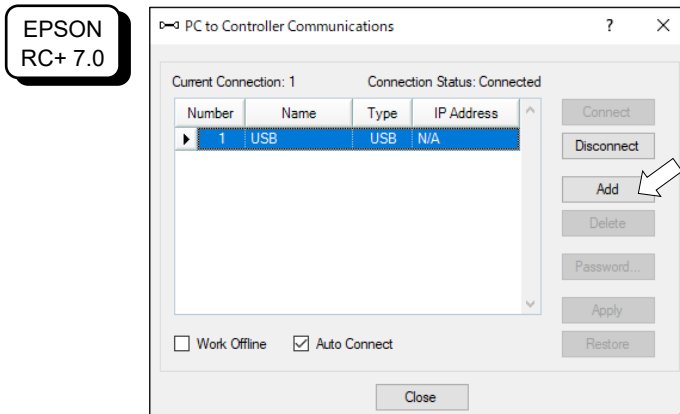
Epson
RC+ 8.0

(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
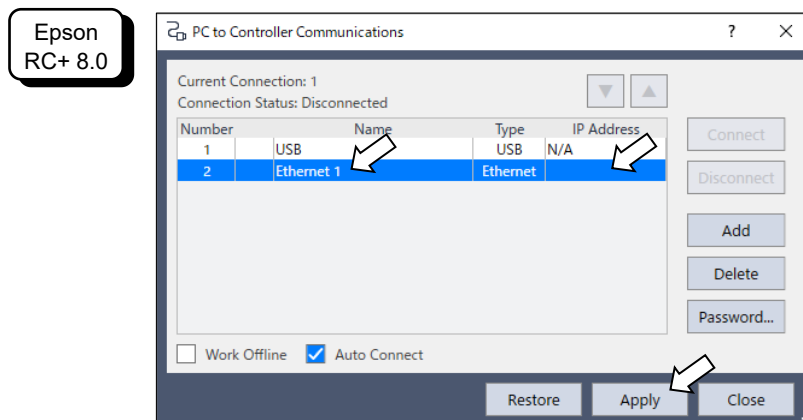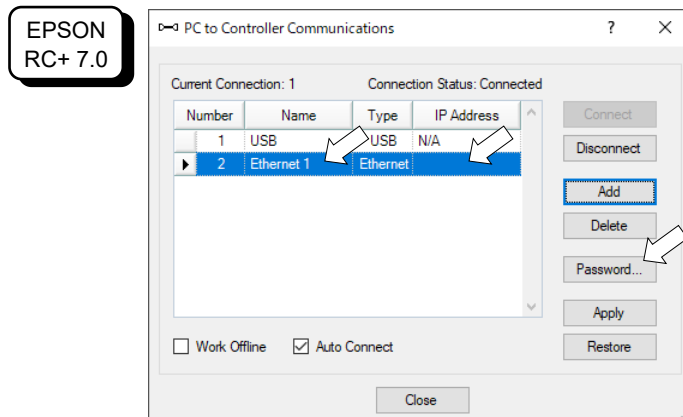
(7) [Name] and [IP Address] specified in procedure (6) is displayed.
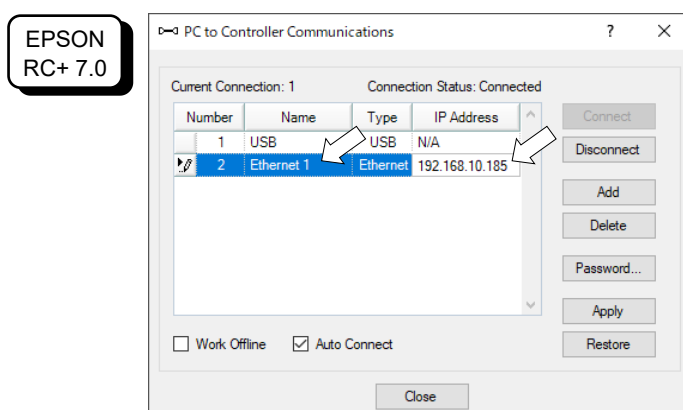
Epson
RC+ 8.0
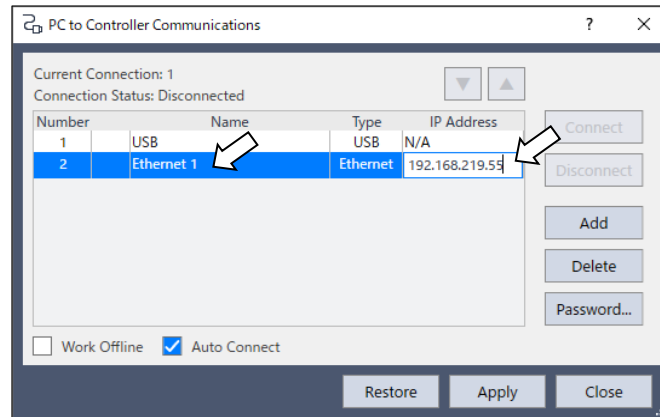
(8) Make sure that "No.2" is selected, and click the <Connect> button.

EPSON
RC+ 7.0
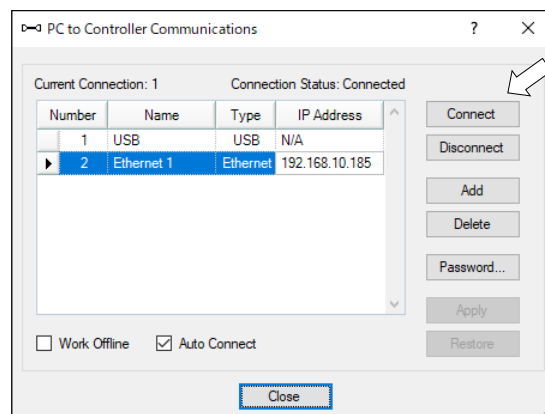
Epson
RC+ 8.0
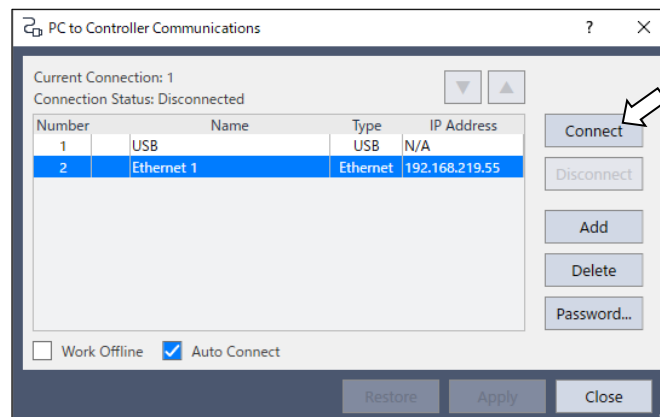
(9) After the development PC and Manipulator connection is completed, "Connected" is displayed in the [Connection status:]. Make sure that "Connected" is displayed and click the <Close> button to close the [PC to Controller Communications] dialog box.

EPSON RC+ 7.0
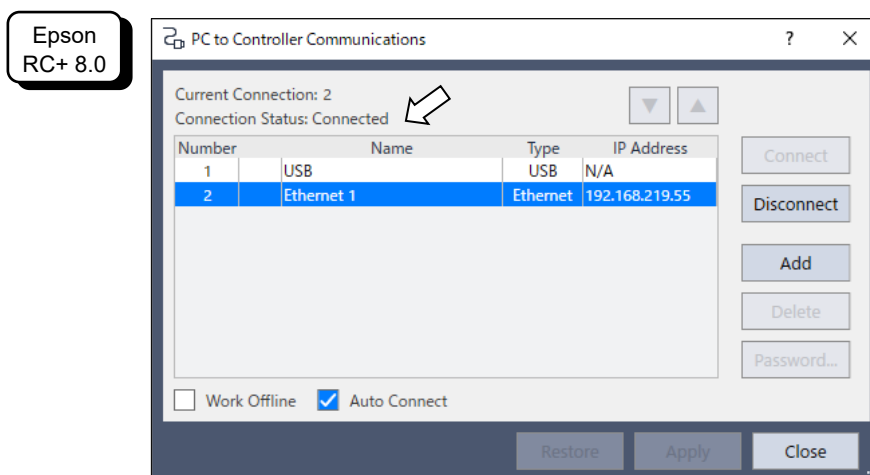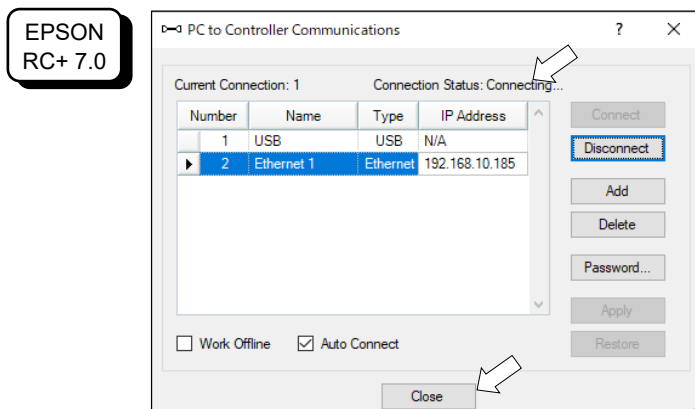
Epson RC+ 8.0

Connection between the development PC and the Manipulator is complete. Now the robot system can be used via an Ethernet connection from Epson RC+.

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 box from [Setup] in Epson RC+ 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 box before the Ethernet cable is removed.

10. TP Port

10.1   What is the TP Port?
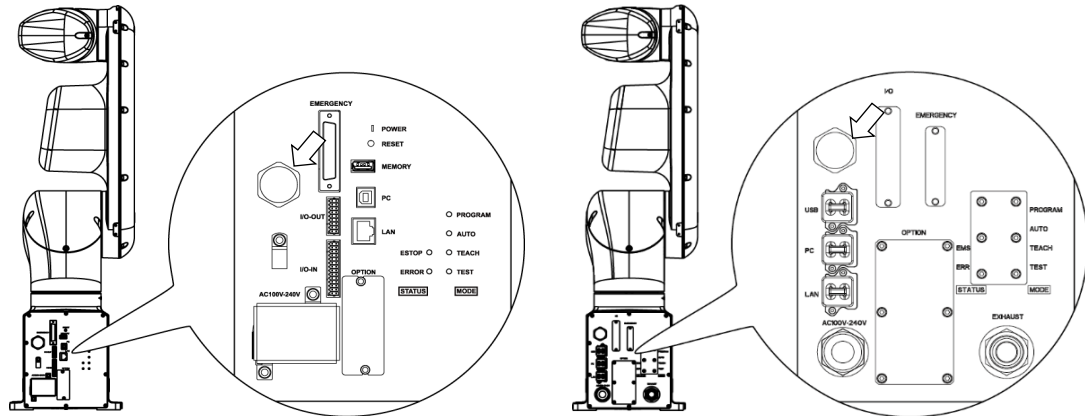
Standard, Cleanroom model   Protection model

The TP port connects the Teach Pendant (TP2, TP3, TP4) to the Manipulator.

Dedicated convert cable* is necessary if connecting TP2 to VT 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 TP bypass plug, TP2, TP3 and TP4 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 the following manuals:
Robot Contoroller Option Teach Pendant TP2.
Robot Contoroller Option Teach Pendant TP3.
Robot Contoroller Option Teach Pendant TP4.

11. Options

VT series Manipulator has the following options.

11.1 Camera Plate Unit

11.2 Tool Adapter (ISO flange)

11.3 Adjustable Mechanical Stops

11.4 External Wiring Kit

11.1 Camera Plate Unit

To mount a camera to the VT series Manipulator, the camera plate unit is requried.

NOTE
☞

For details of tightening the hexagon socket head screws, refer to "*Regular Inspection 1.3 Tightening Hexagon Socket Head Bolts*"

Parts included		Qty.
A	Camera adapter plate	1
B	Camera mid plate	1
C	Camera base plate	2
D	Hexagon socket head screws M4×12	12

A: Camera adapter plate

B: Camera mid plate

C: Camera base plate

Installation

Camera Plate Unit mounting hole   4-M4
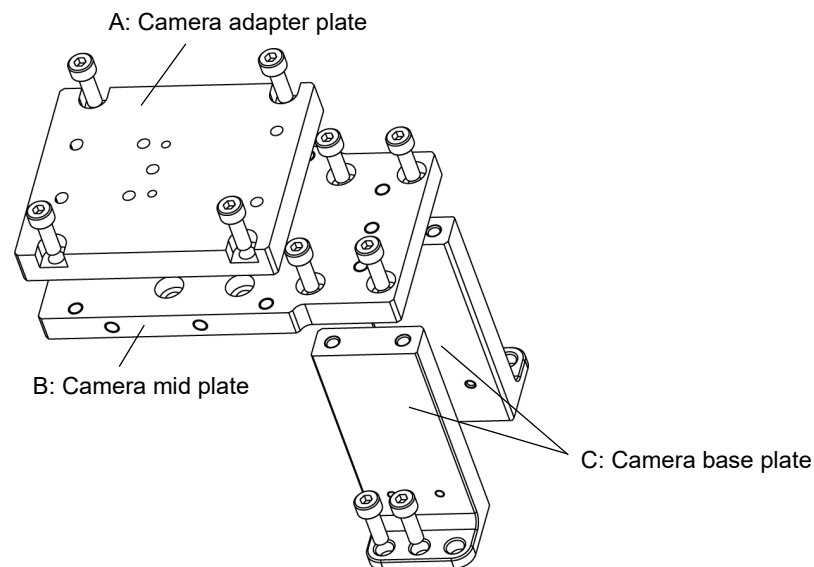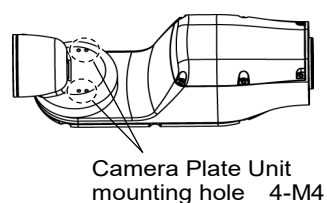
Appearance of arm end with camera

Camera
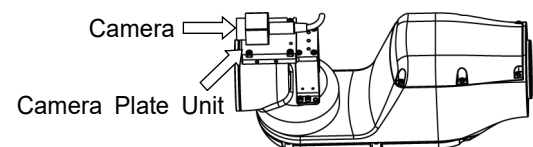
Camera Plate Unit

For the installation steps, refer to the following manual:

Epson RC+ Option Vision Guide 8.0 Hardware & Setup

Dimensions after installing the Camera Plate Unit

3-M4 through hole　　3-M4 depth 7
(*1)　　　　　　　(*1)

14　14
61　55

88
100

Y　camera　4-M4 depth 8
(*1) (*2)

X　73.7　59

25
30
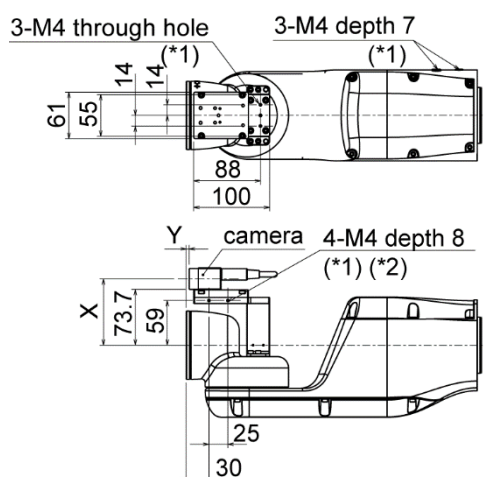
*1: Available for fixing the cables
*2: Includes the opposite side

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

Camera mid plate

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

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

D　C　B　A

40

20　20　20　5

7.5
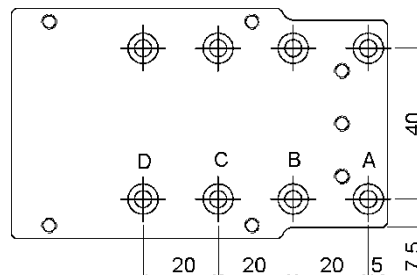
11.2 Tool Adapter (ISO flange)

Using the tool adapter, you can mount the end effector whose dimensions are designed for the ISO flange to the VT series Manipulators.

NOTE
☞

For details of tightening the hexagon socket head screws, refer to "*Regular Inspection 1.3 Tightening Hexagon Socket Head Bolts*"

Parts included	Qty.
ISO flange	1
Pin	2
Hexagon socket head screw M5×15	4

Dimensions of ISO flange

ø6 H7($^{+0.012}_{0}$) depth 6   25 24.5 1   ø 50   4×M6 depth 12 (90 deg.intervals)   45 deg.   90 deg.   6 $^{+0.012}_{0}$ depth 6
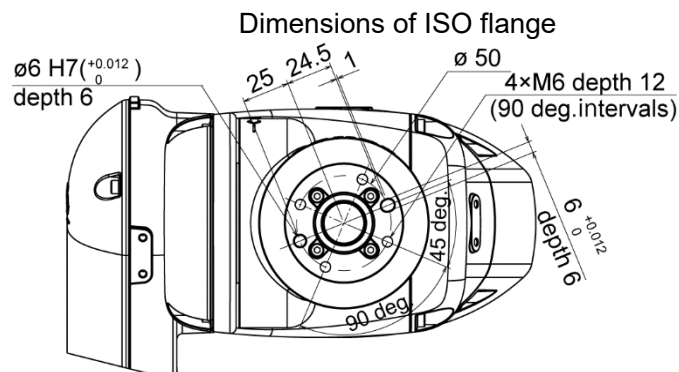
* Each dimension and tolerance complies with ISO9409-1-50-4-M6.

To mount the ISO flange

(1) Press-fit the pin to the Arm #6 end flange.

Pin projection : 4 mm from the flange

Pin
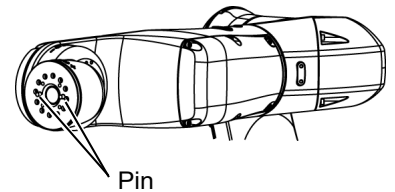
(2) Align the pin and the pin hole on the ISO flange, and then mount the ISO flange.

Hexagon socket head screw: 4-M5×15

ISO Flange
Hexagon socket head screws
4-M5×15
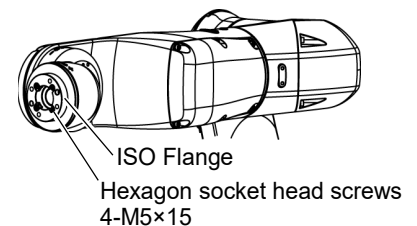
11.3   Adjustable Mechanical Stops

This option is used to mechanically limit the motion range of the Manipulator.

For installation and angle restriction measures, refer to *5.2 Motion Range Setting by Mechanical Stops*.

NOTE
☞ For details of tightening the hexagon socket head screws, refer to "*Regular Inspection 1.3 Tightening Hexagon Socket Head Bolts*"

Adjustable mechanical stop (J1)

Parts included	Qty.
Adjustable mechanical stop (J1)	1
Hexagon socket head screw M4×28	1
Pin	2

Adjustable mechanical stop (J2)

Parts included	Qty.
Adjustable mechanical stop (J2)	1
Hexagon socket head screw M4×16	1
Pin	2

Adjustable mechanical stop (J3)

Parts included	Qty.
Adjustable mechanical stop (J3)	1
Hexagon socket head screw M4×16	1
Pin	2

11.4   External Wiring Kit

Using the external wiring kit, you can fix the wirings and air tubes for the hand along with the Manipulator. The external wiring kit can be used to select the cable fixing plate, according to your Manipulator's operation condition.

NOTE
☞ For details of tightening the hexagon socket head screws, refer to "*Regular Inspection 1.3 Tightening Hexagon Socket Head Bolts*"

Parts included		Qty.
Cable fixing plate	for Base	1
	for Joint #2	1
	for Joint #3 - 1	1
	for Joint #3 - 2	1
	for Joint #5	1
Wire tie		5
Cable protection sheet		5
Hexagon socket head cap bolts M4×10		16

Cable fixing plate list
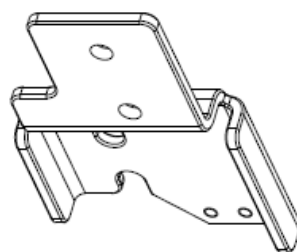
for Base
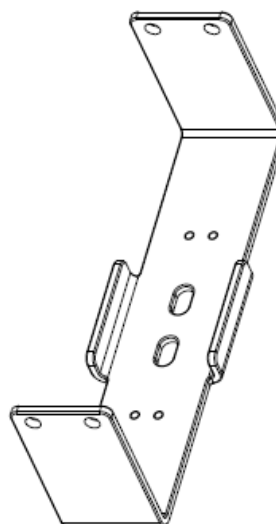
for Joint #2
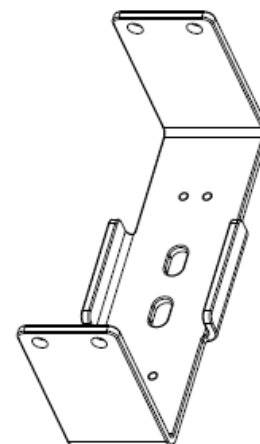
for Joint #3 - 1
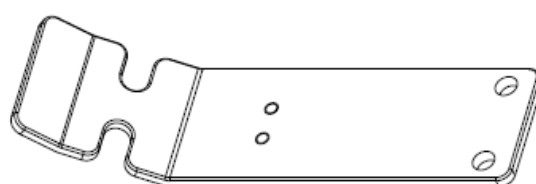
for Joint #3 - 2
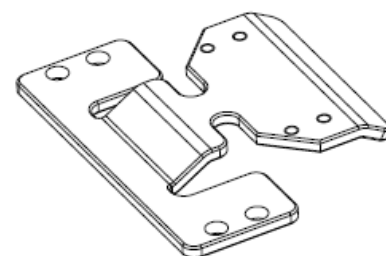
for Joint #5

Location for cable fixing plates

There are two mounting positions for Base on its both sides. Use each cable fixing plate to select the location suitable for the cable routing according to your Manipulator's operation condition.

Mount for Joint #3 - 2
(2×M4 depth 7)

20

10

68

Mount for Joint #5
(4×M4 depth 7)

20

Mount for Base
(2×M4 depth 7)

Mount for Joint #3 - 1
(2×M4 depth 7)

20

Mount for Joint #3 - 1
(2×M4 depth 7)

20

Mount for Joint #2
(2×M4 depth 7)

20

Mount for Joint #2
(2×M4 depth 7)

20

20

Mount for Base
(2×M4 depth 7)
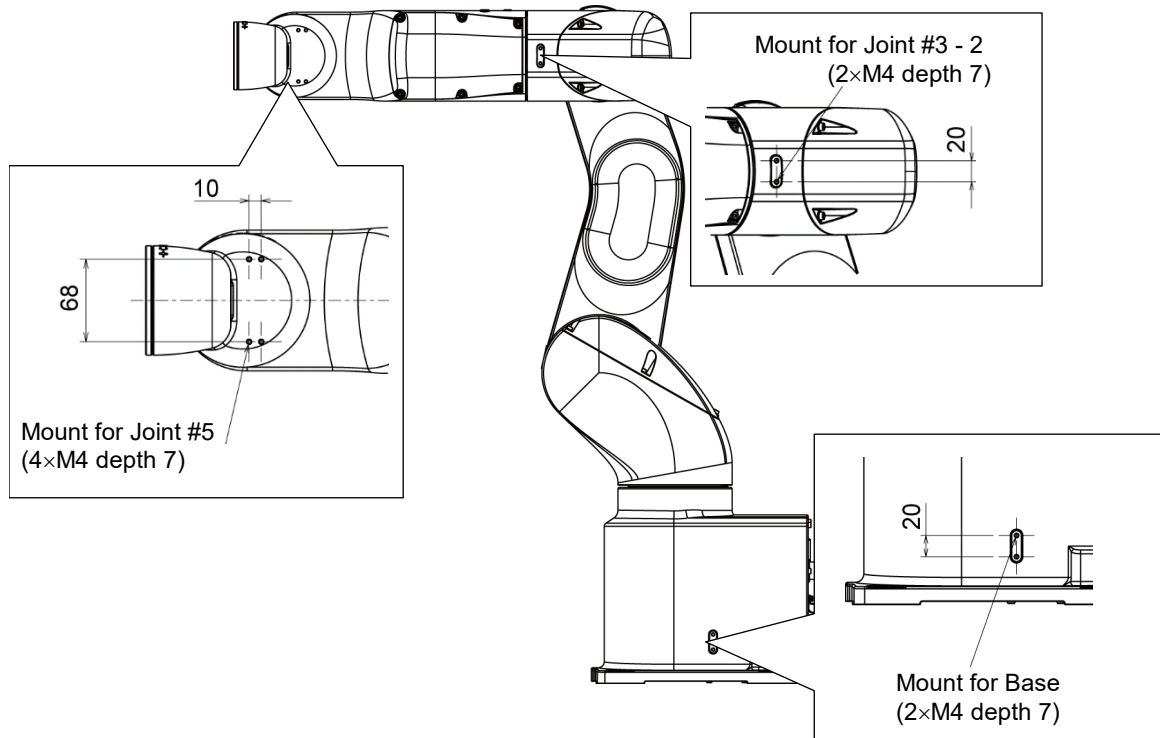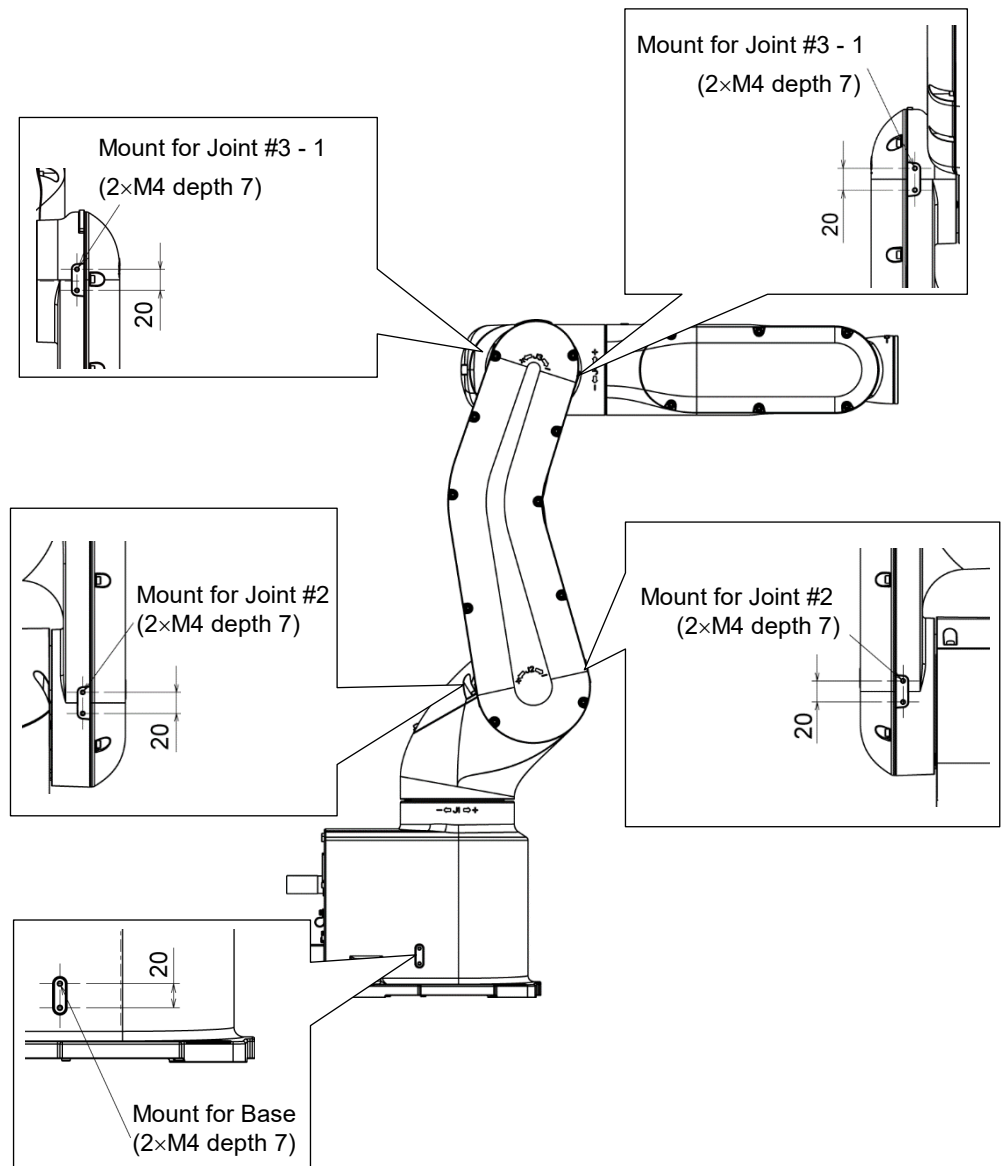
How to mount the cable fixing plates

Plate for Base

Mount   (1) Mount the cable fixing plate on your Manipulator.

Hexagon socket head cap bolt: 2-M4×10
Tightening torque: 4.0 ± 0.2 N·m

Hexagon socket head cap bolt
2-M4×10

How to   (2) Put the wire tie through the cutout for fixing the cables
bind the cables   and the slotted hole on the cable fixing plate.
Then, bind the cables with the wire tie over the cable
protection sheet.

Wire tie

Cable protection sheet

NOTE

☞ When binding the cables, be sure to make extra length so
that the cables will not be tight while each joint operates
and the bending radius is within the specifications of the
cable.

Wire tie

Cable protection
sheet
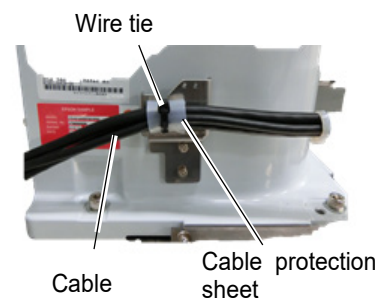
Cable

Plate for Joint #2

Mount

(1) Mount the cable fixing plate on your Manipulator.

Hexagon socket head cap bolt: 4-M4×10
Tightening torque: 4.0 ± 0.2 N·m

Hexagon socket
head cap bolt
4-M4×10

How to
bind the cables

(2) Put the wire tie through the two slotted holes for fixing cables on the cable fixing plate. Then, bind the cables with the wire tie over the cable protection sheet.

Wire tie

Cable protection sheet

Cable

Cable
protection
sheet

Wire tie

NOTE ☞ When binding the cables, be sure to make extra length so that the cables will not be tight while each joint operates and the bending radius is within the specifications of the cable.
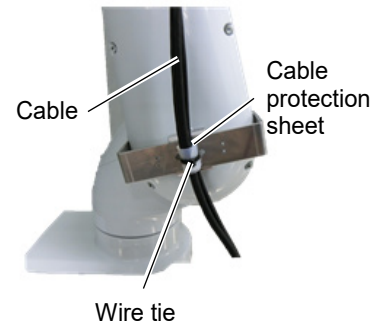
Plate for Joint #3 - 1

Mount

(1) Mount the cable fixing plate on your Manipulator.

Hexagon socket head cap bolt: 4-M4×10
Tightening torque: 4.0 ± 0.2 N·m

Hexagon   socket
head   cap   bolt
4-M4×10

How to
bind the cables

(2) Put the wire tie through the two slotted holes for fixing cables on the cable fixing plate. Then, bind the cables with the wire tie over the cable protection sheet.

Wire tie

Cable protection sheet

Wire tie

Cable

Cable
protection
sheet

NOTE ☞ When binding the cables, be sure to make extra length so that the cables will not be tight while each joint operates and the bending radius is within the specifications of the cable.
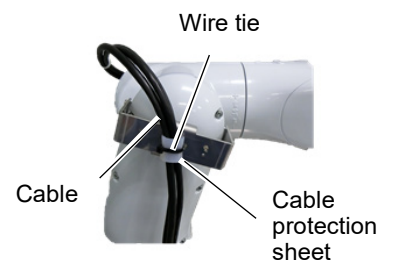
Plate for Joint #3 - 2

Mount   (1) Mount the cable fixing plate on your Manipulator.

                    Hexagon socket head cap bolt: 2-M4×10
                    Tightening torque: 4.0 ± 0.2 N·m

Hexagon socket
head cap bolt
2-M4×10

How to   (2) Put the wire tie through the two cutouts for fixing
bind the cables   cables on the cable fixing plate. Then, bind the cables
                    with the wire tie over the cable protection sheet.

                    Wire tie

                    Cable protection sheet

Wire tie

Cable
protection
sheet
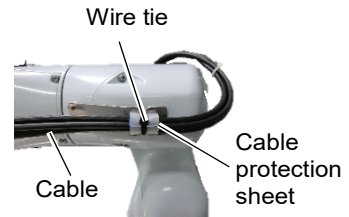
Cable

NOTE   When binding the cables, be sure to make extra length so
☞   that the cables will not be tight while each joint operates
            and the bending radius is within the specifications of the
            cable.

Plate for Joint #5

Mount   (1) Mount the cable fixing plate on your Manipulator.

                    Hexagon socket head cap bolt: 4-M4×10
                    Tightening torque: 4.0 ± 0.2 N·m

Hexagon socket head cap bolt
4-M4×10

How to   (2) Put the wire tie through the two cutouts for fixing the
bind the cables   cables on the cable fixing plate. Then, bind the cables
                    with the wire tie over the cable protection sheet.

                    Wire tie

                    Cable protection sheet

Wire tie

Cable
protection
sheet
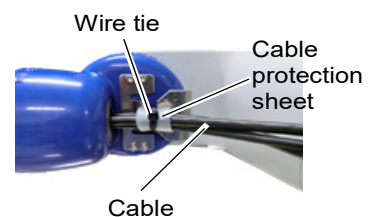
Cable

NOTE   When binding the cables, be sure to make extra length so
☞   that the cables will not be tight while each joint operates
            and the bending radius is within the specifications of the
            cable.

12. EMERGENCY

NOTE
☞

The details of safety requirements for this section are described in *Epson RC+ User's Guide*
- *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.
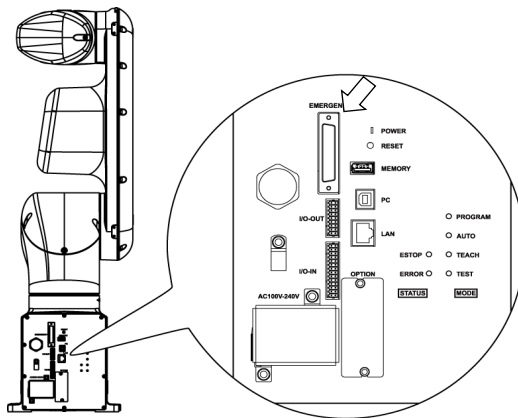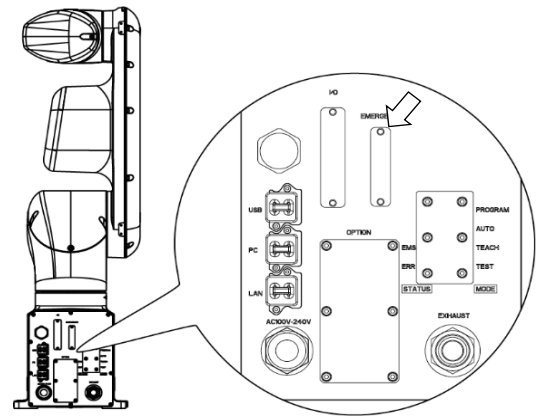
Standard, Cleanroom model   Protection model

12.1   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.

Standard, Cleanroom model

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.

Protection model

Connector	Standard
EMERGENCY connector (Manipulator side)	D-Sub 25 pin male Screwlock #4 - 40
EMERGENCY connector kit (Cable side)	D-Sub 25 pin female Hood for D-Sub 25 pin Mounting screws #4 - 40

* EMERGENCY connector kit (cable side) is included with shipment.

(Applicable diameter for cables is 8.0 to 12.0 mm)

12.1.1   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 Controller.

- Make sure to design the safeguard to prevent the door from closing accidentally.

12.1.2   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.

12.1.3   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 Controller 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.

NOTE ☞

Controller activation may fail when the safety door switch is input during the initialization immediately after turning ON the controller. In this case, delay the input timing of the safety door switch.

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.

12.2   Emergency Stop Switch Connection

12.2.1   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 Controller. Refer to "*12.4 Circuit Diagrams*".
Give the emergency stop function to all the equipment which have executable token.

12.2.2   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 "EStop" 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 "EStop" is dimmed on the main window status bar.

12.2.3   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

12.3   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	+24 V ±10%	3-4, 16-17 pin
Emergency Stop rated input current	37.5 mA ±10% /+24 V input	
Safeguard rated input voltage range	+24 V ±10%	7-8, 20-21 pin
Safeguard rated input current	10 mA/+24 V input	
Latch Release rated input voltage range	+24 V ±10%	18-19 pin
Latch Release rated input current	10 mA/+24 V input	

NOTE

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

⚠ CAUTION

■   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.

12.4   Circuit Diagrams

12.4.1   Example 1: External emergency stop switch typical application

NOTE:+24V GND ▼
+ 5V GND ▽
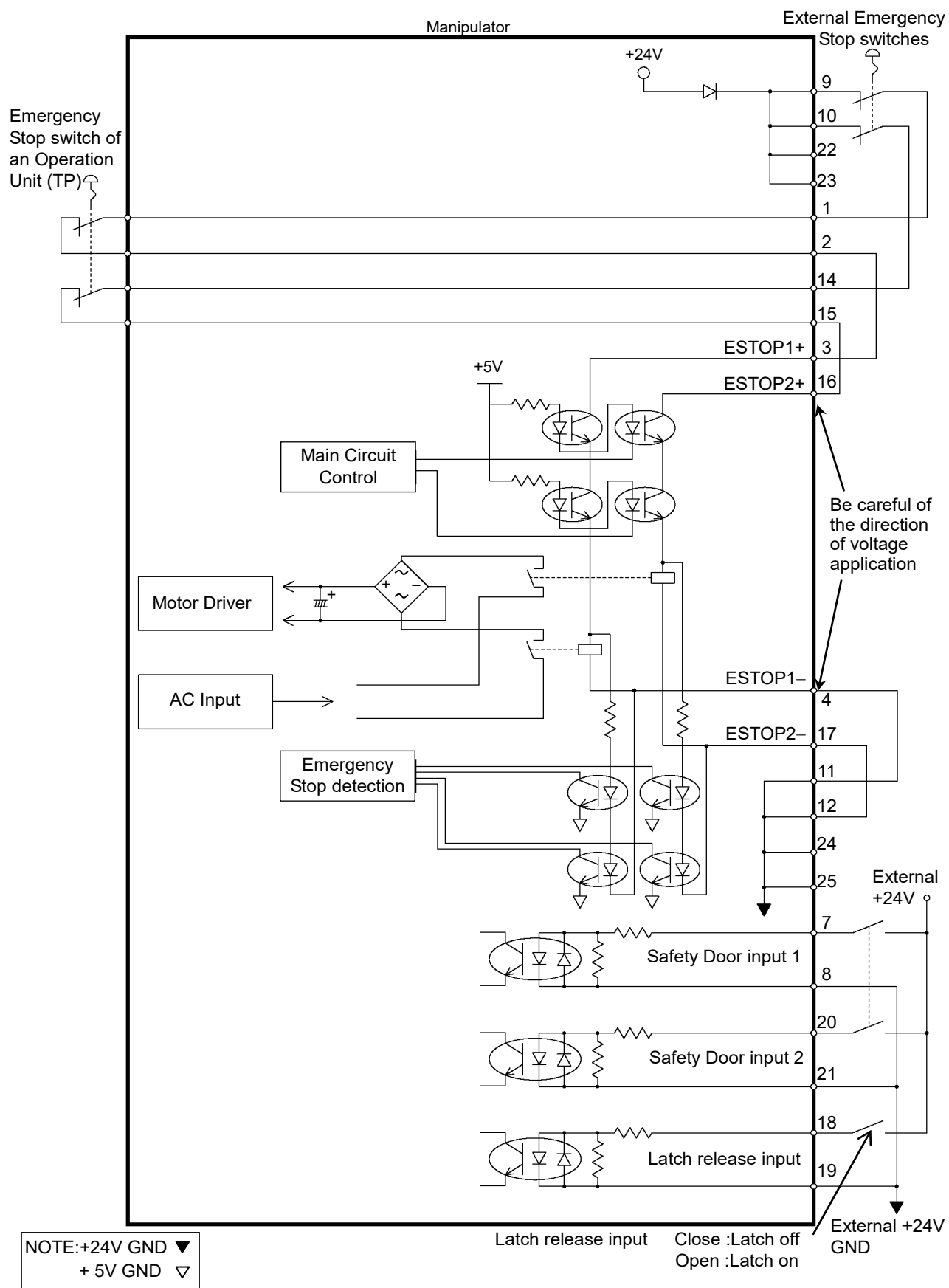
12.4.2   Example 2: External safety relay typical application

Manipulator

Emergency Stop switch of an Operation Unit (TP)

External +24V

Fuse

+24V

09
10
22
23
1
2
14
15
3
16

External +24V GND

External +24V

External safety relay
(The above diagram is simplified for representation.)

Main Circuit Control

+5V

Motor Driver

AC Input

Emergency Stop detection

4
17
11
12
24
25
7
8
20
21
18
19

* For the protection of the emergency stop circuit, the fuse's capacity should be as follows:
   - Meets the capacity of the external safety relay
   - 0.4A or less

External +24V GND

External +24V

Safety Door input 1

Safety Door input 2

Latch Release input

External +24V GND

NOTE:+24V GND ▼
+ 5V GND ▽

Latch release input   Close :Latch off
                       Open :Latch on

VT series   Rev.10   131

12.4.3   Example 3:
Connection example of mobile platform and emergency stop

Manipulator

External +24V

Emergency Stop switch of an Operation Unit (TP)

+24V

Fuse

09
10
22
23
1
2
14
15
3
16

Mobile platform

Emergency stop output

Emergency stop input

+5V

Main Circuit Control

Motor Driver

AC Input

Emergency Stop detection

* For the protection of the emergency stop circuit, the fuse's capacity should be as follows:
- Meets the capacity of the external safety relay
- 0.4A or less

4
17
11
12
24
25

External +24VGND

External +24V

7
8

Safety Door input 1

20
21

Safety Door input 2

18
19

Latch Release input

NOTE: +24V GND ▼
+ 5V GND ▽

Latch release input   Close :   Latch off
Open : Latch on

External +24V GND

13. 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.

13.1   Standard, Cleanroom Model

Connector name	Pins	Bit number
I/O (Input) Connector	24	0-23
I/O (Output) Connector	16	0-15

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*".

13.1.1   Input Circuit (Standard, Cleanroom Model)

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.

Typical Input Circuit Application 1

Standard I/O (Input) connector

GND   +DC

Pin	Label
5	Input No.0 to 7 common
1	Input No.0
15	Input No.1
2	Input No.2
16	Input No.3
3	Input No.4
17	Input No.5
4	Input No.6
18	Input No.7
19	Input No.8 to 15 common
6	Input No.8
20	Input No.9
23	Input No.15
14	Input No.16 to 23 common
10	Input No.16
24	Input No.17
27	Input No.23

(Same as above)

Omit

Omit

Typical Input Circuit Application 2

Standard I/O (Input) connector

GND   +DC

Pin	Label
5	Input No.0 to 7 common
1	Input No.0
15	Input No.1
2	Input No.2
16	Input No.3
3	Input No.4
17	Input No.5
4	Input No.6
18	Input No.7
19	Input No.8 to 15 common
6	Input No.8
20	Input No.9
23	Input No.15
14	Input No.16 to 23 common
10	Input No.16
24	Input No.17
27	Input No.23

(Same as above)

Omit

Omit

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	Input No. 18	25	Input No. 19
12	Input No. 20	26	Input No. 21
13	Input No. 22	27	Input No. 23
14	Input common No. 16 to 23	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
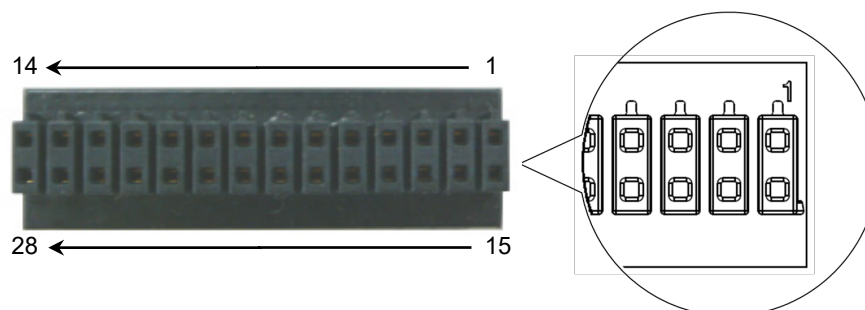
13.1.2   Output Circuit (Standard, Cleanroom Model)

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

Typical Output Circuit Application 1: Sink Type (NPN)

Standard I/O (output) connector

Pin	Signal
1	Output No.0
10	Output No.1
2	Output No.2
11	Output No.3
3	Output No.4
12	Output No.5
4	Output No.6
13	Output No.7
5	Output No.0 to 7 common (GND)
6	Output No.8
15	Output No.9
14	Output No.8 to 15 common (GND)

(Same as above)

Load

Omit

GND   +DC

Typical Output Circuit Application 2: Source Type (PNP)

Standard I/O (output) connector

Pin	Signal
1	Output No.0
10	Output No.1
2	Output No.2
11	Output No.3
3	Output No.4
12	Output No.5
4	Output No.6
13	Output No.7
5	Output No.0 to 7 common (+DC)
6	Output No.8
15	Output No.9
14	Output No.8 to 15 common (+DC)

(Same as above)

Load

Omit

GND   +DC

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 15
6	Output No. 8 (EStopOff)	15	Output No. 9
7	Output No.10	16	Output No.11
8	Output No. 12	17	Output No. 13
9	Output No. 14	18	Output No. 15

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
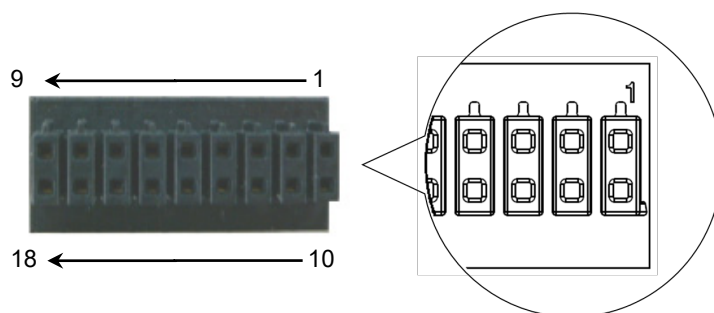
13.2   Protection Model

⚠ 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	But number
I/O connector	Input	24	0-23
	Output	16	0-15

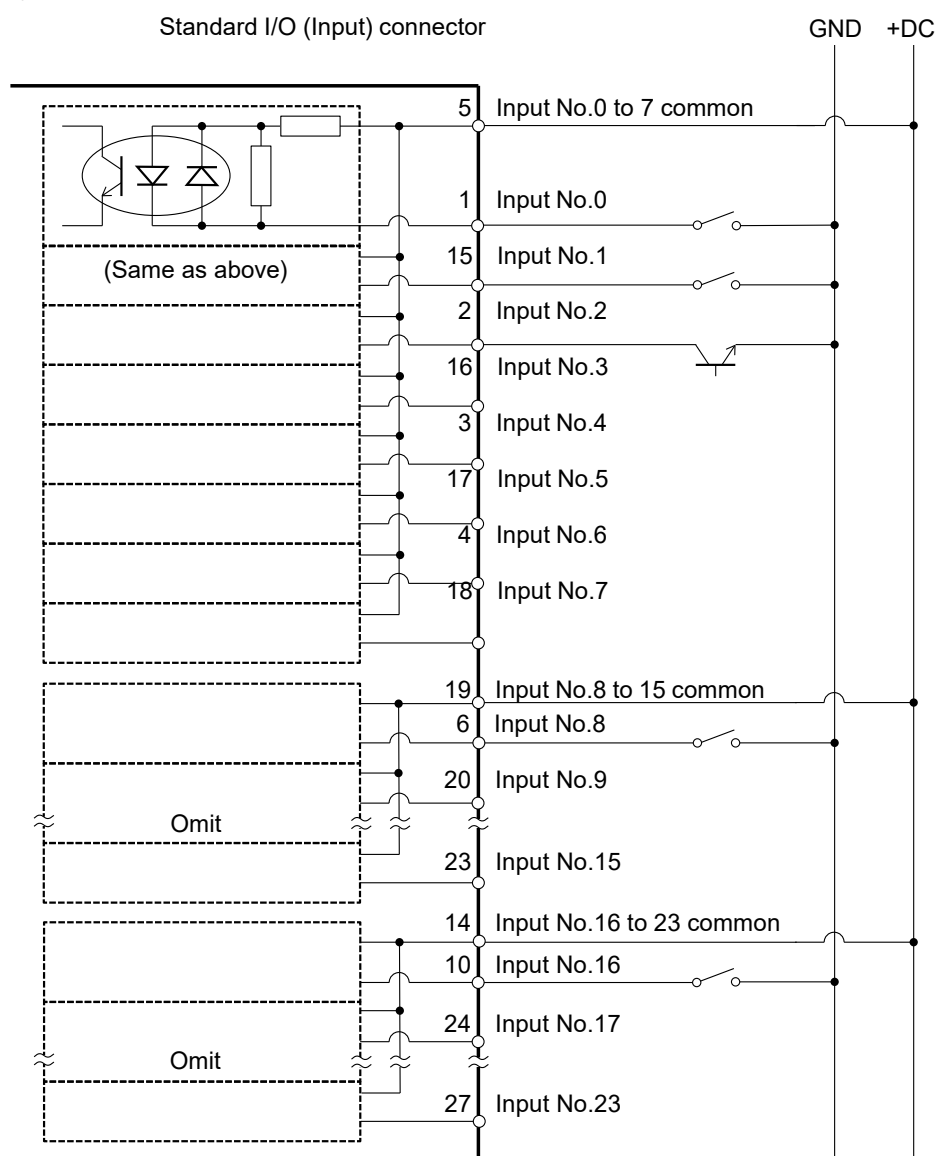For cable wiring, refer to "*3.7.2 Noise Countermeasures*" in order to prevent noise.

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

13.2.1   Input Circuit (Protection Model)

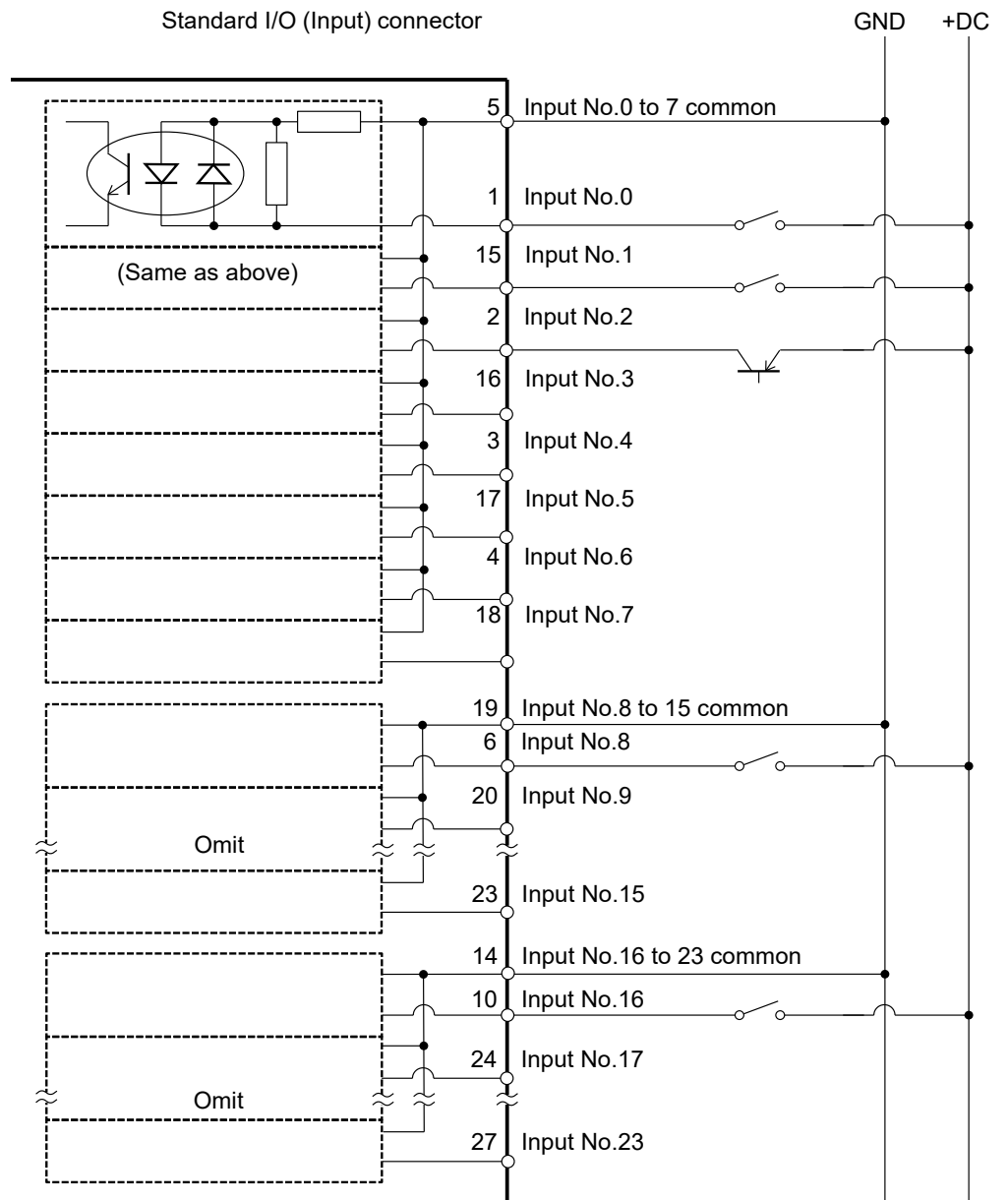Input Voltage Range   : +12 to 24 V ±10%

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.

Typical Input Circuit Application 1: Source type

Standard I/O connector   GND   +DC

Pin	Signal
1	Input No.0 to 7 common
2	Input No.0
3	Input No.1
4	Input No.2
5	Input No.3
6	Input No.4
7	Input No.5
8	Input No.6
9	Input No.7
18	Input No.8 to 15 common
19	Input No.8
20	Input No.9
26	Input No.15
34	Input No.16 to 23 common
35	Input No.16
36	Input No.17
42	Input No.23

(Same as above)

Omit

Omit
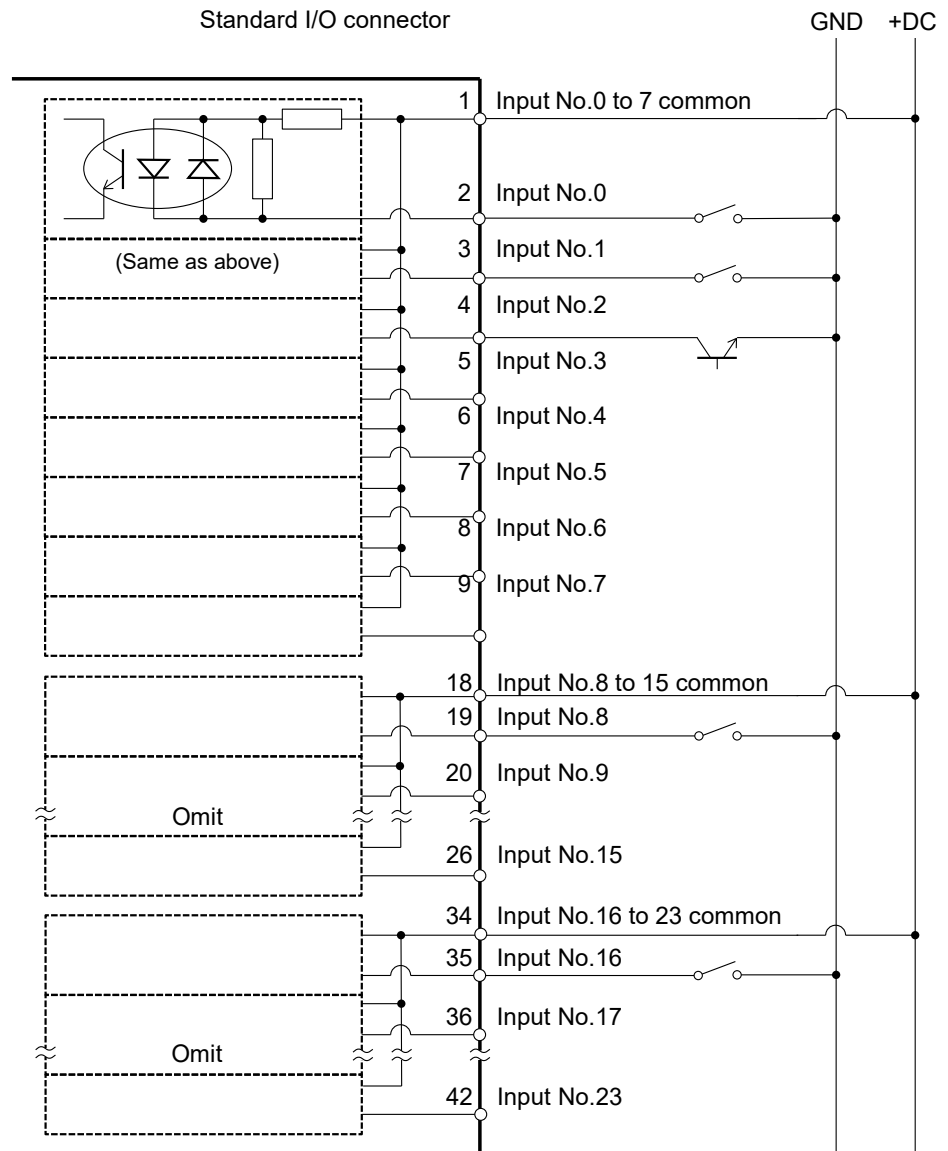
Typical Input Circuit Application 2: Sink type

Standard I/O connector
GND   +DC

Pin	Signal
1	Input No.0 to 7 common
2	Input No.0
3	Input No.1
4	Input No.2
5	Input No.3
6	Input No.4
7	Input No.5
8	Input No.6
9	Input No.7
18	Input No.8 to 15 common
19	Input No.8
20	Input No.9
26	Input No.15
34	Input No.16 to 23 common
35	Input No.16
36	Input No.17
42	Input No.23

(Same as above)

Omit

Omit
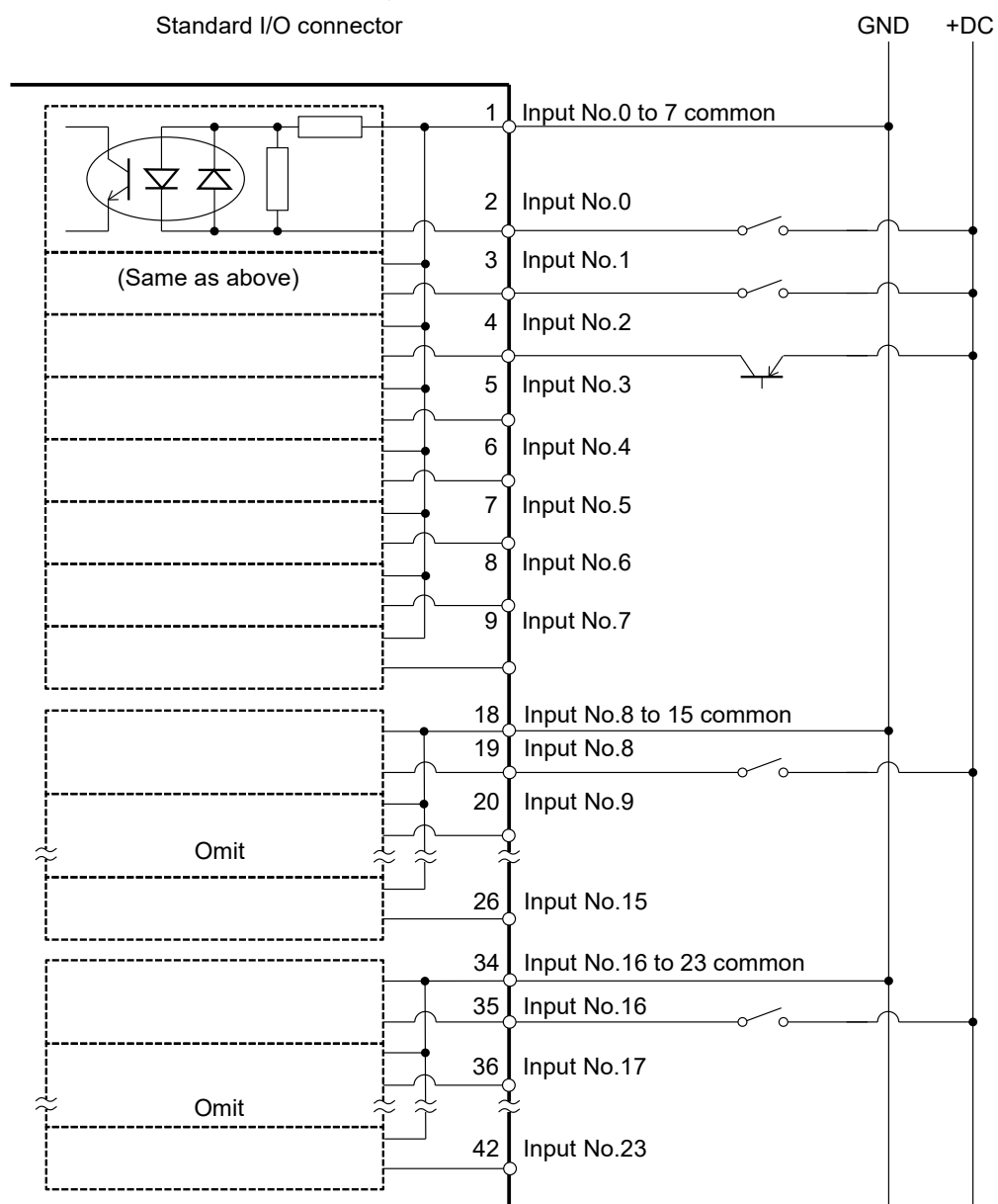
13.2.2   Output Circuit (Protection Model)

Rated Output Voltage   : +12 V to +24 V ±10%

Maximum Output Current   : TYP 100 mA/1 output
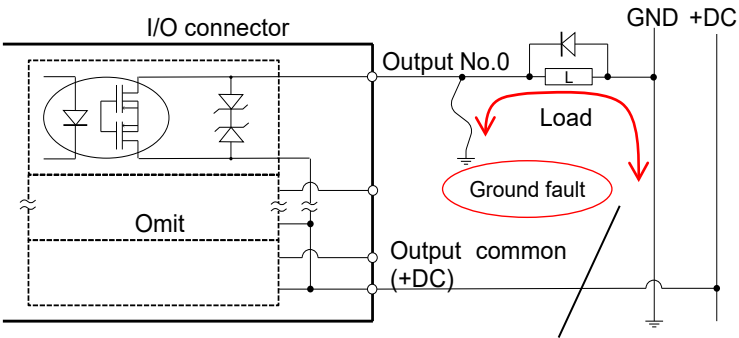
Output device   : PhotoMOS relay

ON resistance   : Less than 0.7 Ω

The following two wirings are available since non-polar PhotoMOS relay is used for output circuit.
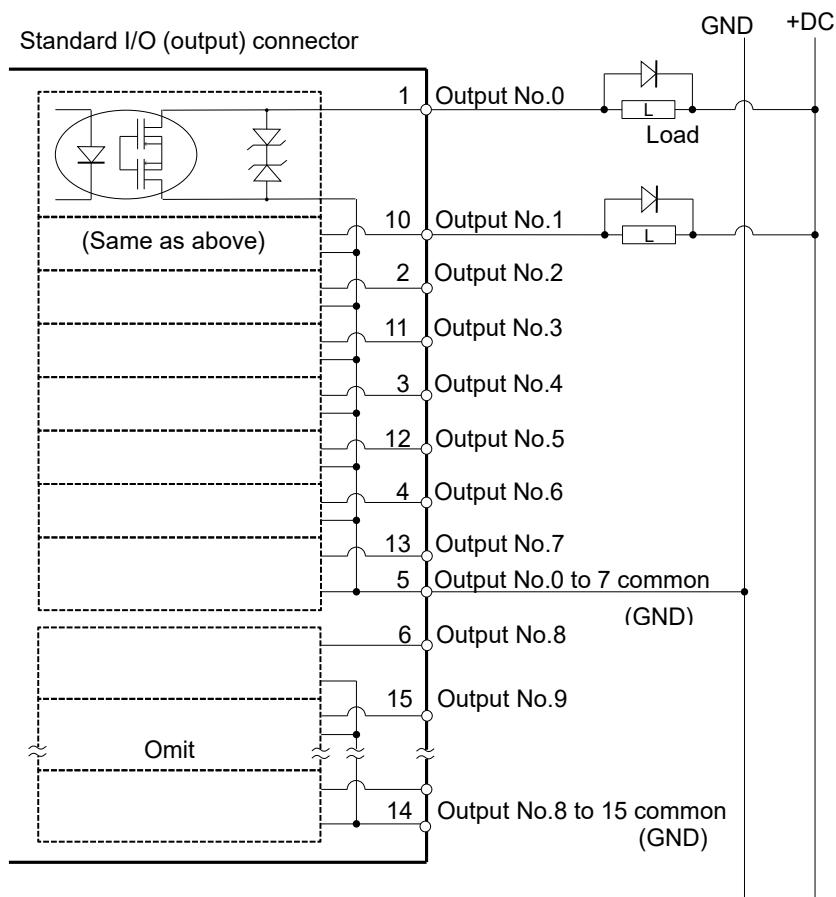
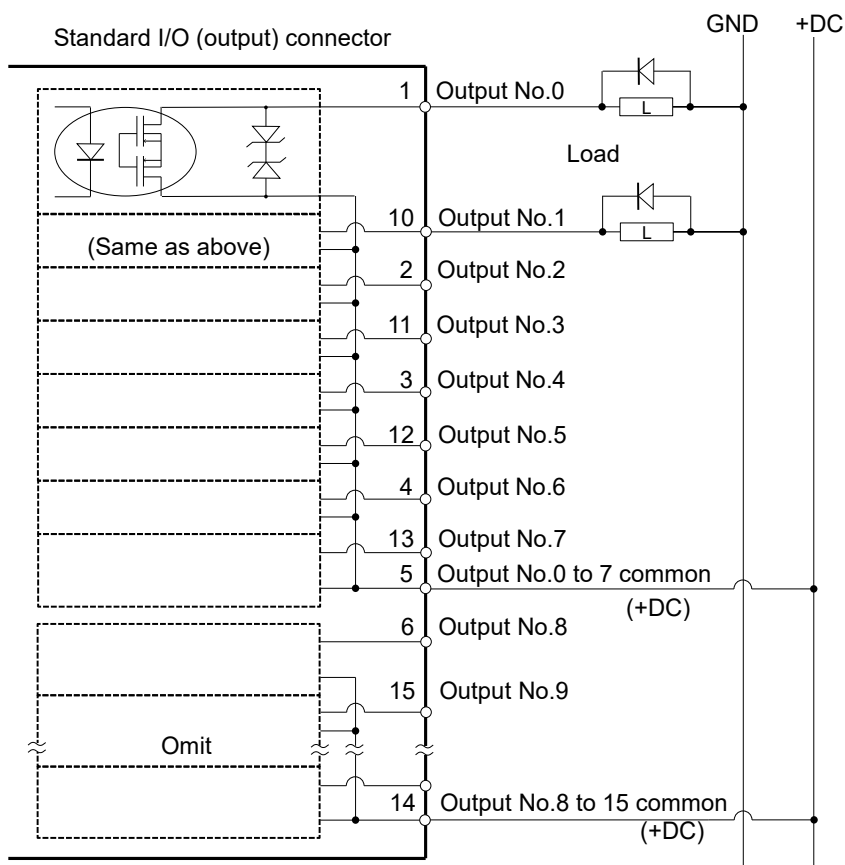|	
⚠️ CAUTION	■ Be sure to wire the output circuit properly because it has no protection circuitry for short-circuit and reverse-connection. Improper wiring may cause malfunction of the parts on the board and then improper function of the robot system. ■ To comply with European Machinery Directive, use 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 Even if a ground fault occurs, the current does not flow to the load and does not operate.

Typical Output Circuit Application 1: Sink Type (NPN)

Standard I/O connector

10	Output No.0	
11	Output No.1	
12	Output No.2	
13	Output No.3	
14	Output No.4	
15	Output No.5	
27	Output No.6	
28	Output No.7	
17	Output No.0 to 7 common	(GND)
29	Output No.8	
30	Output No.9	
33	Output No.8 to 15 common	(GND)

GND +DC

Load

(Same as above)

Omit

Typical Output Circuit Application 2: Source Type (PNP)

Standard I/O connector

10	Output No.0	
11	Output No.1	
12	Output No.2	
13	Output No.3	
14	Output No.4	
15	Output No.5	
27	Output No.6	
28	Output No.7	
17	Output No.0 to 7 common	(+DC)
29	Output No.8	
30	Output No.9	
33	Output No.8 to 15 common	(+DC)

GND +DC

Load

(Same as above)

Omit

13.2.3   Pin Assignments of Input and Output Circuit (Protection Model)

Pin No.	Signal Name	Pin No.	Signal Name	Pin No.	Signal Name
1	Input common No.0 to 7	18	Input common No.8 to 15	34	Input common No.16 to 23
2	Input No.0 (Start)	19	Input No.8	35	Input No.16
3	Input No.1 (SelProg1)	20	Input No.9	36	Input No.17
4	Input No.2 (SelProg2)	21	Input No.10	37	Input No.18
5	Input No.3 (SelProg4)	22	Input No.11	38	Input No.19
6	Input No.4 (Stop)	23	Input No.12	39	Input No.20
7	Input No.5 (Pause)	24	Input No.13	40	Input No.21
8	Input No.6 (Continue)	25	Input No.14	41	Input No.22
9	Input No.7 (Reset)	26	Input No.15	42	Input No.23
10	Output No.0 (Ready)	27	Output No.6 (SError)	43	Output No.11
11	Output No.1 (Running)	28	Output No.7 (Warning)	44	Output No.12
12	Output No.2 (Paused)	29	Output No.8 (EStopOff)	45	Output No.13
13	Output No.3 (Error)	30	Output No.9	46	Output No.14
14	Output No.4	31	Output No.10	47	Output No.15
15	Output No.5(SafeguardOn)	32	Not Used	48	Not Used
16	Not Used	33	Output common No.8 to 15	49	Not Used
17	Output common No.0 to 7			50	Not Used

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

Connector	Standard
I/O connector (Manipulator side)	D-Sub 50 pin male Screwlock #4 - 40
I/O connector kit (Cable side)	D-Sub 50 pin female Hood for D-Sub 50 pin Mounting screws #4 - 40

* I/O connector kit (cable side) is included with shipment.
  (Applicable diameter for cable is 9.0 to 14.0 mm)

13.3   I/O Cable Product Procedure

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

13.3.1   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.
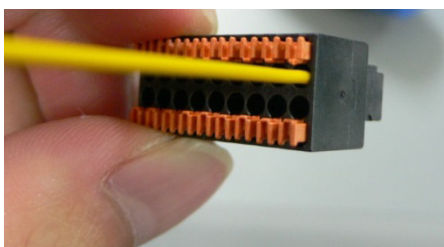
For single wire and stranded wire, peel off the covering of the cable.

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.

13.3.2   How to Fix the I/O Cable

You can fix the I/O cables using cable clamp on the back of the Manipulator.
(Only for Standard model and Cleanroom model.)
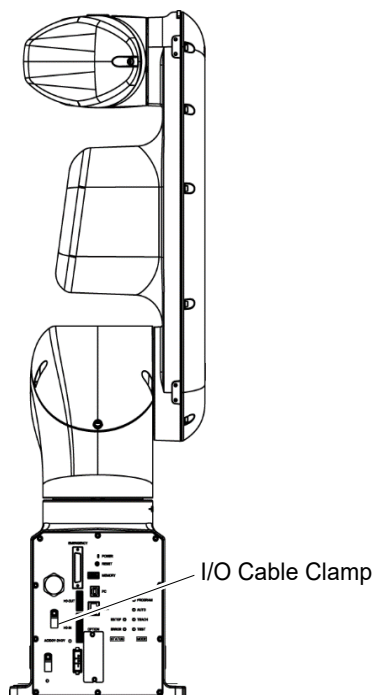
I/O Cable Clamp

NOTE

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

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+ 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+ User's Guide - Remote Control*.

For details about I/O cable connection, refer to sections "*13. Standard I/O Connector*" and "*16. Fieldbus I/O*".

For details about communication with external equipment, refer to *Epson RC+ User's Guide - 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.

NOTE ☞

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

- 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 the following manual.
  Robot Controller Option Fieldbus I/O.

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+.

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.
- If remote input commands do not meet the input acceptance condition, a CmdError signal outputs. The CmdError signal is not set to remote I/O output signal by default. When you use the remote function, set the CmdError signal to the remote I/O output signal.

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	

Name	Initial	Description	Input Acceptance Condition (*1)
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)	
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

Name	Initial	Description	Input Acceptance Condition (*1)
			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)	
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.	

(*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+ 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+ Help* or *Reset* in *SPEL+ Language Reference*.

(*5) VT series is invalid.

(*6) Initializes the Manipulator parameter.
For details, refer to *Epson RC+ Help* or *Motor* in *SPEL+ Language Reference*.

(*7) For details, refer to *Epson RC+ 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

(*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+ User's Guide - [Setup]-[System Configuration]-[Controller]-[Preferences] in [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.

This signal is not safety signal. Do not this use for safety functions.

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.

Name	Initial	Description
EnableOn	Not set	Turns ON when the enable switch is ON.
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.

Name	Initial	Description
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.

(*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+ Help* or *Box* in *SPEL⁺ Language Reference*.

(*4) For details, refer to *Epson RC+ 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) T, VT series is invalid.

(*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 "Greasing" section of maintenance manual.

(*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"

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
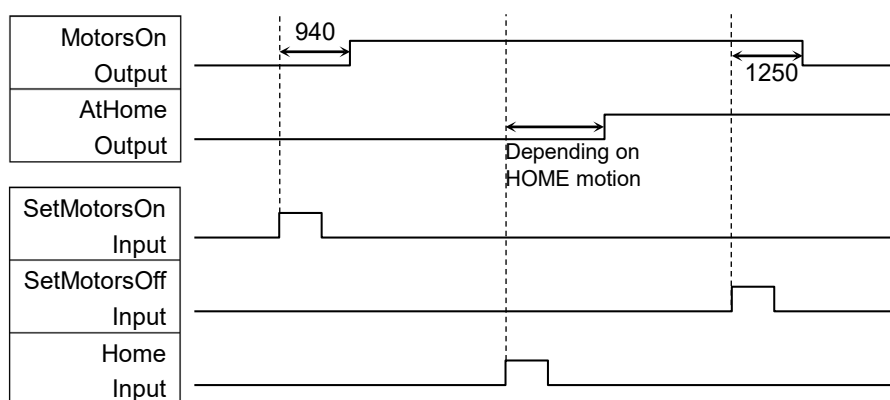
14.2.3   Timing Diagram for Program Execution Sequence
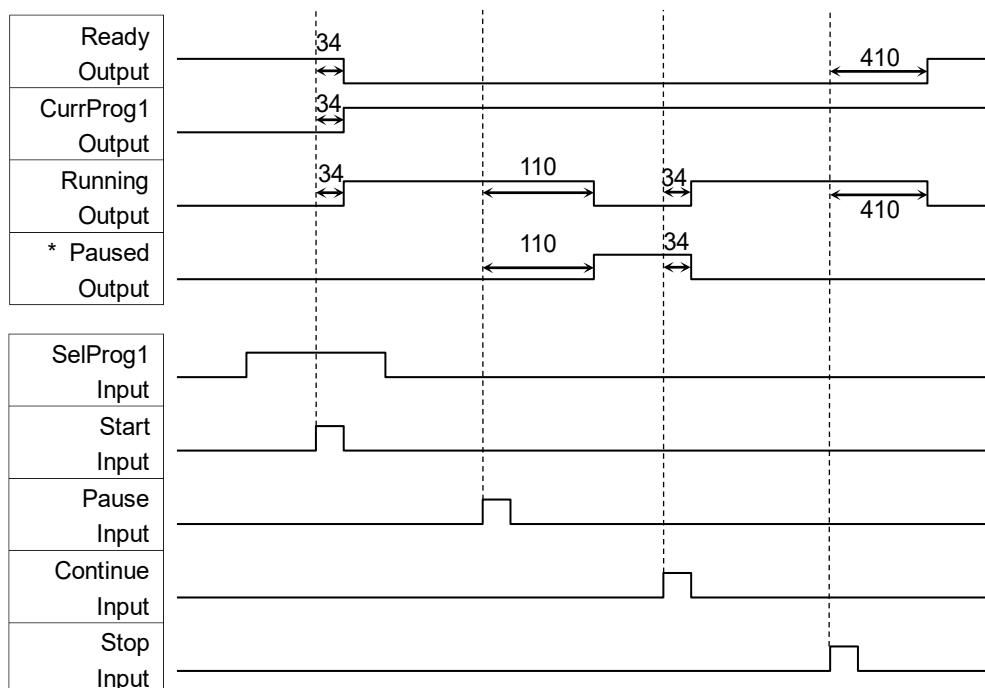
*   The duration varies depending on the Quick Pause (QP) setting and the program's operating status at the time of Pause input
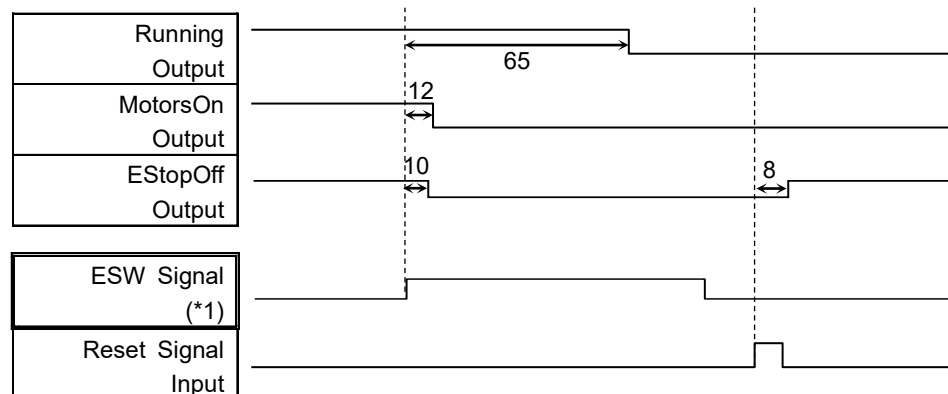
## 14.2.4   Timing Diagram for Safety Door Input Sequence
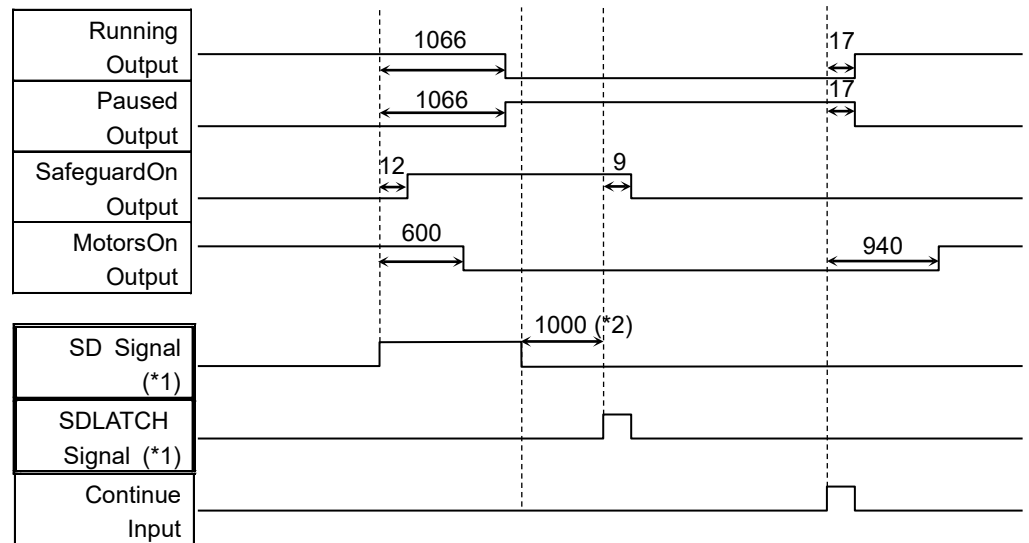
[Unit: msec]

(*1) A logical signal to explain the timing of the internal processing of the controller. For the input signal name and operating conditions, refer to the *12.3 Pin Assignments.*

(*2) If the interval between SD Signal input and SDLATCH Signal input is short, chattering may cause the error 9626.

14.2.5   Timing Diagram for Emergency Stop Sequence

[Unit: msec]

(*1) A logical signal to explain the timing of the internal processing of the controller. For the input signal name and operating conditions, refer to the *12.3 Pin Assignments.*
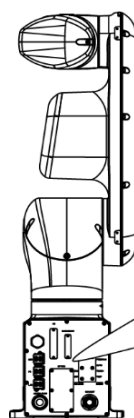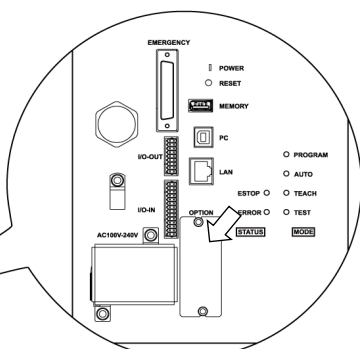
15. SD Card Slot

⚠ 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*".
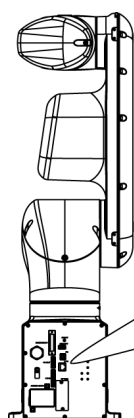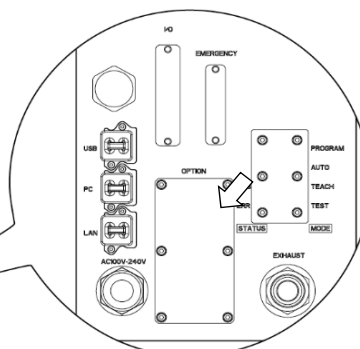
Standard, Cleanroom model   Protection model   (inside the optional slot)

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

Reference: *VT series Maintenance Manual   18.6   Replacing SD Card*

NOTE

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

16. Fieldbus I/O

Fieldbus I/O of the VT 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+ User's Guide - Fieldbus Slave I/O

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

VT series Maintenance Manual   18.7   Fieldbus I/O

17. Restrictions

For VT 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   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_AdjustGet 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	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.

17.3.2   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.

17.3.3   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

17.3.4   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.

17.3.5   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.

17.3.6   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)

17.3.7   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.

17.3.8   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

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 VT series Manipulator if CV1/CV2 is used and the following two conditions are fulfilled.

- When connecting PC and VT series Manipulator by USB connection

- When the configuration of default gateway of VT 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 8.0 Hardware & Setup
   Setup: 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 VT series Manipulator.

NOTE : Backup Controller function that acquired by actual equipment can be restored to VT series Manipulator.

17.5   Command only available in DC specification Manipulator

The following command is only available in DC specification Manipulator.   If using it in AC specification Manipulator, an error occurs.

```
CtrlInfo(15)
```
Acquire DC power source voltage (100 times greater than input voltage)

Example

```
Do
    Voltage = CtrlInfo(15) / 100.0   'Acquire voltage value

    if Voltage < 43 then
        print "Voltage became under 43V"
    endif

    Wait 1
Loop
```

NOTE

☞   When using the command, be sure to operate Manipulator within proper voltage range while monitoring the voltage.

18. Error Code Table

For error code, 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 VT6L 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.	Brake for Arm #1 to #6	√	√	√	√	√
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 arm does not fall when in MOTOR OFF. If the arm 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 near the Joint #3 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 near the Joint #3 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   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.
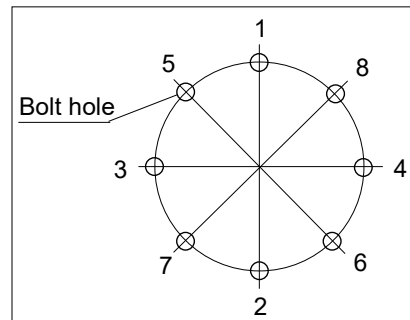
Do not fasten all bolts securely at one time. Divide the number of times that the bolts are fastened into two or three and fasten the bolts securely with a hexagonal wrench.   Then, use a torque wrench so that the bolts are fastened with tightening torques shown in the table above.

Appendix

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

Appendix A: Specifications

VT6L Specifications

Item				Specifications		
Model Number				VT6-A901*	VT6-A901*R	VT6-A901*W
Model Name				VT6L		
Mounting type *1				Table Top mounting	Ceiling mounting	Wall mounting
Weight	DC	Standard		40 kg: 89 lbs. (not include the weight of cables)		
	AC	Standard Cleanroom				
		Protection		42 kg: 92 lbs. (include the weight of cables)		
Driving method		All joints		AC servo motor		
Max. operating speed *2		Joint #1		166.2°/s		
		Joint #2		122.5°/s		
		Joint #3		141.2°/s		
	Joint #4	AC	Standard Cleanroom	268.7°/s		
			Protection	188.1°/s		
		DC	Standard			
		Joint #5		296.8°/s		
	Joint #6	AC	Standard Cleanroom	293.2°/s		
			Protection	234.5°/s		
		DC	Standard			
Maximum synthetic speed				4563 mm/s		
Repeatability		Joints #1 to #6		± 0.1 mm		
Max. motion range		Joint #1		± 170°		± 30°
		Joint #2		− 160° to + 65°		
		Joint #3		− 51° to + 190°		
		Joint #4		± 200°		
		Joint #5		± 125°		
		Joint #6		± 360°		
Max. pulse range		Joint #1		± 8488472		±1497966
		Joint #2		− 9986438 ~ + 4056990		
		Joint #3		− 2366604 ~ + 8816759		
		Joint #4		± 8128764		
		Joint #5		± 4599018		
		Joint #6		± 13410735		
Resolution		Joint #1		0.0000200°/pulse		
		Joint #2		0.0000160°/pulse		
		Joint #3		0.0000215°/pulse		
		Joint #4		0.0000246°/pulse		
		Joint #5		0.0000271°/pulse		
		Joint #6		0.0000268°/pulse		
Motor rated capacity		Joint #1		300 W		
		Joint #2		300 W		
		Joint #3		200 W		
		Joint #4		100 W		
		Joint #5		100 W		
		Joint #6		100 W		
Payload *3		Rated.		3 kg		
		Max.		6 kg		

Item		Specifications		
Model Number		VT6-A901*	VT6-A901*R	VT6-A901*W
Allowable moment	Joint #4	12 N·m (1.22 kgf·m)		
	Joint #5	12 N·m (1.22 kgf·m)		
	Joint #6	7 N·m (0.71 kgf·m)		
Allowable moment of inertia *4 ($GD^2/4$)	Joint #4	0.3 kg·m^2		
	Joint #5	0.3 kg·m^2		
	Joint #6	0.1 kg·m^2		
Environmental requirements *5	Ambient Temperature	5 to 40 °C		
	Ambient relative humidity	10 ~ 80 % RH (no condensation)		
	Vibration	4.9 m/s^2 (0.5 G) or less		
Noise level *6		L_{Aeq} = 70 dB (A) or under		
Environment		Standard, Cleanroom *7, Protection (IP67) *8		
Setting value range ( ) Default value	Speed	1 ~ (5) ~ 100		
	Accel *9	1 ~ (5) ~ 120		
	SpeedS	0.1 ~ (50) ~ 2000		
	AccelS *10	0.1 ~ (200) ~ 10000		
	Fine	0 ~ (10000) ~ 65535		
	Weight	0 ~ (3) ~ 6		
	Inertia	0 ~ (0.03) ~ 0.1		
Motion Control	Development Environment	Epson RC+		
	Programming Language	SPEL+ (multi-tasking robot language)		
	Joint Control	Standard 6 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%
		               Auto acceleration/deceleration
		CP motion :Programmable
		               (Actual value to be manually entered.)		

Item			Specifications		
Model Number			VT6-A901*	VT6-A901*R	VT6-A901*W

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: 24 points Output: 16 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		

	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, TP4)		
	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		
Controller Status Save			Save to USB memory Save in RC+ (PC)		

AC specification Manipulator

Item	Specifications
Model	VT6-A901S, VT6-A901C, VT6-A901P, VT6-A901SR, VT6-A901SW
Voltage	100 to 240 VAC
Phase	Single phase
Frequency	50 / 60 Hz
Momentary Power Interrupt	Less than 10 ms
Rated Capacity	1, 200 VA
Short-circuit Current Rating	5kA
Maximum Load Current	6.0A (Case of 200V) 12.0A (Case of 100V)
Inrush Current (When AC power is turned ON)	Max. 60A (Less than 2 ms)
Leak Current	Max. 10 mA
Ground Resistance	Less than 100Ω

DC specification Manipulator

Item	Specifications
Model	VT6-A901S-DC
Voltage	48 VDC
Available voltage	43 to 60 VDC (Be careful not to exceed the value when voltage rises.)
Absolute Maximum Ratings	72 VDC
Inrush Current (When DC power is turned ON)	Max. 40A (less than 10 ms)
Rated Capacity	1200 W
Maximum Load Current	25A
Grounding	Ground wire and DC power wire (−) are connected.

*1: Mounting types other than "Table Top mounting", "Ceiling mounting", and "Wall mounting" are out of specification.   Only Table Top mounting is available for DC specification Manipulator, Cleanroom model, and Protection model.

*2: In case of PTP control

*3: Do not apply the load exceeding the maximum payload.

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

*5: For details of the environmental requirements, refer to the *3.1 Environmental Conditions*.
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.

*6: Conditions of Manipulator at measurement are as follows:
Operating conditions: Under rated load, all arms simultaneous motion, maximum speed, maximum acceleration/deceleration, VT6L: duty 50%
Measurement point: 1000 mm apart from the rear of Manipulator

*7: The exhaust system in the Cleanroom-model Manipulator draws air from the base interior and arm cover interior.
A crack or other opening in the base unit can cause loss of negative air pressure in the outer part of the arm, which can cause increased dust emission.

Cleanliness level	:	ISO Class 4 (ISO14644-1)
Exhaust system	:	Fitting for ø12 mm pneumatic tube 60 L/min vacuum
Exhaust tube	:	Polyurethane tube Outer diameter: ø12 mm (Inner diameter: ø8 mm)

*8   Protection level for the protection-model Manipulators is IP67 (IEC standard).   The Manipulators can be used in environments where the possibility of dust, water, and water-soluble cutting oil falling of the Manipulator exists.
However, please be careful of the following:

- The Manipulator is not rust-proofed.   Do not use the Manipulator in environment where corrosive liquids exist.
- Fluids that deteriorate the sealing materials, such as organic solvents, acids, alkalis, and chlorine cutting fluids, cannot be used
- The Manipulator cannot be used for underwater operations.
                 <Reference>
          - IP67 of IEC standard
      [Protection level against ingress of solid objects]
          Totally protected against dust.
      [Protection level against liquids]
          Protection from ingress of water in harmful quantity when the Manipulator is immersed in water for 30 minutes under the condition that the highest point of the Manipulator is located 0.15 m below the surface of the water and the lowest point is located 1 m below the surface of the water.   (Tested while the Manipulator is stopped.)

*9:   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.

*10: Maximum AccelS setting value varies depending on the load.   Refer to the table below for details. Setting the value which exceeds the maximum AccelS causes an error.   In such a case, check the setting value.

Maximum AccelS setting value
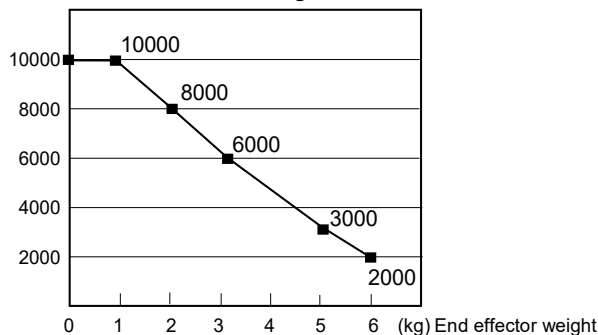
Appendix B: Stopping time and Stopping distance in Emergency

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

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

Condition:

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

These conditions are based on the ISO 10218-1:2011 Annex B.

Accel : 100 ,100
Speed: 100 %, 66 %, 33 %Settings
Weight: 100 %, 66 %, 33 % of the maximum payload, rated payload
Arm elongation rate: 100 %, 66 %, 33 % *1
Other : Default
Motion: Singular axis motion of a Go command
Input timing of the Stop signal: input with maximum speed. In this motion, it is the center of the motion range.

*1 Arm elongation rate

The arm elongation rate L is as shown below:

The graphs indicate the results where the stopping time and the stopping distance in the longest among the arm elongation rates.

Axis	L=100%	L=66%	L=33%
J1			

| J2 | |

Description of legend:

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

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

VT6L Stopping time and Stopping distance in Emergency

VT6-A901**: J1(Table Top mounting, Ceiling mounting)
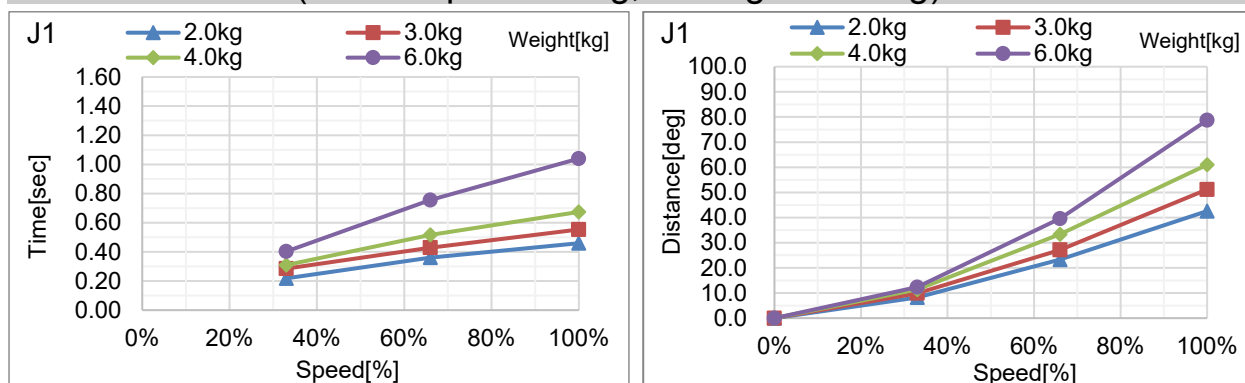
VT6-A901**: J2(Table Top mounting, Ceiling mounting)

VT6-A901**: J3(Table Top mounting, Ceiling mounting)
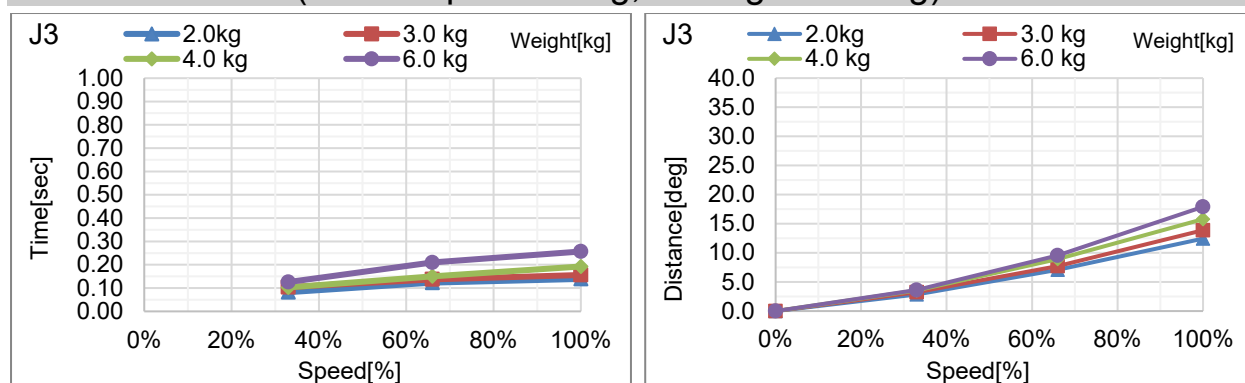
VT6-A901**: J4(Table Top mounting, Ceiling mounting)
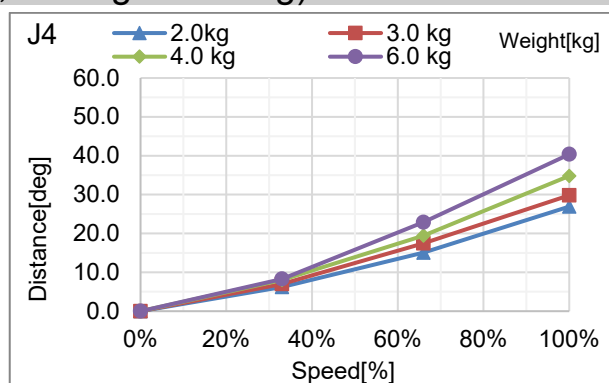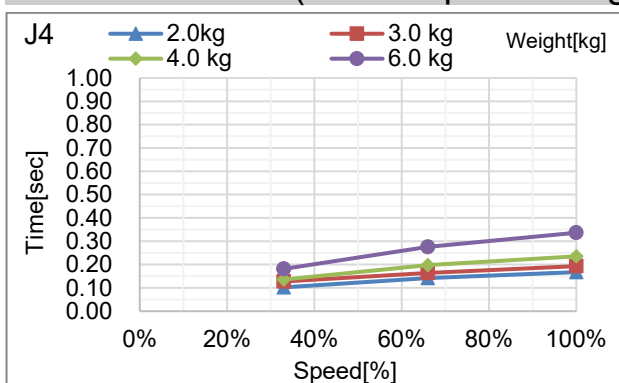
VT6-A901**: J5(Table Top mounting, Ceiling mounting)
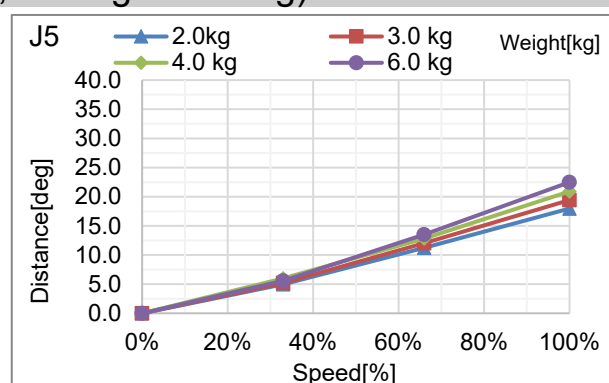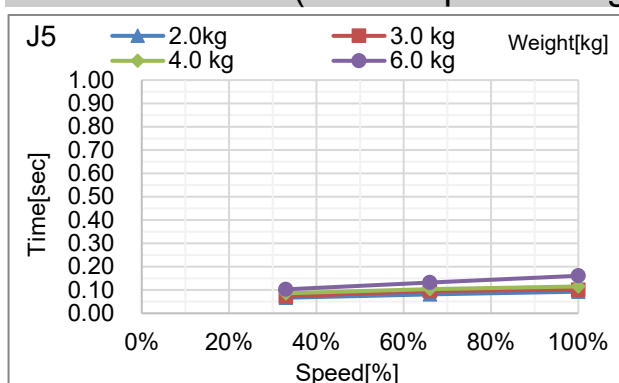
VT6-A901**: J6(Table Top mounting, Ceiling mounting)
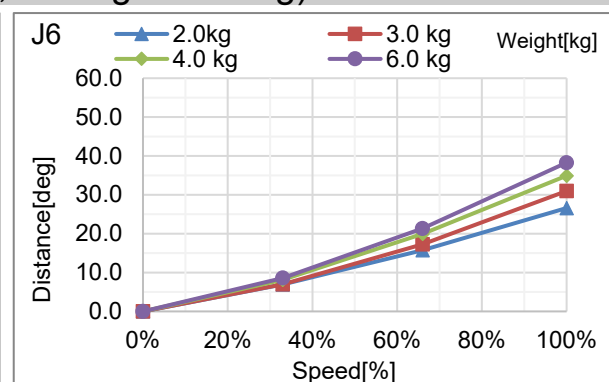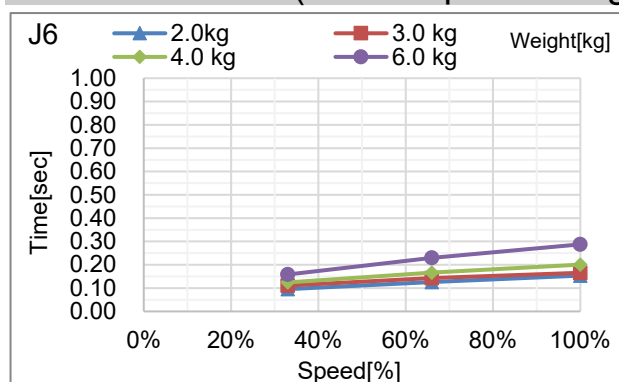
VT6-A901**: J1(Wall mounting)
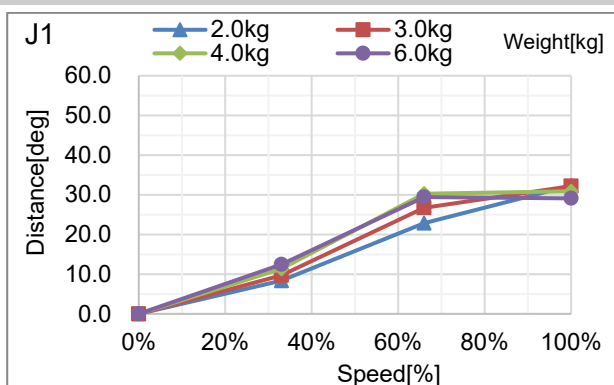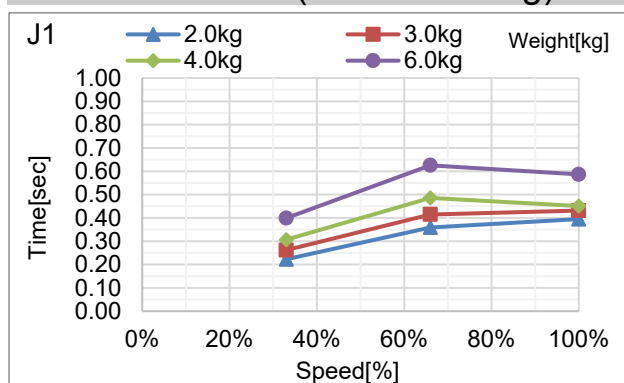
VT6-A901**: J2(Wall mounting)
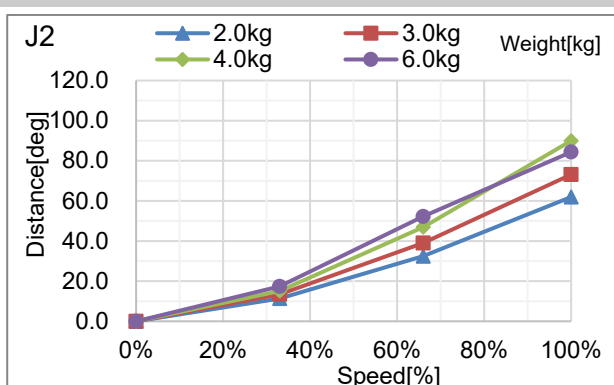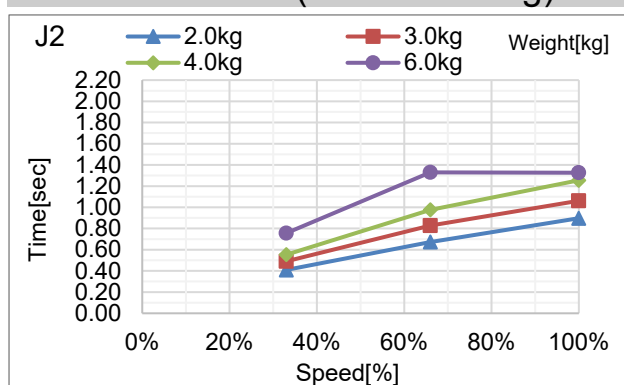
VT6-A901**: J3(Wall mounting)
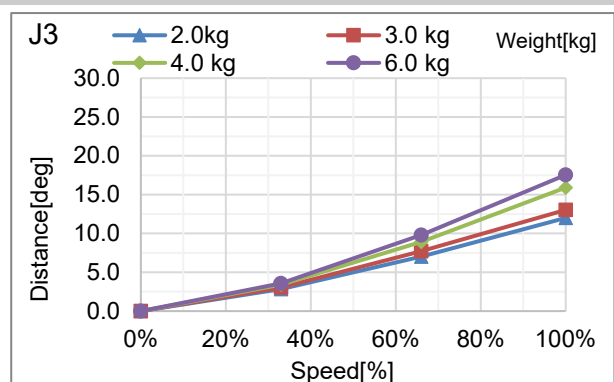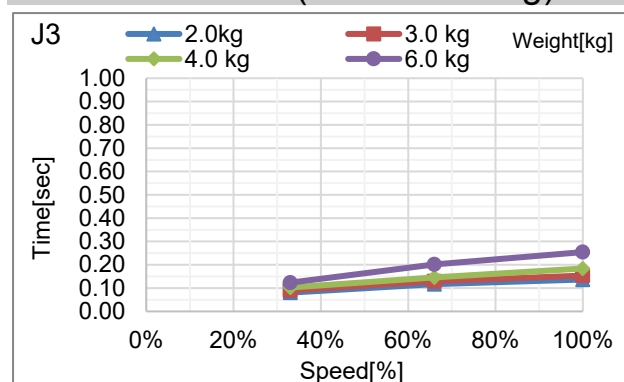
VT6-A901**: J4(Wall mounting)

VT6-A901**: J5(Wall mounting)

VT6-A901**: J6(Wall mounting)
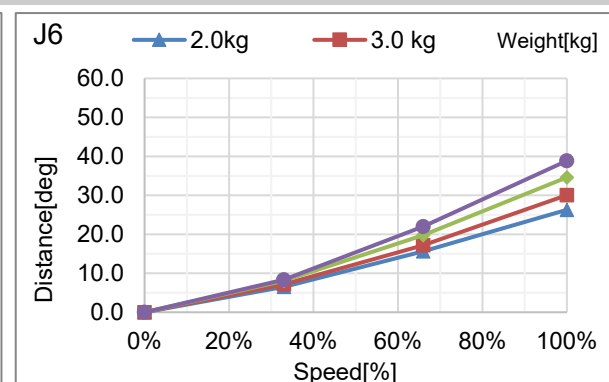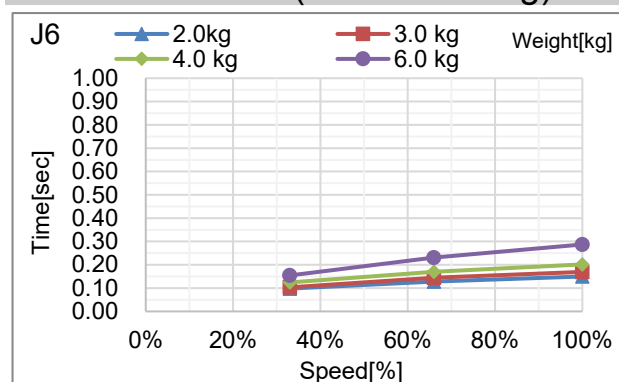
Supplementary Information regarding the Stopping Time and Stopping Distance at Emergency Stop

The stopping time and stopping distance described in Appendix B was measured by the motion determined by us based on the ISO 10218-1.

Therefore, it does not guarantee the maximum value of the stopping time and stopping distance in the customer's environment.

The stopping time and stopping distance differs depending on the robot's model, motion, and input timing of the stop signal. Make sure to always measure the stopping time and stopping distance that matches the customer's environment.

NOTE

☞ The following are included in the robot's motion and parameter.
- The motion's starting point, target point, and relay point
- Motion commands (Go, Move, Jump commands etc.)
- Weight and Inertia Settings
- Motion speed, acceleration, deceleration, and one where the motion timing changes

Also, refer to the following description.

"4.3 Weight and Inertia Settings"

"4.4 Precautions for Auto Acceleration "

How to check the stopping time and stopping distance in the customer's environment

Measure the stopping time and stopping distance of the actual motion with the following method.

1. Create a motion program in the customer's environment.

2. After the motion to check the stopping time and stopping distance starts, input the stop signal at your own timing.

3. Record the time and distance from when the stop signal was input until the robot stopped.

4. Check the maximum stopping time and stopping distance by repeating 1 through 3 mentioned above.

- How to input the stop signal: Operate the stop switch manually or input the stop signal with the safety PLC.

- How to measure the stopping position: Measure with a tape measure. The angle could also be measured with the Where or RealPos command.

- How to measure the stopping time: Measure with a stop watch. The Tmr function can also be used to measure the stopping time.

⚠ CAUTION	■ The stopping time and stopping distance changes depending on the timing the stop signal is input. In order to prevent collision with people or objects, perform a risk assessment based on the maximum stopping time and stopping distance and perform an equipment design. Therefore, make sure to measure the maximum value by changing the timing of the stop signal input during the actual motion and measure repeatedly.

Commands that can be useful when measuring stopping time and stopping distance

Commands	Functions
Where	Returns the data of the robot's current position.
RealPos	Returns the current position of the specified robot *Unlike the motion target position of the CurPos, this obtains the position of the actual robot from the encoder in real time.

PAgl	Returns by calculating the Joint position from the specified coordinate value.
	    P1 = RealPos 'Obtain the current position
	    Joint1 = PAgl(P1, 1) ' Request the J1 angle from the current position

Tmr	The Tmr function returns the elapsed time from when the timer starts in seconds.
Xqt	Runs the program specified with the function name and complete the task. The function used to measure the stopping time and stopping distance should be used to run tasks that were launched by attaching the NoEmgAbort options. You can run a task that does not stop with the emergency stop and safeguard open.

For more information, refer to the following manual.

"Epson RC+ SPEL+ Language Reference"

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

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

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

Condition:

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

These conditions are based on the ISO 10218-1:2011 Annex B.

    Accel : 100 ,100
    Speed: 100 %, 66 %, 33 %Settings
    Weight: 100 %, 66 %, 33 % of the maximum payload, rated payload
    Arm elongation rate: 100 %, 66 %, 33 % *1
    Other   : Default
    Motion: Singular axis motion of a Go command
    Input timing of the Stop signal: input with maximum speed. In this motion, it is the center of the motion range.

*1 Arm elongation rate

    The arm elongation rate L is as shown below:
    The graphs indicate the results where the stopping time and the stopping distance in the longest among the arm elongation rates.

Axis	L=100%	L=66%	L=33%

J1	
J2	

Description of legend:

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

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

VT6L Stopping time and Stopping distance When Safeguard Is Opened

VT6-A901**: J1(Table Top mounting, Ceiling mounting)
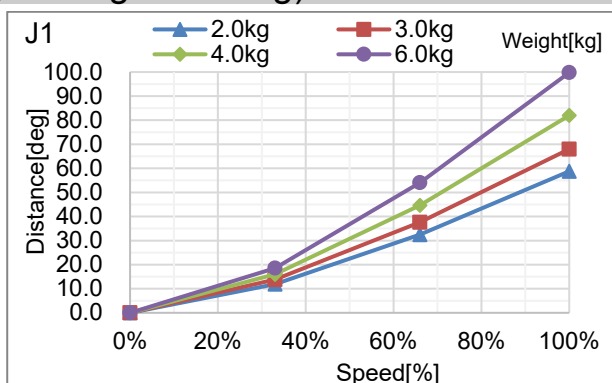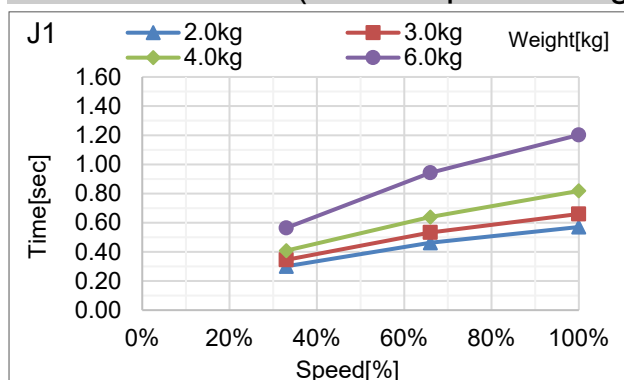
VT6-A901**: J2(Table Top mounting, Ceiling mounting)

VT6-A901**: J3(Table Top mounting, Ceiling mounting)

VT6-A901**: J4(Table Top mounting, Ceiling mounting)
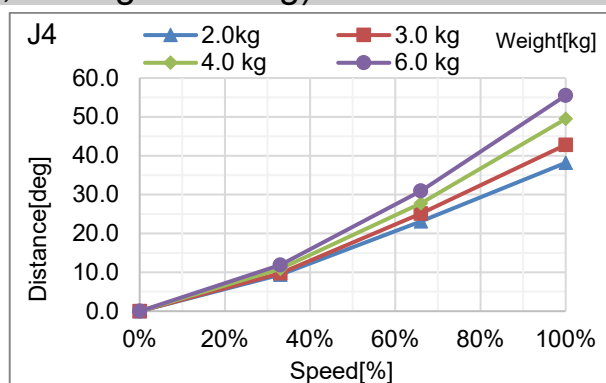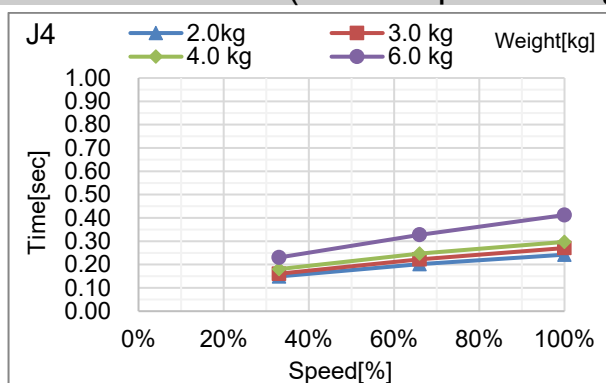
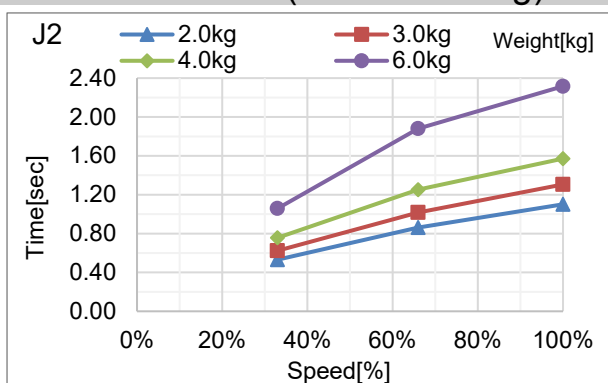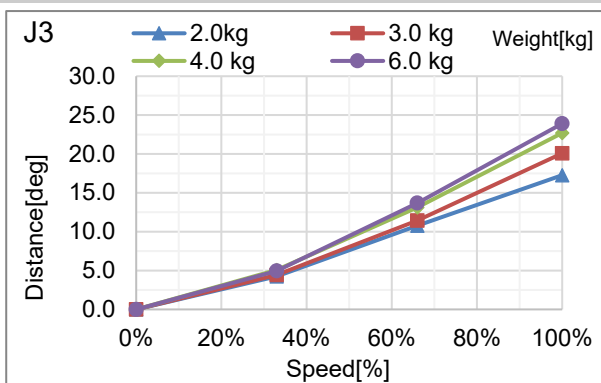## VT6-A901**: J5(Table Top mounting, Ceiling mounting)
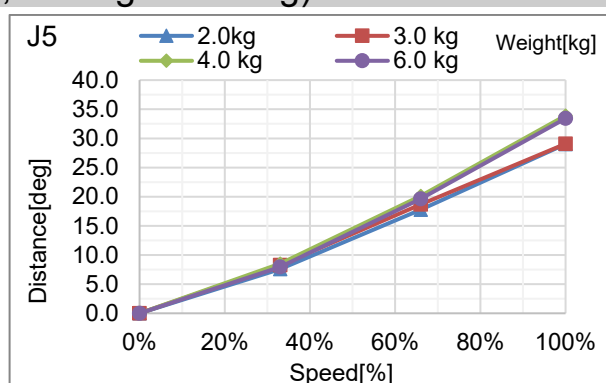
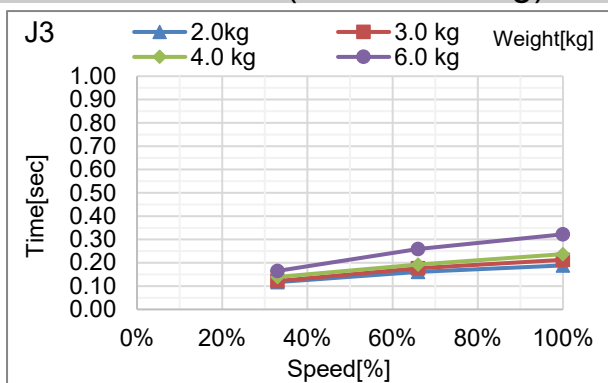## VT6-A901**: J6(Table Top mounting, Ceiling mounting)
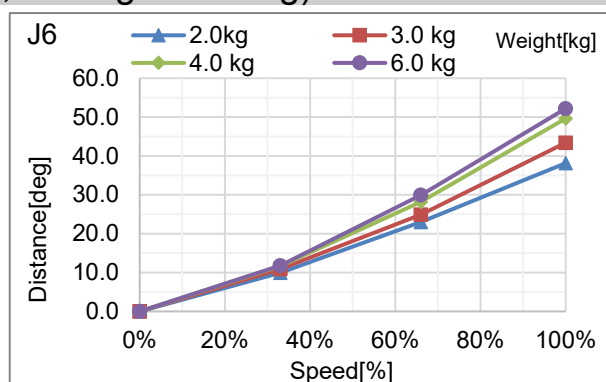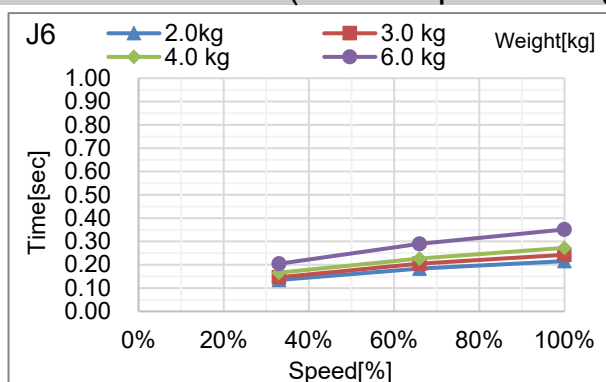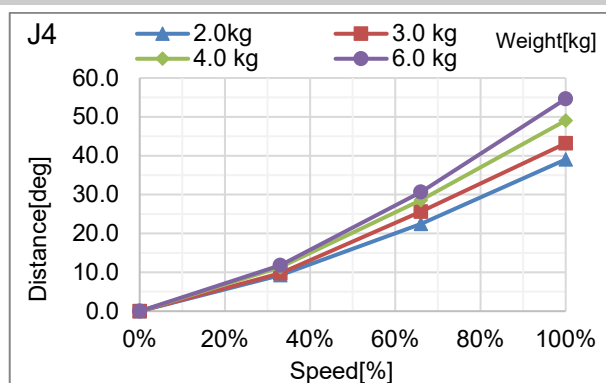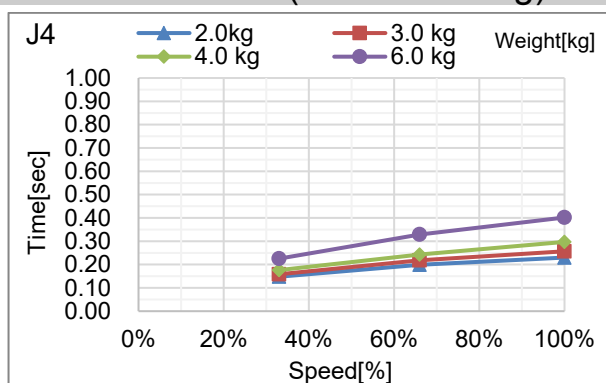
VT6-A901**: J1(Wall mounting)
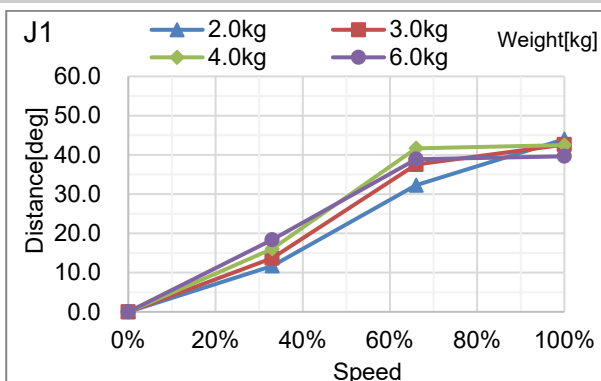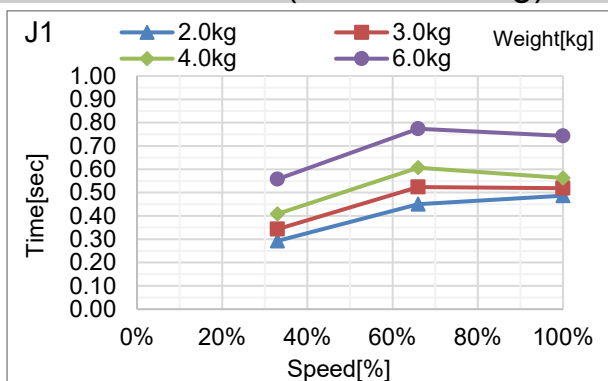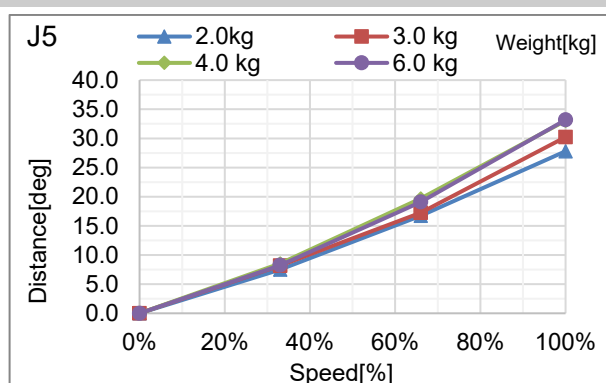

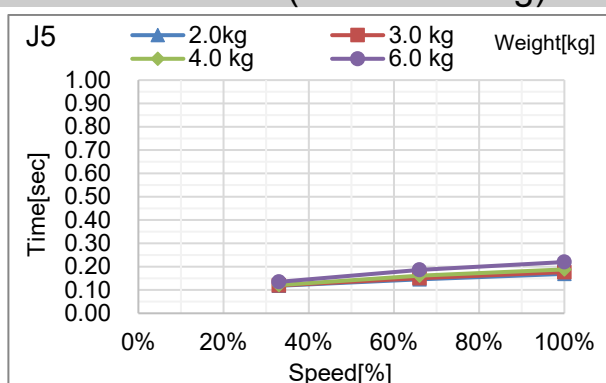## VT6-A901**: J2(Wall mounting)
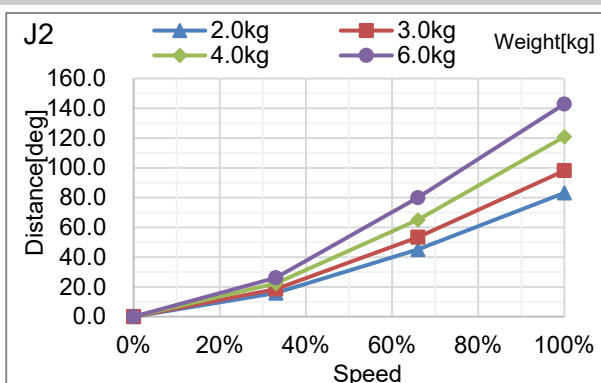
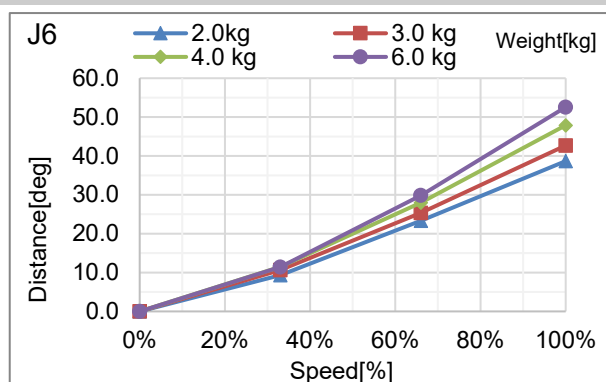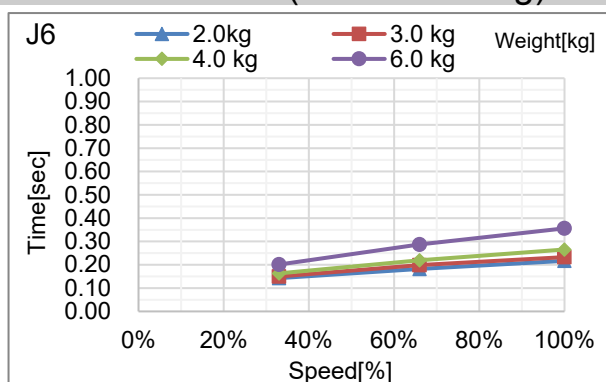## VT6-A901**: J3(Wall mounting)

VT6-A901**: J4(Wall mounting)

VT6-A901**: J5(Wall mounting)

VT6-A901**: J6(Wall mounting)

Supplementary Information regarding the Stopping Time and Stopping Distance when the Safeguard is Open

The stopping time and stopping distance described in Appendix C was measured by the motion determined by us based on the ISO 10218-1.

Therefore, it does not guarantee the maximum value of the stopping time and stopping distance in the customer's environment.

The stopping time and stopping distance differs depending on the robot's model, motion, and input timing of the stop signal. Make sure to always measure the stopping time and stopping distance that matches the customer's environment.

NOTE

☞

The following are included in the robot's motion and parameter.
- 　　　The motion's starting point, target point, and relay point
- 　　　Motion commands (Go, Move, Jump commands etc.)
- 　　　Weight and Inertia Settings
- 　　　Motion speed, acceleration, deceleration, and one where the motion timing changes

Also, refer to the following description.
"4.3 Weight and Inertia Settings"
"4.4 Precautions for Auto Acceleration "

How to check the stopping time and stopping distance in the customer's environment

Measure the stopping time and stopping distance of the actual motion with the following method.

1. Create a motion program in the customer's environment.

2. After the motion to check the stopping time and stopping distance starts, input the stop signal at your own timing.

3. Record the time and distance from when the stop signal was input until the robot stopped.

4. Check the maximum stopping time and stopping distance by repeating 1 through 3 mentioned above.

- How to input the stop signal: Operate the stop switch/safeguard manually or input the stop signal with the safety PLC.

- How to measure the stopping position: Measure with a tape measure. The angle could also be measured with the Where or RealPos command.

- How to measure the stopping time: Measure with a stop watch. The Tmr function can also be used to measure the stopping time.

⚠ CAUTION	■ The stopping time and stopping distance changes depending on the timing the stop signal is input. In order to prevent collision with people or objects, perform a risk assessment based on the maximum stopping time and stopping distance and perform an equipment design. Therefore, make sure to measure the maximum value by changing the timing of the stop signal input during the actual motion and measure repeatedly.

Commands that can be useful when measuring stopping time and stopping distance

Commands	Functions
Where	Returns the data of the robot's current position.
RealPos	Returns the current position of the specified robot *Unlike the motion target position of the CurPos, this obtains the position of the actual robot from the encoder in real time.
PAgl	Returns by calculating the Joint position from the specified coordinate value. 　　P1 = RealPos 'Obtain the current position 　　Joint1 = PAgl(P1, 1)　' Request the J1 angle from the current position
Tmr	The Tmr function returns the elapsed time from when the timer starts in seconds.
Xqt	Runs the program specified with the function name and complete the task. The function used to measure the stopping time and stopping distance should be used to run tasks that were launched by attaching the NoEmgAbort options. You can run a task that does not stop with the emergency stop and safeguard open.

For more information, refer to the following manual.

"Epson RC+ SPEL+ Language Reference"

VT series   Rev.10