EPSON

6-Axis Robots

VT series

MANIPULATOR MANUAL

Rev.9

EM208R4487F

MANIPULATOR MANUAL VT series Rev.9

6-Axis Robots

VT series Manipulator Manual

Rev.9

Copyright © 2018-2020 SEIKO EPSON CORPORATION. All rights reserved.

FOREWORD

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

WARRANTY

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

Product malfunctions resulting from normal handling or operation will be repaired free of charge during the normal warranty period. (Please contact the supplier of your region for warranty period information.)

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

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

Warnings, Cautions, Usage:

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

TRADEMARKS

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

TRADEMARK NOTATION IN THIS MANUAL

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

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 and Installation Read this manual first

Regarding battery disposal



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

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

The battery removal/replacement procedure is described in the following manuals:
VT series manipulator manual
Maintenance: 18.4 Replacing the Lithium Battery

Before Reading This Manual

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

Structure of Robot System

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

	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+ 7.0 Ver.7.4.7

Shape of Motors

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

Setting by Using Software

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



Setup & Operation

1. Safety 3

1.1 Conventions ... 3
1.2 Design and Installation Safety ... 4
1.3 Operation Safety ... 5
1.4 Emergency Stop ... 7
1.5 How to Move Arms with the Electromagnetic Brake ... 9
1.5.1 Arm Motions ... 9
1.5.2 Release the Brake by the Software ... 10
1.6 Precaution for Operation in Low Power Status ... 10
1.7 Labels ... 11

2. Specifications 13

2.1 Features of VT series Manipulators ... 13
2.2 Model Number ... 13
2.3 Part Names ... 14
2.4 Outer Dimensions ... 16
2.5 Standard Motion Range ... 18
2.6 System Example ... 20
2.7 Specifications ... 21
2.8 How to Set the Model ... 25

3. Environments and Installation 26

3.1 Environmental Conditions ... 26
3.2 Base Table ... 28
3.3 Mounting Dimensions ... 30
3.4 Unpacking and Transportation ... 31
3.5 Installation Procedure ... 32
3.6 Power Supply ... 34
3.6.1 Specifications ... 34
3.6.2 Power Cable ... 34
3.6.3 Breaker ... 36
3.6.4 Grounding ... 37
3.7 Connecting the Cables ... 38
3.8 Relocation and Storage ... 42
3.8.1 Precautions for Relocation and Storage ... 42
3.8.2 Relocation ... 43
3.9 Checking the Basic Orientation ... 45
3.10 Origin Position Label ... 45

4. Setting of End Effectors 46
4.1 Attaching an End Effector 46
4.2 Attaching Cameras and Air Valves 47
4.3 Weight and Inertia Settings 47
4.3.1 Weight Setting 50
4.3.2 INERTIA Setting 53
4.4 Precautions for Auto Acceleration/Deceleration of Joint #3 57

5. Motion Range 58
5.1 Motion Range Setting by Pulse Range (for All Joints) 58
5.1.1 Max. Pulse Range of Joint #1 59
5.1.2 Max. Pulse Range of Joint #2 59
5.1.3 Max. Pulse Range of Joint #3 60
5.1.4 Max. Pulse Range of Joint #4 60
5.1.5 Max. Pulse Range of Joint #5 60
5.1.6 Max. Pulse Range of Joint #6 61
5.2 Motion Range Setting by Mechanical Stops 62
5.2.1 Motion Range Setting of Joint #1 62
5.2.2 Motion Range Setting of Joint #2 63
5.2.3 Motion Range Setting of Joint #3 64
5.3 Restriction of Manipulator Operation by Joint Angle Combination 65
5.4 Coordinate System 66
5.5 Changing the Robot 67
5.6 Setting the Cartesian (Rectangular) Range in the XY Coordinate System of the Manipulator 68

6. Operation Mode & LED 69
6.1 Overview 69
6.2 Switch Operation Mode 69
6.3 Program Mode (AUTO) 70
6.3.1 What is Program Mode (AUTO)? 70
6.3.2 Setup from EPSON RC+ 7.0 70
6.4 Auto Mode (AUTO) 71
6.4.1 What is Auto mode (AUTO)? 71
6.4.2 Setup from EPSON RC+ 7.0 71
6.4.3 Setup from Control Device 72
6.5 LED 73

7. Development PC Connection Port 74
7.1 What is Development PC Connection Port 74
7.2 Precaution 75
7.3 Software Setup and Connection Check 75
7.4 Disconnection of Development PC and Manipulator 76

8. Memory Port 77
8.1 What is Controller Status Storage Function? 77
8.2 Before Using Controller Status Storage Function 77
8.2.1 Precautions 77
8.2.2 Adoptable USB Memory 78
8.3 Controller Status Storage Function 78
8.3.1 Controller Status Storage 78
8.3.2 Load Data with EPSON RC+ 7.0 79
8.3.3 Transfer with E-mail 80
8.4 Details of Data 81

9. LAN (Ethernet Communication) Port 82
9.1 What is the LAN (Ethernet Communication) Port 82
9.2 IP Address 83
9.3 Changing Manipulator IP Address 83
9.4 Connection of Development PC and Manipulator with Ethernet 84
9.5 Disconnection of Development PC and Manipulator with Ethernet 86

10. TP Port 87
10.1 What is the TP Port? 87
10.2 Teach Pendant Connection 87

11. Options 88
11.1 Camera Plate Unit 88
11.2 Tool Adapter (ISO flange) 90
11.3 Adjustable Mechanical Stops 91
11.4 External Wiring Kit 91

12. EMERGENCY 98
12.1 Safeguard Switch and Latch Release Switch 98
12.1.1 Safeguard Switch 99
12.1.2 Latch Release Switch 100
12.1.3 Checking Latch Release Switch Operation 100
12.2 Emergency Stop Switch Connection 101
12.2.1 Emergency Stop Switch 101
12.2.2 Checking Emergency Stop Switch Operation 101
12.2.3 Recovery from Emergency Stop 101
12.3 Pin Assignments 102

12.4 Circuit Diagrams....103
12.4.1 Example 1: External emergency stop switch typical application....103
12.4.2 Example 2: External safety relay typical application....104
12.4.3 Example 3: Connection example of mobile platform and emergency stop....105

13. Standard I/O Connector 106
13.1 Standard, Cleanroom Model....106
13.1.1 Input Circuit (Standard, Cleanroom Model)....106
13.1.2 Output Circuit (Standard, Cleanroom Model)....110
13.2 Protection Model....113
13.2.1 Input Circuit (Protection Model)....113
13.2.2 Output Circuit (Protection Model)....116
13.2.3 Pin Assignments of Input and Output Circuit (Protection Model)....118
13.3 I/O Cable Product Procedure....119
13.3.1 I/O Cable Connecting Method....119
13.3.2 How to Fix the I/O Cable....119

14. I/O Remote Settings 120
14.1 I/O Signal Description....121
14.1.1 Remote Input Signals....121
14.1.2 Remote Output Signals....125
14.2 Timing Specifications....128
14.2.1 Precautions for Remote Input Signals....128
14.2.2 Timing Diagram for Operation Execution Sequence....128
14.2.3 Timing Diagram for Program Execution Sequence....128
14.2.4 Timing Diagram for Safety Door Input Sequence....129
14.2.5 Timing Diagram for Emergency Stop Sequence....129

15. SD Card Slot 130

16. RESET Switch 131

17. Fieldbus I/O 132
17.1 Standard, Cleanroom model....133
17.2 Protection Model....134

Maintenance

1. Safety Maintenance 141

2. General Maintenance 142
2.1 Maintenance Inspection 142
2.1.1 Schedule for Maintenance Inspection 142
2.1.2 Inspection Point 143
2.2 Overhaul (Parts Replacement) 144
2.3 Tightening Hexagon Socket Head Cap Bolts 146
2.4 Matching Origins 146
2.5 Layout of Maintenance Parts 147

3. Manipulator Structure 148
3.1 AC Specification Manipulator 148
3.2 DC Specification Manipulator 150

4. Alarm 151
4.1 Maintenance 152
4.2 Maintenance Information 153
4.2.1 How to Check the Maintenance Information 153
4.2.2 How to Edit the Maintenance Information 154
4.2.3 Alarm Notifying Method 155
4.2.4 How to Cancel the Alarm 155

5. Backup and Restore 156
5.1 What is the Backup Controller Function 156
5.2 Backup Data Types 156
5.3 Backup 157
5.4 Restore 158

6. Firmware Update 161
6.1 Updating Firmware 161
6.2 Firmware Upgrade Procedure 161
6.3 Manipulator Recovery 163
6.4 Firmware Initialization Procedure 164
6.5 Adding Confirmation Steps by Strengthening Security of EtherNet Connection 166

7. Covers 170
7.1 Arm #1 Cover 171
7.2 Arm #2 Cover 173
7.3 Arm #3 Cover 174

7.4 Arm #4 Cover 1 175
7.5 Arm #4 Cover 2 176
7.6 Power Cable Cover 178
7.7 Connector Plate 179

8. Cable 181
8.1 Replacing Cable Unit 182
8.2 Insert or Pull out of Power Cable 199

9. Joint #1 200
9.1 Replacing Joint #1 Motor 201
9.2 Replacing Joint #1 Reduction Gear Unit....205
9.3 Replacing Joint #1 Timing Belt 206

10. Joint #2 211
10.1 Replacing Joint #2 Motor 212
10.2 Replacing Joint #2 Reduction Gear Unit....218
10.3 Replacing Joint #2 Timing Belt 219

11. Joint #3 220
11.1 Replacing Joint #3 Motor 221
11.2 Replacing Joint #3 Reduction Gear Unit....227
11.3 Replacing Joint #3 Timing Belt 228

12. Joint #4 229
12.1 Replacing Joint #4 Motor 230
12.2 Replacing Joint #4 Reduction Gear Unit....235
12.3 Replacing Joint #4 Timing Belt 236

13. Joint #5 240
13.1 Replacing Joint #5 Motor 241
13.2 Replacing Joint #5 Reduction Gear Unit....245
13.3 Replacing Joint #5 Timing Belt 246

14. Joint #6 247
14.1 Replacing Joint #6 Motor 248
14.2 Replacing Joint #6 Reduction Gear Unit....252
14.3 Replacing Joint #6 Timing Belt 253

15. AMP Board 254
15.1 Replacing AMP Board on Joint #1, #2, and #3 256
15.2 Replacing AMP Board on Joint #4 258
15.3 Replacing AMP Board on Joint #5 and #6 259

16. LED Plate 260
16.1 Replacing LED Plate 261

17. Felt Sheet 262
17.1 Replacing Joint #1 Felt Sheet 263
17.2 Replacing Joint #2 Felt Sheet 264
17.3 Replacing Joint #3 Felt Sheet 265

18. Controller Unit 266
18.1 Replacing Controller Unit 267
18.1.1 Standard, Cleanroom Model 268
18.1.2 Protection Model 271
18.2 Replacing Power Board 275
18.3 Replacing CPU/DPB Board 276
18.4 Replacing Lithium Battery 279
18.5 Replacing Cooling Fan 279
18.6 Replacing SD Card 280
18.6.1 Standard, Cleanroom Model 280
18.6.2 Protection Model 281

19. Calibration 282
19.1 Overview 282
19.2 Calibration Procedures 285

20. Restrictions 289
20.1 Commands Cannot Use 289
20.2 Commands Cause Motion Error If Specifying RS-232C 289
20.3 Commands Cause Error 290
20.3.1 Conveyor Tracking Commands 290
20.3.2 PG Commands 291
20.3.3 R-I/O Commands 291
20.3.4 Force Sensing Commands 291
20.3.5 Other (FineDist) 291
20.3.6 Other (HealthCalcPeriod) 291
20.3.7 Other (ChDisk) 291

20.4 Restrictions of Functions....292
20.4.1 TP3....292
20.4.2 Loop Processing....292
20.4.3 Camera Searching by CV1/CV2....293
20.4.4 Restore the Data of Backup Controller Function....293
20.5 Command only available in DC specification Manipulator....294

21. Error Code Table 295

22. Maintenance Parts List 296

23. Option Parts List 298

Appendix A: Open Source Software License 299

Setup & Operation

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

1. Safety

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

1.1 Conventions

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

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

1.2 Design and Installation Safety

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

The following items are safety precautions for design personnel:

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

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

1.3 Operation Safety

The following items are safety precautions for qualified Operator personnel:

⚠ WARNING	■ Please carefully read the 1.3 *Safety-related Requirements* in the *Safety* chapter of the *Safety and Installation* manual before operating the robot system. Operating the robot system without understanding the safety requirements is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system. ■ Do not enter the operating area of the Manipulator while the power to the robot system is turned ON. Entering the operating area with the power ON is extremely hazardous and may cause serious safety problems as the Manipulator may move even if it seems to be stopped. ■ Before operating the robot system, make sure that no one is inside the safeguarded area. The robot system can be operated in the mode for teaching even when someone is inside the safeguarded area. The motion of the Manipulator is always in restricted (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 power cable to a power plug. DO NOT connect it directly to a factory power source. ■ Before performing any replacement procedure, turn OFF the robot system and related equipment, and then disconnect the power plug from the power source. Performing any replacement procedure with the power ON is extremely hazardous and may result in electric shock and/or malfunction of the robot system. ■ Do not connect or disconnect the motor connectors while the power to the robot system is turned ON. Connecting or disconnecting the motor connectors with the power ON is extremely hazardous and may result in serious bodily injury as the Manipulator may move abnormally, and also may result in electric shock and/or malfunction of the robot system. ■ 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 for polarity. If connecting Manipulator cable to wrong polarity, it may result in malfunction of the robot system. For details on connection, refer to *Setup & Operation 3.6.2 Power Cable*.

 CAUTION	■ Whenever possible, only one person should operate the robot system. If it is necessary to operate the robot system with more than one person, ensure that all people involved communicate with each other as to what they are doing and take all necessary safety precautions. ■ Each Joint: If the joints are operated repeatedly with the operating angle less than 5 degrees, the Manipulator may get damaged early due to the bearings are not being covered with grease during movement. To prevent early breakdown, move the joints larger than 30 degrees for about five to ten times a day. ■ 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.

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.

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

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

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

Refer to the *Setup & Operation: 12. EMERGENCY* for instructions on how to wire the Emergency Stop switch circuit.

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

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

If the Manipulator is stopped by turning OFF 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 the *Maintenance 19. Calibration* in this manual. Also, the same troubles may occur if an error occurs and the Manipulator stops in emergency during the operation. Check the Manipulator condition and perform calibration if necessary.

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

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

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

Safety and Installation
2.5 Connection to EMERGENCY Connector

To check brake problems, refer to the following manuals.

Manipulator Manual *Maintenance*
2.1.2 Inspection Point - Inspection While the Power is ON (Manipulator is operating)

Safety and Installation
5.1.1 Manipulator
- Inspection While the Power is ON (Manipulator is operating)

Free running distance in emergency

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

Weight of the end effector	Weight setting
Weight of workpiece	Speed setting
Operating pose	Accel setting

Conditions for measurement

	VT series
ACCEL Setting	100
SPEED Setting	100
Load [kg]	6
WEIGHT Setting	6

			VT6-A901**
Free running time [sec.]	Arm #1		0.8
	Arm #2		1.5
	Arm #3		0.3
	Arm #4		0.3
	Arm #5		0.3
	Arm #6		0.4
Free running angle [°]	Arm #1	Table Top Ceiling	35
		Wall	30
	Arm #2		50
	Arm #3		10
	Arm #4		10
	Arm #5		10
	Arm #6		15

1.5 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.

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

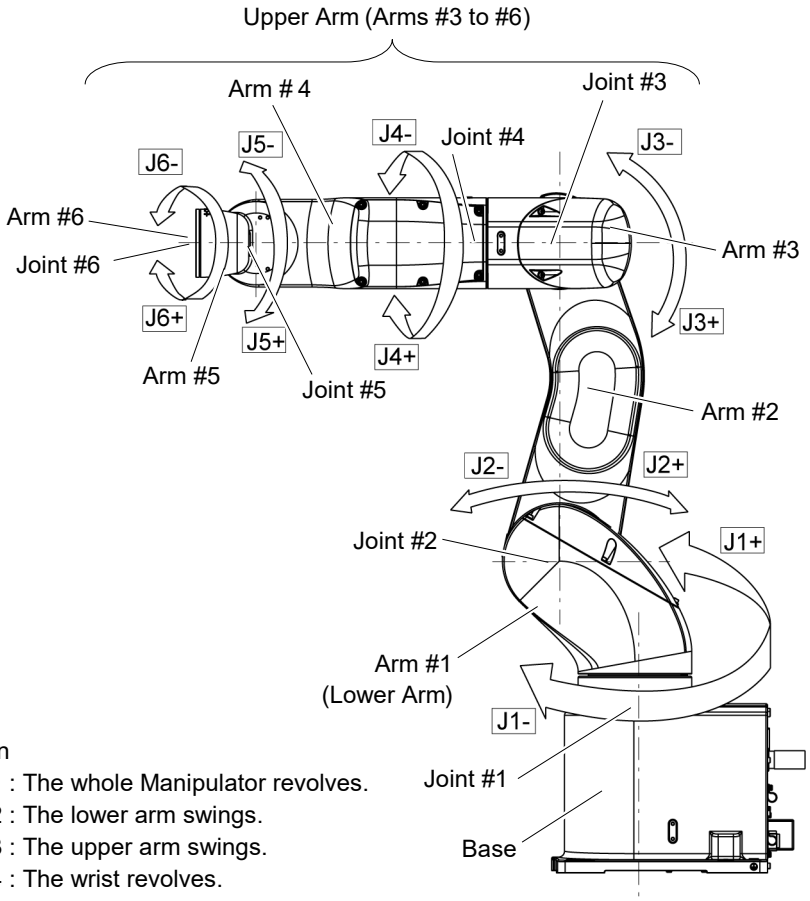
NOTE

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.

1.5.1 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.

1.5.2 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, be sure to keep the Emergency Stop switch handy so that you can immediately press the Emergency Stop switch. Otherwise, you cannot immediately stop the arm falling due to an erroneous operation. The arm falling may cause equipment damage 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]
```

1.6 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

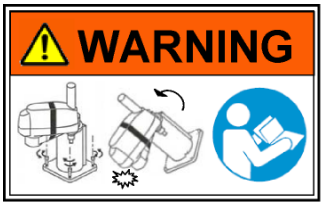
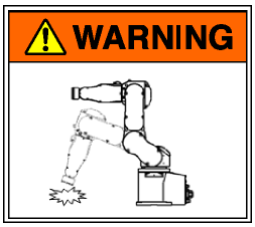
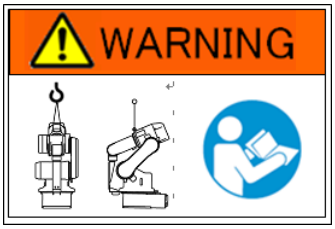
VT6-A901SW (Wall mounting)

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.

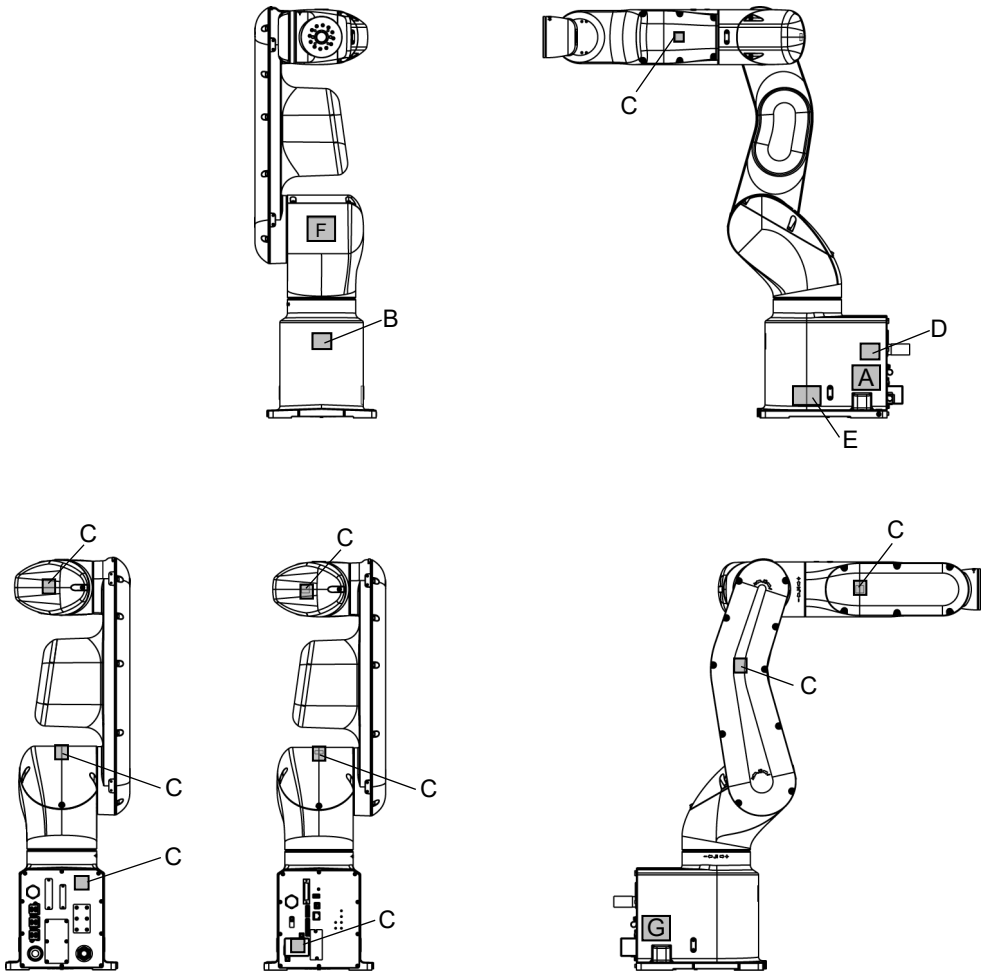
1.7 Labels

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. For transport and install procedures, follow the steps described in this manual.
B		Do not enter the operation area while the Manipulator is moving. The robot arm may collide against the operator. This is extremely hazardous and may result in serious safety problems.
C		Hazardous voltage exists while the Manipulator is ON. To avoid electric shock, do not touch any internal electric parts.
D		When releasing the brakes, be careful of the arm falling due to its own weight.
E		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.
F		You may get your hand or fingers caught when bringing your hand close to moving parts.

Location	Warning Label	NOTE
G	MODEL :VT6-A901S SERIAL NO. :VT60****** MANUFACTUREI :12/2018 AC100−240V 50/60Hz SINGLE PHASE 1200VA max WEIGHT:40kg MAX PAYLOAD:6kg MOTOR POWER AXIS1 : 300W AXIS2 : 300W AXIS3 : 200W AXIS4 : 100W AXIS5 : 100W AXIS6 : 100W MANUFACTURER : SEIKO EPSON CORPORATION 3-5,OWA3-CHOME,SUWA-SHI NAGANO-KEN,392-8502JAPAN https://global.epson.com/company/ ENTITY PLACING ON EU MARKET: Epson Europe B.V. Azie building, Atlas ArenA Hoogoorddreef 5 1101 BA Amsterdam Zuidoost The Netherlands https://www.epson.eu :VT60****** MADE IN CHINA	Signature label S/N (Serial Number) label

Location of labels



Protection model Standard model, Cleanroom model

2. Specifications

2.1 Features of VT series Manipulators

The VT series Manipulators are Controller integrated Manipulators.
The features of the VT series Manipulators are as follows:

For Device design and tooling

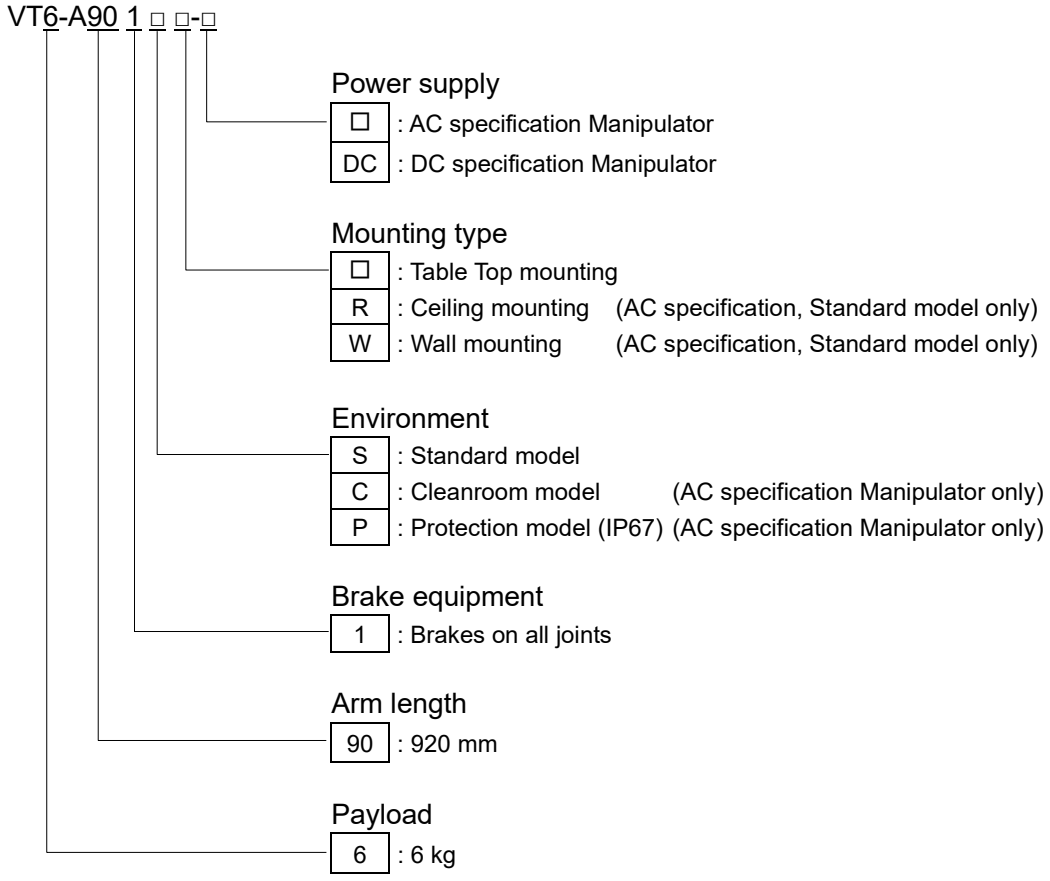
- There is no external Controller
  No installation space required for an external Controller.
  No design is required for external Controller installation or tooling.
- No robot to Controller external cables
  There are no external cables required between the robot and Controller.
- DC specification: battery-driven Manipulator. No fixed power supply is required
  Easy to connect to the mobile platform*.

*Mobile platform indicates Cartesian coordinate robot, wheeled platform, AGV, etc.
In this manual, these terms are referred to as “mobile platform”.

For Maintenance

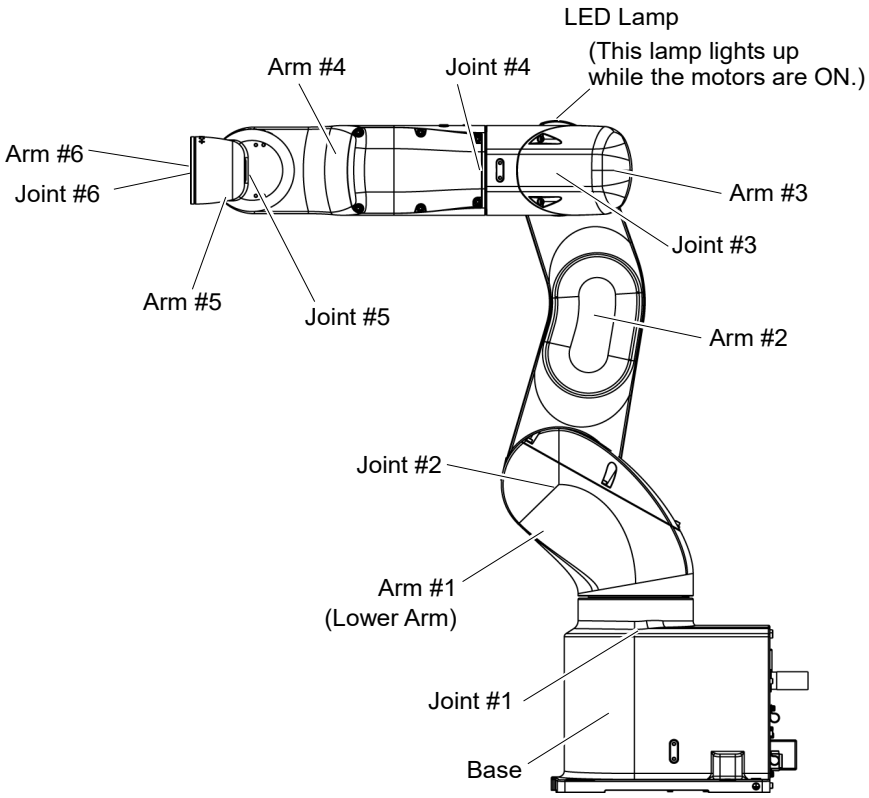
- There are no motor unit batteries for the robot
  No longer necessary to connect external devices for battery replacement.
- Easy to replace the Manipulator

2.2 Model Number



For details on the specifications, refer to *Setup & Operation: 2.7 Specifications*.

2.3 Part Names

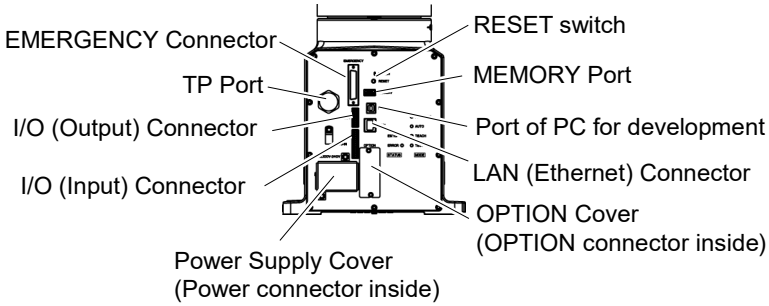


NOTE

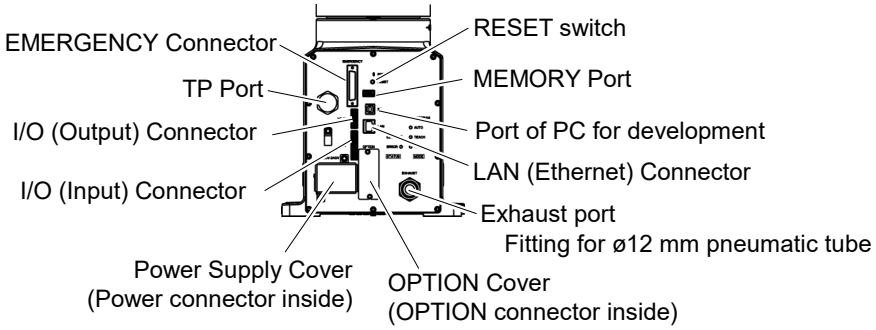
When the LED lamp is lighting or the Controller power is ON, current is being applied to the Manipulator. (The LED lamp may not be seen depending on the Manipulator's posture. Be very careful.)

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.

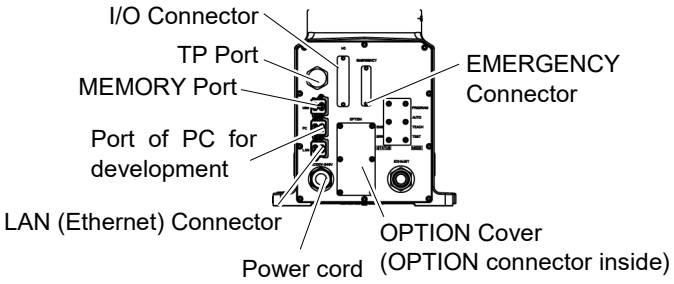
Standard model



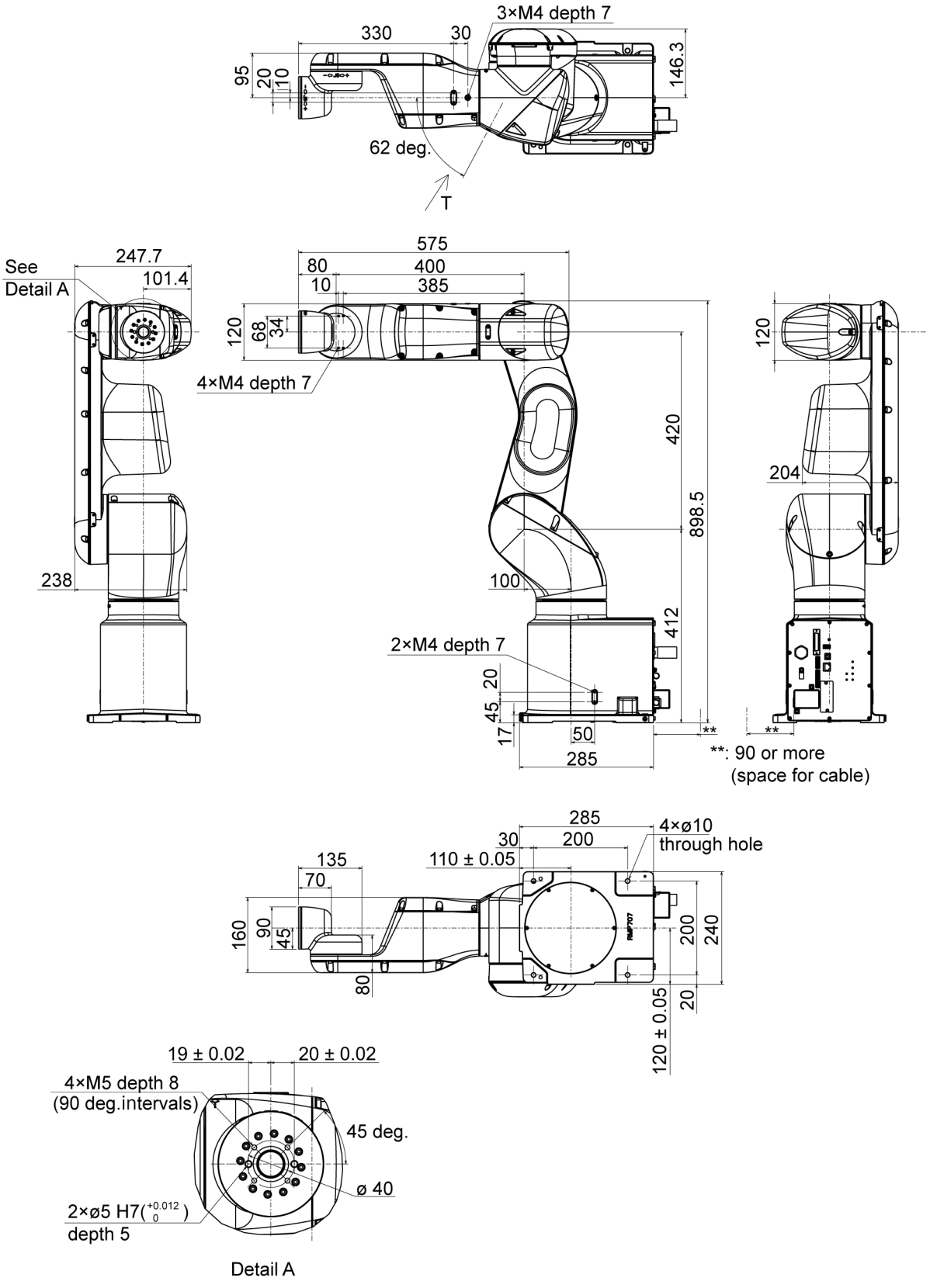
Cleanroom model

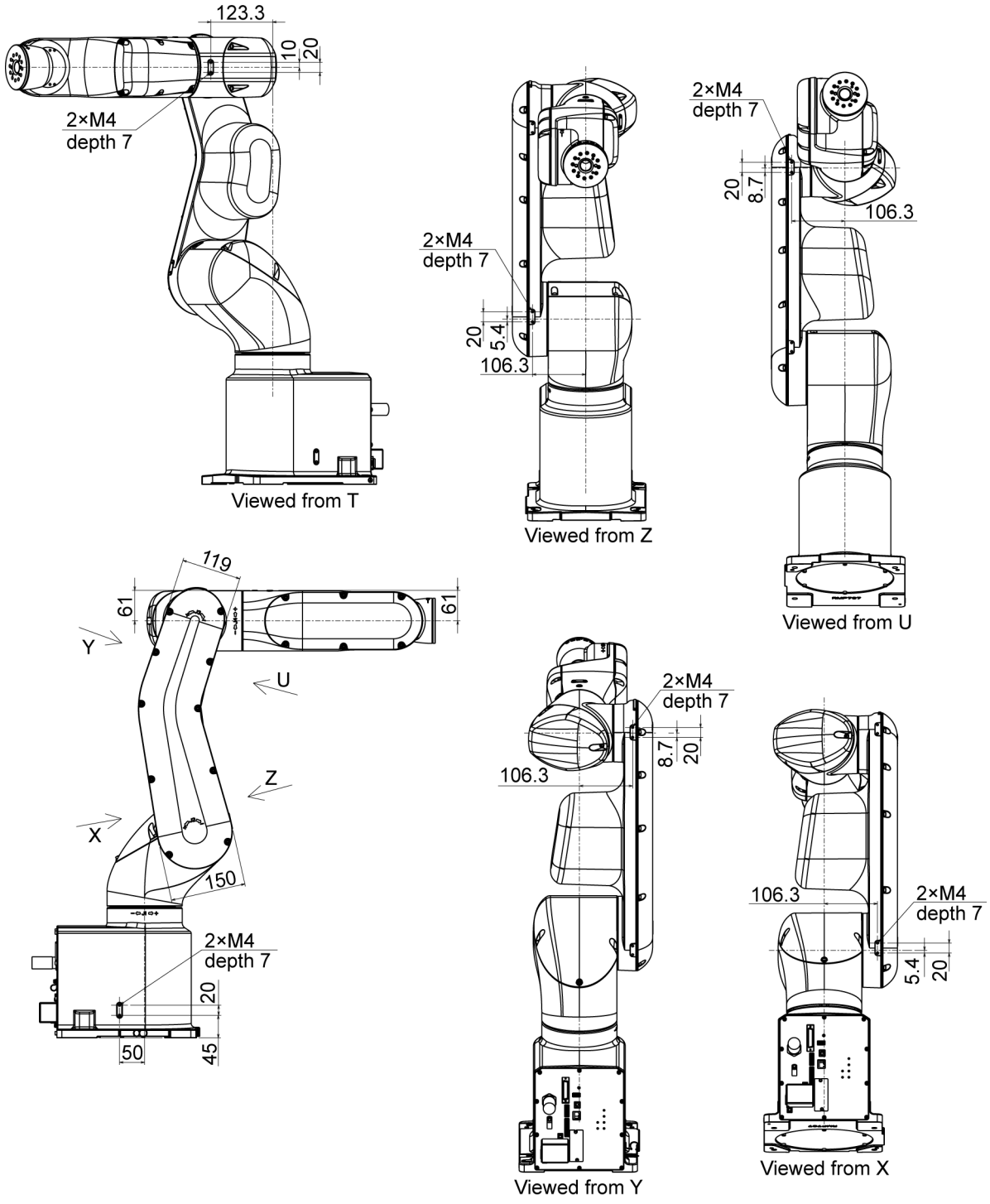


Protection model



2.4 Outer Dimensions

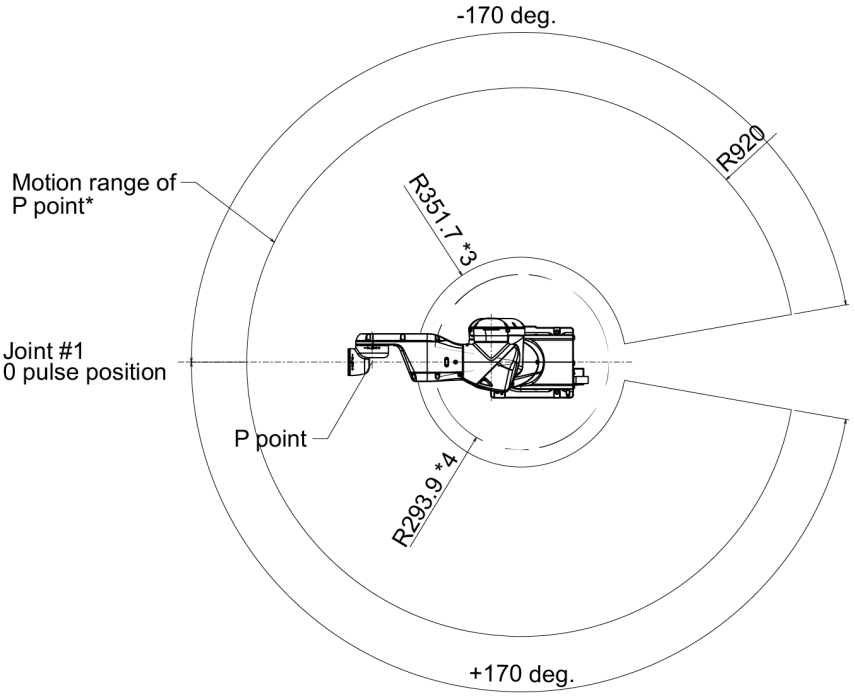



123.3
10
20
2×M4
depth 7
Viewed from T
2×M4
depth 7
20
5.4
106.3
Viewed from Z
2×M4
depth 7
20
8.7
106.3
Viewed from U
119
61
61
Y
U
Z
X
150
2×M4
depth 7
20
50
45
2×M4
depth 7
106.3
8.7
20
Viewed from Y
106.3
2×M4
depth 7
5.4
20
Viewed from X

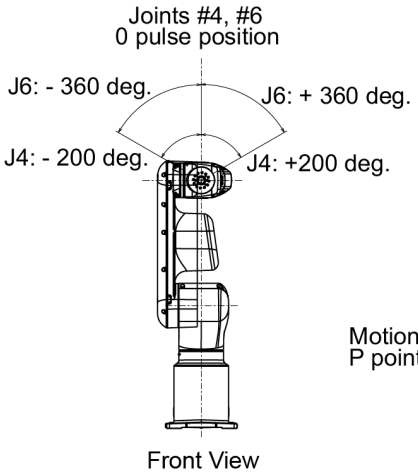
[Unit: mm]

2.5 Standard Motion Range

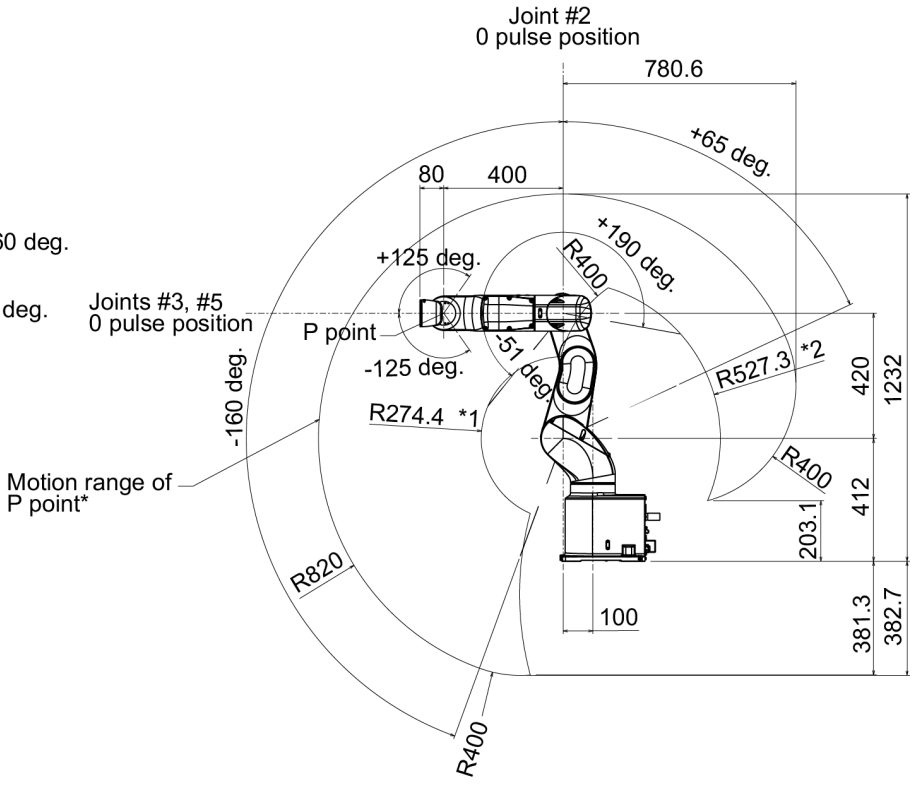
[Unit: mm]



Top View



Front View



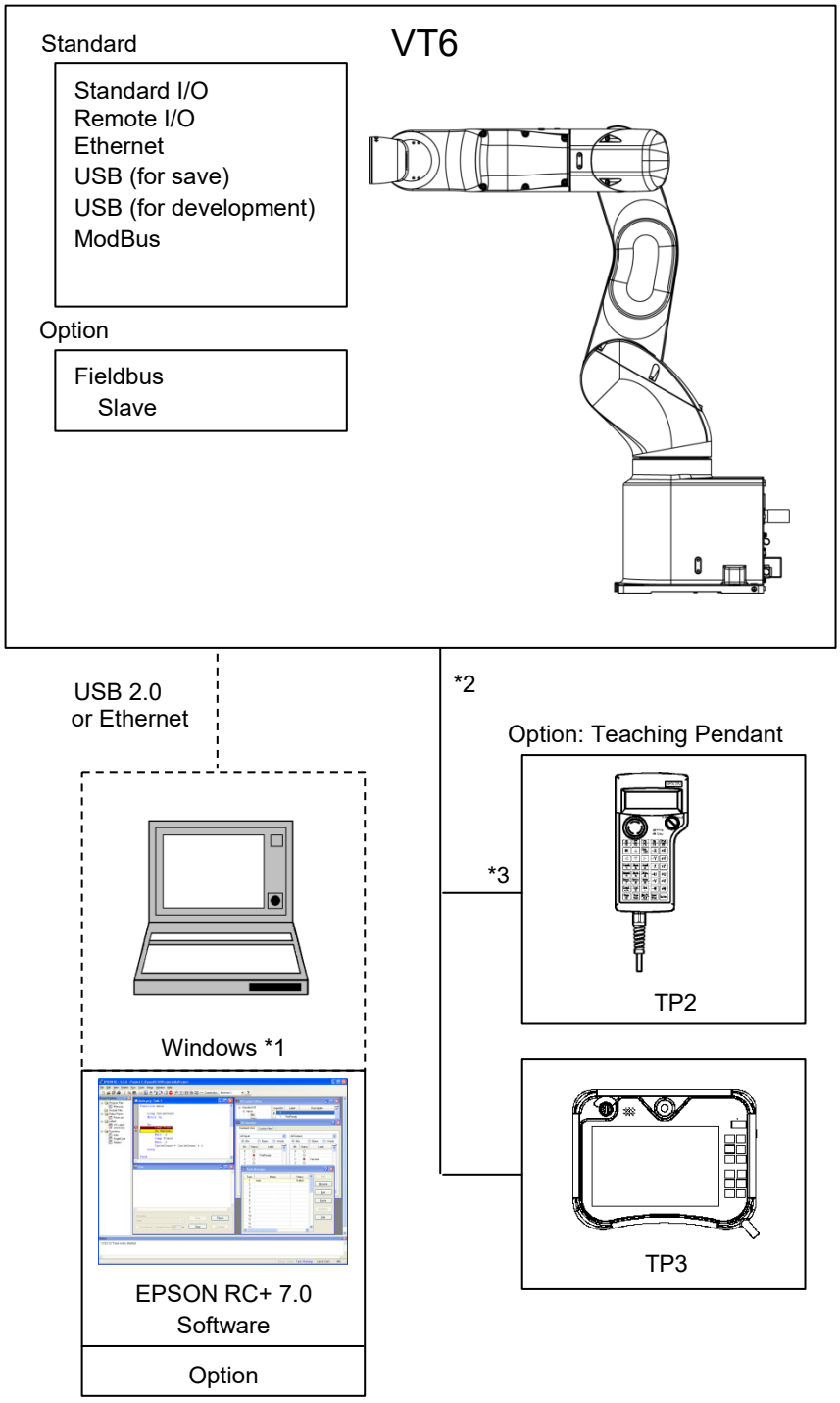
Lateral view

(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.

2.6 System Example



*1 EPSON RC+ 7.0 supports the following OS
Windows 8.1 Pro (EPSON RC+7.0 Ver.7.1.0 or later)
Windows 10 Pro (EPSON RC+7.0 Ver.7.2.0 or later)

*2 Either teaching pendant is available.

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

2.7 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		
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)		

Item			Specifications
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
Default values (Max. setting values)	Speed		(5) 100
	Accel *9		(5, 5) 120, 120
	SpeedS		(50) 2000
	AccelS *10		(200) 10000
	Fine		(10000, 10000, 10000, 10000, 10000, 10000) 65535, 65535, 65535, 65535, 65535, 65535
	Weight		3 (6)
	Inertia		0.03 (0.1)
Motion Control	Development Environment		EPSON RC+ 7.0
	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.)
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, ErrorEStopOn, SafeguardOn, SError, Warning
	Field bus Slave (Option)		Input: 256 points Output: 256 points Enable to add only one more module
	TP Connection Port		Supported for teach pendant (Option: TP2, TP3)
	PC Connection Port		USB B connector Supported for USB 2.0 High Speed / Full Speed
	USB Memory Connection Port		USB A connector Supported for USB 2.0 High Speed / Full Speed

Item		Specifications
	Ethernet Port	Supported for 10/100 Mbps Available up to 8 ports
	RESET Switch	Enable to use for reset of system
Display	Mode Display LED	TEACH, AUTO, PROGRAM, TestMode, Error, E-STOP
Controller Status Save		Save to USB memory Save in RC+ (PC)
Safety standard		CE Marking: EMC Directive, Machinery Directive, RoHS Directive KC Marking / KCs Marking (VT6-A901S, VT6-A901C, VT6-A901P) ANSI/RIA R15.06 NFPA 79

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
Peak 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
Peak Current (When DC power is turned ON)	Max. 40A (less than 10 ms)
Rated Capacity	1200 W
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 *Setup & Operation 3.1 Environmental Conditions*.

*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:

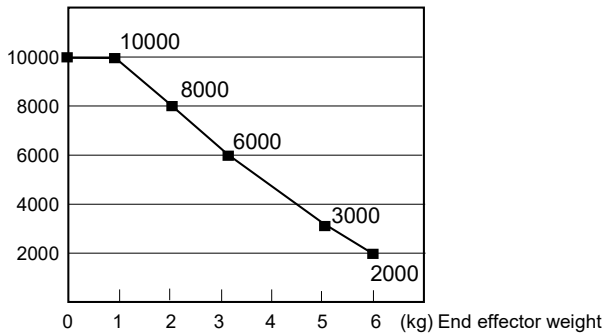
- The Manipulator is not rust-proofed. Do not use the Manipulator in environment where corrosive liquids exist.
- Fluids that deteriorate the sealing materials, such as organic solvents, acids, alkalis, and chlorine cutting fluids, cannot be used
- The Manipulator cannot be used for underwater operations.

<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



2.8 How to Set the Model

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

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

NOTE

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

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

The Manipulator model can be set from software.

Refer to the following manual.

Chapter *Robot Configuration* in the *EPSON RC+ User's Guide*.

3. Environments and Installation

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 (with minimum temperature variation)
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
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 shocks or vibrations. - Keep away from sources of electric noise. - Keep away from strong electric or magnetic fields.

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.

*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 *Setup & Operation: 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.

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.

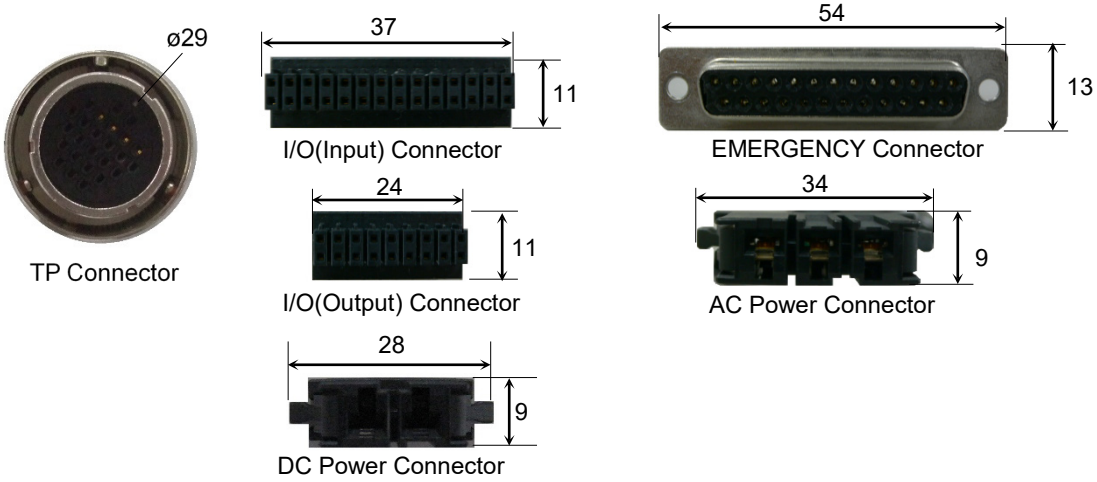
The Manipulator must be installed horizontally.

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

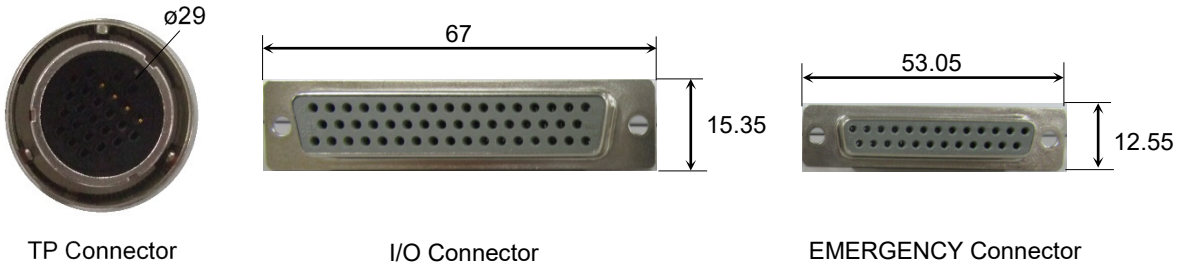
If you are passing cables through the holes on the base table, see the figures below.

(Unit: mm)

Standard model, Cleanroom model



Protection model



WARNING	■ To ensure safety, a safeguard must be installed for the robot system. For details on the safeguard, refer to the *EPSON RC+ User's Guide*.

3.3 Mounting Dimensions

Mounting Area

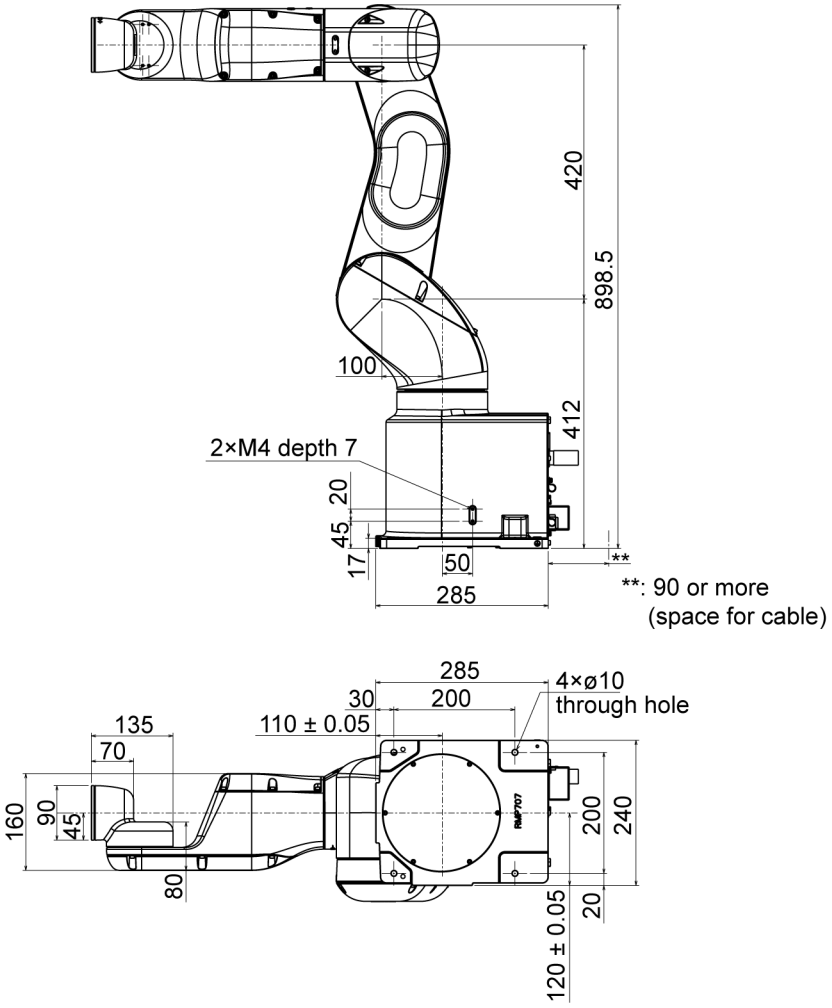
Be sure to have the following space available in addition to the space for mounting the Manipulator and peripheral equipment.

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

THE INSTALLATION SHALL BE PREFORMED BY QUALIFIED INSTALLATION PERSONNEL AND SHOULD CONFORM TO ALL NATIONAL AND LOCAL CODES.

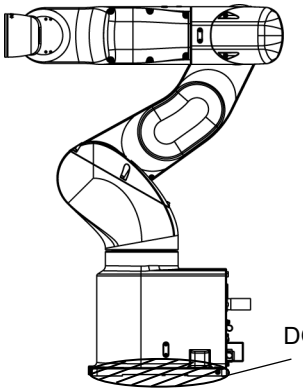
WARNING	■ Only authorized personnel should perform sling work and operate a crane and a forklift. When these operations are performed by unauthorized personnel, it is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system. ■ Stabilize the Manipulator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

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

■ When transporting the Manipulator, avoid excessive vibration or shock. Excessive vibration or shock may cause equipment damage and/or malfunction of the Manipulator.

■ Stabilize the Manipulator with your hands when hoisting it. Unstable hoisting is extremely hazardous and may result in fall of the Manipulator.

■ When transporting the Manipulator for a long distance, secure it to the delivery equipment 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 qualified installation personnel and should conform to all national and local codes.

WARNING	■ To ensure safety, a safeguard must be installed for the robot system. For details on the safeguard, refer to the Installation and Design Precautions in the Safety chapter of the EPSON RC+ User's Guide. ■ Install the Manipulator in a location with sufficient space so that a tool or a work piece does not touch a wall or a safeguard when the Manipulator extends its arm fully while holding a work piece. Installing the Manipulator at a location with insufficient space is extremely hazardous and may result in serious bodily injury and/or severe equipment damage to the robot system as a tool or a work piece may collide with a wall or a safeguard. ■ Anchor the Manipulator before turning ON the power 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 for 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

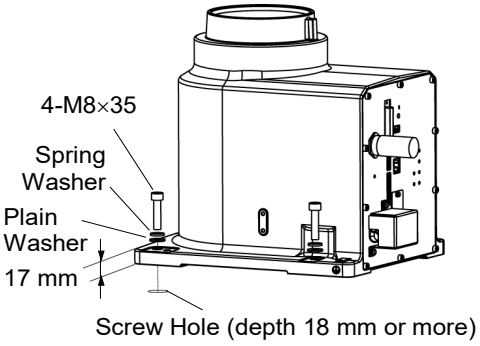
For the dimensions, refer to *Setup & Operation 3.3 Mounting Dimensions*.

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)



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

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

3.6.1 Specifications

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
Peak Current (When AC power is turned ON)	Max. 60A (Less than 2 ms)
Leak Current	Max. 10 mA
Ground Resistance	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.)
Peak Current (When DC power is turned ON)	Max. 40A (less than 10 ms)
Rated Capacity	1200 W
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, we recommend to ground directly via a hole on the base to ground the Manipulator completely. The equipment must be grounded properly at all times to avoid the risk of electric shock. ■ 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.

AC specification Manipulator

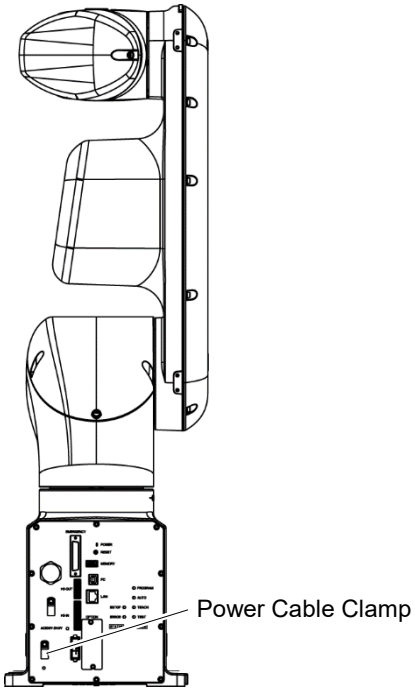
Item	Specification
AC power wire (2 cables)	Black, White
Ground wire	Green/Yellow
Cable length	5 m
Terminal	M4 round solderless terminal

DC specification Manipulator

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

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

(Only for Standard model, Cleanroom model)



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 can handle the “peak current” described in the following section.

Setup & Operation 3.6.1 Specifications

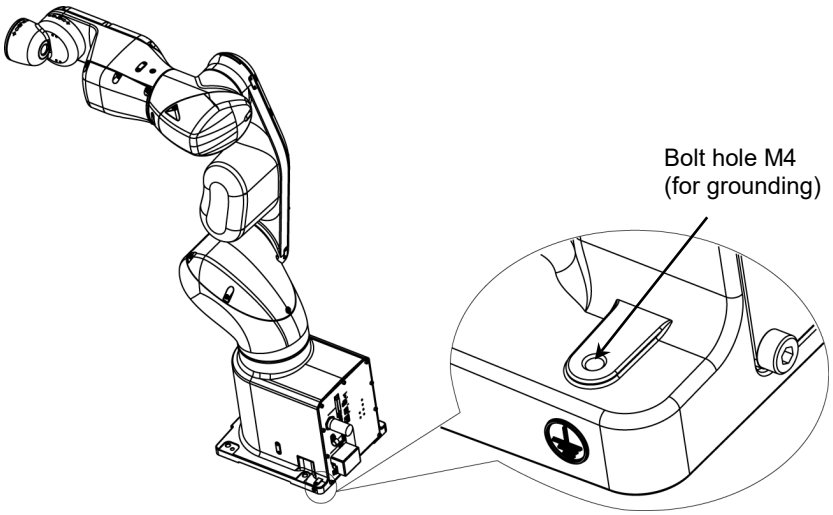
The power receptacle shall be installed near the equipment and shall be easily accessible.

3.6.4 Grounding

WARNING	■ Ground resistance must be 100 Ω or less. Improper ground resistance may result in fire and/or electric shock. ■ Do not use the ground line for the Manipulator in common with other ground lines or grounding electrodes for other electric power, motor power, welding devices, etc. Using the ground line for the Manipulator in common with other ground lines or grounding electrodes may result in electric shock and/or malfunction of the robot system. ■ When using metal ducts, metallic conduits, or distributing racks for cable, ground in accordance with national and local electric equipment technical standards. Grounding that does not meet the standards may result in electric shock and/or malfunction of the robot system.

Follow local regulations for grounding. It is recommended that the core size of the grounding wire be 5.5 mm^2 or more.
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 (–).



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. ■ Before performing any replacement procedure, turn OFF the Controller and related equipment, and then disconnect the power plug from the power source. Performing any replacement procedure with the power ON is extremely hazardous and may result in electric shock and/or malfunction of the robot system. ■ Be sure to connect the cables properly. Do not allow unnecessary strain on the cables. (Do not put heavy objects on the cables. Do not bend or pull the cables forcibly.) The unnecessary strain on the cables may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system. ■ 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.

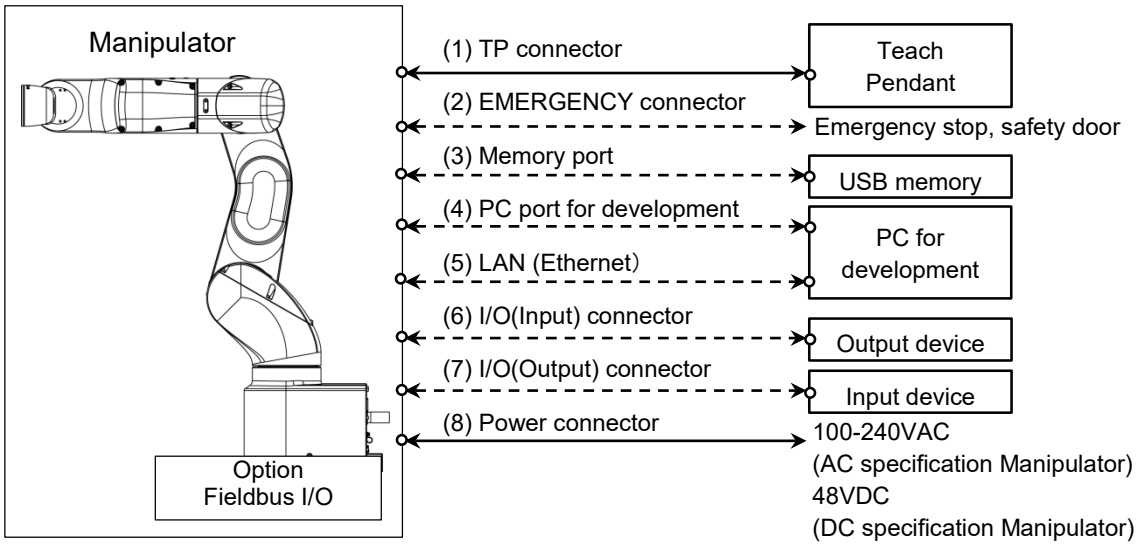
3.7.1 Connection Example

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 the *Setup & Operation 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 the *Setup & Operation 12. EMERGENCY.*

(3) Memory port
Connect to USB memory.
For details, refer to the *Setup & Operati*on 8. *Memory port.*

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

(5) LAN (EtherNet Communication)
Connect the EtherNet cable.
For details, refer to the *Setup & Operation 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 the *Setup & Operation 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 the *Setup & Operation 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.

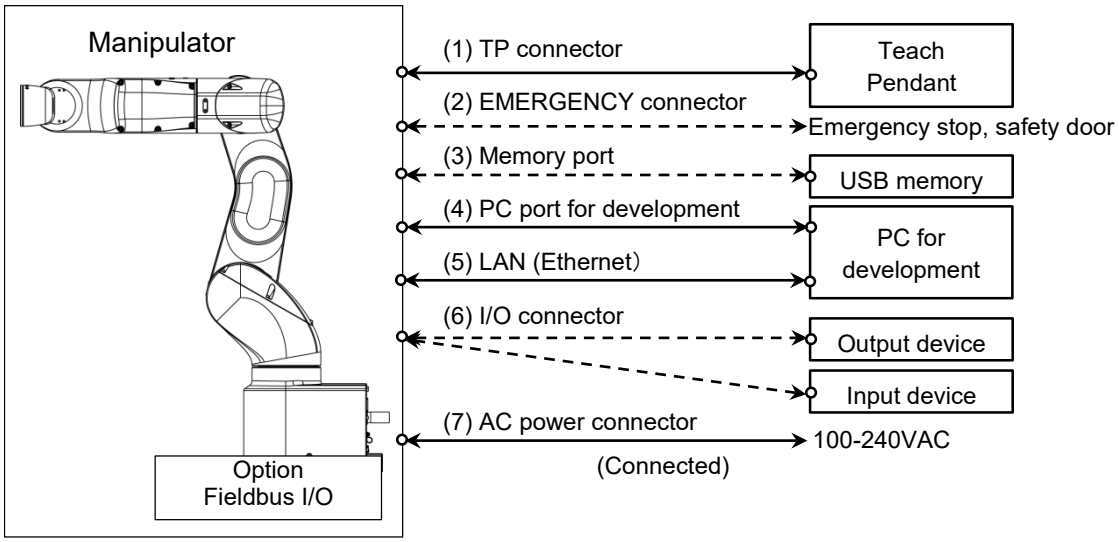
For the Cleanroom model Manipulator, an exhaust system is necessary. For details, refer to *Setup & Operation: 2.6 Specifications*.

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 the *Setup & Operation 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 the *Setup & Operation 12. EMERGENCY.*

(3) Memory port
Connect to USB memory.
For details, refer to the *Setup & Operati*on 8. *Memory port.*

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

(5) LAN (EtherNet Communication)
Connect the EtherNet cable.
For details, refer to the *Setup & Operation 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 the *Setup & Operation 13. Standard I/O connector.*

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

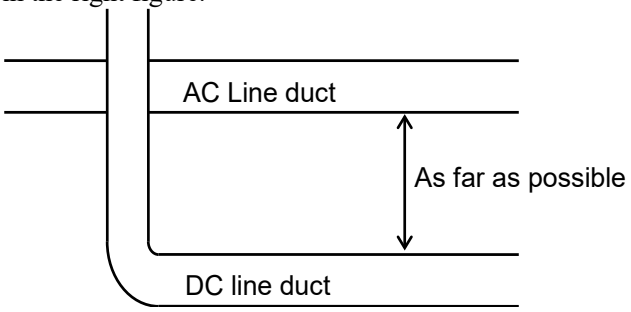
For the Protection model Manipulator, also make sure to follow the following precautions.

CAUTION	■ When operating the Manipulator under special environmental conditions (adverse conditions with dust and oily smoke), do not place the Controller in the same condition since the Controller does not comply with IP67. Doing so may cause equipment damage to and/or malfunction of the Controller.

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 the *Setup & Operation 3.6 Power Supply*.
- Do not tap power from a power line that connects to any equipment which may cause noise.
- Do not run AC power lines and DC power lines in the same wiring duct, and separate them as far as possible. For example, separate the AC motor power line and the Manipulator power line as far as possible from the sensor or valve I/O lines; and do not bundle both sets of wiring with the same cable tie. If more than one duct/cable must cross each other, they should cross perpendicularly. The preferable example is shown in the right figure.



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

3.8 Relocation and Storage

3.8.1 Precautions for Relocation and Storage

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

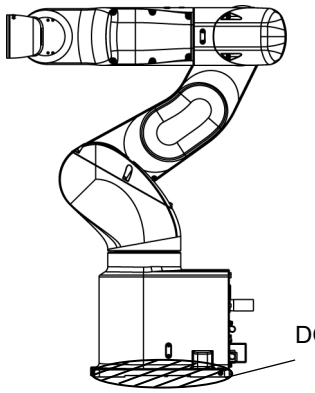
THE INSTALLATION SHALL BE PREFORMED BY QUALIFIED INSTALLATION PERSONNEL AND SHOULD CONFORM TO ALL NATIONAL AND LOCAL CODES.

WARNING

- Only authorized personnel should perform sling work and operate a crane 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.
- Stabilize the Manipulator with your hands when hoisting it. Unstable hoisting is extremely hazardous and may result in fall of the Manipulator.
- When transporting the Manipulator for a long distance, secure it to the delivery equipment so that the Manipulator 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	0 to 45 °C
Ambient relative humidity	10 % to 80 % (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.

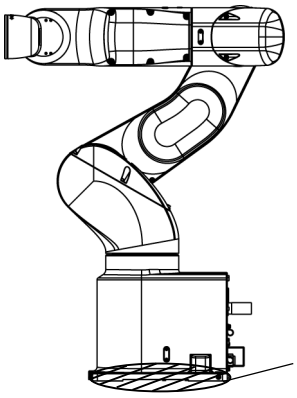
When condensation occurs on the Manipulator during transport or storage, turn ON the power only after the condensation dries.

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.



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 *Setup & Operation: 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.

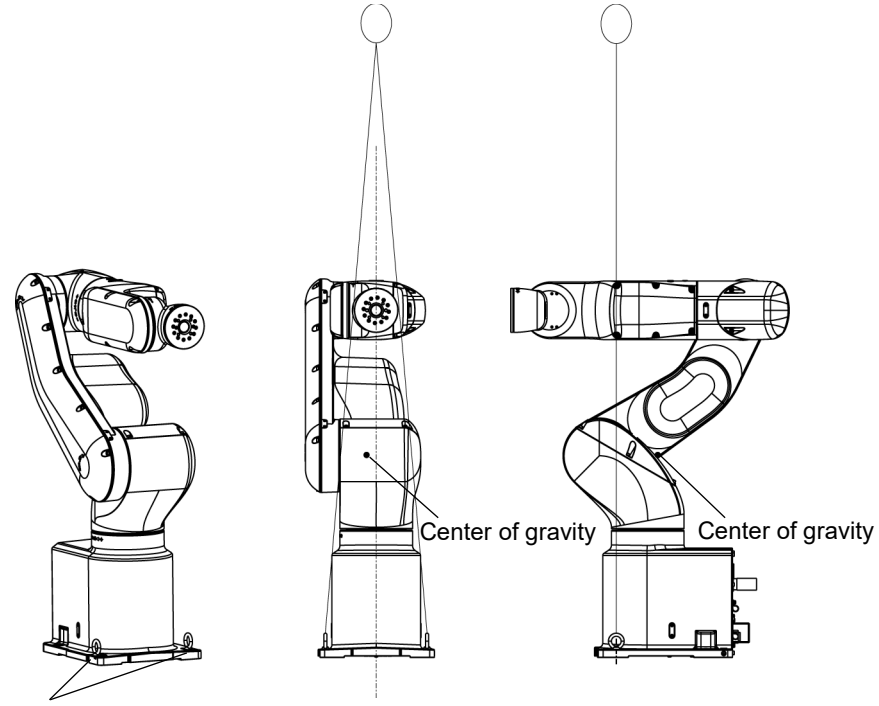
Using Eyebolt

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.



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.

THE INSTALLATION SHALL BE PREFORMED BY QUALIFIED INSTALLATION PERSONNEL AND SHOULD CONFORM TO ALL NATIONAL AND LOCAL CODES

WARNING	■ Only authorized personnel should perform sling work and operate a crane 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

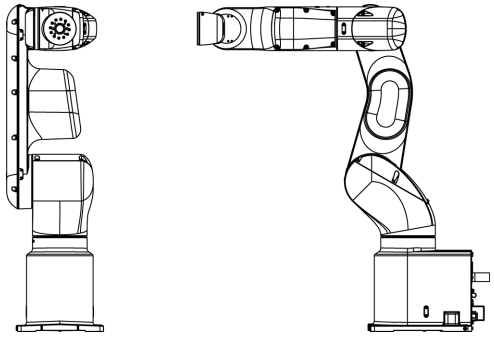
After parts have been replaced (motors, reduction gear units, belts, etc.), the Manipulator cannot operate properly because a gap exists between the origin positions stored in each motor and these stored in the Controller. The process to compensate the position gap is called “Calibration”.

At the time of shipment, the basic orientation of the Manipulator shown below is set as the origin position.

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.

To make the Manipulator move to the origin position, select [Tools]-[Robot Manager] - [Control Panel] and click <Home>.

If the gap still exists and the Manipulator cannot be in the basic orientation after the calibration, please contact the supplier of your region.

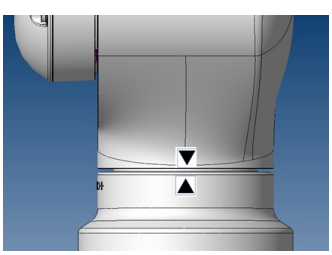


3.10 Origin Position Label

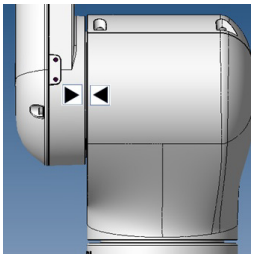
12 origin position labels (6 labels + spare) are included in the robot at shipment See the figures below and attach labels on each axis.

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.

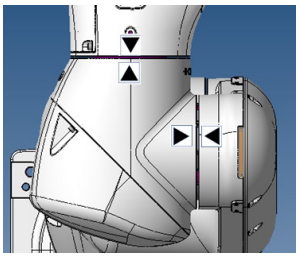
If origin position is misaligned after replacing motors, reduction gear units, or belts due to a malfunction, look the origin position labels to align positions roughly.



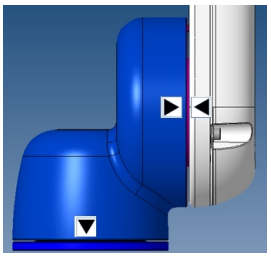
Arm #1



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.

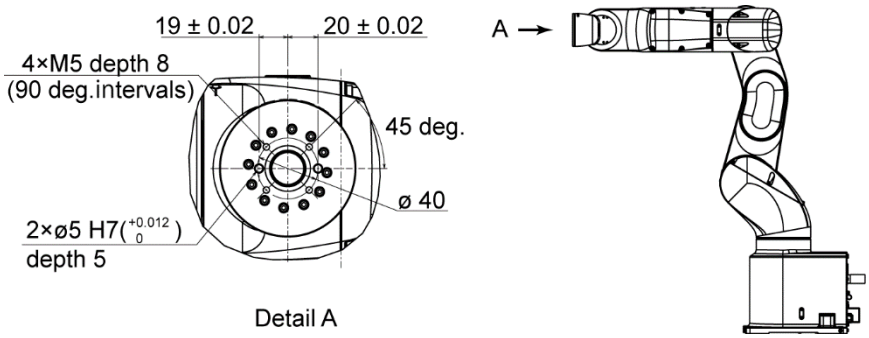
4. Setting of End Effectors

4.1 Attaching an End Effector

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

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

Wrist Flange



Arm #6

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

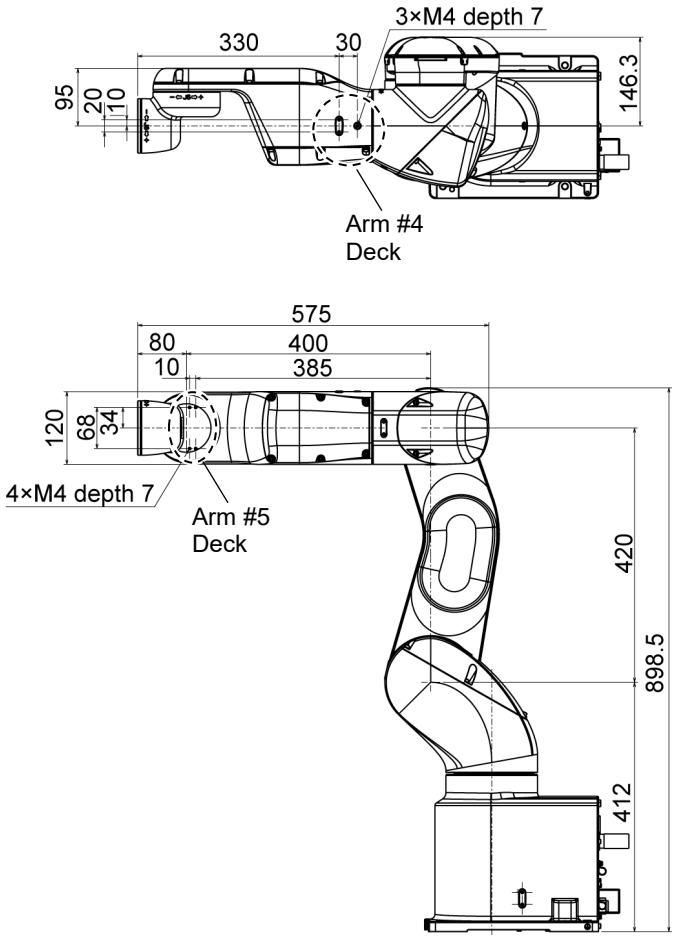
Compatibility with ISO flange:

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 *Setup & Operation: 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 *Setup & Operation: 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 the *Setup & Operation 4.3.1 WEIGHT Setting* and *4.3.2 INERTIA Setting*, to set parameters.
Setting parameters makes the operation of the Manipulator optimal, reduces vibration to shorten the operating time, and improves the capacity for larger loads. In addition, it reduces persistent vibration produced when the inertia moment of the end effector and work piece is bigger.

The allowable load for 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.

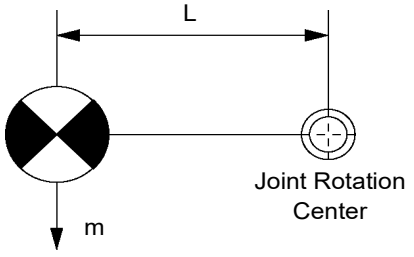
Inertia moment

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.

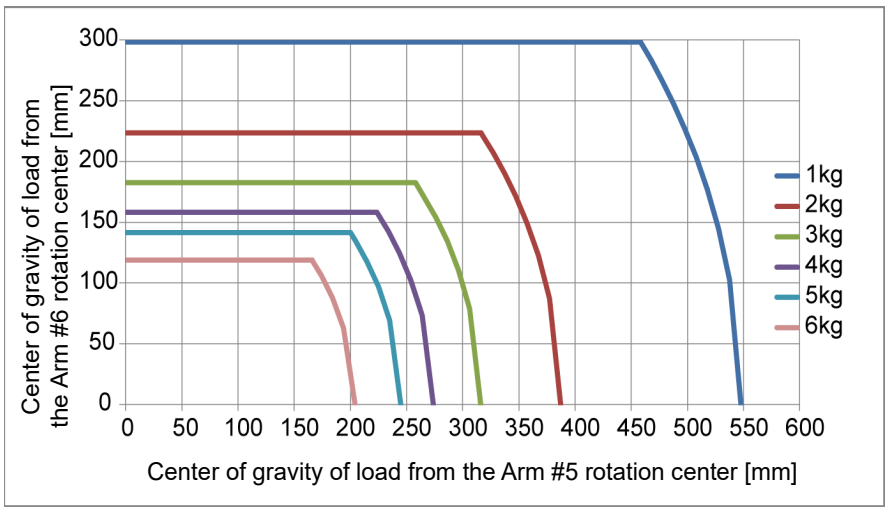
The moment M (Nm) and inertia moment I (kgm^2) when the volume of the load (end effector + work piece) is small can be obtained by the following formula.

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

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 *Setup & Operation 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:

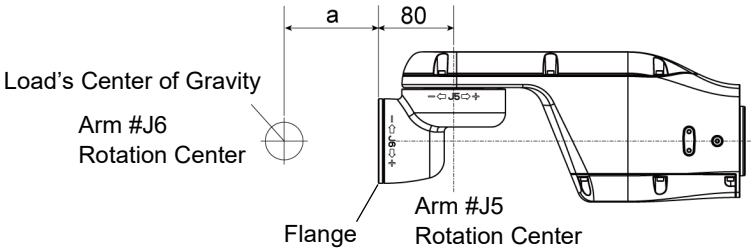
(0.3 kgm2/6 kg)1/2 = 0.223 m = 223 mm

Due to the allowable moment control, center of gravity for the load limit is 212 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.

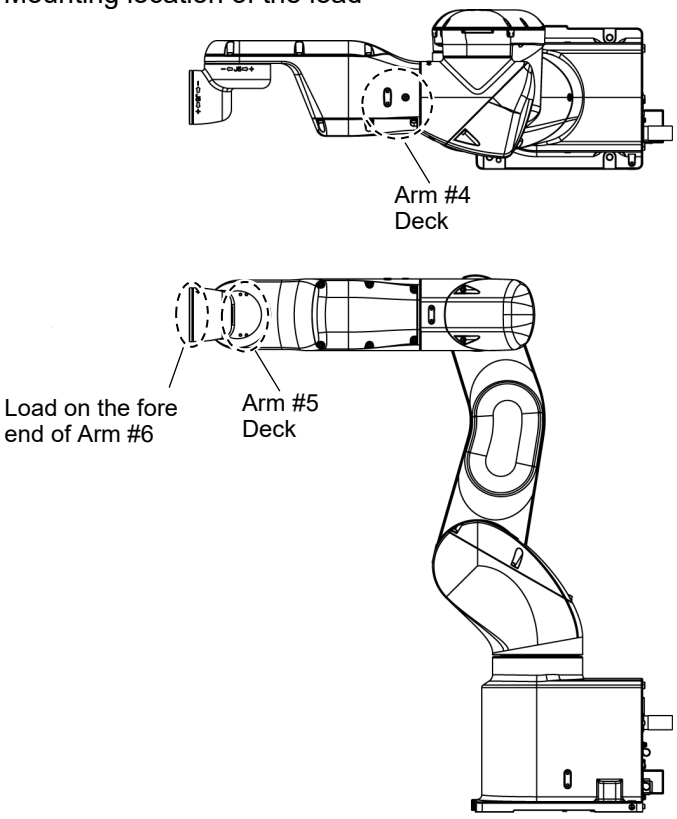
Setting method of Weight parameters

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



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)

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

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

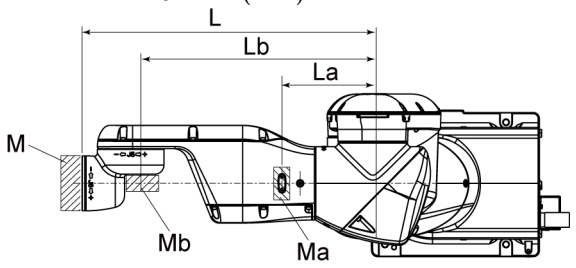
M_a : Weight of the air valve on the Arm #4 deck

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)

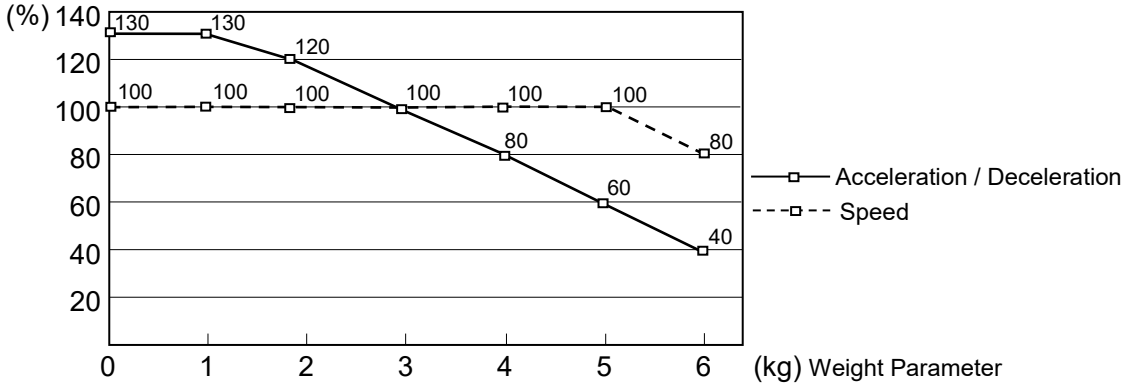
L_b : Distance between the Joint #3 and the center of gravity of the camera on the Arm #5 deck (mm)



<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.
$W_a=1.5\times150^2/480^2=0.15 \rightarrow 0.2$ (round up)
$W_b=1.0\times390^2/480^2=0.66 \rightarrow 0.7$ (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 "*Setup & Operation 2.7 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.

CAUTION

■ 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.

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.

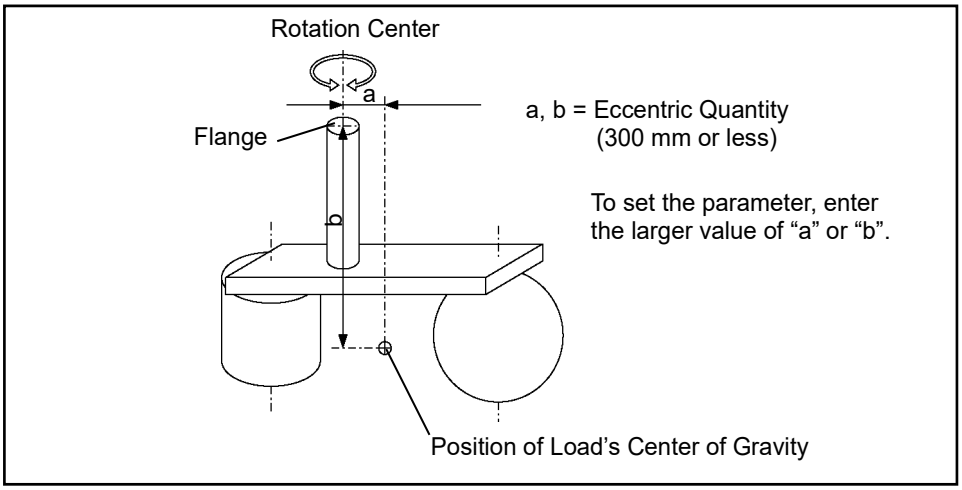
EPSON RC+

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.
When the eccentric quantity of the load exceeds the rating, change the setting of eccentric quantity parameter using the INERTIA command. After changing the setting, the maximum acceleration/deceleration speed of Manipulator corresponding to “eccentric quantity” is set automatically.



Eccentric Quantity

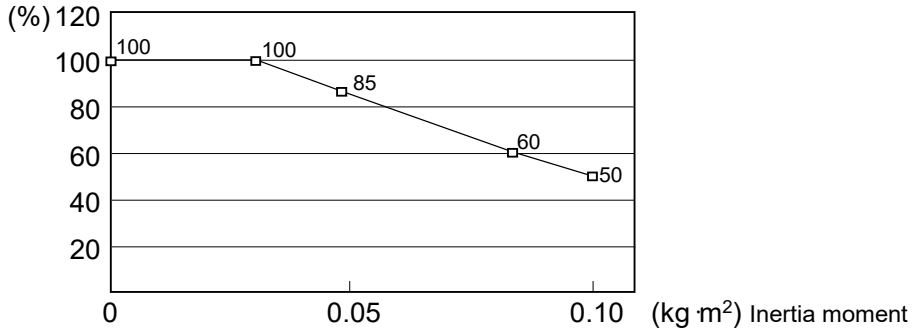
Eccentric quantity of load on Arm #6

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

EPSON RC+

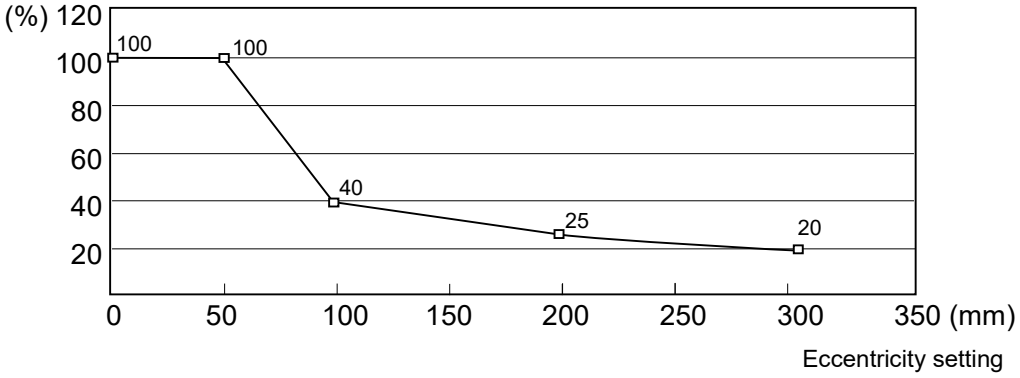
Select [Tools]–[Robot Manager]-[Inertia] panel and enter the value into [Eccentricity:].
You may also execute the Inertia command from [Command Window].

Automatic acceleration/deceleration setting by INERTIA (eccentric quantity)
The percentage in the graph is based on the acceleration/ deceleration at rated eccentricity (0.03 kg·m2) as 100%.



Moment of inertia setting (kg·m^2)	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%

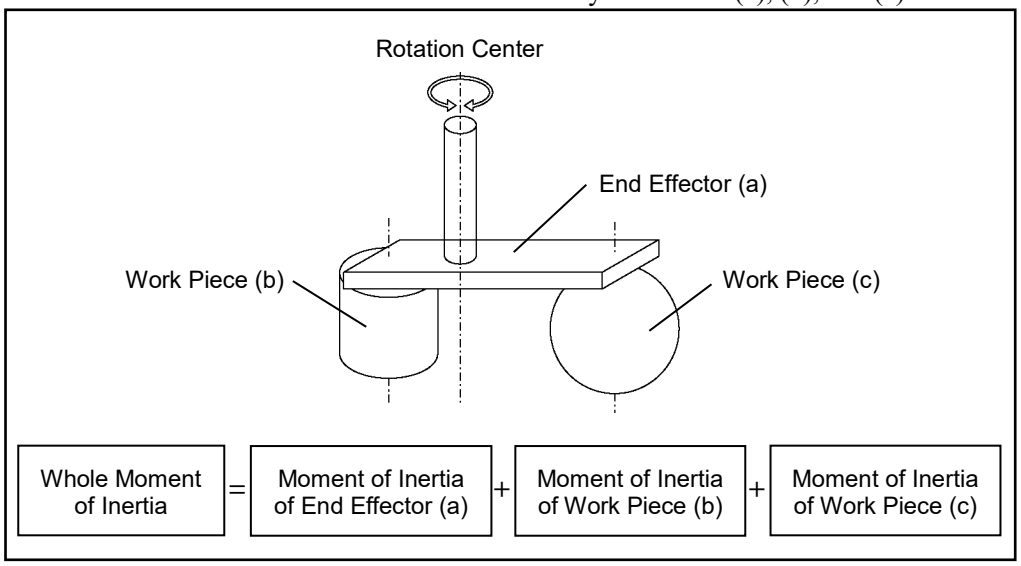


Eccentric quantity parameter (mm)	Automatic acceleration/deceleration setting by Inertia (eccentric quantity) (%)
0	100
50	100
100	40
200	25
300	20

Calculating the Inertia Moment

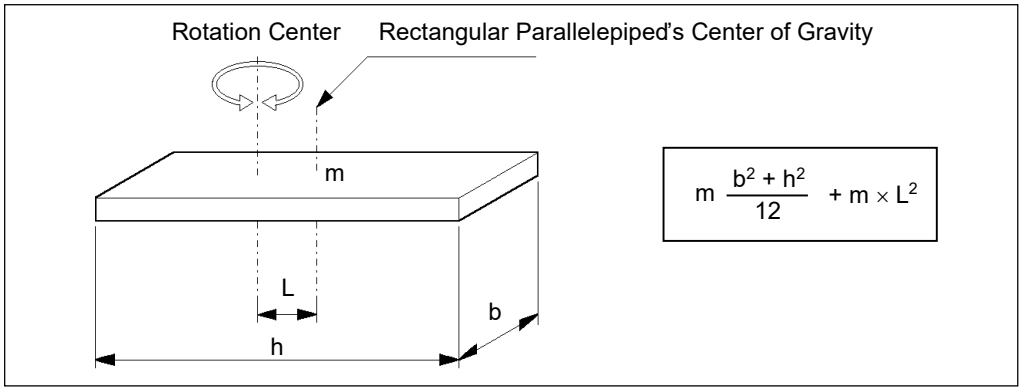
Refer to the following example formulas to calculate the inertia moment of the load (end effector with work piece).

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

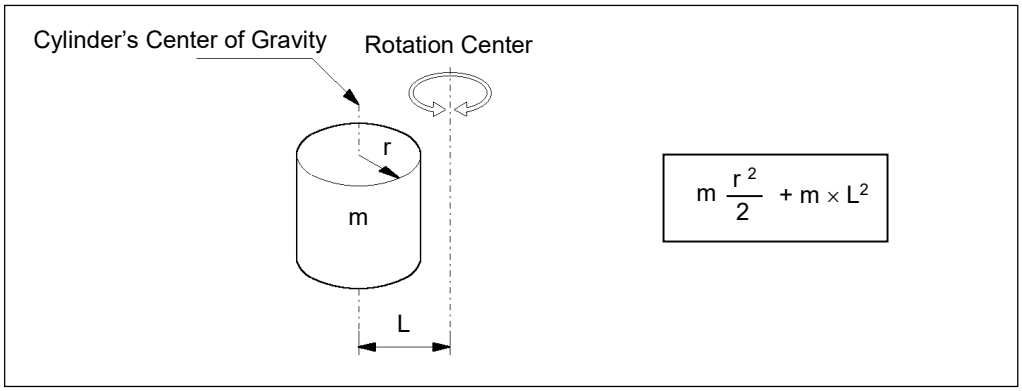


The methods for calculating the inertia moment for (a), (b), and (c) are shown in this and the next page. Figure out the whole inertia moment using the basic formulas below.

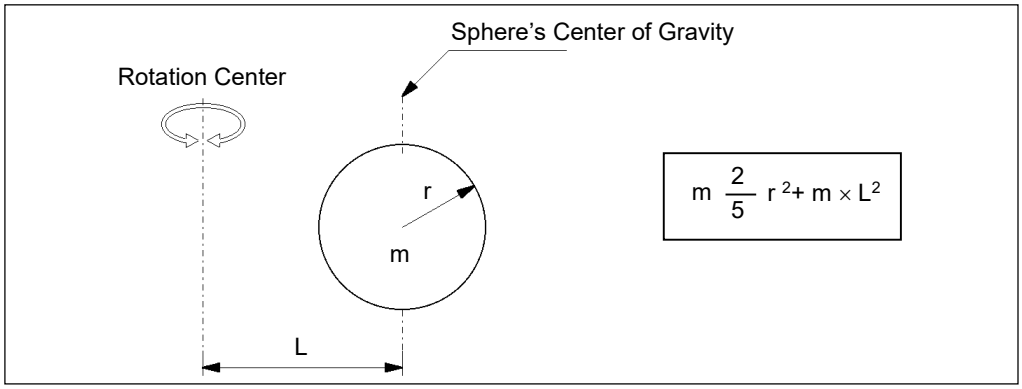
(a) Inertia moment of a rectangular parallelepiped



(b) Inertia moment of a cylinder



(c) Inertia moment of a sphere



4.4 Precautions for Auto Acceleration/Deceleration of Joint #3

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.

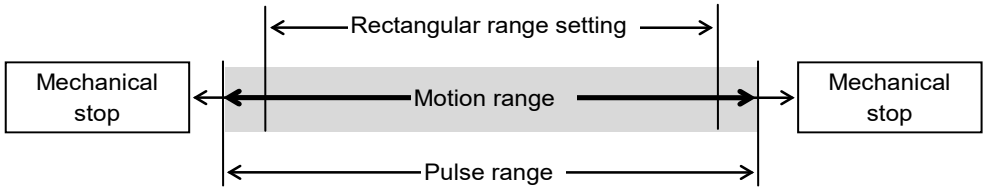
5. Motion Range

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 *Setup & Operation: 2.5 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.

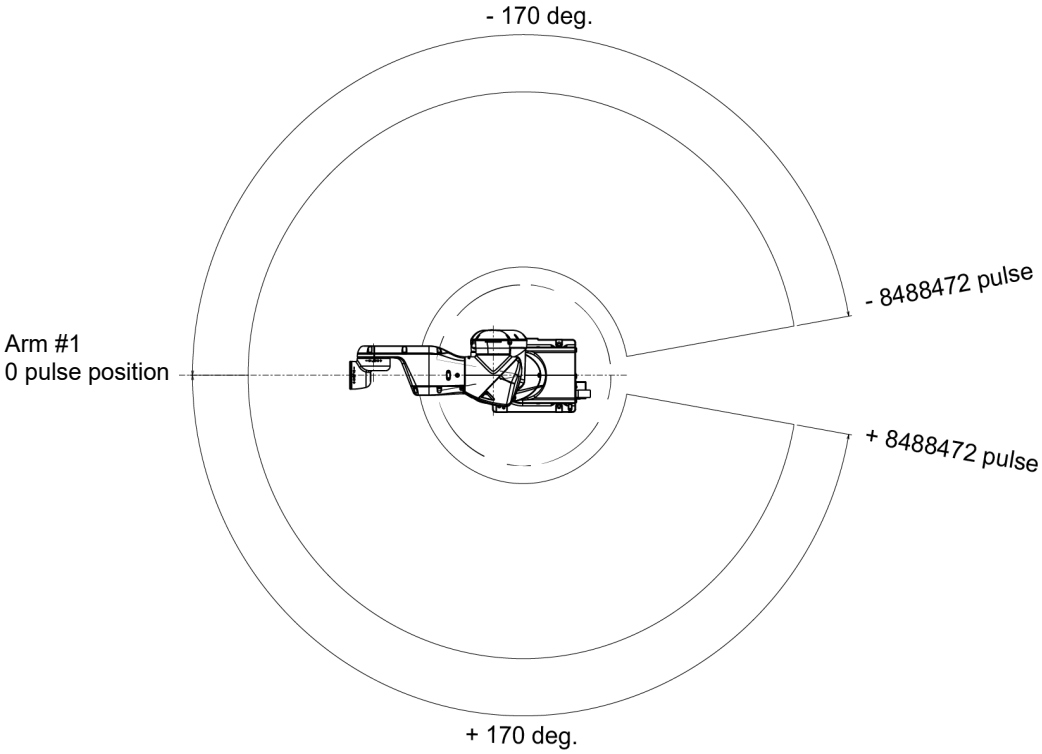
NOTE The Arms #4 and #6 do not have a mechanical stop.

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].

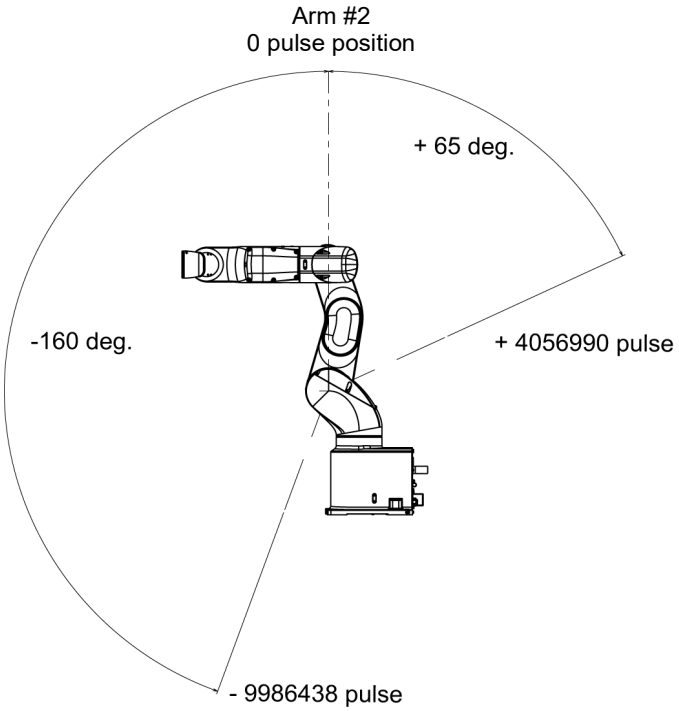
5.1.1 Max. Pulse Range of Joint #1

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



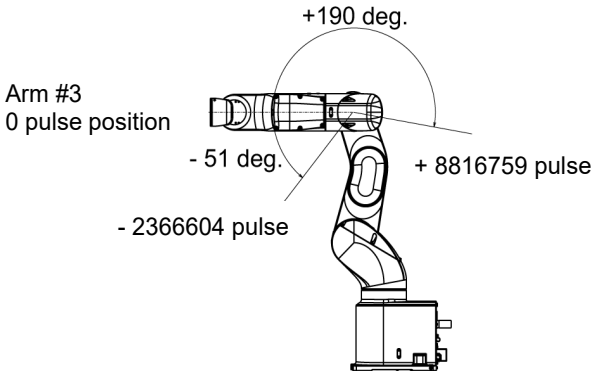
5.1.2 Max. Pulse Range of Joint #2

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



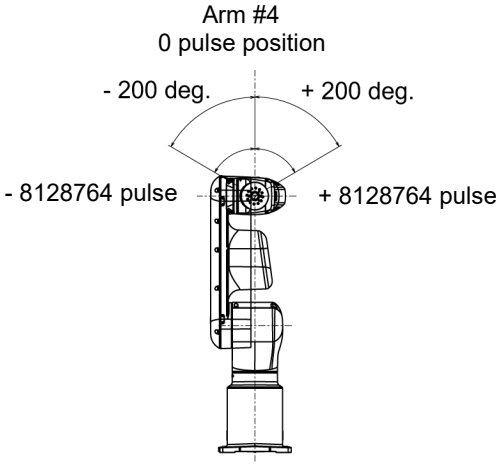
5.1.3 Max. Pulse Range of Joint #3

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



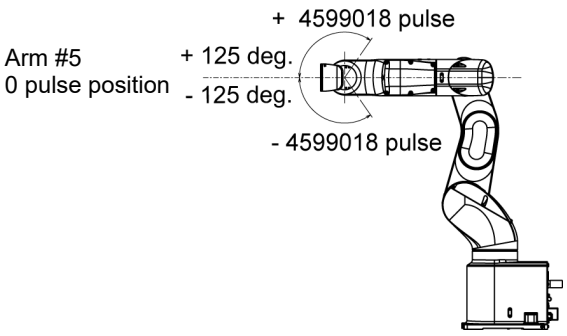
5.1.4 Max. Pulse Range of Joint #4

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



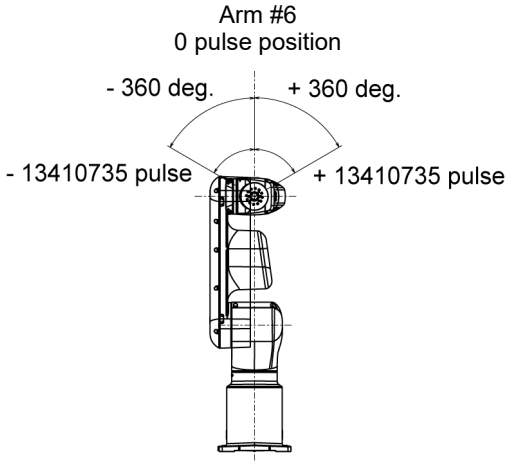
5.1.5 Max. Pulse Range of Joint #5

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



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 (－).



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.

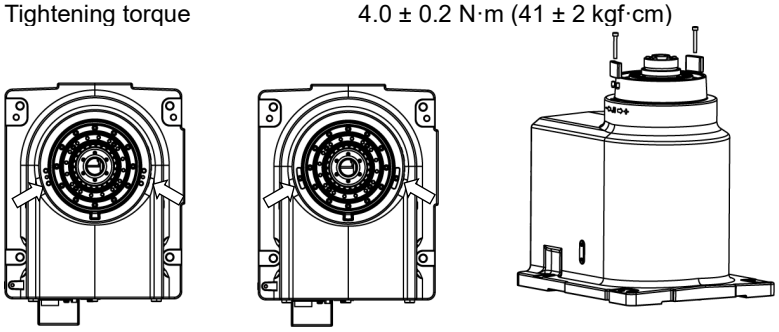
For details on the pulse range setting, refer to the following section.
Setup & Operation 5.1 Motion Range Setting by Pulse Range (for All Arms).

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

5.2.1 Motion Range Setting of 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)
Tightening torque 4.0 ± 0.2 N·m (41 ± 2 kgf·cm)



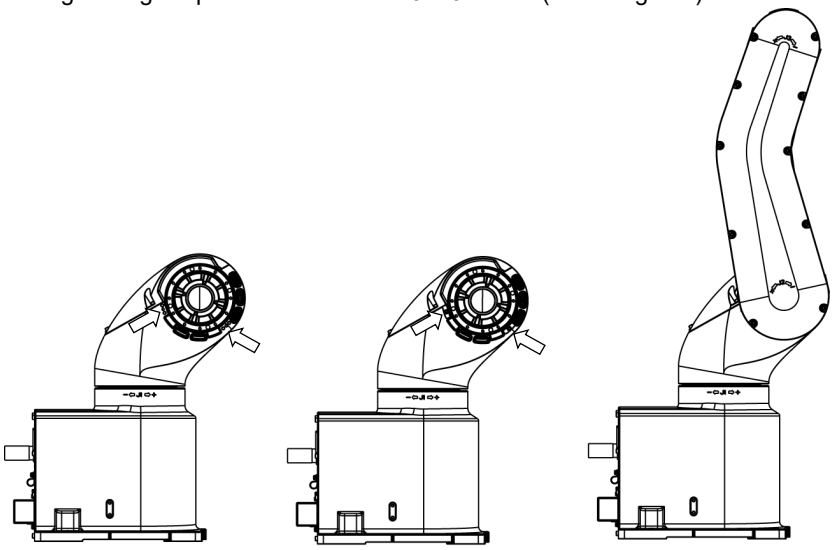
a b

	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)
Tightening torque	4.0 ± 0.2 N·m (41 ± 2 kgf·cm)



c d

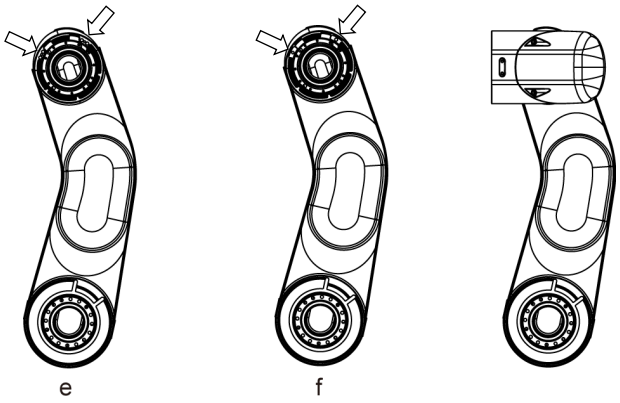
	c	d
Angle (°)	–160, +65	–160 to +43, or –148 to +65
Pulse (pulse)	–9986438 +4056990	–9986438 to +2683855, or –9237455 to +4056990
Adjustable mechanical stop (J2)	Not applied (standard)	Applied

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)

Tightening torque 4.0 ± 0.2N·m (41 ± 2 kgf·cm)



e f

	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:

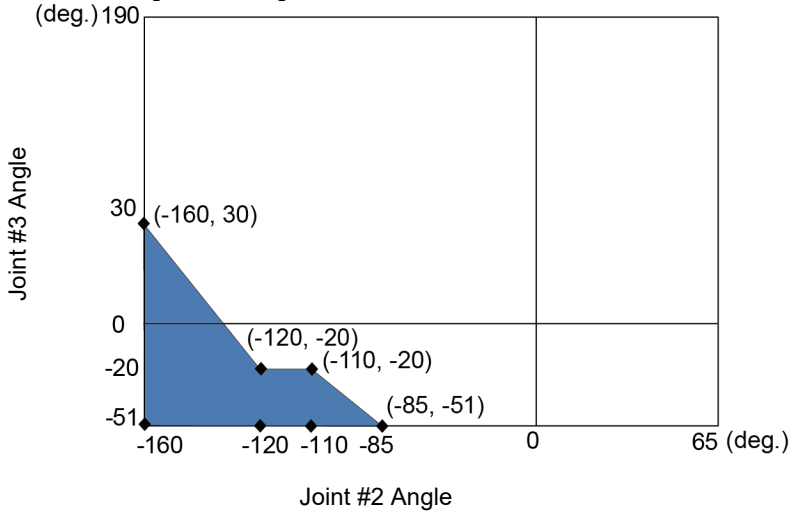
- During CP motion command execution
- When you attempt to execute the motion command for moving the Manipulator to a target point (or pose) in the specified motion range.

The restriction to the Manipulator operation is disabled:

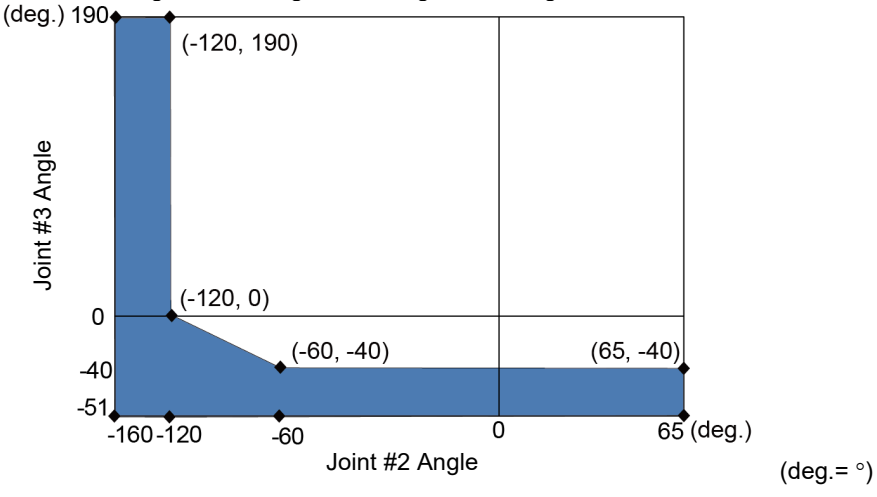
- The Arms of the Manipulator momentarily go through the specified motion range during the PTP motion command execution even though the joint angles of the Arms are in the colored area of the figures above.

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.

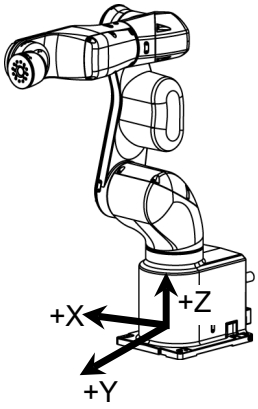


(deg.= °)

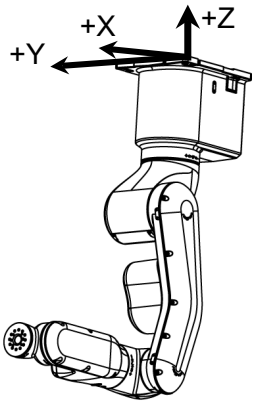
5.4 Coordinate System

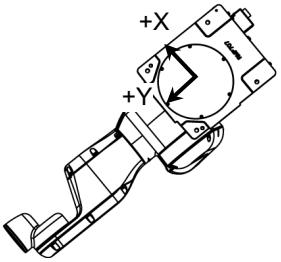
The origin point is where the Manipulator's installation face intersects with the rotation axis of Joint #1.
For details on the coordinate system, refer to the *EPSON RC+ User's Guide manual*.

Table Top mounting

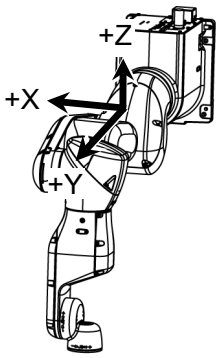


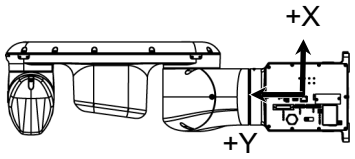
Ceiling mounting*





Wall mounting*





*: Only for Standard model, AC specification Manipulator

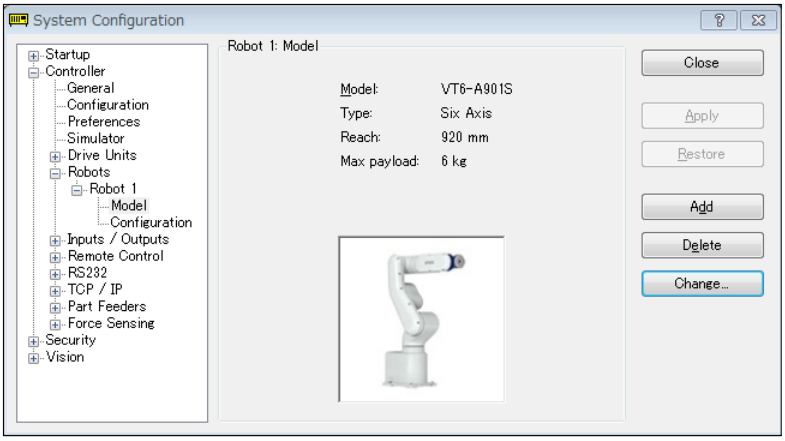
5.5 Changing the Robot

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

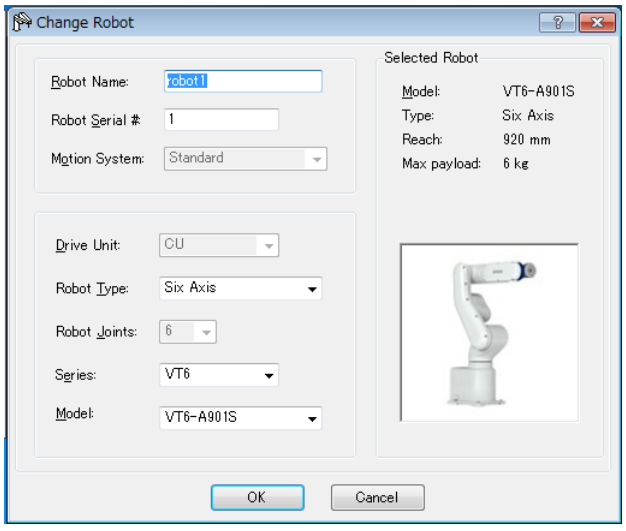
CAUTION	■ Changing the Manipulator should be done with great caution. It initializes the robot calibration parameters (Hofs, CalPls), additional axis information, and PG parameter data. Before changing the robot, make sure to save the calibration data by following the procedure below. (1) Select the EPSON RC+ 7.0 menu-[Setup]-[System Configuration]. (2) Select [Robot]-[Robot**]-[Calibration] from the tree list. Then, click <Save>.

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

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



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



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

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

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

(7) Select the robot model in the [Model] box. Available robots will be 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.



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)?

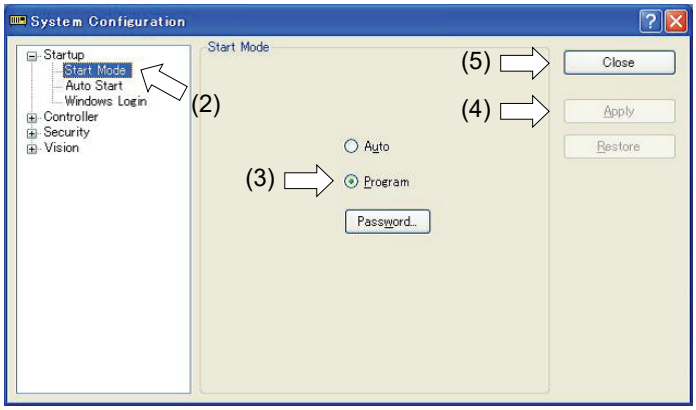
Program mode is for programming, debug, adjustment, and maintenance of the Robot system.

Follow the procedures below to switch to the Program mode.

6.3.2 Setup from EPSON RC+ 7.0

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

(1) Select EPSON RC+ 7.0 menu-[Setup]-[System Configuration] to display the [System Configuration] dialog 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+ 7.0 to “Auto” and start the EPSON RC+ 7.0.
(Refer to *Setup & Operation* 6.3.2 *Setup from EPSON RC+ 7.0.*)

B: Offline the EPSON RC+ 7.0.

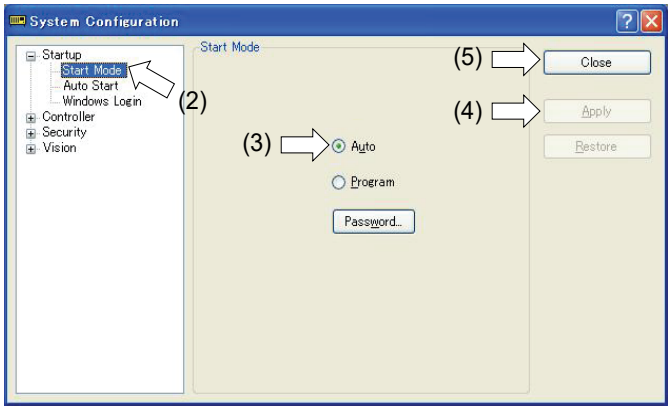
NOTE

Execute and stop the program from the control device specified by the EPSON RC+ 7.0. (Refer to *Setup & Operation* 6.4.3 *Setup Control Device*.)

6.4.2 Setup from EPSON RC+ 7.0

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

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



(2) Select [Startup].

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

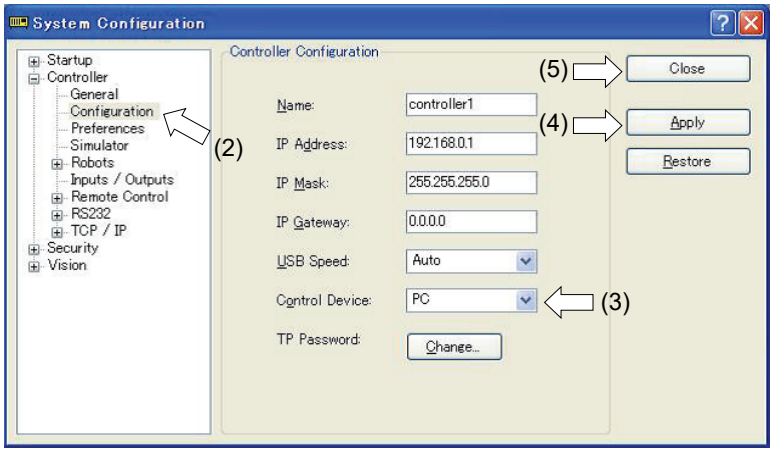
(4) Click the <Apply> button.

(5) Click the <Close> button.

6.4.3 Setup from Control Device

Set the control device from EPSON RC+ 7.0.

(1) Select EPSON RC+ 7.0 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 (I/O)

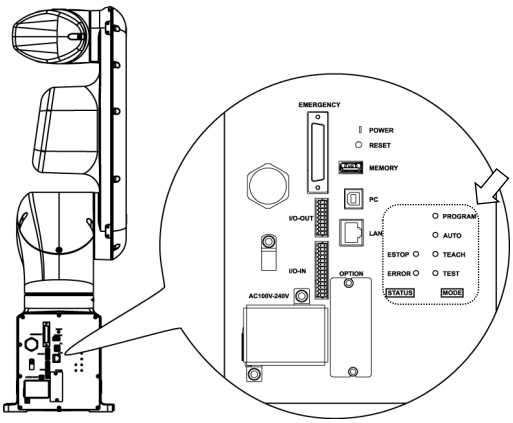
(4) Click the <Apply> button.

(5) Click the <Close> button.

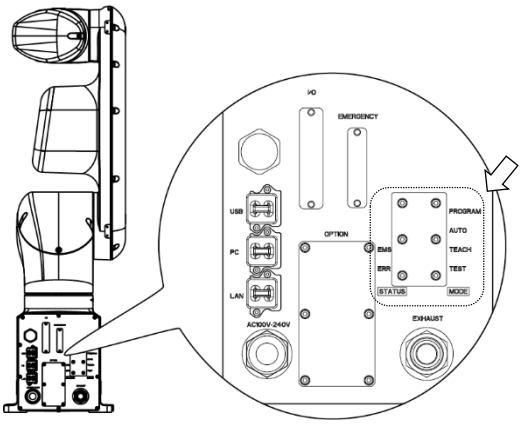
6.5 LED

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

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



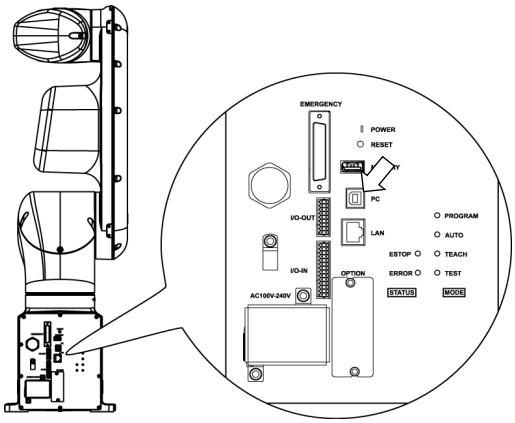
Standard, Cleanroom model



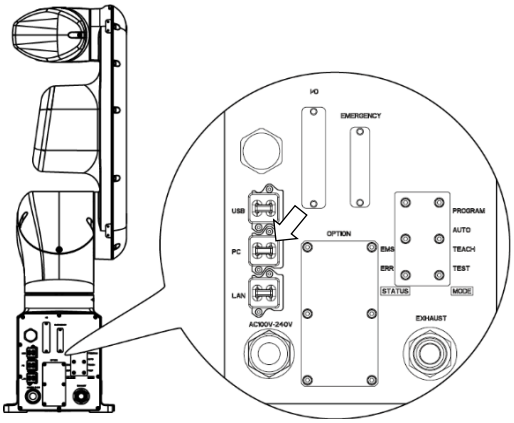
Protection model

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+ 7.0 User's Guide
  5.12.1 PC to Controller Communications Command.

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

7.1 What is Development PC Connection Port

The development PC connection port supports the following USB types.

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

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

Connect the Manipulator and development PC by a USB cable to develop the robot system or set the Manipulator configuration with the EPSON RC+ 7.0 software installed in the development PC.
Development PC connection port supports hot plug feature. Cables insert and remove from the development PC and the Manipulator are available when the power is ON. However, stop occurs when USB cable is removed from the Manipulator or the development PC during connection.

7.2 Precaution

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

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

7.3 Software Setup and Connection Check

Connection of the development PC and the Manipulator is indicated.

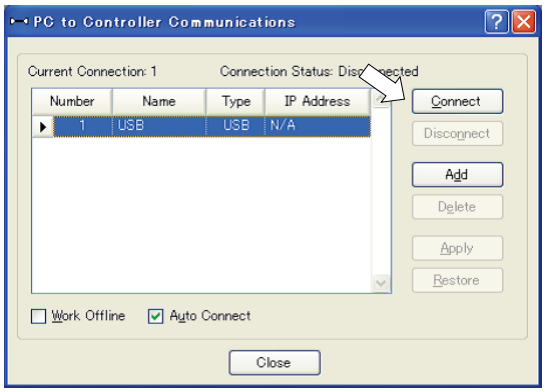
(1) Make sure that software EPSON RC+ 7.0 is installed to the Manipulator connected to the development PC.
(Install the software when it is not installed. Refer to *Robot System Safety and Installation* or *EPSON RC+ 7.0 User's Guide.*

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

(3) Turn ON the Manipulator.

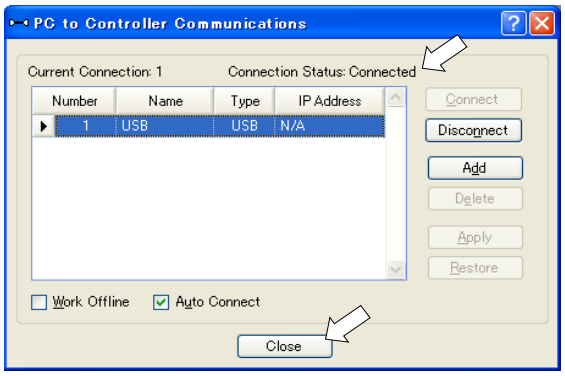
(4) Start EPSON RC+ 7.0.

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



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

7.4 Disconnection of Development PC and Manipulator

Disconnection of the development PC and the Manipulator communication.

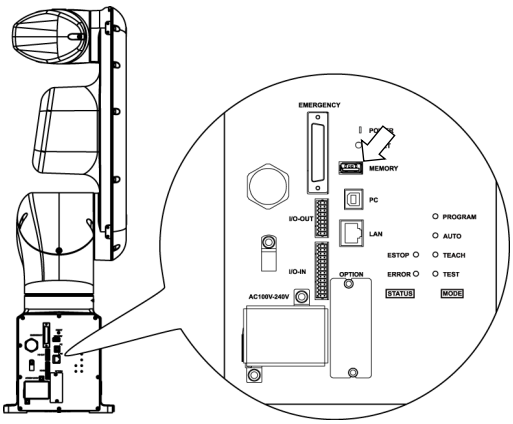
(1) Select the EPSON RC+ 7.0 menu-[Setup]-[PC to Controller Communications] to display the [PC to Controller Communications] dialog box.

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

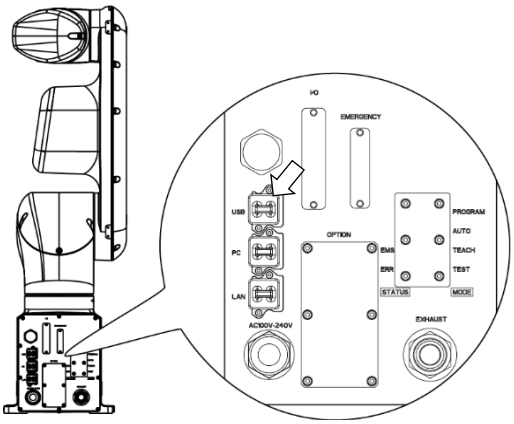
NOTE If the USB cable is removed when the Manipulator and the development PC are connected, the Manipulator will stop. Be sure to click the <Disconnect> button in the [PC to Controller Communications] dialog box before USB cable is removed.

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+ 7.0 to get the status of the Manipulator and the program simply and accurately.

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

8.2 Before Using Controller Status Storage Function

8.2.1 Precautions

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

- Make sure that the USB port is used only for USB memory even though the port on the 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, or Windows 10, Linux.
  (For supported operating systems for the EPSON RC+ 7.0, refer to *Setup & Operation 2.6 System Example*.)

8.3 Controller Status Storage Function

8.3.1 Controller Status Storage

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

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

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

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

(3) Remove the USB memory from the Manipulator.

NOTE

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

8.3.2 Load Data with EPSON RC+ 7.0

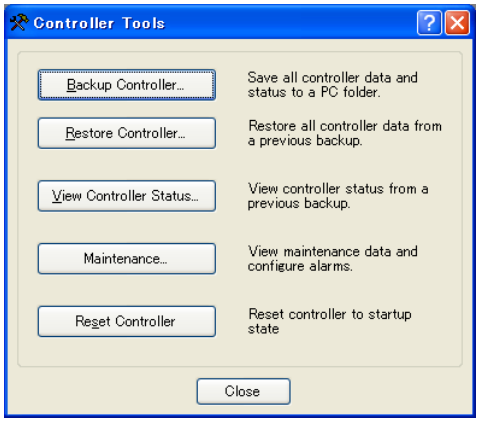
The following shows the procedure to load the data stored in the USB memory by EPSON RC+ 7.0 and display the Controller status.

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

(2) Make sure that the following folder is indicated in the USB memory.
B_VT_serial number_data status was saved
→ Example: B_VT_12345_2013-10-29_092951

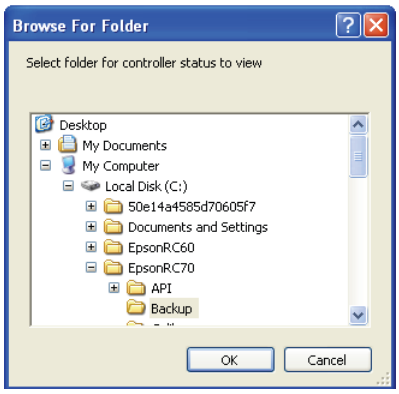
(3) Copy the folder confirmed in procedure (2) to the "\EpsonRC70\Backup" folder.

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

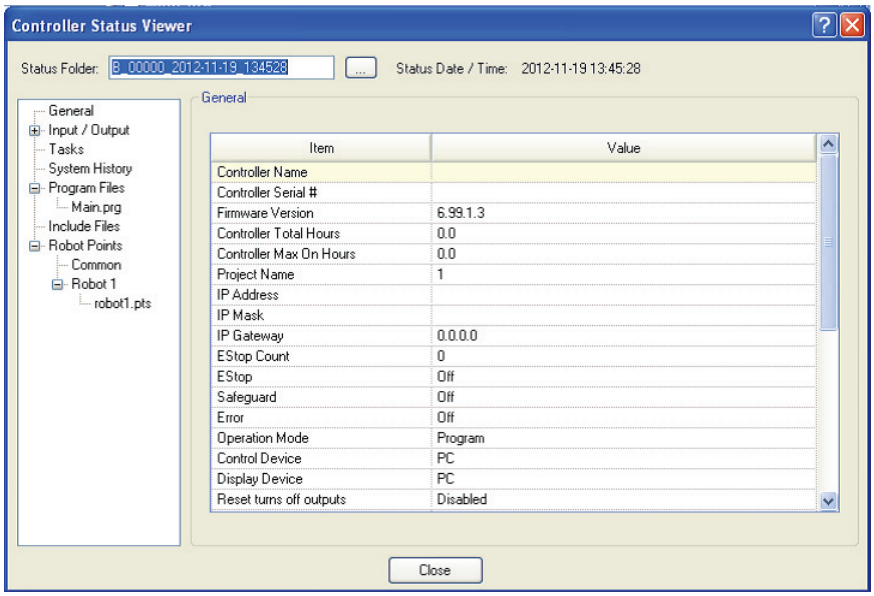


(5) Click the <View Controller Status…> button.

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



(7) [Controller Status Viewer] dialog box appears to confirm the Controller status.
For details, refer to *View Controller Status* in *EPSON RC+ 7.0 User's Guide 5.11.8 Controller Command (Tools Menu)*.



8.3.3 Transfer with E-mail

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

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

(2) Make sure that the USB memory has following folders.
B_VT_serial number_data status was saved
→ Example: B_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.

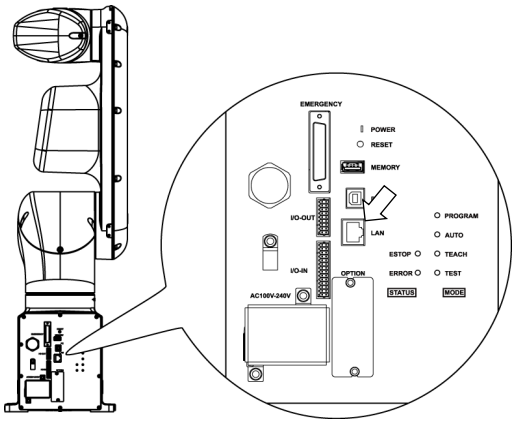
File Name	Outline	
Backup.txt	Information file for restore	File with information for Manipulator restore.
CurrentMnp01.PRM	Robot parameter	Saves information such as ToolSet.
CurrentStatus.txt	Save status	Saves program and I/O status.
ErrorHistory.csv	Error history	
InitFileSrc.txt	Initial setting	Saves 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+ 7.0 menu-[Setup]-[System Configuration]-[Controller]-[Preference], the project file is stored. Includes program files.

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

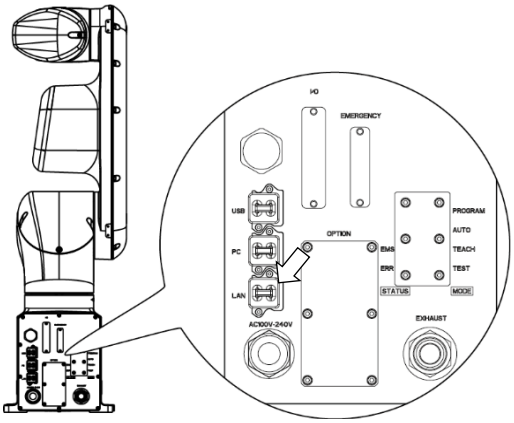
9. LAN (Ethernet Communication) Port

NOTE

- Refer to *EPSON RC+ 7.0 User's Guide 5.12.1 [PC to Controller Communications] Command (Setup Menu)* for other details for the development PC and Manipulator connection.
- For Ethernet (TCP/IP) communication with robot application software, refer to *EPSON RC+ 7.0 Online Help* or *User's Guide 14. TCP/IP Communications*.



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

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.

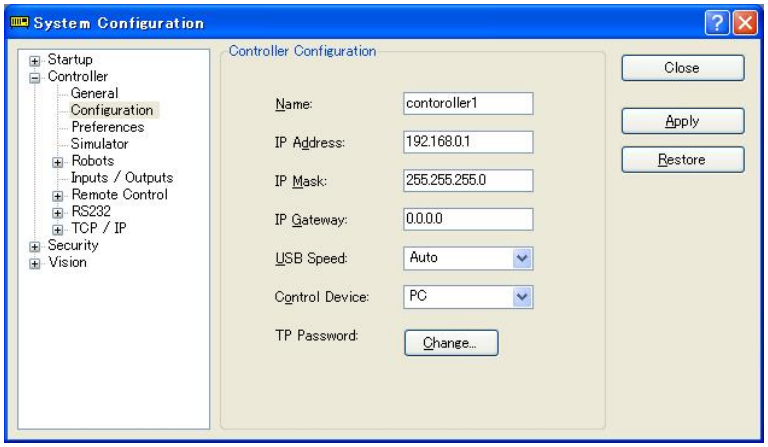
IP Address : 192.168.0.1
IP Mask : 255.255.255.0
IP Gateway : 0.0.0.0

9.3 Changing Manipulator IP Address

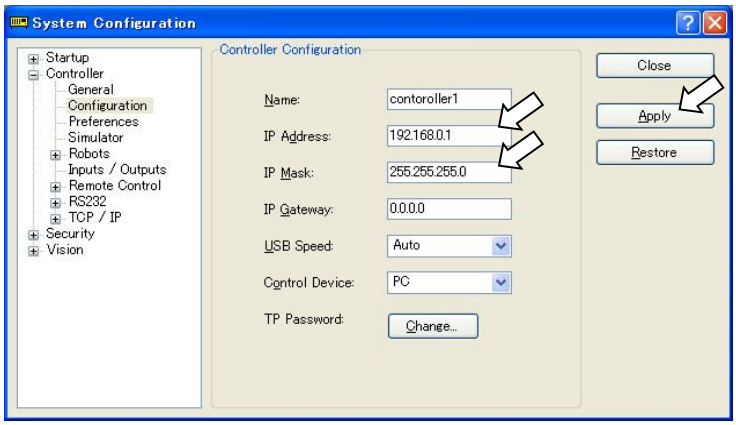
In this section, the procedure to change the Manipulator IP address when connecting Manipulator development PC connection port and the development PC by the USB cable is indicated.

(1) For connection between the development PC and the Manipulator.
Refer to *Setup & Operation: 7. Development PC Connection Port.*

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

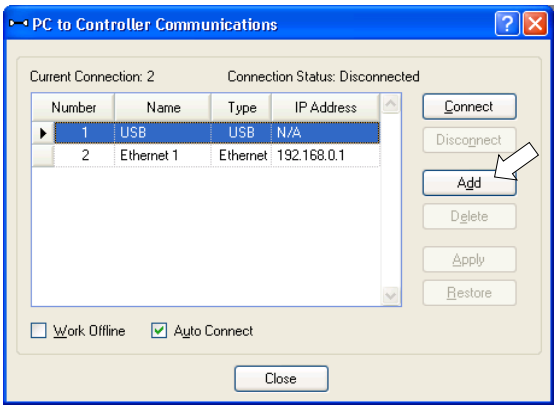
(1) Connect the development PC and the Manipulator using the Ethernet cable.

(2) Turn ON the Manipulator.

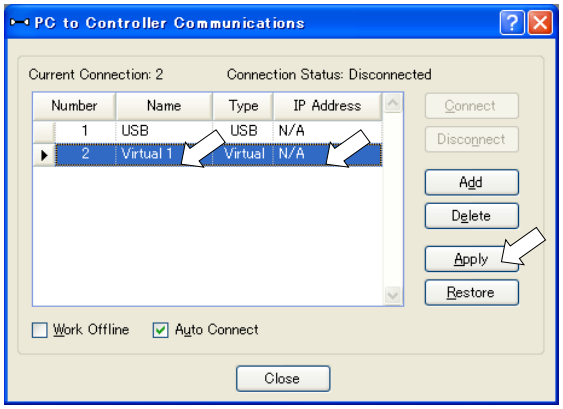
(3) Start EPSON RC+ 7.0.

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

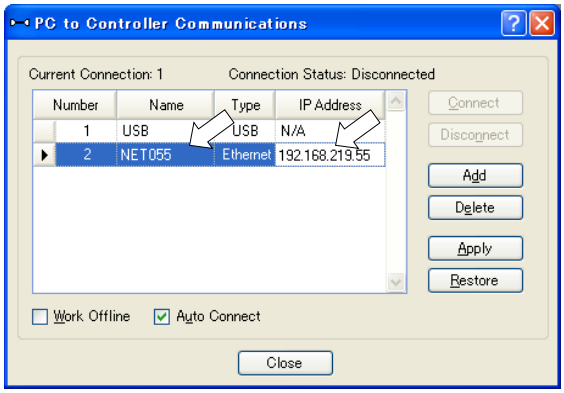
(5) Click the <Add> button.



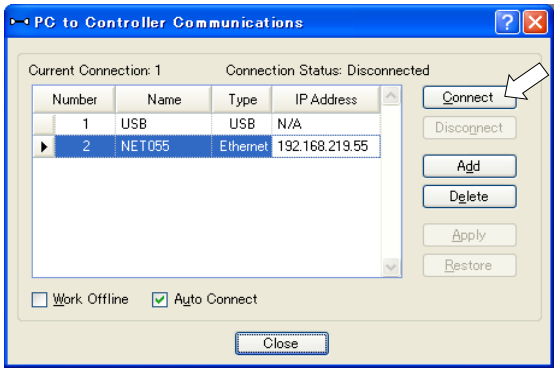
(6) Connection “No.2” is added. Set the following and click the <Apply> button.
Name : Valid value to identify the Manipulator to connect
IP Address : IP address for Manipulator to connect



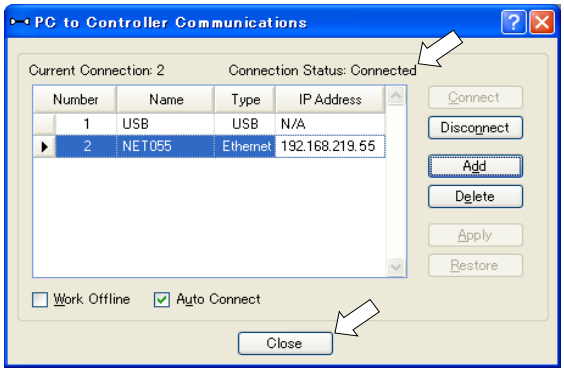
(7) [Name] and [IP Address] specified in procedure (6) is displayed.



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



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



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

9.5 Disconnection of Development PC and Manipulator with Ethernet

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

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

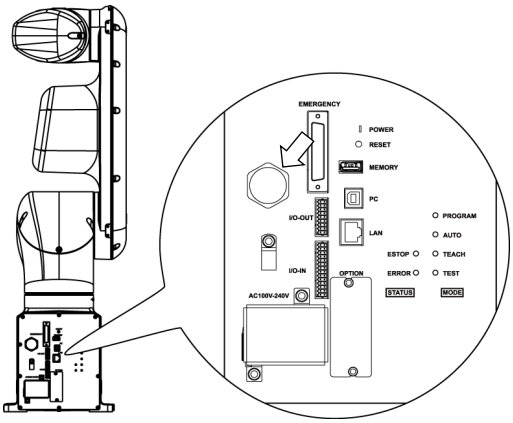
(2) Click the <Disconnect> button.
Communication between the Manipulator and the development PC is disconnected and the Ethernet cable can be removed.

NOTE

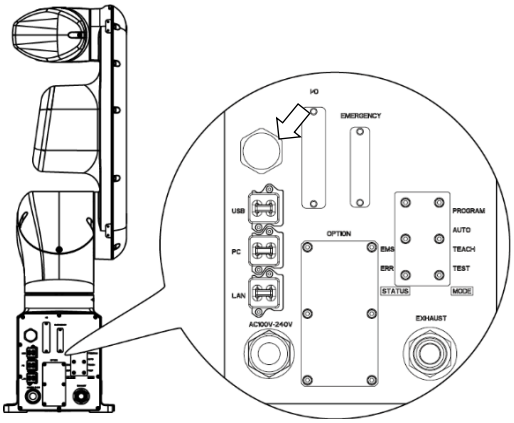
If the Ethernet cable is removed when the Manipulator and the development PC is connected, Emergency Stop occurs and the Manipulator stops. Be sure to click the <Disconnect> button in the [PC to Controller Communications] dialog box before the Ethernet cable is removed.

10. TP Port

10.1 What is the TP Port?



Standard, Cleanroom model



Protection model

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

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

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.

For details, refer to the following manuals:

Robot Contoroller RC700/RC90 Option Teach Pendant TP2.
Robot Contoroller RC700-A Option Teach Pendant TP3.

11. Options

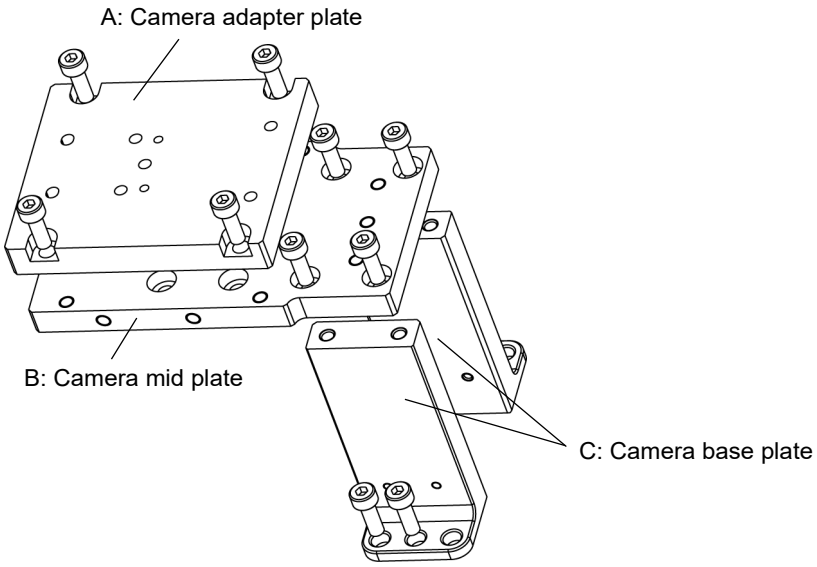
VT series Manipulator has the following options.

11.1 Camera Plate Unit
11.2 Tool Adapter (ISO flange)
11.3 Adjustable Mechanical Stops
11.4 External Wiring Kit

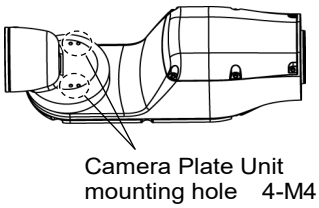
11.1 Camera Plate Unit

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

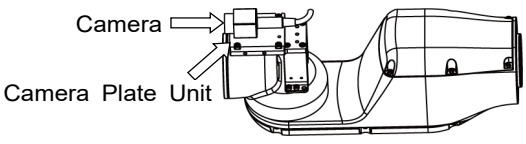
Parts included	Qty.
A Camera adapter plate	1
B Camera mid plate	1
C Camera base plate	2
D Hexagon socket head screws M4×12	12



Installation



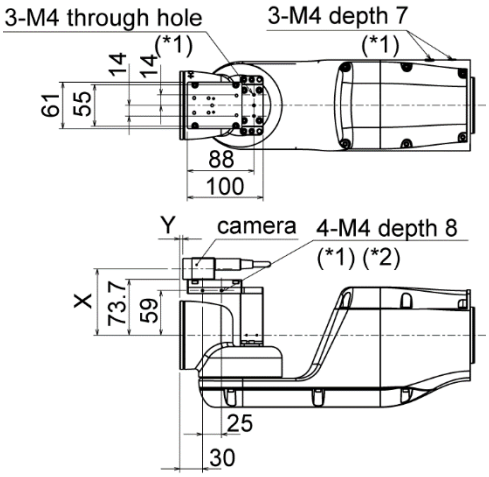
Appearance of arm end with camera



For the installation steps, refer to the following manual:

EPSON RC+ Option Vision Guide 7.0 Hardware & Setup

Dimensions after installing the Camera Plate Unit

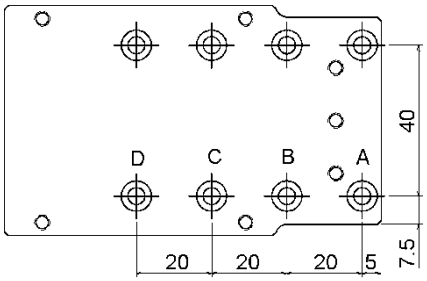


*1: Available for fixing the cables
*2: Includes the opposite side

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.

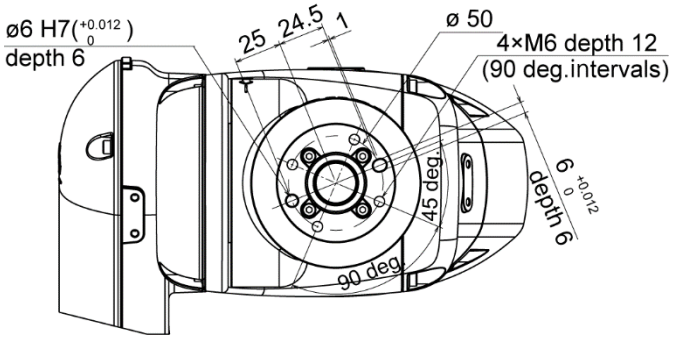


11.2 Tool Adapter (ISO flange)

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

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

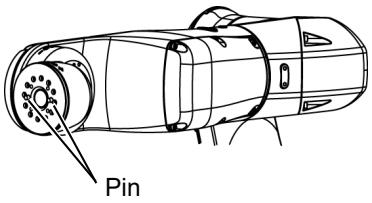
Dimensions of ISO flange



To mount the ISO flange

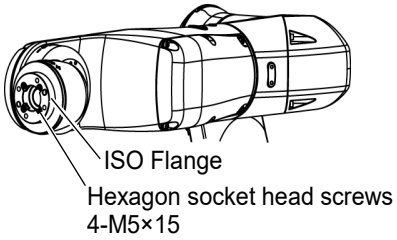
(1) Press-fit the pin to the Arm #6 end flange.

Pin projection : 4 mm from the flange



(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



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 *Setup & Operation 5.2 Motion Range Setting by Mechanical Stops*.

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)

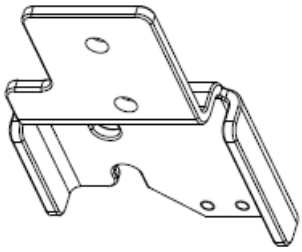
Parts included	Qty.
Adjustable mechanical stop (J3)	1
Hexagon socket head screw M4×16	1
Pin	2

11.4 External Wiring Kit

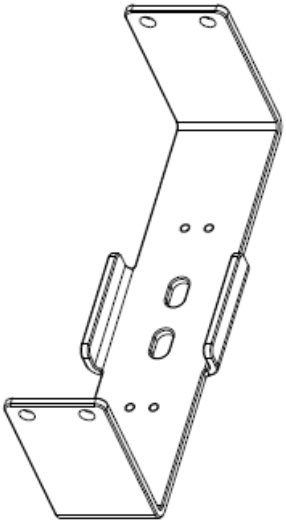
Using the external wiring kit, you can fix the wirings and air tubes for the hand along with the Manipulator. The external wiring kit can be used to select the cable fixing plate, according to your Manipulator's operation condition.

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

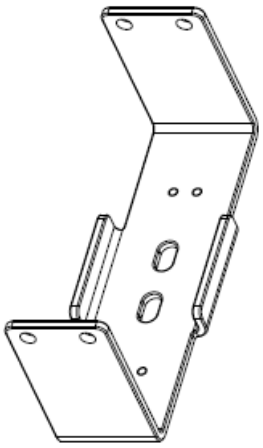
Cable fixing plate list



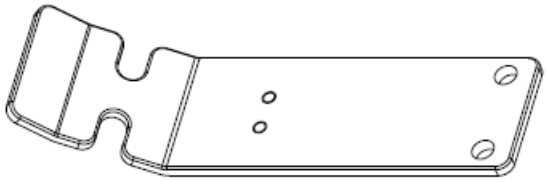
for Base



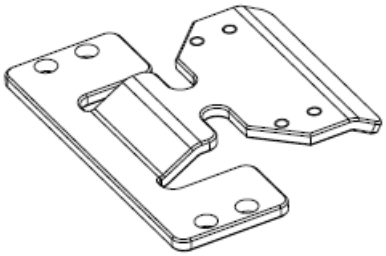
for Joint #2



for Joint #3 - 1



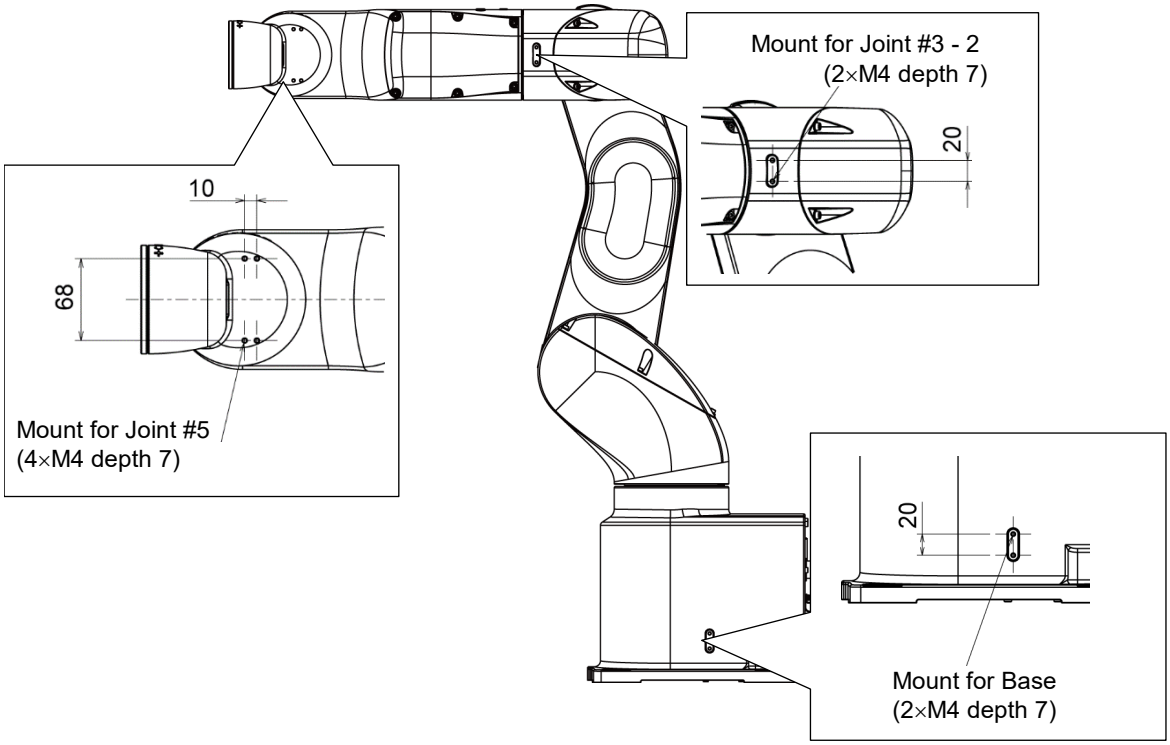
for Joint #3 - 2

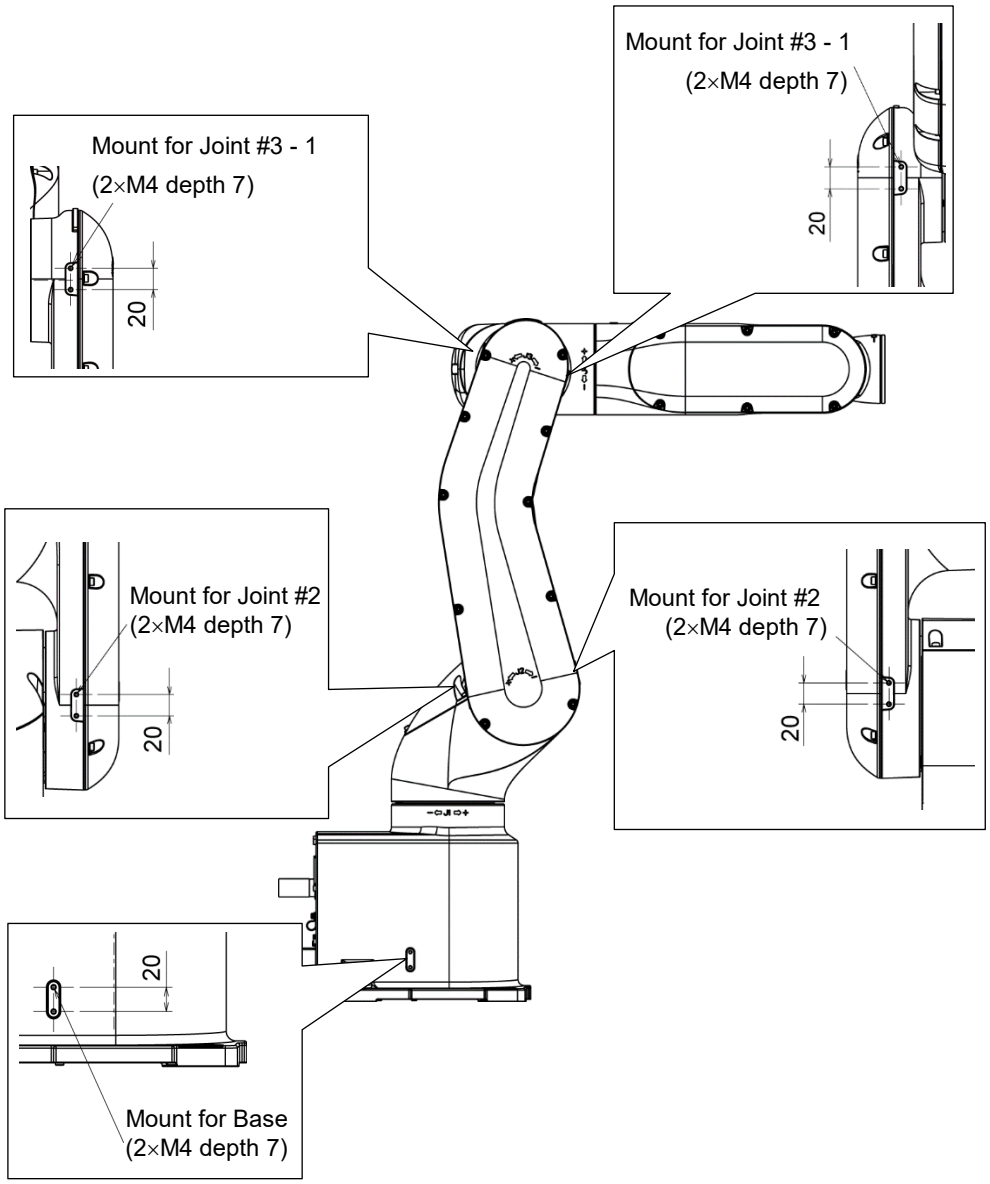


for Joint #5

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 - 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



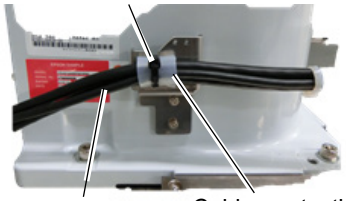
Hexagon socket head cap bolt
2-M4×10

How to bind the cables

(2) Put the wire tie through the cutout for fixing 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.

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



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

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.

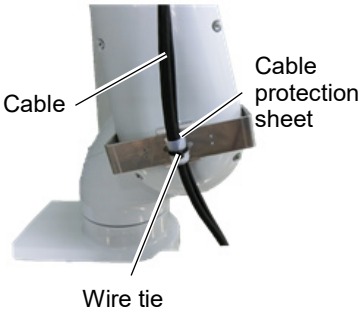
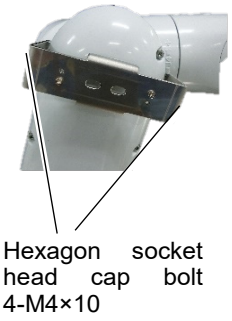


Plate for Joint #3 - 1

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



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

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.

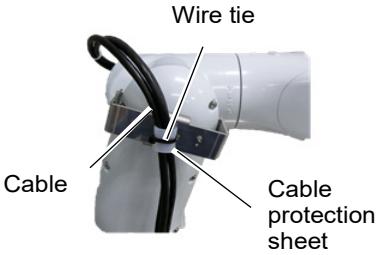


Plate for Joint #3 - 2

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

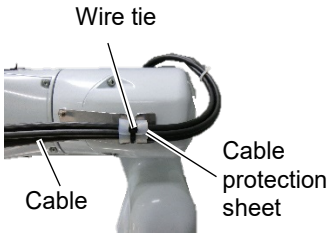


How to bind the cables

(2) Put the wire tie through the two cutouts 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



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

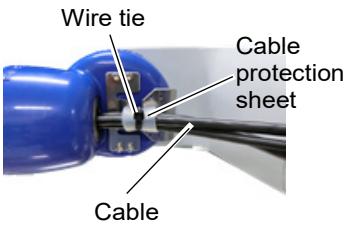


How to bind the cables

(2) Put the wire tie through the two cutouts for fixing the cables 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.

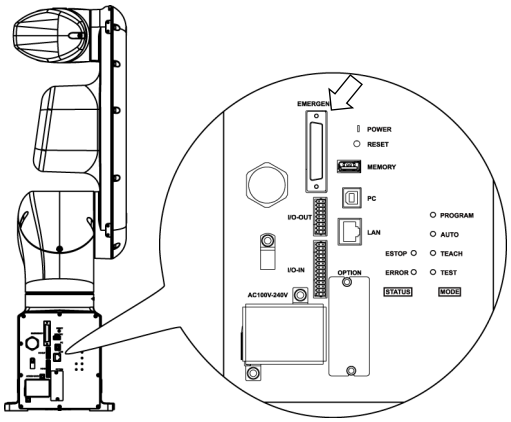
12. EMERGENCY

NOTE

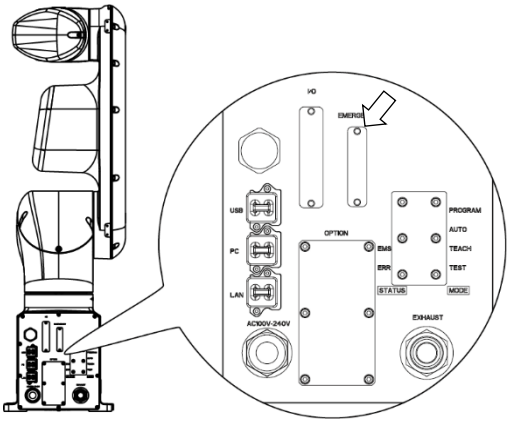
The details of safety requirements for this section are described in *EPSON RC+ 7.0 User's Guide 2. Safety*. Please refer to them to keep the robot system safe.

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

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



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 the *Setup & Operation 12.4 Circuit Diagrams*.

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

NOTE

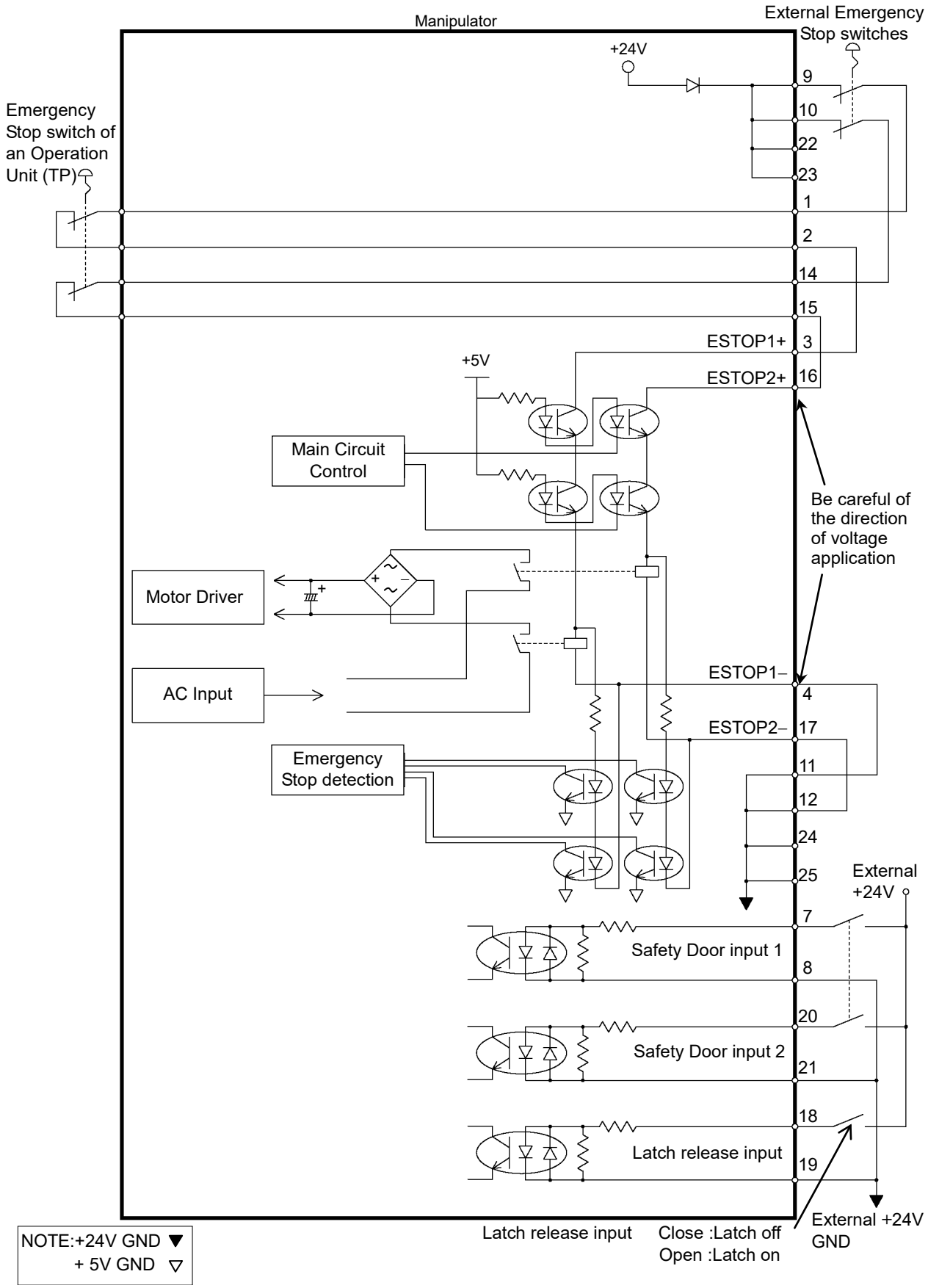
The total electrical resistance of the Emergency Stop switches and their circuit should be 1 Ω or less.

CAUTION

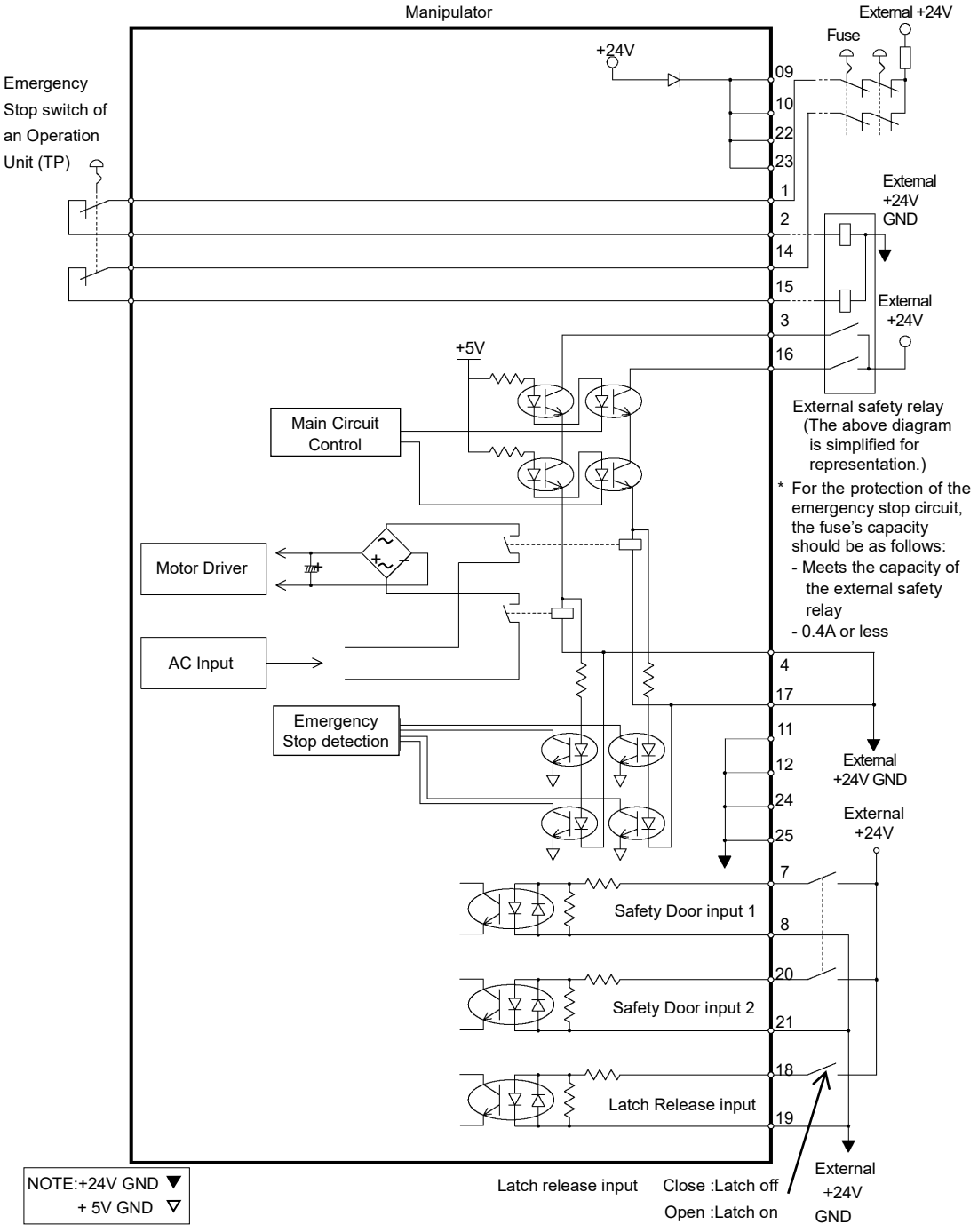
- The 24 V output is for emergency stop. Do not use it for other purposes. Doing so may result in system malfunction.
- Do not apply reverse voltage to the Emergency Stop circuit. Doing so may result in system malfunction.

12.4 Circuit Diagrams

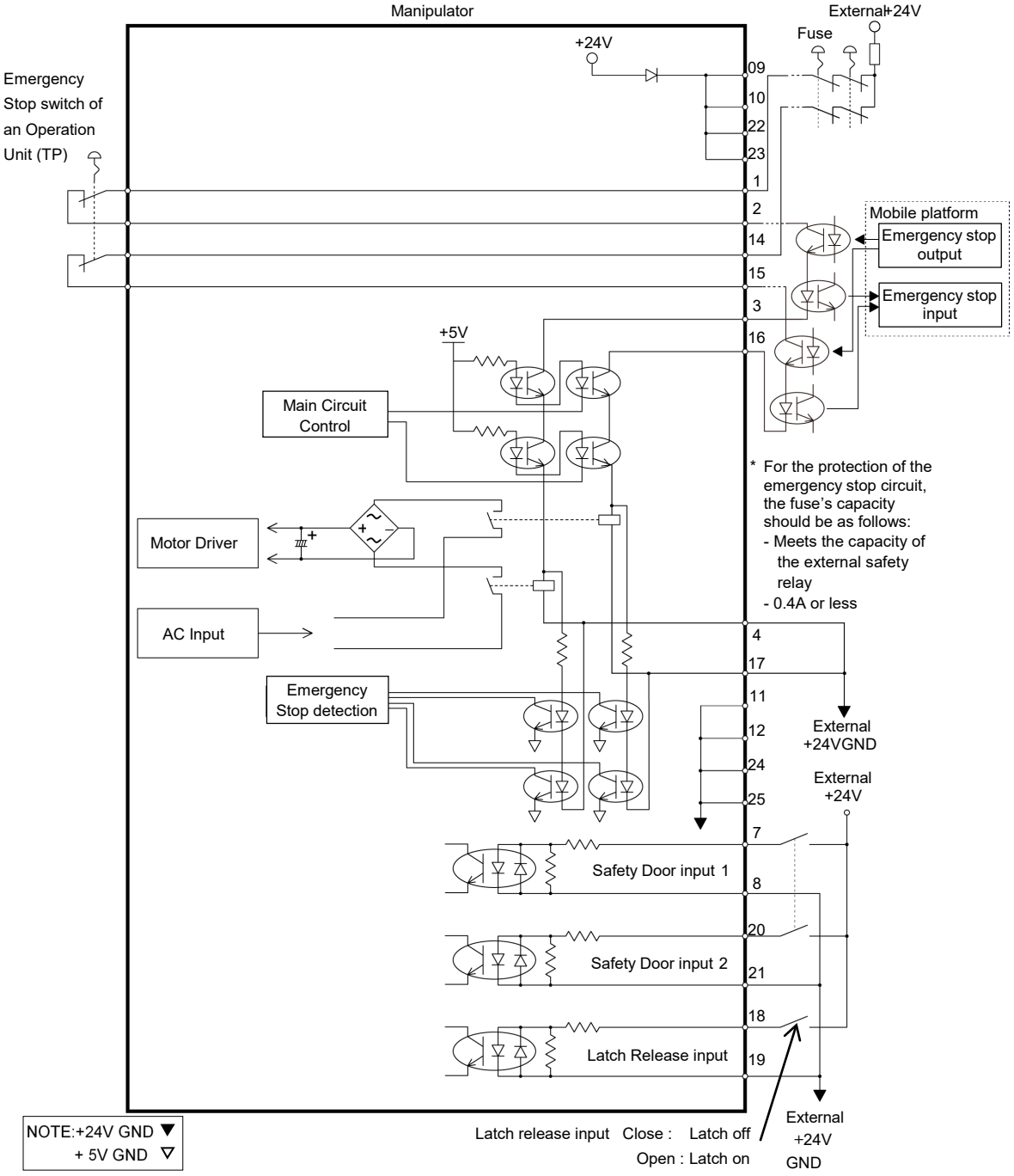
12.4.1 Example 1: External emergency stop switch typical application



12.4.2 Example 2: External safety relay typical application



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



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 the *Setup & Operation 3.7.2 Noise Countermeasures* in order to prevent noise.

Remote function is initially assigned to both input and output from 0 to 7. For further details, refer to *Setup & Operation 14. I/O Remote Settings*.

13.1.1 Input Circuit (Standard, Cleanroom Model)

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

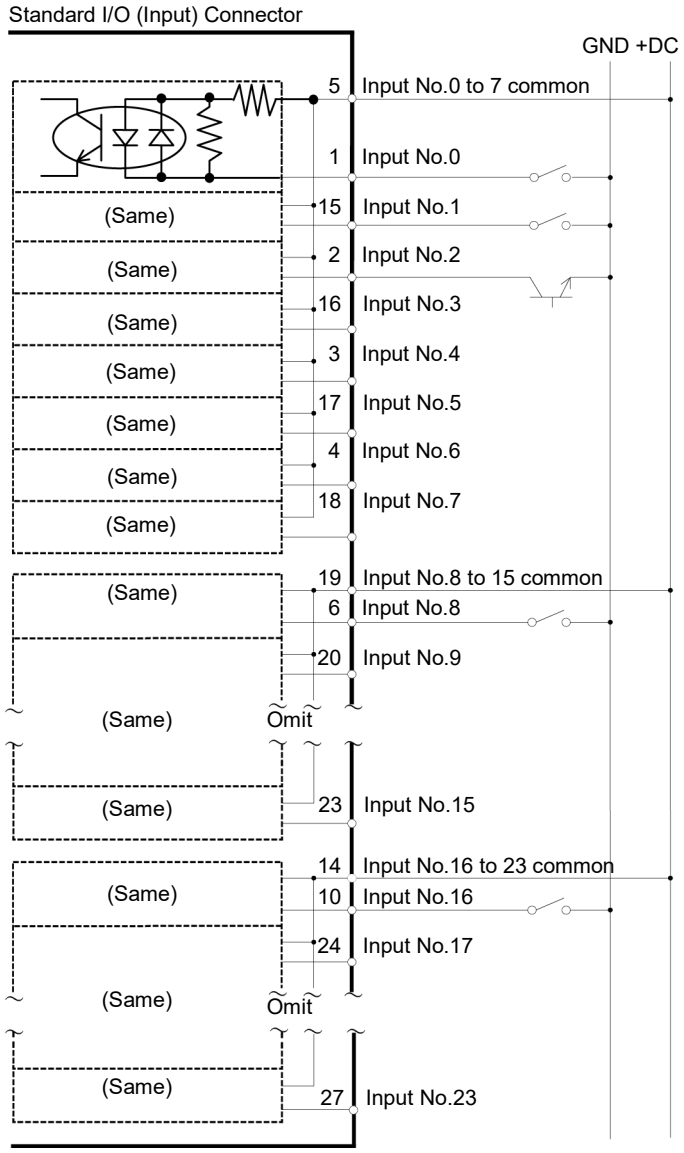
ON Voltage : +10.8 V (min.)

OFF Voltage : +5 V (max.)

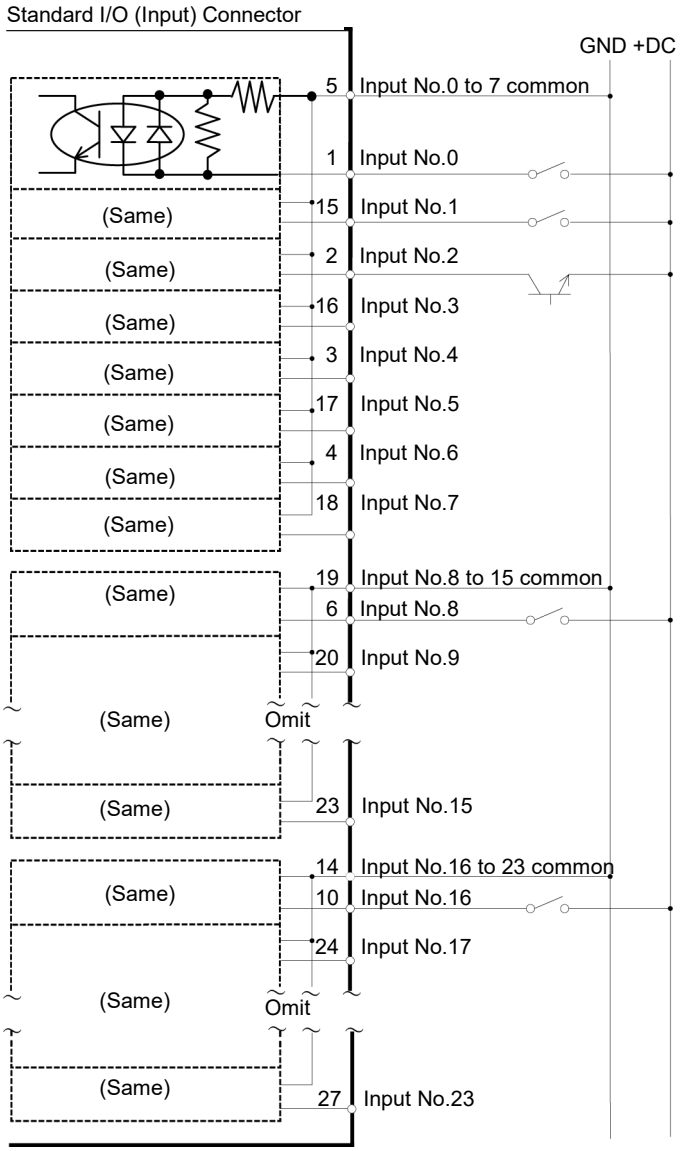
Input Current : 10 mA (TYP) at +24 V input

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

Typical Input Circuit Application 1



Typical Input Circuit Application 2



Pin Assignments of Input Circuit

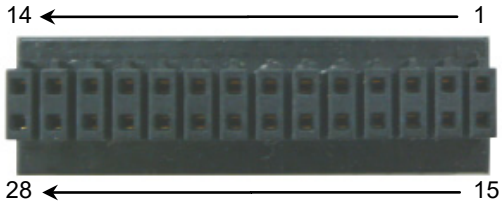
Pin No.	Signal Name	Pin No.	Signal Name
1	Input No. 0 (Start)	15	Input No. 1 (SelProg1)
2	Input No. 2 (SelProg2)	16	Input No. 3 (SelProg4)
3	Input No. 4 (Stop)	17	Input No. 5 (Pause)
4	Input No. 6 (Continue)	18	Input No. 7 (Reset)
5	Input common No. 0 to 7	19	Input common No. 8 to 15
6	Input No. 8	20	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 *Setup & Operation 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



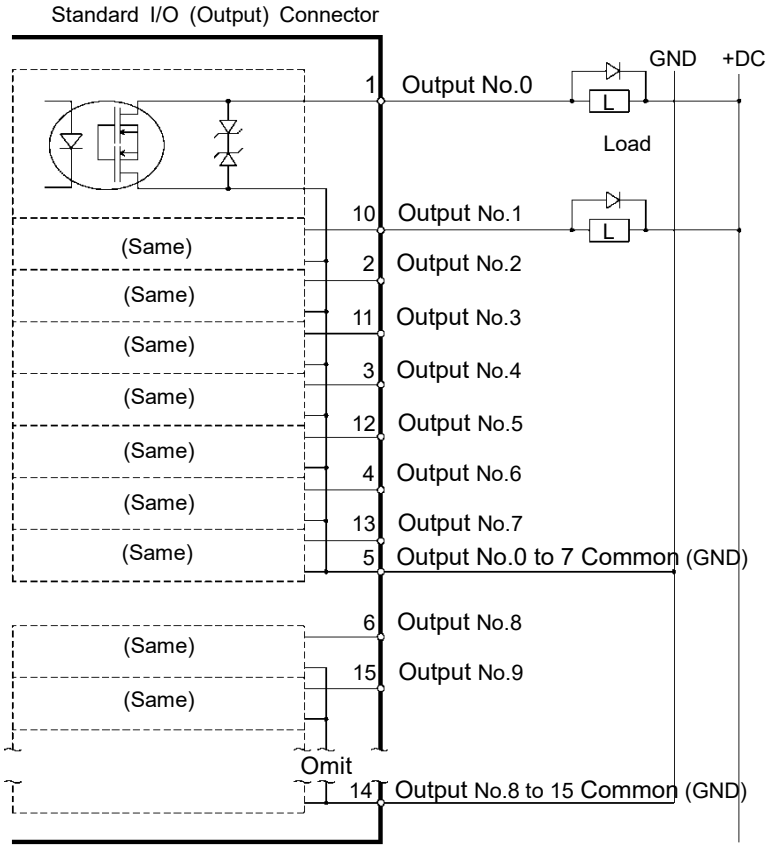
13.1.2 Output Circuit (Standard, Cleanroom Model)

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

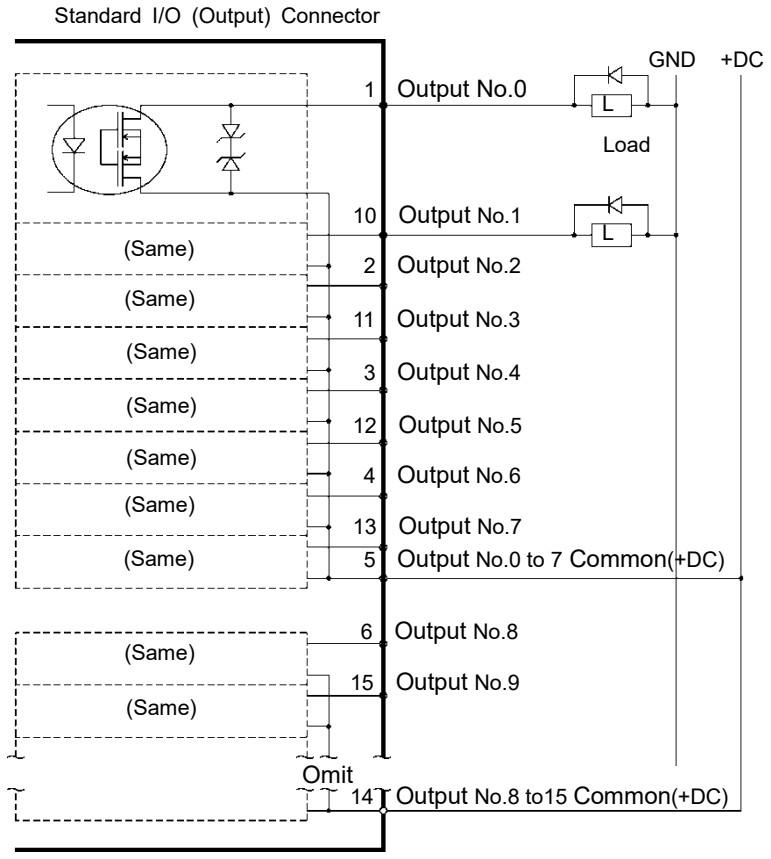
The following two wirings are available since non-polar PhotoMOS relay is used for output circuit.

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.

Typical Output Circuit Application 1: Sink Type (NPN)



Typical Output Circuit Application 2: Source Type (PNP)



Pin Assignments of Output Circuit

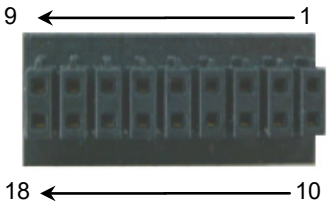
Pin No.	Signal Name	Pin No.	Signal Name
1	Output No. 0 (Ready)	10	Output No.1 (Running)
2	Output No.2 (Paused)	11	Output No.3 (Error)
3	Output No.4 (EstopOn)	12	Output No.5 (SafeguardOn)
4	Output No.6 (SError)	13	Output No.7 (Warning)
5	Output common No. 0 to 7	14	Output common No. 8 to 15
6	Output No. 8	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 7. For further details, refer to *Setup & Operation 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 the *Setup & Operation 3.7.2 Noise Countermeasures* in order to prevent noise.

Remote function is initially assigned to both input and output from 0 to 7. For further details, refer to *Setup & Operation 14. I/O Remote Settings*.

13.2.1 Input Circuit (Protection Model)

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

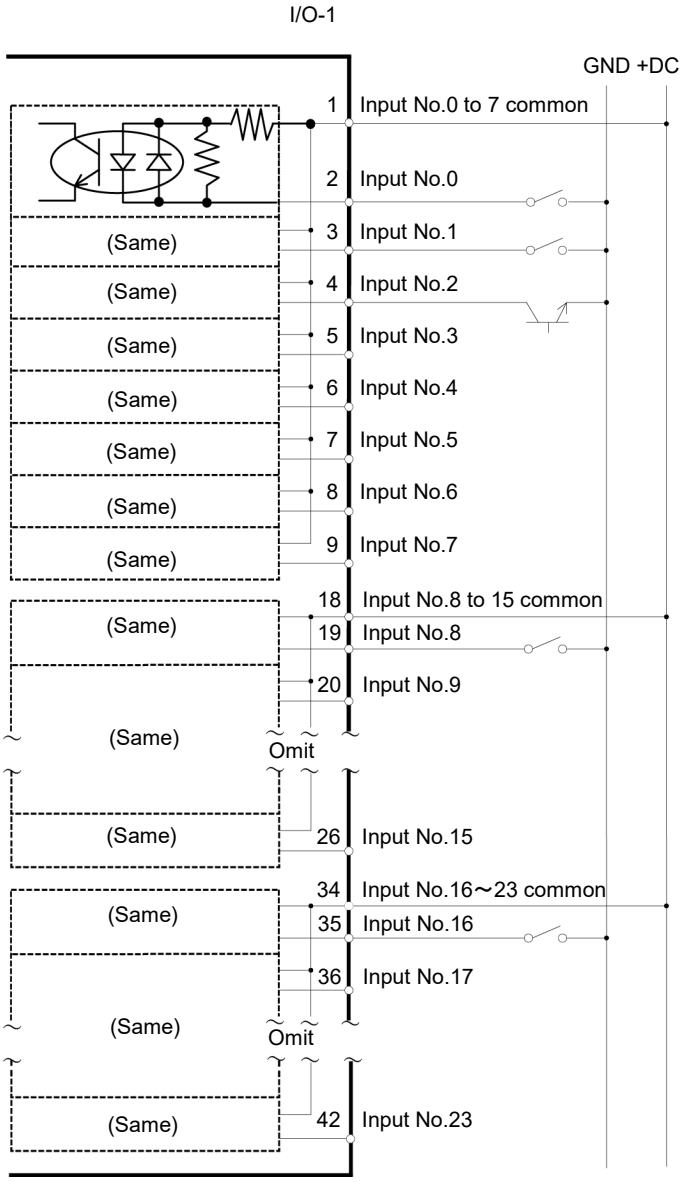
ON Voltage : +10.8 V (min.)

OFF Voltage : +5 V (max.)

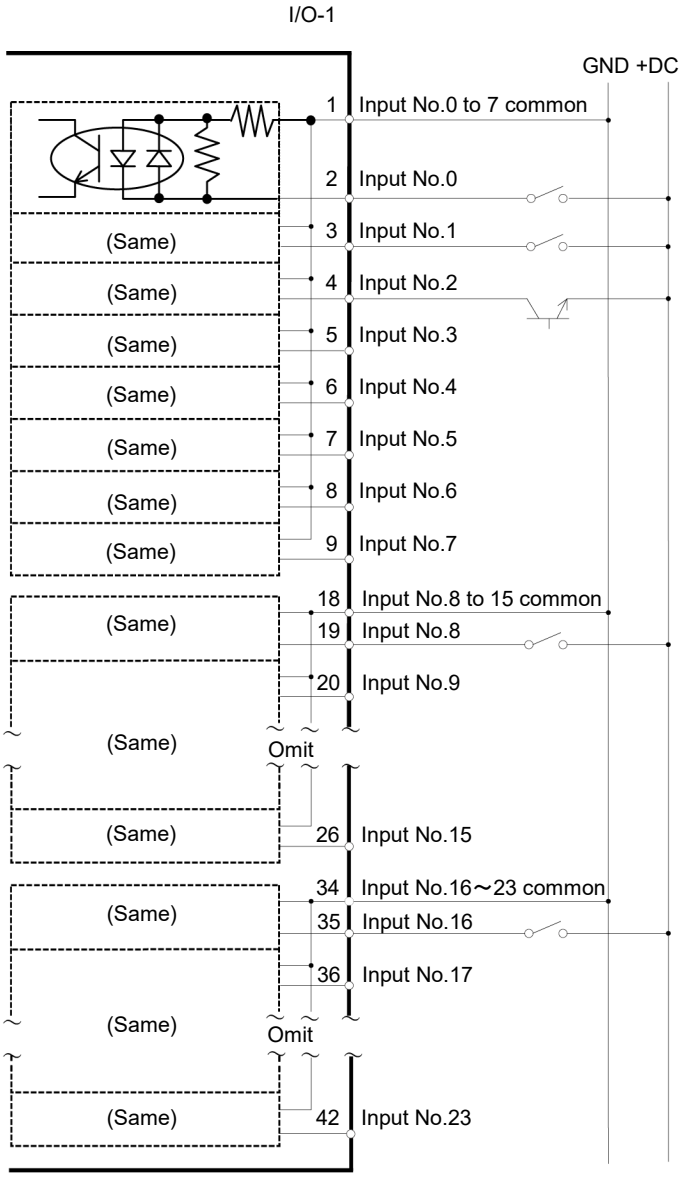
Input Current : 10 mA (TYP) at +24 V input

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

Typical Input Circuit Application 1



Typical Input Circuit Application 2



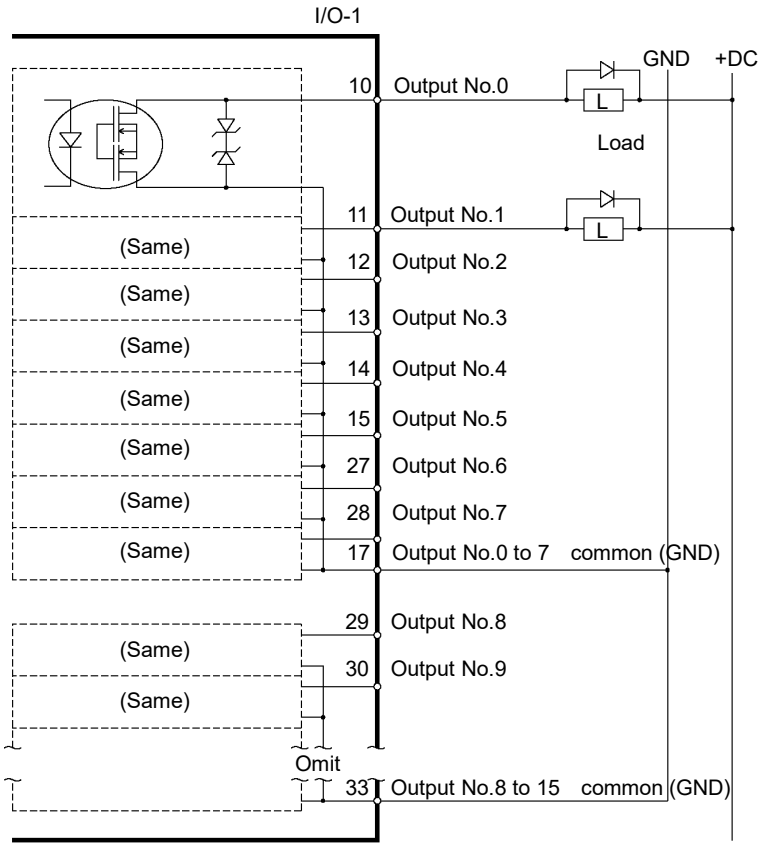
13.2.2 Output Circuit (Protection Model)

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

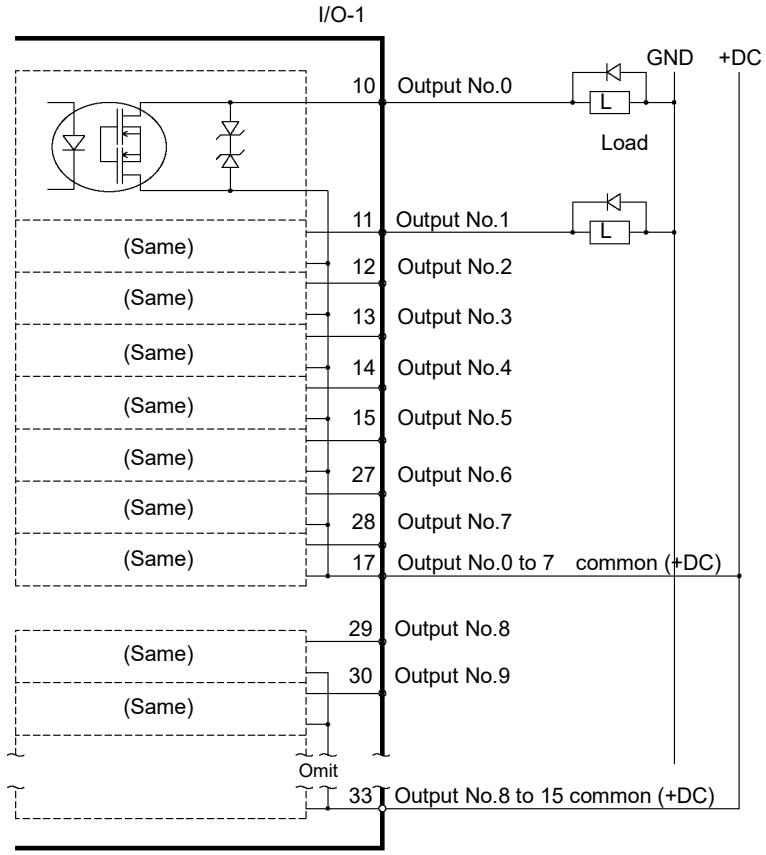
The following two wirings are available since non-polar PhotoMOS relay is used for output circuit.

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.

Typical Output Circuit Application 1: Sink Type (NPN)



Typical Output Circuit Application 2: Source Type (PNP)



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	45	Output No.13
13	Output No.3 (Error)	30	Output No.9	46	Output No.14
14	Output No.4 (EstopOn)	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 7. For further details, refer to *Setup & Operation 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)

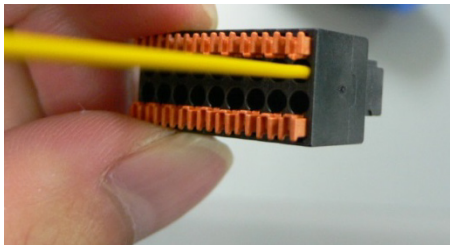
13.3 I/O Cable Product Procedure

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.



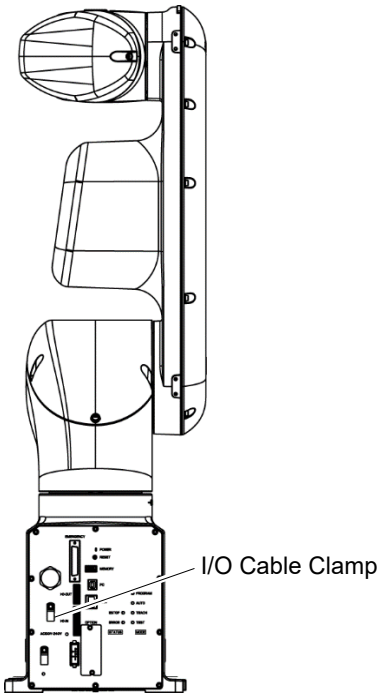
For single wire and stranded wire, peel off the covering of the cable.

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.)



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 7.

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

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

For details about I/O cable connection, refer to sections on *Setup & Operation 13: Standard I/O Connector* and *17. Fieldbus I/O*.

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

CAUTION	■ When using remote I/O, always make sure of the following. Using the robot system under unsatisfactory conditions may cause malfunction of the system and/or safety problems. - 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 RC700 / RC90 Option Fieldbus I/O.

14.1 I/O Signal Description

Remote function is initially assigned to both input and output from 0 to 7.

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

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

14.1.1 Remote Input Signals

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

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

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

Name	Initial	Description	Input Acceptance Condition (*1)
SelRobot1 SelRobot2 SelRobot4 SelRobot8 SelRobot16	Not set	Specify the number of Manipulator which executes a command. (*5)	
SetMotorsOn	Not set	Turn ON Manipulator motors. (*5) (*6)	Ready output ON EStopOn output OFF SafeguardOn output OFF SetMotorOff input OFF
SetMotorsOff	Not set	Turn OFF Manipulator motors.	Ready output ON
SetPowerHigh	Not set	Set the Manipulator power mode to High (*5)	Ready output ON EStopOn output OFF SafeguardOn output OFF 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 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 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 RecoverReqd output ON Pause input OFF Stop input OFF
ResetAlarm	Not Set	Cancel the alarm (*11)	
SelAlarm1 SelAlarm2 SelAlarm4 SelAlarm8	Not Set	Specify the alarm number to cancel (*10)	
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+ 7.0 Online Help* or *Pause* in *SPEL+ Language Reference*.

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

(*5) VT series is invalid.

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

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

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

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

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

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

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

0=OFF, 1=ON

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

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

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

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

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

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

14.1.2 Remote Output Signals

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

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

Name	Initial	Description
Ready	0	Turns ON when the Manipulator startup completes and no task is running.
Running	1	Turns ON when task is running. However, turns OFF when “Paused output” is OFF.
Paused	2	Turns ON when pause task exists.
Error	3	Turns ON when an error occurs. Use “Reset input” to recover from the error.
EStopOn	4	Turns ON at Emergency Stop.
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.
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.
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.
CmdRunning	Not set	Turns ON when an input command is executing.
CmdError	Not set	Turns ON when an input command cannot be accepted.
CurrProg1 CurrProg2 CurrProg4 CurrProg8 CurrProg16 CurrProg32	Not set	Indicates the running or the last main function number (*1)
AutoMode	Not set	Turns ON in remote input acceptable status. (*2)
TeachMode	Not set	Turns ON in TEACH mode.
TestMode	Not set	Turns ON in TEST mode.
EnableOn	Not set	Turns ON when the enable switch is ON.
ErrorCode1 ⋮ ErrorCode8192	Not set	Indicates the error number.
InsideBox1 ⋮ InsideBox15	Not set	Turns ON when the Manipulator is in the approach check area. (*3)

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

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

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

0=OFF, 1=ON

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

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

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

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

(*5) Manipulator status is output as follows, according to the condition selected in SelRobot. Wait at least 40 ms before inputting the signal after changing the condition in SelRobot.

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

(*6) 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.

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.

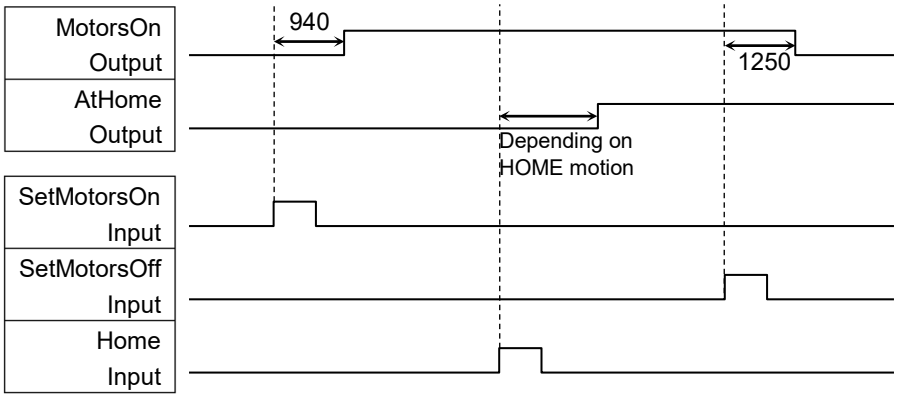
The indicated time lapses (time durations) should be referred to only as reference values since the actual timing values vary depending on the number of tasks running, as well as CPU speed of the Manipulator. Check carefully and refer to the following charts for the timing interrelation when you enter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

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

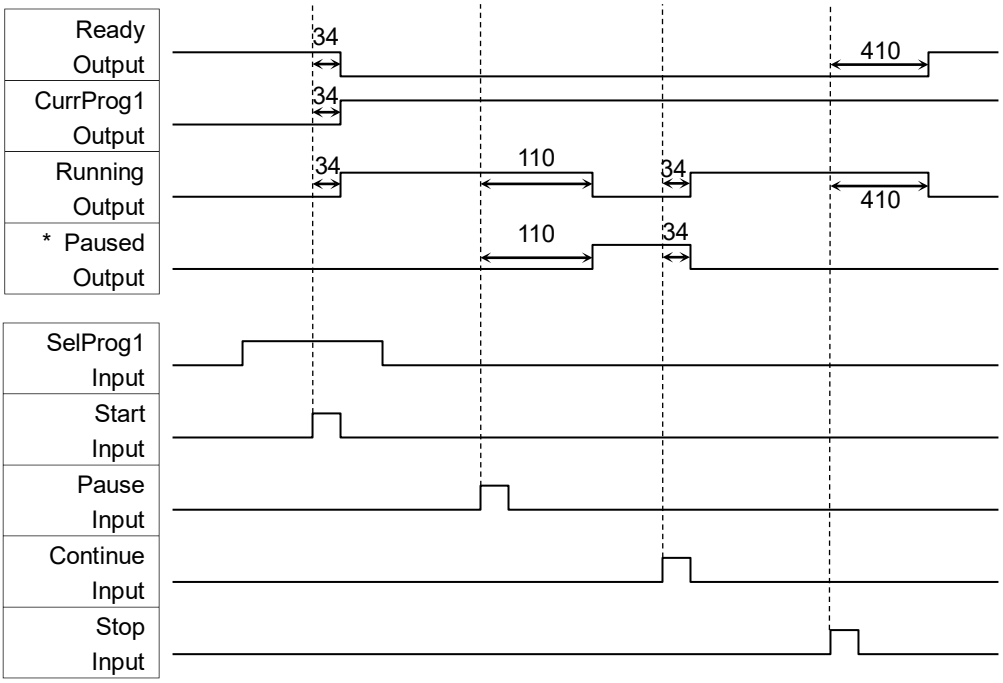
The pulse width of an input signal must be 25 or more milliseconds to be detected.

[Unit: ms]

14.2.2 Timing Diagram for Operation Execution Sequence

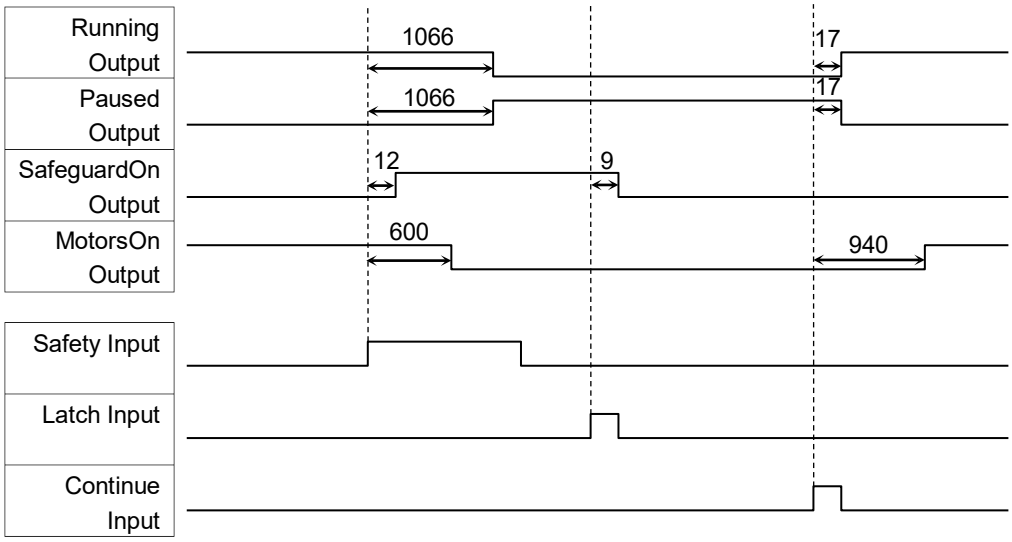


14.2.3 Timing Diagram for Program Execution Sequence

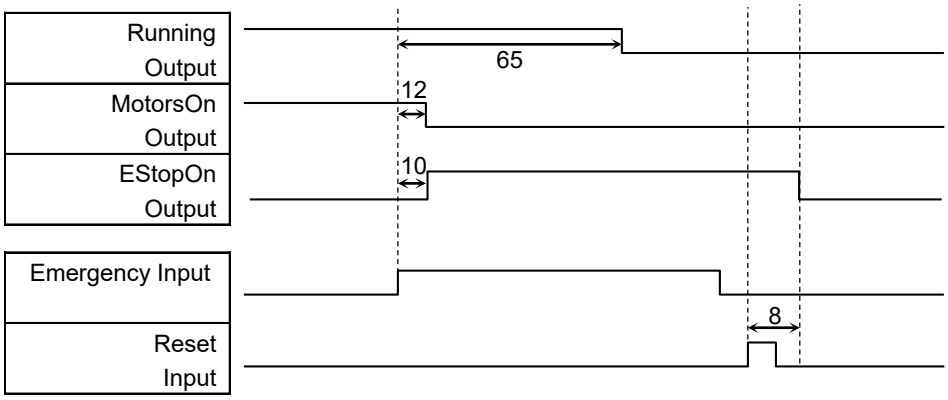


* The duration varies depending on the Quick Pause (QP) setting and the program's operating status at the time of Pause input

14.2.4 Timing Diagram for Safety Door Input Sequence

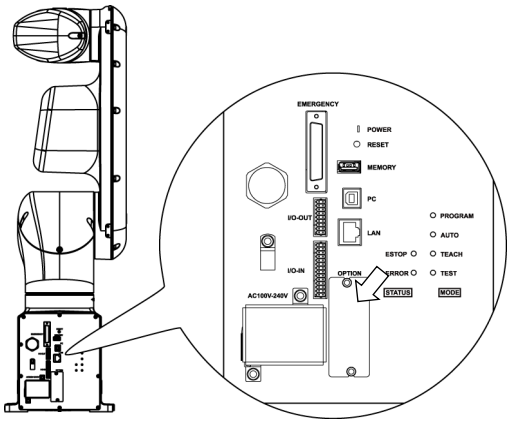


14.2.5 Timing Diagram for Emergency Stop Sequence

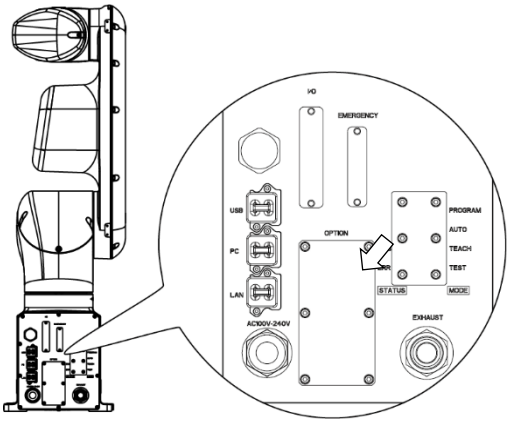


15. SD Card Slot

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.



Standard, Cleanroom model

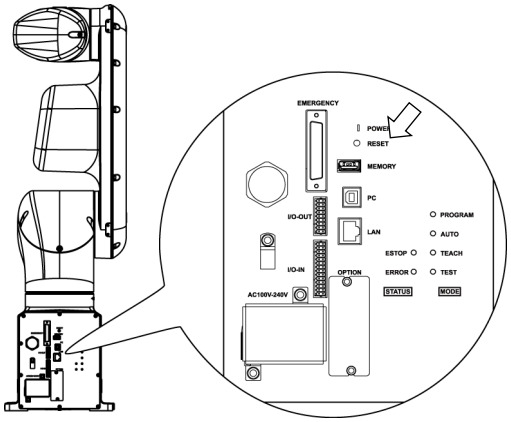


Protection model (inside the optional slot)

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

Reference: *Maintenance 18.6 Replacing SD Card*

16. RESET Switch



Standard, Cleanroom model

RESET switch has following function.

Manipulator reboot

Push the RESET switch for three seconds when booting the Manipulator.
Manipulator reboots.

Shape of RESET switch is difficult to push. Use a sharp edged object when pushing the RESET switch.

There is no RESET switch for Protection model.

17. 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 RC700 / RC90 Option Fieldbus I/O
EPSON RC+ 7.0 User's Guide 11.7 Fieldbus Slave I/O

*: VT6-A901P (Protection model) is not supported.
Please contact the supplier of your region for support timing.

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

CAUTION	■ Check the clips of the fieldbus I/O module are securely hooked on the board when installing fieldbus I/O module. If the clips do not be hooked securely, connecter or fieldbus I/O module may get damages.

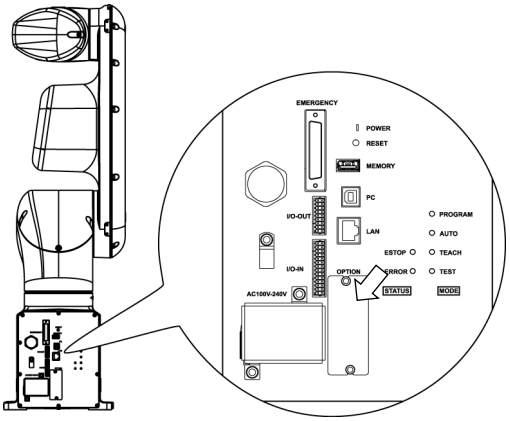
17.1 Standard, Cleanroom model

Fieldbus I/O Module Installation

Standard, Cleanroom model

(1) Turn OFF the Manipulator.

(2) Remove the optional slot cover on the back side of the Manipulator.



Sems bolt: 2-M3×6

(3) Inset the fieldbus I/O module to the optional slot.

CAUTION	■ Check the tabs of the fieldbus I/O module are securely hooked on the board when installing fieldbus I/O module. If tabs do not be hooked securely, connecter or fieldbus I/O module may get damages.

(4) Tighten screws by using special tool until fieldbus I/O module is fixed completely.



Image of installation



Front



Back

Fieldbus I/O Module Removal

Standard, Cleanroom model

(1) Unscrew the screws by using special tool until fieldbus I/O module is loosened.

(2) Remove the fieldbus I/O module.
You can remove the module by pulling loosened screws toward.

(3) Mount the optional slot cover.

17.2 Protection Model

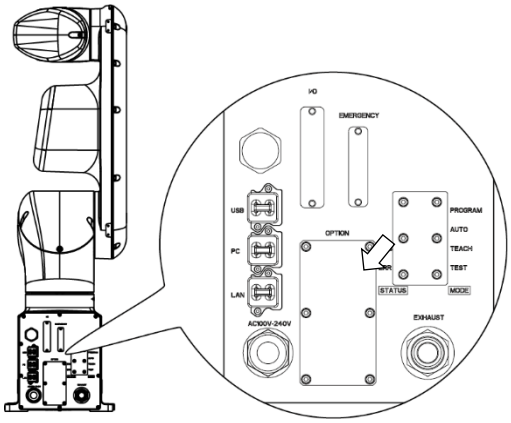
Fieldbus I/O Module Installation

Protection Model

(1) Turn OFF the Manipulator.

(2) Remove the following parts on the rear side of the Manipulator.
Optional slot cover
Gaskets
Spacers

Hexagon socket head bolts
: 6-M3×8




Optional slot cover


Gasket + Spacers

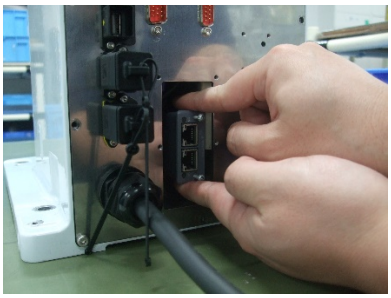

Gasket, Spacers

NOTE

Note that the spacers may fall out when removing the gasket.

Be careful not to damage the mounting surface of the gasket. If the surface is damaged, water protection performance may not be ensured.

(3) Insert the fieldbus I/O module into the optional slot.

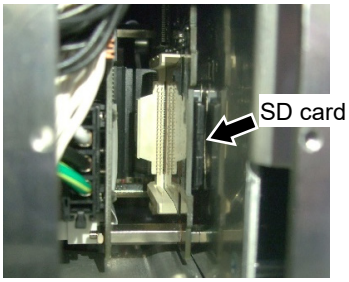


NOTE

Make sure that the fieldbus I/O module is completely inserted. Move the module up and down lightly and check whether the module is fixed in place.

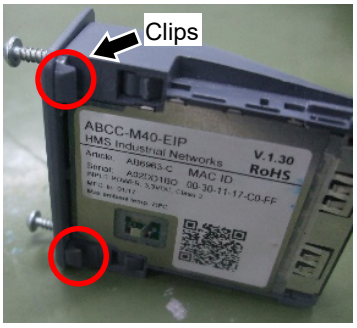
NOTE

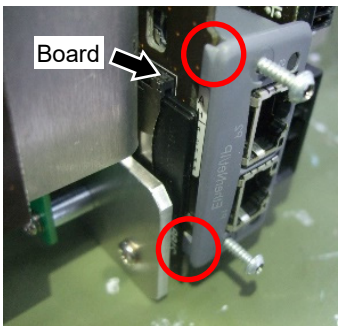
If you touch the SD card while installing the fieldbus I/O module, it may come out. Manipulator (Controller part) will not operate properly if the SD card is not inserted.



CAUTION	■ Check the clips of the fieldbus I/O module are securely hooked on the board when installing fieldbus I/O module. If the clips do not be hooked securely, connecter or fieldbus I/O module may get damages.

Installation image





(4) Tighten the screws by using the supplied hex lobe wrench until the fieldbus module is fixed completely.

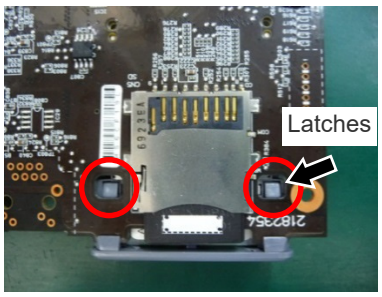
Tightening torque: 0.25 N·m



Installation image



Front

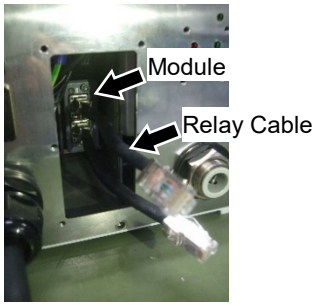


Back

NOTE

When tightening the screws of the fieldbus I/O module, two latches protrude to lock the fieldbus I/O module to the board.

(5) Connect the relay cable to the fieldbus I/O module.
(The cable is supplied with the module.)



(6) Install the spacers to the gasket.
(6 spacers: the gasket is supplied with the module.)

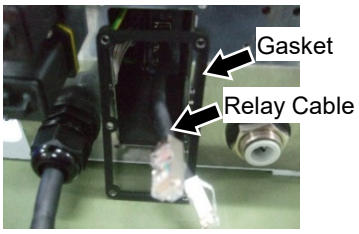


Gasket + Spacers



Gasket, Spacers

(7) Pass the relay cable through the gasket.



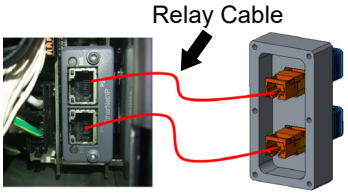
(8) Mount the optional block on the connector plate.

Hexagon socket head bolts:
6-M3×30 (with seal washer. The bolts are supplied with the module.)

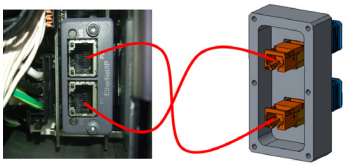
Tightening torque: 2.0 ± 0.1 N·m

Connect the relay cable as shown below. Be careful not to cross the cables.

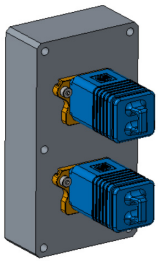
Correct



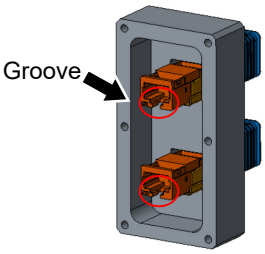
Wrong



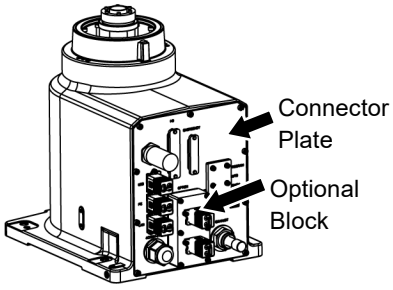
When mounting the optional block, make sure that a groove of the connector faces downward.



Optional Block (Outside)



Optional Block (Inside)



NOTE

Be sure to embed the seal washers (supplied with the module) when tightening with hexagon socket head bolts.
If the seal washers are not embedded, water protection performance may not be ensured.



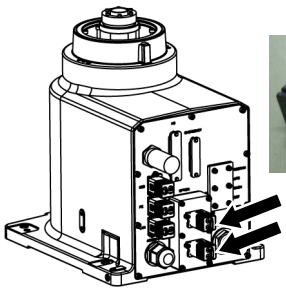
Seal washers

NOTE

Make sure that there is no scratches and/or dust on the gasket mounting surface.
If the gasket is damaged or dusty, water protection performance may not be ensured.

NOTE

Be sure to install the dust covers (supplied with the module) on the unused connectors.
If the dust covers are not installed on connectors completely, water protection performance may not be ensured.





Duct Covers

NOTE

Be sure to use the dedicated cable (supplied with the module) for communication.
If other cables are used, water protection performance may not be ensured.





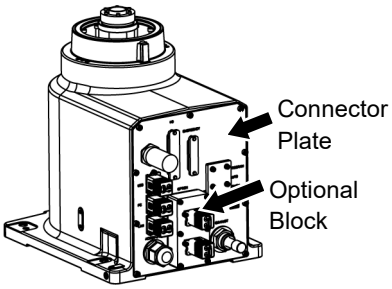
Fieldbus I/O Module Removal

Protection Model

(1) Turn OFF the Manipulator.

(2) Remove the optional block from the connector plate.

Hexagon socket head bolts:
(supplied with the module.)
6-M3×30 (with seal washer)

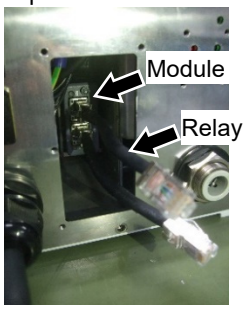


(3) Remove the gasket and spacers.

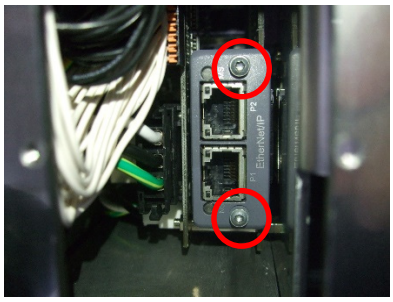

Gasket + Spacers


Gasket, Spacers

(4) Disconnect the relay cable from the fieldbus I/O module.



(5) Loosen the screws by using the supplied hex lobe wrench until the fieldbus module can be removed.



(6) Remove the fieldbus I/O module.

The module can be removed by pulling the screws forward with the screws loosened.

(7) Install the optional slot cover, gasket, and spacers.

Hexagon socket head bolts: 6-M3×8 (with seal washer.)

Tightenning torque: 2.0 ± 0.1N·m

NOTE

Be sure to embed the seal washers (supplied with the module) when tightening with hexagon socket head bolts.
If the seal washers are not embedded, water protection performance may not be ensured.
Make sure that there is no scratch and dust on the gasket mounting surface.
If the gasket is damaged or dusty, water protection performance may not be ensured.

Maintenance

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

1. Safety Maintenance

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

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

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

 WARNING	■ To shut off power to the robot system, 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. ■ Before performing any replacement procedure, turn OFF the Controller and related equipment, and then disconnect the power plug from the power source. Performing any replacement procedure with the power ON is extremely hazardous and may result in electric shock and/or malfunction of the robot system.

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

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

2. General Maintenance

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

2.1 Maintenance Inspection

2.1.1 Schedule for Maintenance Inspection

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

	Inspection Point					
	Daily inspection	Monthly inspection	Quarterly inspection	Biannual inspection	Annual inspection	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

2.1.2 Inspection Point

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

Inspection Point	Inspection Place	Daily	Monthly	Quarterly	Biannual	Annual
Check looseness or backlash of bolts, screws. Tighten them if necessary. (For the tightening torque, refer to *Maintenance: 2.3 Tightening Hexagon Socket Head Cap Bolts*.)	End effector mounting bolts	√	√	√	√	√
	Manipulator mounting bolts	√	√	√	√	√
	Each joint	√	√	√	√	√
	Bolts, screws securing motors, reduction gear units, etc.					√
Check looseness of connectors. If the connectors are loosen, push it securely or tighten.	External connectors on Manipulator (on the connector plates etc.)	√	√	√	√	√
	Manipulator cable unit		√	√	√	√
Visually check for external defects. Clean up if necessary.	External appearance of Manipulator	√	√	√	√	√
	External cables		√	√	√	√
Check for bends or improper location. Repair or place it properly if necessary.	Safeguard etc.	√	√	√	√	√
Check tension of timing belts. Tighten it if necessary.	Inside of Arm #2				√	√
Lithium Battery	Refer to *Maintenance: 18.4 Replacing Lithium Battery*					

Inspection While the Power is ON (Manipulator is operating)

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

2.2 Overhaul (Parts Replacement)

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

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

The time between overhauls is 20,000 operation hours of the Manipulator as a rough indication.

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

NOTE

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

Refer to the *Maintenance: 4. Alarm.*

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

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

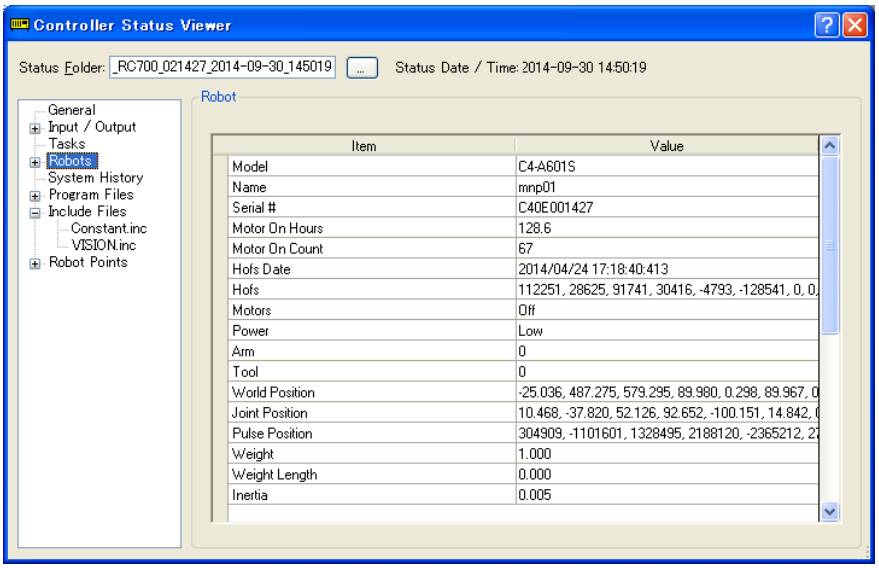
(1) Select EPSON RC+ menu-[Tools]-[Controller] to open the [Controller Tools] dialog box.

(2) Click the <View Controller Status> button to open the [Browse For Folder] dialog box.

(3) Select the folder where the information is stored.

(4) Click <OK> to view the [Controller Status Viewer] dialog box.

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



For the parts subject to overhaul, refer to *Maintenance: 22. Maintenance Parts List.*

For details of replacement of each part, refer to the *Maintenance* section.

Please contact the supplier of your region for further information.

2.3 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.

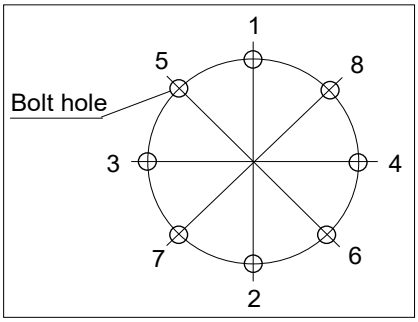
When it is necessary to refasten these bolts in some procedures in this manual (except special cases as noted), use a torque wrench so that the bolts are fastened with the appropriate tightening torques as shown below.

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.

2.4 Matching Origins

After parts have been replaced (e.g. motor units, reduction gear units, timing belts), the Manipulator cannot operate properly because a mismatch exists between the origin stored in each motor and its corresponding origin stored in the Robot system.
Because of that, it is necessary to perform calibration (encoder rest and calibration) to match these origins.

For calibration, the pulse values for a specific position must be recorded in advance.
Before replacing parts, select easy point (pose) data from the registered point data to check the accuracy. Then, follow the steps below to display the pulse values and record them.

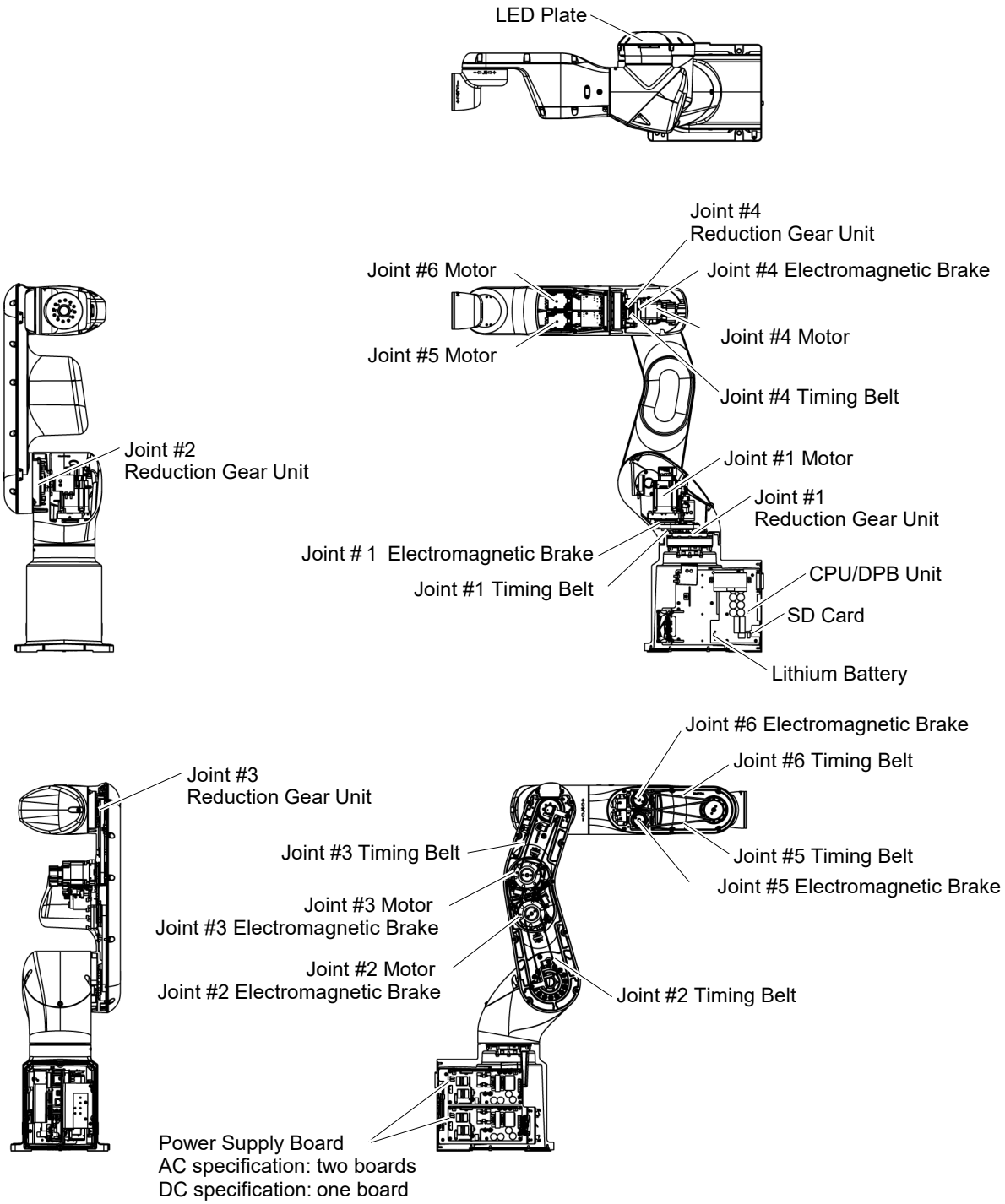
EPSON RC+

Execute the following command from the [Command Window].

```
>PULSE
```

`PULSE:` [Joint #1 Pulse value] `pls` [Joint #2 Pulse value] `pls` [Joint #3 Pulse value] `pls` [Joint #4 Pulse value] `pls`[Joint #5 Pulse value]`pls` [Joint #6 Pulse value]`pls`

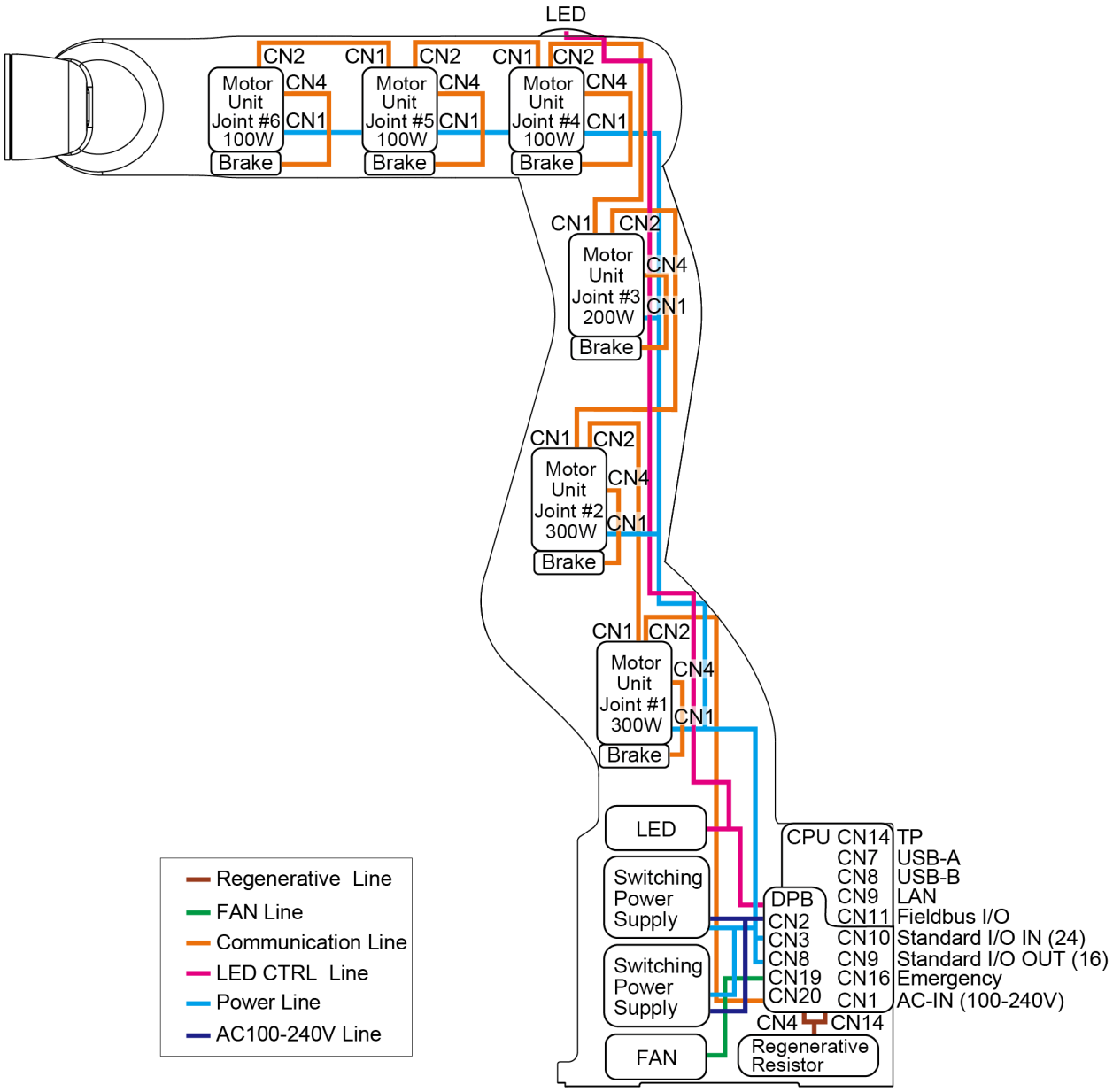
2.5 Layout of Maintenance Parts



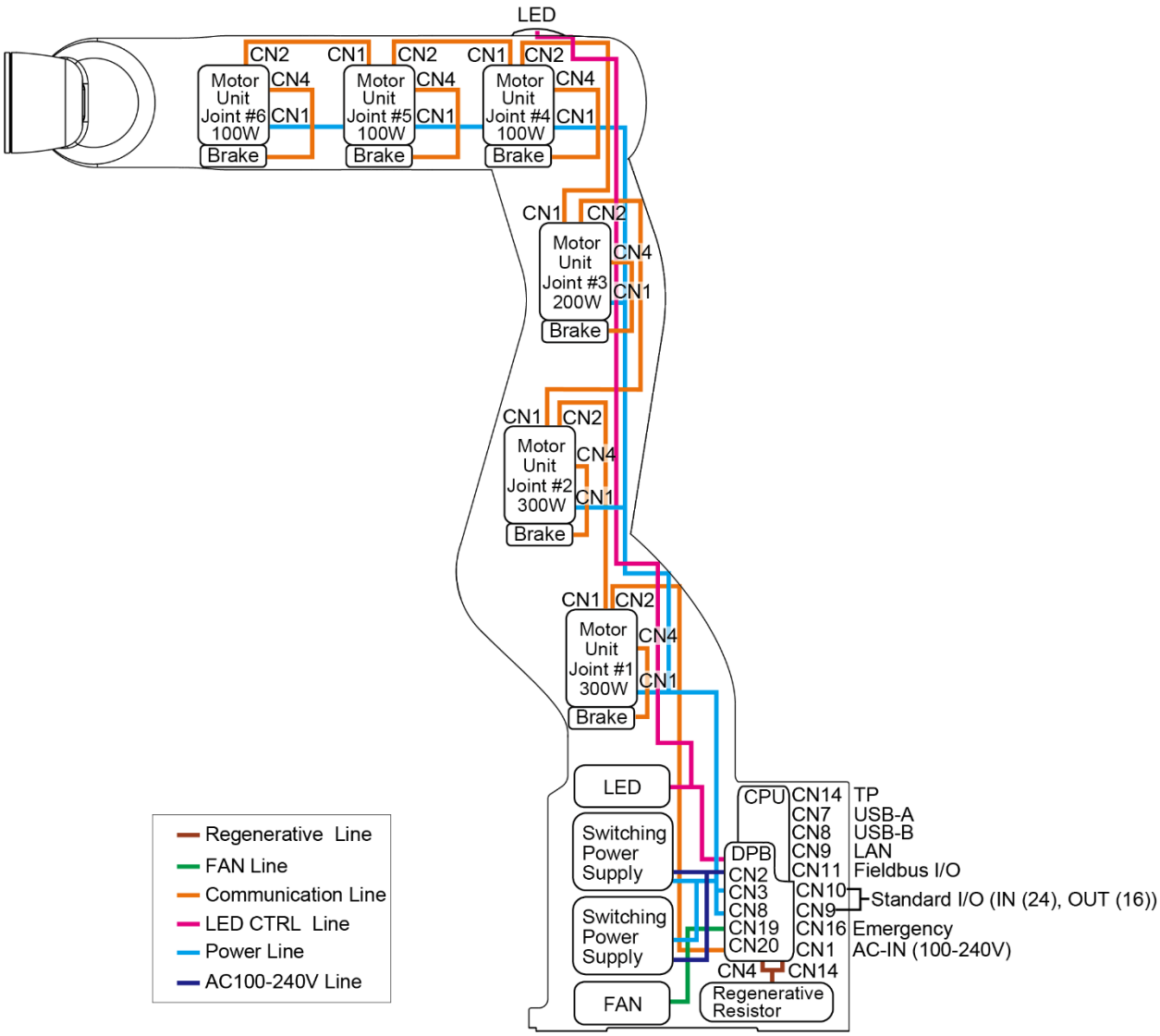
3. Manipulator Structure

3.1 AC Specification Manipulator

Standard, Cleanroom model

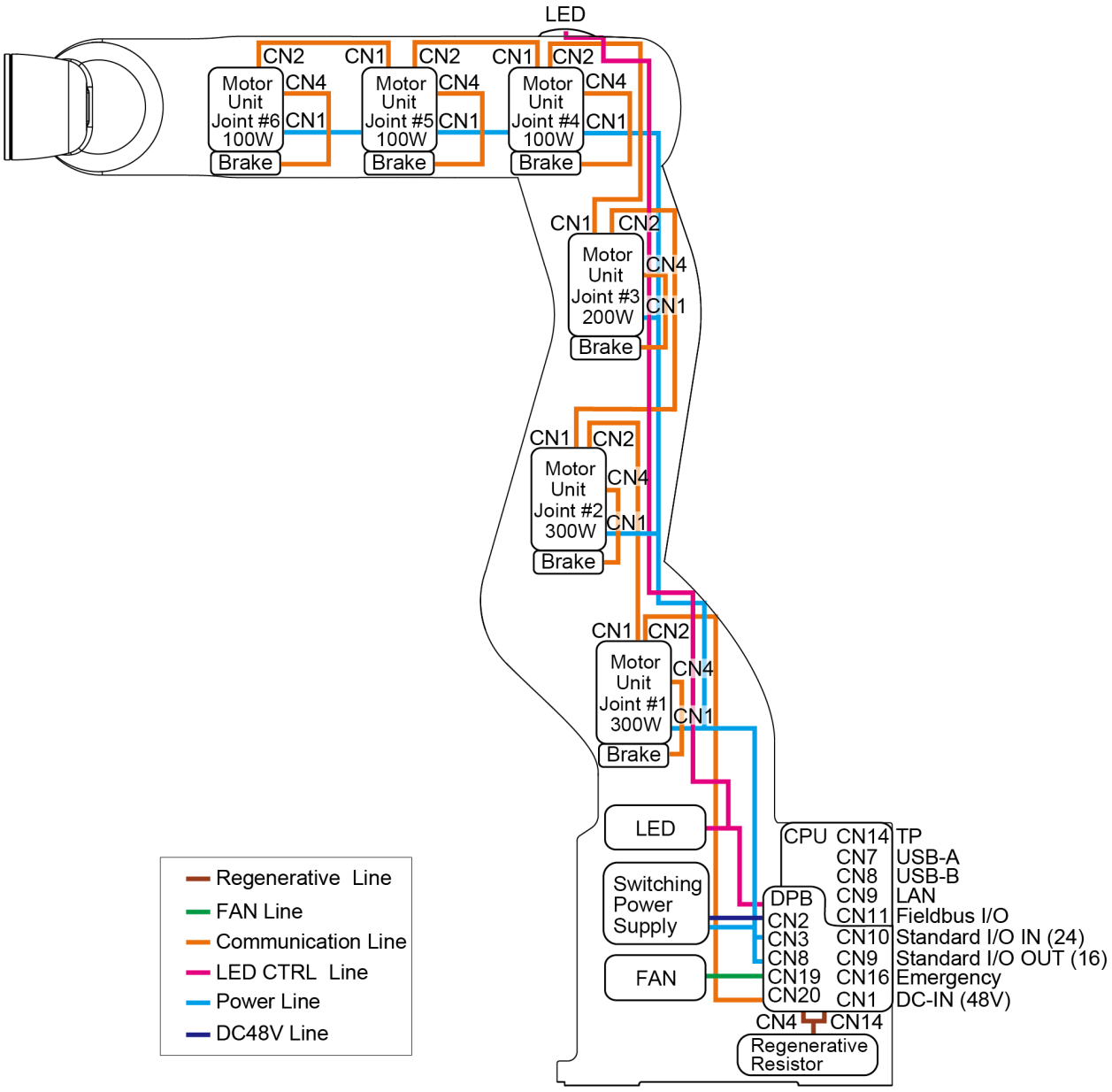


Protection model



3.2 DC Specification Manipulator

Standard model



4. Alarm

When the lithium batteries run out, a voltage reduction alarm warning occurs. However, the warning does not guarantee that the battery lasts until you replace it. Therefore, you need to replace the battery immediately. If the battery has run out, the Manipulator parameters will be lost and recalibration of the Manipulator will be required.

In addition, the parts of the Manipulator joints may cause accuracy decline or malfunction due to deterioration of the parts resulting from long term use. If the Manipulator breaks down due to deterioration of the parts, it will take significant time and cost for repair.

The following sections describe the alarm function which announces the following maintenance timings in order to perform maintenance well ahead of time before the warning error.

- Battery replacement
- Grease up
- Replacement of the timing belt
- Replacement of the motor
- Replacement of the reduction gear unit

4.1 Maintenance

The recommended replacement time can be configured for the batteries, timing belts, motors, and reduction gear units.

CAUTION	■ Make sure that the date and time on the Manipulator are set correctly. Maintenance cannot be performed properly with improper date and time setting. ■ If the CPU/DPB board or SD card is replaced, the Maintenance information may be lost. When you replaced these parts, confirm the date and time of the Manipulator and the Maintenance information.

NOTE

Settings of the Maintenance are different depending on installation methods of the firmware.

Initial installation : Maintenance is enabled.

Upgrade : Maintenance inherits the previous data.
(Disables as default)

For details for enabling or disabling the Maintenance, refer to the *EPSON RC+ 7.0 User's Guide 5.12.2 [System Configuration] Command (Setup Menu) - [Setup]-[System Configuration]-[Controller]-[Preferences] Page*.

NOTE

Maintenance is enabled at shipment.

If enabled, the Maintenance information for the timing belts, motors, and reduction gear units will be configured automatically when the robot is configured or changed.

When the Manipulator is deleted from the configuration, the Maintenance information will also be automatically deleted.

For details on the Manipulator configuration, refer to *the EPSON RC+ 7.0 User's Guide 10.1 Setting the Robot Model*.

CAUTION	■ Changing of the Manipulator should be done carefully. The alarm setting will be reset when the Manipulator is changed.

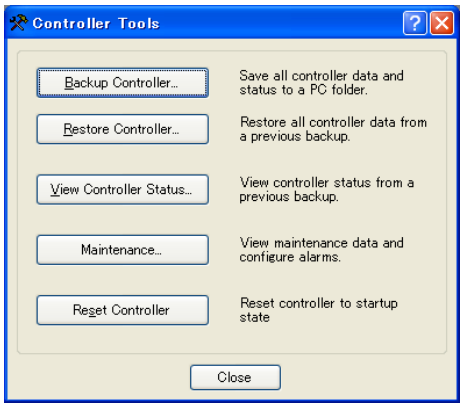
If the Maintenance is enabled, the battery is automatically configured at the first connection.

4.2 Maintenance Information

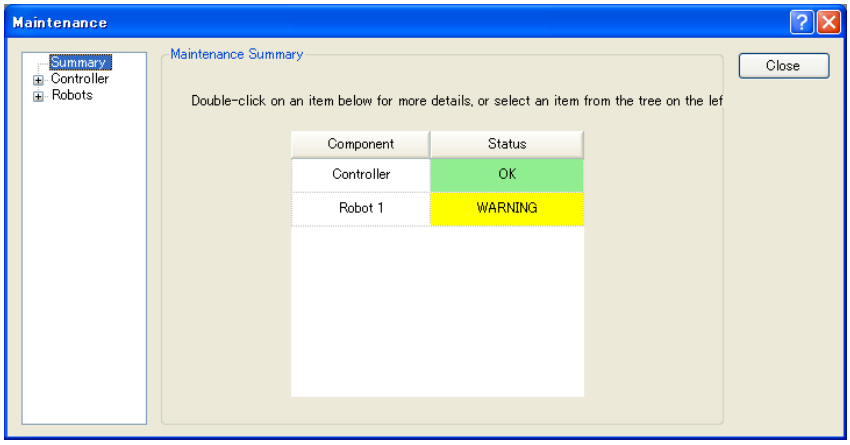
4.2.1 How to Check the Maintenance Information

The configured Maintenance information can be checked in the EPSON RC+.

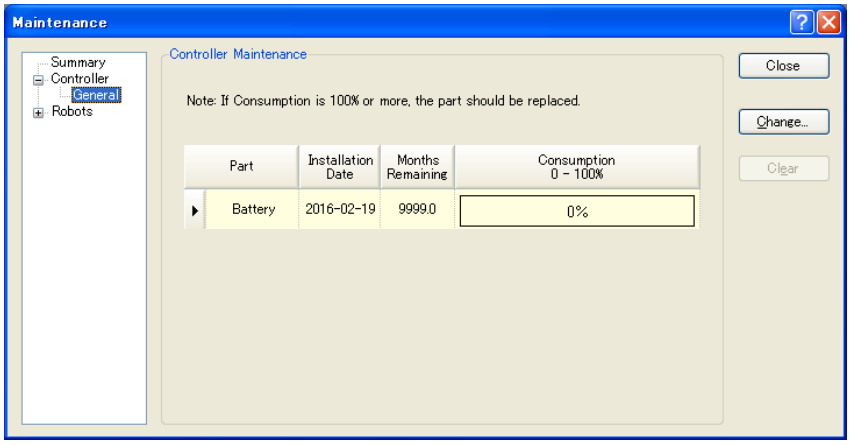
(1) Select EPSON RC+ 7.0 menu-[Tools]-[Maintenance] to display the [Controller Tools] dialog box.



(2) To check the Controller Maintenance information, click the <Maintenance> button and display the [Maintenance] dialog box.



(3) Select “General” or specify the axis from the tree to display information of the target parts.



NOTE The recommended replacement time for the battery is calculated based on the battery capacity and the Manipulator ON time. The battery may run out if it passes the recommended replacement time.

NOTE The recommended replacement time for the parts (e.g. timing belts, motors, reduction gear units) is when it reaches the L10 life (time until 10% failure probability). In the dialog box, the L10 life is displayed as 100%.

4.2.2 How to Edit the Maintenance Information

The configured Maintenance information can be edited in the EPSON RC+.

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

(2) To edit the Maintenance information, display the [Maintenance] dialog box.

(3) Select “General” or specify the axis from the tree to display information of the target parts.

(4) Select the alarm to be changed and click the <Change> button.

(5) Display the [Change Alarm] dialog box and enter any of the following.



Purchase or replacement date of the battery
Date of grease up
Purchase or replacement date of the timing belt
Purchase or replacement date of the motor
Purchase or replacement date of the reduction gear unit

(6) Click the <OK> button and change the specified alarm information.

NOTE The offset can be set for the consumption rate of already installed parts.
Follow the steps below to calculate a rough offset setting value.

1. Measure the usable months for the past operation by HealthRBAnalysis.
2. Confirm the past Motor ON time in the Controller status viewer.
3. Calculate a rough offset value with the following formula.

$$\text{Offset}=100\times\frac{\textit{Motor On time}}{24\times30.4375\times\textit{Usable months}}$$

For details, refer to the following manual.
EPSON RC+ 7.0 SPEL+ Language Reference.

4.2.3 Alarm Notifying Method

The Manipulator status becomes warning and displays warning message if any parts required to perform replacement or grease up.

For details, refer to the following manual.

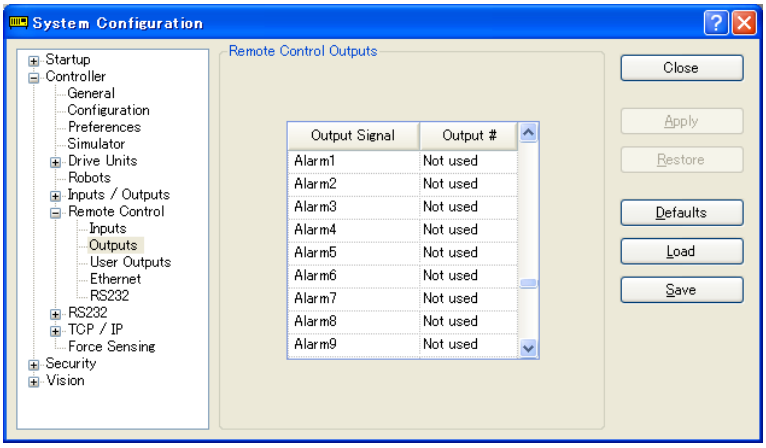
SPEL+ Language Reference SPEL+ Error Message

The alarm notifying method can be configured by the output bit of the Remote I/O.

The Remote I/O can be configured in the EPSON RC+ 7.0- [Setup] - [System Configuration] - [Controller] - [Remote Control].

For details, refer to the following manual.

EPSON RC+ 7.0 User's Guide 12.1 Remote I/O.



NOTE

The Controller enters the warning state if an alarm occurs.

4.2.4 How to Cancel the Alarm

An alarm occurs when the consumption rate of the parts reaches 100%.

NOTE

The alarm cannot be canceled by executing the Reset command or restarting the Controller. The alarm can be canceled by the following method.

Operation from [Maintenance] dialog box of the EPSON RC+ 7.0

HealthCtrlReset Command

HealthRBReset Command

Refer to the following section to change the alarm information in the same steps.

Maintenance 4.2.2 How to Edit the Maintenance Information

5. Backup and Restore

5.1 What is the Backup Controller Function

The Manipulator configuration set by EPSON RC+ 7.0 can be stored with the “Backup Controller” function.

The Manipulator settings can be restored easily using the data previously stored with “Backup Controller” after a configuration mistake or Manipulator problem.

Be sure to execute “Backup Controller” before changing the Manipulator setup, before maintenance, or after teaching.

For some problems, backup may not be available before maintenance has to be performed. Be sure to backup the data after making changes, before problems occur.

NOTE ☞ “Controller Status Storage” is one of the VT series Manipulator functions. It saves the Controller setup data same as “Backup Controller.”

There data can be used as the backup data at restoring.

The methods for “Controller Status Storage” are as follows:

A : “Controller status storage to USB memory”
For details, refer to *Setup & Operation 8. Memory Port*.

B : “Export Controller Status function” in EPSON RC+ 7.0.
For details, refer to the following manual.
EPSON RC+ 7.0 User’s Guide 5.9.9 Import Command (Project Menu).

5.2 Backup Data Types

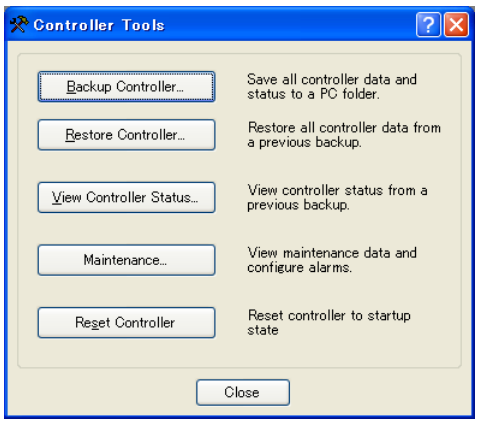
The table below shows the files created with “Backup Controller”.

File Name	Overview	
Backup.txt	Information file for restore	File including information for restoring the Manipulator.
CurrentMnp01.PRM	Manipulator parameters	Stores information such as ToolSet.
InitFileSrc.txt	Initial configuration	Stores various Manipulator parameters.
MCSys01.MCD	Manipulator configuration	Stores connected Manipulator information.
All the files related to Project	Project related	All the project files transferred to the Controller. Includes program files when EPSON RC+ 7.0 is configured to transfer source code to the Controller.
GlobalPreserves.dat	Global Preserve variables	Saves values of Global Preserve variables.
WorkQueues.dat	WorkQue information	Saves information of Queues information of the WorkQue.

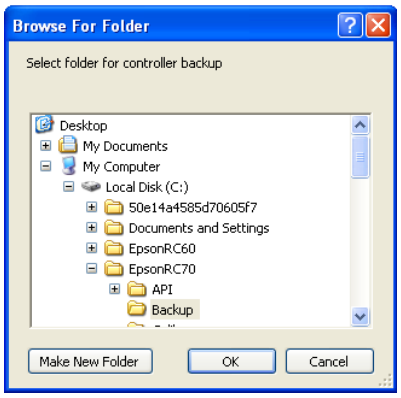
5.3 Backup

Backup the Manipulator status from EPSON RC+ 7.0.

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



(2) Click the <Backup Controller…> button to display the [Browse For Folder] dialog box.



(3) Specify the folder to save the backup data. Create a new folder if desired.

(4) Click the <OK> button. A folder is created in the specified folder containing the backup data with a name in the following format.
B_VT_ serial number_ date status was saved
→ Example: B_VT_12345_2016-04-03_092941

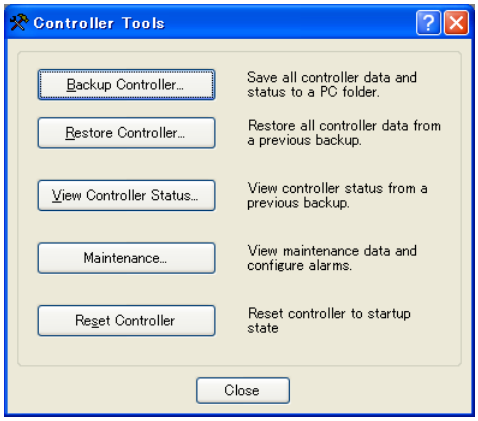
CAUTION	■ Do not edit the backup files. Otherwise, operation of the robot system after data restoration to the Manipulator is not assured.

5.4 Restore

Restore the Manipulator status from EPSON RC+ 7.0.

CAUTION	■ Make sure that the data used for restore was saved previously for same Manipulator. ■ Do not edit the backup files. Otherwise, operation of the robot system after data restoration to the Manipulator is not assured.

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



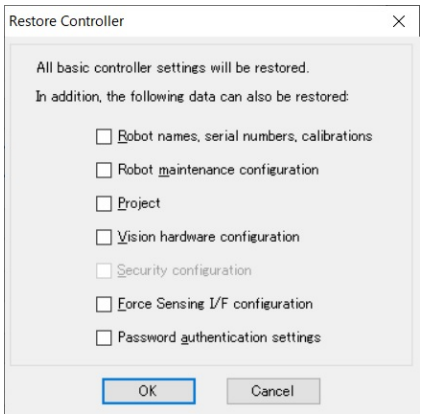
(2) Click the <Restore Controller…> button to display the [Browse For Folder] dialog box.



(3) Specify the folder that contains the backup data. Backup data folders are named using the following format:
B_VT_ serial number_ date status was saved
→ Example: B_VT_12345_2016-04-03_092941

NOTE ☞ Controller status backup to USB memory function can also be specified for restore. Specify the following folder.

(4) Click the <OK> button to display the dialog box to select the restore data.



Robot name, serial #, calibration

This checkbox allows you to restore the robot (Manipulator) name, Manipulator serial number, Hofs data, and CalPls data. Make sure that the correct Hofs data is restored. If the wrong Hofs data is restored, the Manipulator may move to wrong positions.

This is not selected by the default setting.

Robot maintenance configuration

This checkbox allows you to restore the robot alarm related files.

For details, refer to *Maintenance 4. Alarm*.

This is not selected by the default setting.

Project

This checkbox allows you to restore the files related to projects.

This is not selected by the default setting.

When a project is restored, the values of Global Preserve variables are loaded.

For details about Global Preserve variable backup, refer to the following manual.

EPSON RC+ 7.0 User's Guide 5.10.10 Display Variables Command (Run Menu).

Vision hardware configuration

This checkbox allows you to restore the vision hardware configuration.

For details, refer to refer to the following manual.

EPSON RC+ 7.0 option Vision Guide 7.0.

This is not selected by the default setting.

Security configuration

This checkbox allows you to restore the security configuration.

For details, refer to refer to the following manual.

EPSON RC+ 7.0 User's Guide 15. Security.

This is not selected by the default setting.

Force Sensing I/F configuration

This checkbox allows you to restore the Force Sensing I/F configuration.

This is not selected by the default setting.

This function is not supported for VT series Manipulator.

Password authentication setting

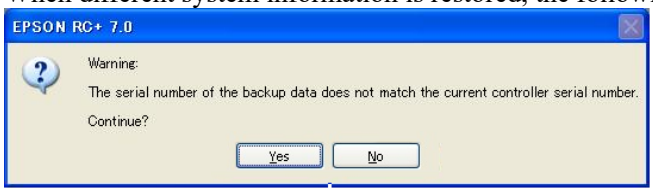
This checkbox allows you to restore the setting of authentication for PC connection. The authentication password for PC connection and the setting to disable connection authentication are restored.

This is not selected by the default setting.

(5) Click the <OK> button to restore the system information.

NOTE

Restore the system configuration saved using Backup Controller only for the same system. When different system information is restored, the following warning message appears.



Click the <No> button (do not restore data) except for special situations such a Manipulator replacement.

NOTE

When restoring the backup including the robot information other than VT series, an error occurs.

NOTE

You cannot restore the backup including T series robot created in the virtual Controller of EPSON RC+ 7.0 to the VT series robot.

6. Firmware Update

This chapter describes the firmware upgrade procedure and data file initialization when firmware or Manipulator configuration errors cause Manipulator startup or operation failure.

6.1 Updating Firmware

Firmware (software stored in non-volatile memory) and data files necessary to control the Manipulator are preinstalled in the Manipulator. Controller configuration set from EPSON RC+ 7.0 is always saved in the Manipulator.

Firmware is supplied by CD-ROM as needed. Please contact the supplier of your region for information.

You must use a PC running EPSON RC+ 7.0 connected to a Manipulator with USB to update the Manipulator firmware. Firmware cannot be updated with an Ethernet connection.

NOTE

When installing the firmware Ver.7.5.0.x or later, be sure to use the PC which EPSON RC+ 7.0 Ver.7.5.0 or later is installed.

6.2 Firmware Upgrade Procedure

The firmware upgrade procedure is described as follows:

CAUTION	■ DO NOT unplug the USB cable, or turn OFF the Manipulator or the development PC during upgrade of the firmware. Doing so may result in malfunction of the robot system.

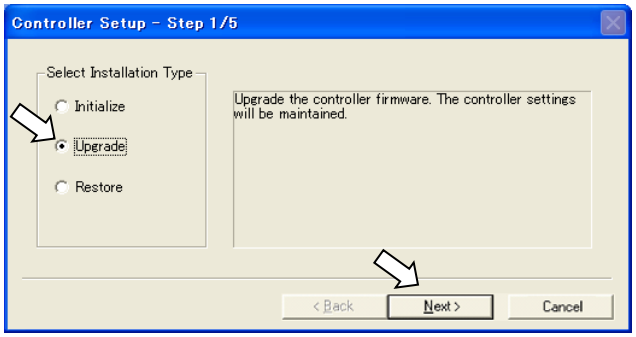
(1) Connect the development PC and the Manipulator with a USB cable (the firmware cannot be changed with an Ethernet connection).

(2) Turn ON the Manipulator. (Do not start the development software EPSON RC+ 7.0 until the firmware upgrade is completed.)

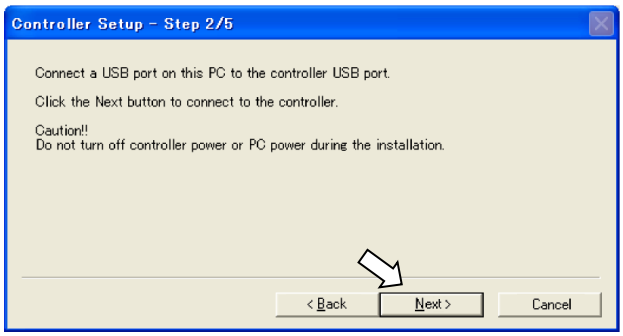
(3) Insert the “firmware CD-ROM” in the development PC CD-ROM drive

(4) Execute “CtrlsetupT.exe”. The following dialog box appears.

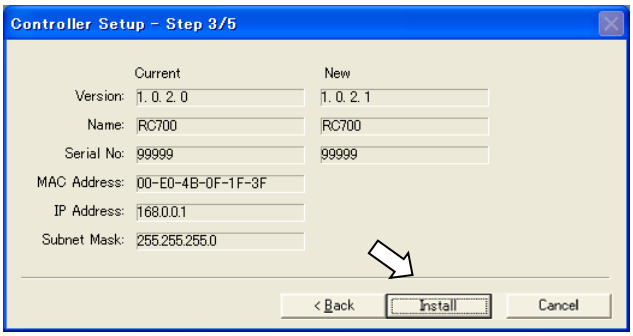
(5) Select the <Upgrade> option button and click the <Next> button.



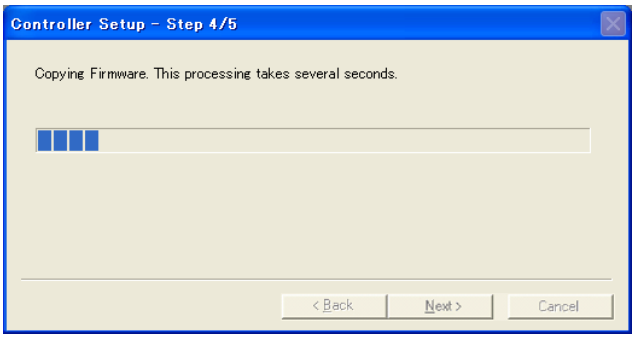
(6) Make sure that the development PC is connected to the Manipulator with a USB cable and Click the <Next> button.



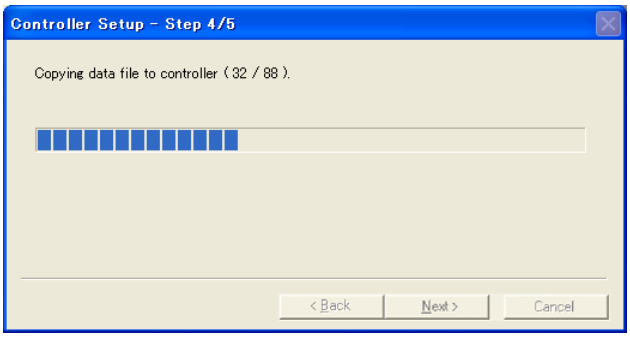
(7) Check the current firmware version and the new firmware version and click the <Install> button.



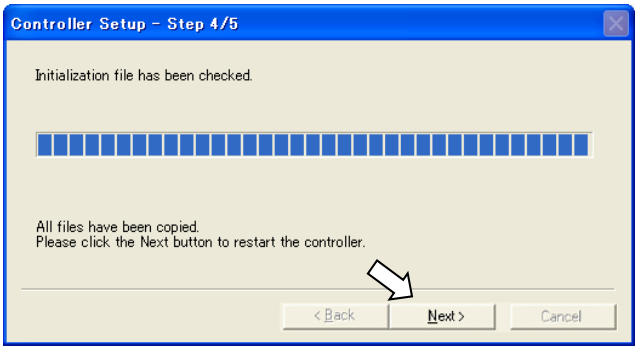
(8) The firmware upgrade starts. It takes several minutes to complete.



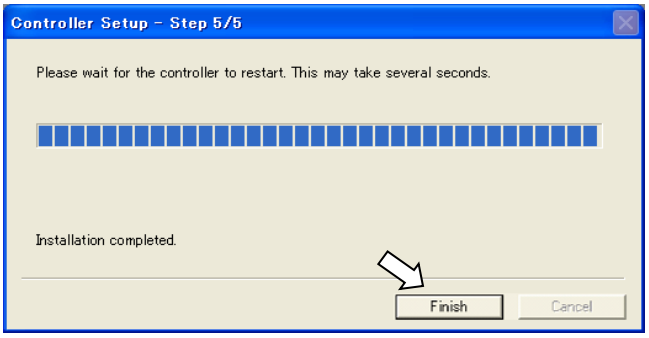
(9) Continuous data file transfer starts.



(10) The following dialog box appears when transfer has completed. Click the <Next> button to reboot the Manipulator.



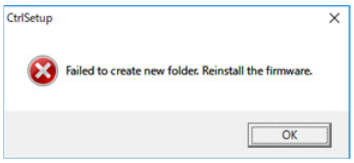
(11) The following dialog box appears after the Controller reboot. Click the <Finish> button.



The firmware upgrade is complete.

NOTE

When you install the firmware (Ver.7.4.0.2 or later) on the Controller which the firmware (before Ver.7.4.0.2) has been installed, the following message is displayed.



When the message is displayed, re-install the firmware.

6.3 Manipulator Recovery

If the Manipulator becomes inoperable, use the procedures described in this section to recover.

NOTE

Controller Backup is recommended for easy recovery of the Controller operation.
For details of Controller Backup, refer to refer to the following manual.
Maintenance 5. Backup and Restore.

6.4 Firmware Initialization Procedure

The firmware initialization procedures are described in this section.

CAUTION	■ DO NOT unplug the USB cable, or turn OFF the Manipulator or the development PC during upgrade of the firmware. Doing so may result in malfunction of the robot system.

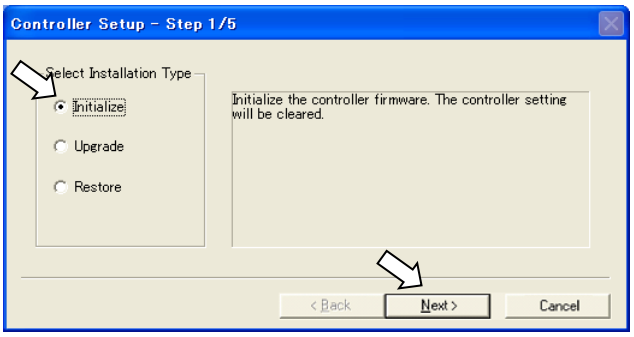
(1) Connect the development PC to the Manipulator with a USB cable (the firmware cannot be changed with an Ethernet connection).

(2) Turn ON the Manipulator. Do not start the development software EPSON RC+ 7.0 until firmware initialization is complete.

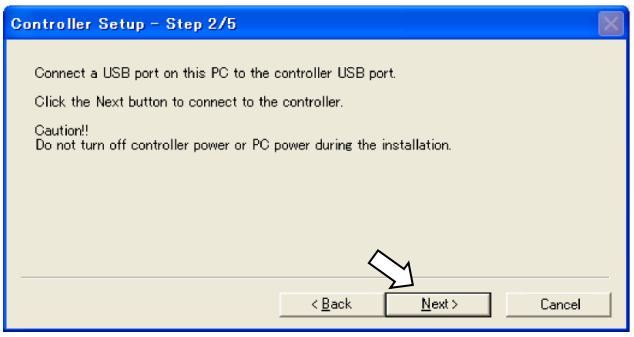
(3) Insert the “Firmware CD-ROM” in the development PC CD-ROM drive.

(4) Execute “Ctrlsetup.exe”.

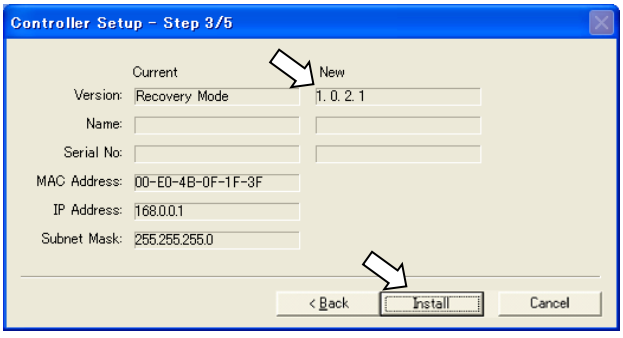
(5) Select the <Initialize> option button and click the <Next> button.



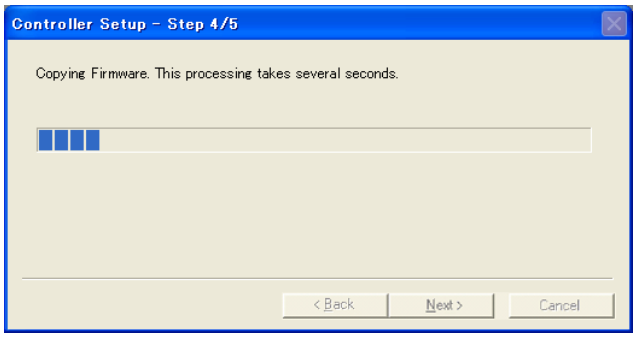
(6) Make sure that the development PC is connected to the Controller with a USB cable and Click the <Next> button.



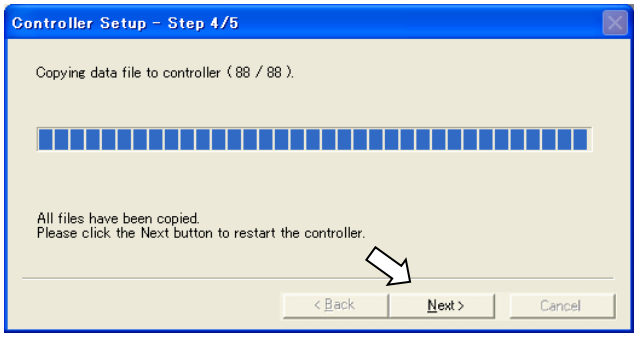
(7) Check the version information and click the <Install> button.



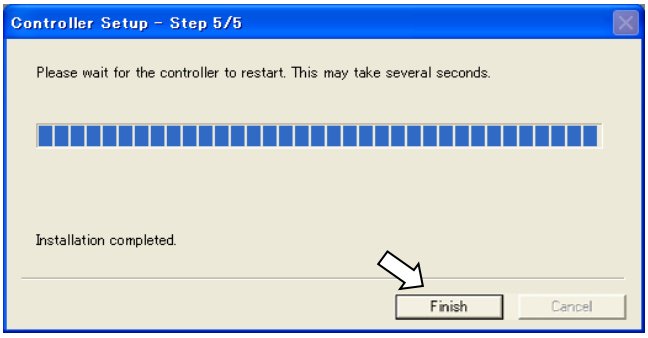
(8) Firmware and data file transfer starts. It takes several minutes to complete.



(9) The following dialog box appears when transfer is completed. Click the <Next> button to reboot the Manipulator.



(10) The following dialog box appears after the Manipulator reboot. Click the <Finish> button.

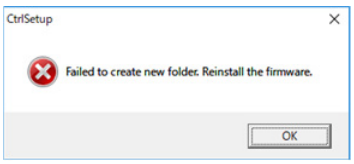


The firmware upgrade is completed.

Start EPSON RC+ 7.0 and restore the Controller settings.
For details of restoring the operating system, refer to *Maintenance 5. Backup and Restore*.

NOTE

When you install the firmware (Ver.7.4.0.2 or later) on the Controller which the firmware (before Ver.7.4.0.2) has been installed, the following message is displayed.



When the message is displayed, re-install the firmware.

6.5 Adding Confirmation Steps by Strengthening Security of EtherNet Connection

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

In the following cases, connections of EtherNet (PC) connector and Remote Ethernet are not available.

Controller IP address is set to global IP address
Firmware version is Ver.7.4.58 or later
EPSON RC+7.0 is Ver.7.4.7 or before

When the Controller firmware is updated under the following conditions, additional steps to confirm whether to continue the firmware update may be execute depending on the configuration settings of the Controller. (step 3 or later shown below)

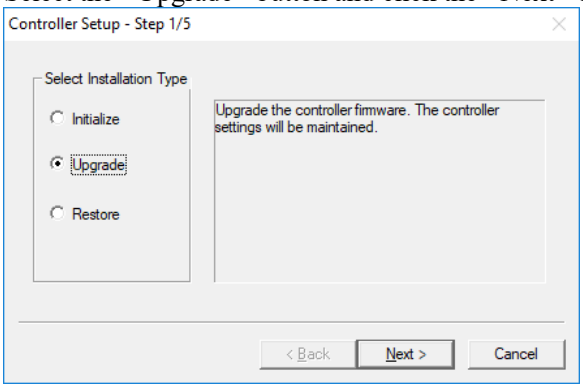
Controller IP address is set to global IP address
Firmware version to be installed is 7.4.8.x or later

The following describes the steps to confirm whether to continue the firmware update.

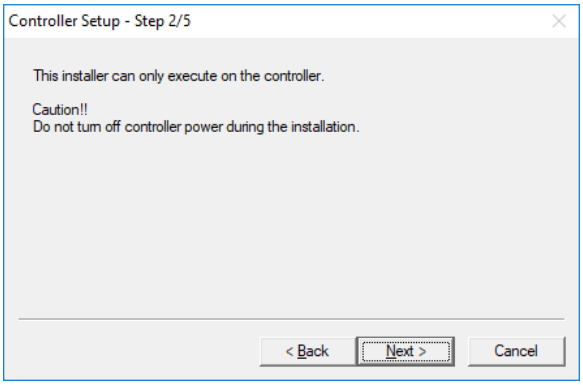
(1) Insert “Firmware CD-ROM” to be installed into the CD-ROM driver of the development PC.

(2) Execute “CtrlsetupT.exe”.

(3) Controller Setup window is displayed.
Select the <Upgrade> button and click the <Next> button.

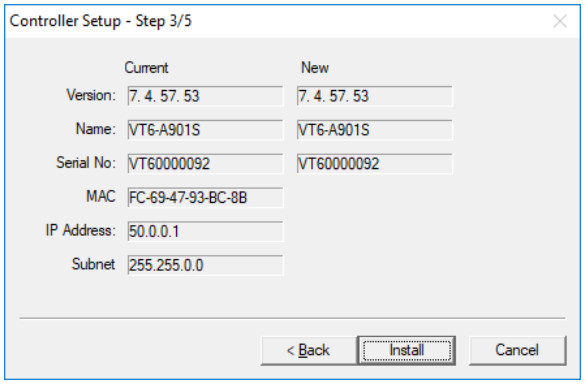


(4) Step 2 window is displayed.
Click the <Next> button.

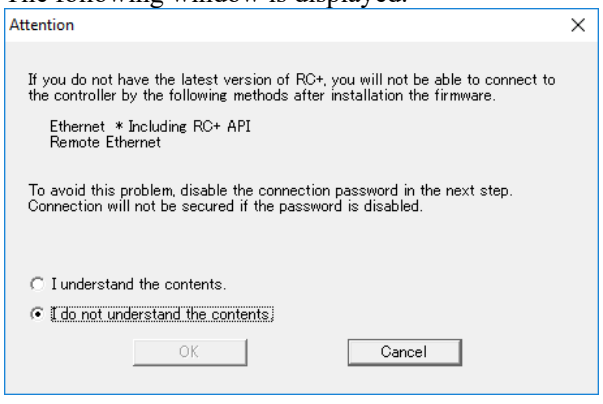


(5) Step 3 window is displayed.

(5)-1 When the steps to confirm whether to continue the firmware update is not executed:
Step 3 window is displayed.
Follow the instructions on the window and install the firmware.

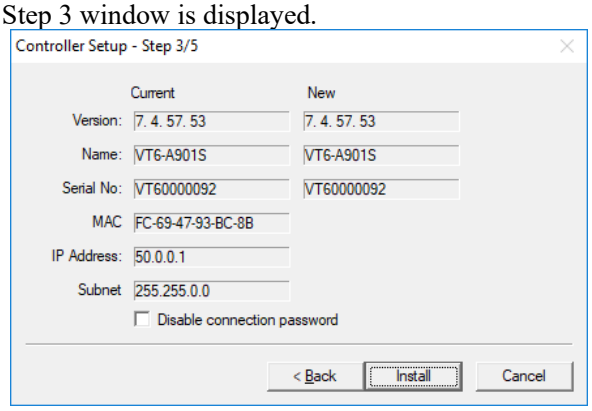


(5)-2 When the steps to confirm whether to continue the firmware update is executed:
The following window is displayed.



When the <I understand the contents> button is selected, the <OK> button will be enabled.
When the <OK> button is clicked, Step3 window is displayed. Go to the step (6).
When the <Cancel> button is clicked, Step3 window is displayed. The [Disable connection password] checkbox and the <Install> button will be grayed out and cannot be selected.

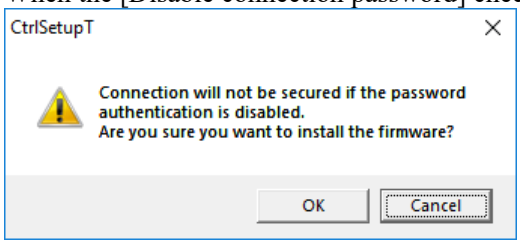
(6) Step 3 window is displayed.



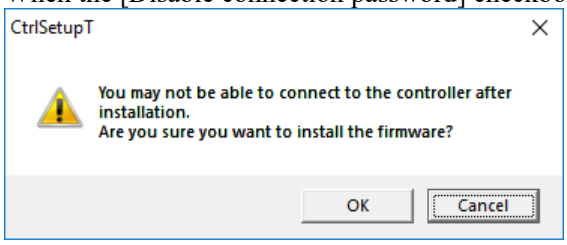
(6)-1 If the [Disable connection password] checkbox is selected, connection authentication after updating the firmware is disabled.

(6)-2 If the <Install> button is clicked, the confirmation window is displayed.

When the [Disable connection password] checkbox is selected:



When the [Disable connection password] checkbox is not selected:

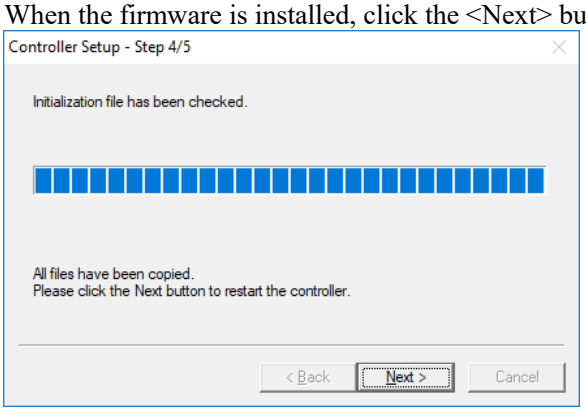


When the <OK> button is clicked, Step 4 window is displayed. Go to the step (7).

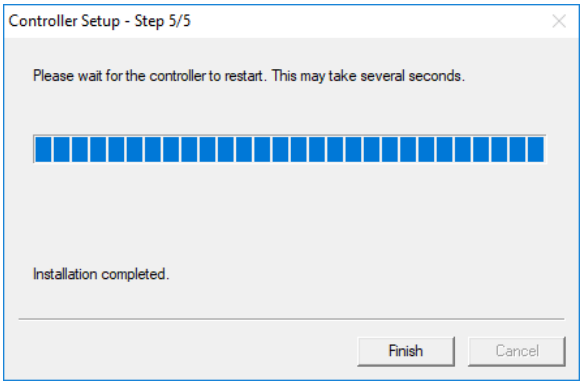
When the <Cancel> button is clicked, the window is closed.

(7) Firmware installation starts.

When the firmware is installed, click the <Next> button. Reboot the Controller.



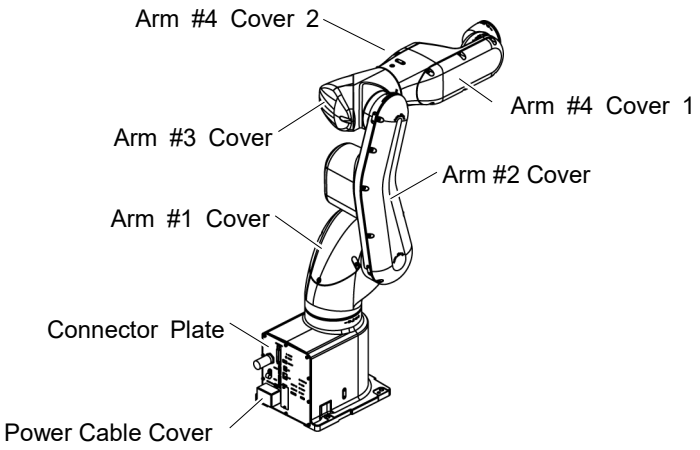
(8) When the Controller is rebooted, the following window is displayed.
Confirm that the firmware is installed.
Click the <Finish> button.



7. Covers

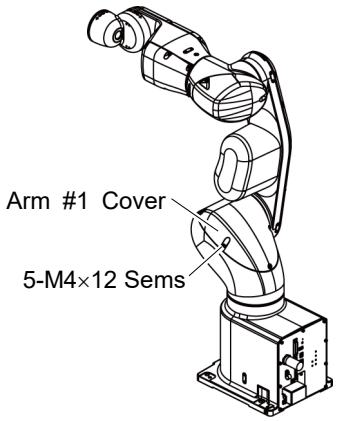
All procedures for removing and installing covers in maintenance are described in this chapter.

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



7.1 Arm #1 Cover

CAUTION	■ Do not remove the cover forcibly. Removing the cover forcibly 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. ■ When installing the cover, be careful not to allow the cables to interfere with the cover mounting and do not bend these cables forcibly to push them into the cover. Unnecessary strain on 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. When routing the cables, observe the cable locations after removing the cover. Be sure to place the cables back to their original locations.



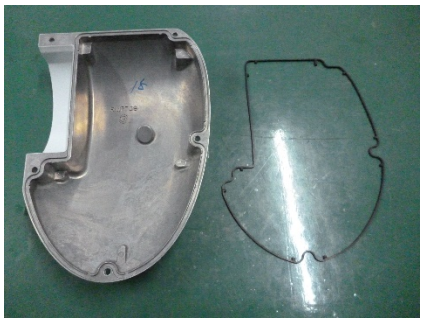
Arm #1 Cover Removal

Standard, Cleanroom model:

Unscrew the mounting bolts, and then lift the Arm #1 Cover.

Protection model:

Unscrew the mounting bolts, and then lift the Arm #1 Cover and Arm #1 gasket together.



NOTE
Be careful for wires and tubes when removing the cover.

NOTE
If the Arm #2 interferes with the tools when unscrewing the mounting bolts, move the Arm #2 to the position where it does not interfere with the tools before be performing operations.

Arm #1 Cover Installation

Standard, Cleanroom model:

Put the Arm #1 Cover to the Manipulator and secure with the mounting bolts.

Hexagon socket head cap bolts with captive washer: 5-M4×12 Sems

Tightening torque: 4 ± 0.2 Nm

Protection model:

Mount Arm #1 gasket in the groove of Arm #1 Cover. (Replace the gasket if there are flaws or deteriorations.)

Put the Arm #1 Cover to the Manipulator and secure with the mounting bolts.

Hexagon socket head cap bolts with captive washer: 5-M4×12 Sems

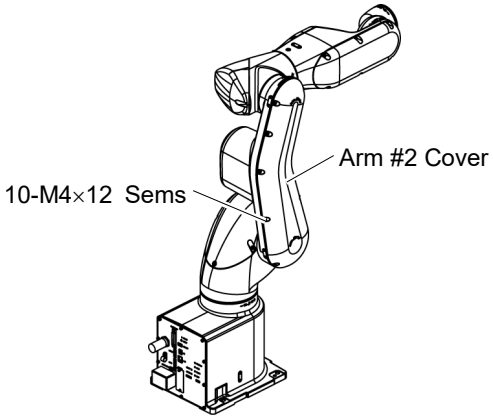
Tightening torque: 4 ± 0.2 Nm

NOTE
When installing the cover, be careful not to get the gaskets and cables caught between the arm and cover.

7.2 Arm #2 Cover

CAUTION

- Do not remove the cover forcibly. Removing the cover forcibly 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.
- When installing the cover, be careful not to allow the cables to interfere with the cover mounting and do not bend these cables forcibly to push them into the cover. Unnecessary strain on 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.
  When routing the cables, observe the cable locations after removing the cover. Be sure to place the cables back to their original locations.



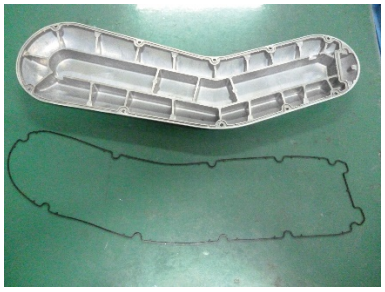
Arm #2 Cover Removal

Standard, Cleanroom model:

Unscrew the mounting bolts, and then lift the Arm #2 Cover.

Protection model:

Unscrew the mounting bolts, and then lift the Arm #2 Cover and Arm #2 gasket together.



NOTE

Be careful for wires and tubes when removing the cover.

Arm #2 Cover Installation

Standard, Cleanroom model:

Put the Arm #2 Cover to the Manipulator and secure with the mounting bolts.

Hexagon socket head cap bolts with captive washer: 10-M4×12 Sems
Tightening torque: 4 ± 0.2 Nm

Protection model:

Mount Arm #2 gasket in the groove of Arm #2 Cover. (Replace the gasket if there are flaws or deteriorations.)

Put the Arm #2 Cover to the Manipulator and secure with the mounting bolts.

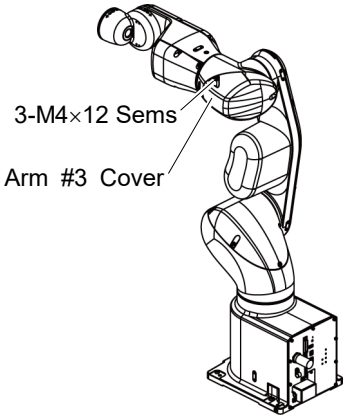
Hexagon socket head cap bolts with captive washer: 10-M4×12 Sems
Tightening torque: 4 ± 0.2 Nm

NOTE

When installing the cover, be careful not to get the gaskets and cables caught between the arm and cover.

7.3 Arm #3 Cover

CAUTION	■ Do not remove the cover forcibly. Removing the cover forcibly 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. ■ When installing the cover, be careful not to allow the cables to interfere with the cover mounting and do not bend these cables forcibly to push them into the cover. Unnecessary strain on 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. When routing the cables, observe the cable locations after removing the cover. Be sure to place the cables back to their original locations.



Arm #3 Cover Removal

Standard, Cleanroom model:

Unscrew the mounting bolts, and then lift the Arm #3 Cover.

Protection model:

Unscrew the mounting bolts, and then lift the Arm #3 Cover and Arm #3 gasket together.



NOTE

Be careful for wires and tubes when removing the cover.

Arm #3 Cover Installation

Standard, Cleanroom model:

Put the Arm #3 Cover to the Manipulator and secure with the mounting bolts.

Hexagon socket head cap bolts with captive washer: 3-M4×12 Sems
Tightening torque: 4 ± 0.2 Nm

Protection model:

Mount Arm #3 gasket in the groove of Arm #3 Cover. (Replace the gasket if there are flaws or deteriorations.)

Put the Arm #3 Cover to the Manipulator and secure with the mounting bolts.

Hexagon socket head cap bolts with captive washer: 3-M4×12 Sems
Tightening torque: 4 ± 0.2 Nm

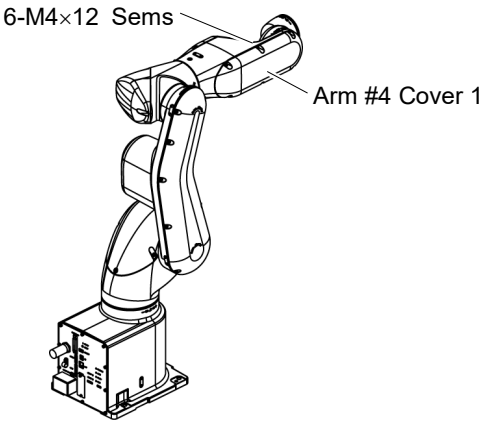
NOTE

When installing the cover, be careful not to get the gaskets and cables caught between the arm and cover.

7.4 Arm #4 Cover 1

CAUTION

- Do not remove the cover forcibly. Removing the cover forcibly 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.
- When installing the cover, be careful not to allow the cables to interfere with the cover mounting and do not bend these cables forcibly to push them into the cover. Unnecessary strain on 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.
  When routing the cables, observe the cable locations after removing the cover. Be sure to place the cables back to their original locations.



Arm #4 Cover 1 Removal

Standard, Cleanroom model:

Unscrew the mounting bolts, and then lift the Arm #4 Cover 1.

Protection model:

Unscrew the mounting bolts, and then lift the Arm #4 Cover 1 and Arm #4 gasket 1 together.



NOTE

Be careful for wires and tubes when removing the cover.

Arm #4 Cover 1 Installation

Standard, Cleanroom model:

Put the Arm #4 Cover 1 to the Manipulator and secure with the mounting bolts.

Hexagon socket head cap bolts with captive washer: 6-M4×12 Sems
Tightening torque: 4 ± 0.2 Nm

Protection model:

Mount Arm #4 gasket 1 in the groove of Arm #4 Cover 1. (Replace the gasket if there are flaws or deteriorations.)

Put the Arm #4 Cover 1 to the Manipulator and secure with the mounting bolts.

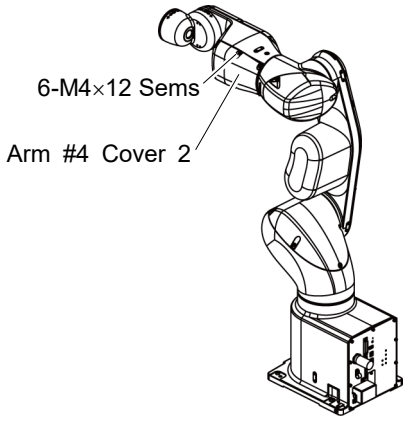
Hexagon socket head cap bolts with captive washer: 6-M4×12 Sems
Tightening torque: 4 ± 0.2 Nm

NOTE

When installing the cover, be careful not to get the gaskets and cables caught between the arm and cover.

7.5 Arm #4 Cover 2

CAUTION	■ Do not remove the cover forcibly. Removing the cover forcibly 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. ■ When installing the cover, be careful not to allow the cables to interfere with the cover mounting and do not bend these cables forcibly to push them into the cover. Unnecessary strain on 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. When routing the cables, observe the cable locations after removing the cover. Be sure to place the cables back to their original locations.



Arm #4 Cover 2 Removal

(1) Unscrew the mounting bolts, and then lift the Arm #4 Cover 2.

NOTE
Do not remove the cover forcibly when removing it.

(2) Disconnect the connector from the board mounted on the rear side of the Arm #4 Cover 2.

(3) Only for Protection model:
Remove Arm #4 gasket 2 from the Arm #4 Cover 2.



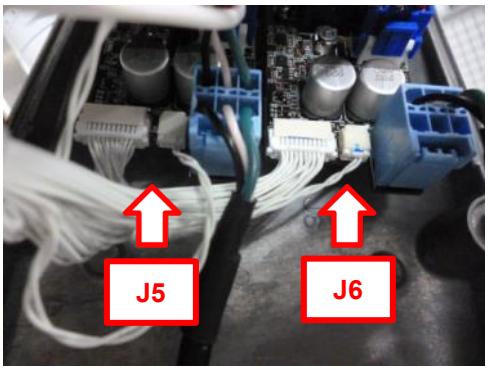
Arm #4 Cover 2 Installation

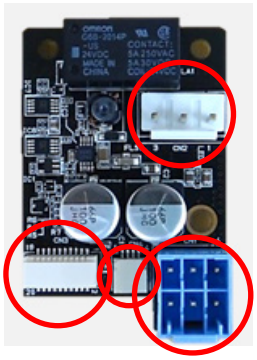
(1) Only for Protection model:
Mount Arm #4 gasket 2 in the groove of Arm #4 Cover 2. (Replace the gasket if there are flaws or deteriorations.)

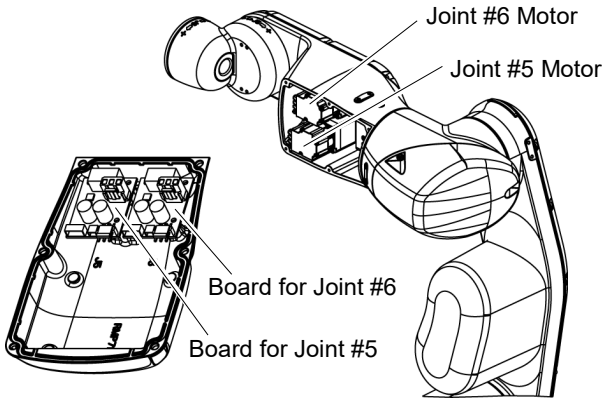


(2) Connect the connector to the board on the rear side of the Arm #4 Cover 2.

NOTE Connect the connector to the board which supports each motor (J5, J6). Be careful not to connect it to wrong board or forget to connect.







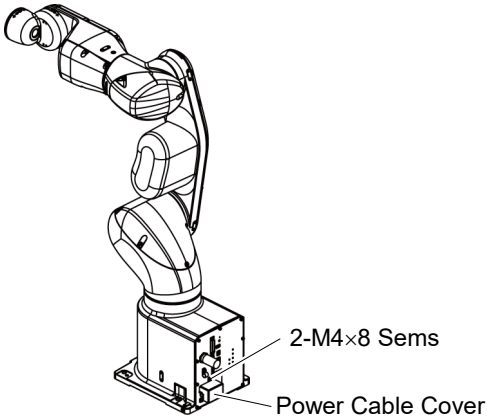
(3) Put the Arm #4 Cover 2 to the Manipulator and secure with the mounting bolts.

Hexagon socket head cap bolts with captive washer: 6-M4×12 Sems
Tightening torque: 4 ± 0.2 Nm

NOTE When installing the cover, be careful not to get the gaskets and cables caught between the arm and cover.

7.6 Power Cable Cover

Standard, Cleanroom model:



Power Cable Cover Removal

Unscrew the mounting bolts, and then lift the Power Cable Cover.

Power Cable Cover Installation

Put the Power Cable Cover to the connector plate and secure with the mounting bolts.

Hexagon socket head cap bolts with captive washer: 2-M4×8 Sems
Tightening torque: 0.9 ± 0.1 Nm

NOTE When installing the cover, be careful not to get the cables caught between the arm and cover

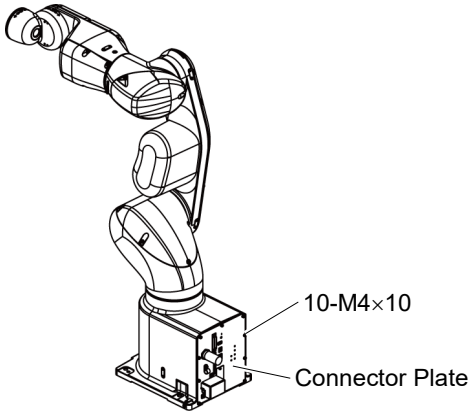
Protection model:

There is no Power Cable Cover.

7.7 Connector Plate

CAUTION

- Do not remove the connector plate forcibly. Removing the connector plate forcibly 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.
- When installing the connector plate, be careful not to allow the cables to interfere with the plate mounting and do not bend these cables forcibly to push them into the cover.
  Unnecessary strain on 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.
  When routing the cables, observe the cable locations after removing the connector plate. Be sure to place the cables back to their original locations.



Connector Plate Removal

Standard, Cleanroom model:

(1) Remove the Power Cable Cover.

Refer to *Maintenance: 7.6 Power Cable Cover.*

(2) Remove the power cable clamp and then remove Power Cable Connector.

NOTE When removing the Power cable connector, pull it out with pushing clips on both side of the connector.

(3) Unscrew the Connector Plate mounting bolts and then remove the Connector Plate.

Protection model:

(1) Unscrew the Connector Plate mounting bolts and then remove the Connector Plate.

(2) Remove the base gasket from the base.

Connector Plate Installation

Standard, Cleanroom model:

(1) Put the Connector Plate to the base and secure using the mounting bolts.
Hexagon socket head cap button bolt: 10-M4×10
Tightening torque: 4.0 ± 0.2 N·m

(2) Connect the Power Cable Connector and install the power cable clamp.

(3) Mount the Power Cable Cover.
Refer to *Maintenance: 7.6 Power Cable Cover.*

Protection model:

(1) Mount the base gasket in the groove of the base.
(Replace the gasket if there are flaws or deteriorations.)

(2) Put the Connector Plate to the base and secure using the mounting bolts.
Hexagon socket head cap button bolt: 10-M4×10
Tightening torque: 4.0 ± 0.2 N·m

NOTE

When installing the connector plate, be careful not to get the gaskets and cables caught between the arm and cover.

8. Cable

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

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

8.1 Replacing Cable Unit

	Name		Quantity	Note
Maintenance part	Cable Unit		1	2191349
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
	Torque wrench		1	For tightening torque control
	Cross-point screwdriver (No. 2)		1	For cross-recessed screw
	Nippers		1	For cutting wire tie
Material	Wire tie		-	
Grease	GPL-224		-	For purchasing grease, please contact the supplier of your region.

CAUTION	■ If the connectors have been disconnected during the replacement of the cable unit, be sure to reconnect the connectors to their proper positions. Refer to the wiring diagrams. Improper connection of the connectors may result in improper function of the robot system. For details on the connections, refer to the following manual. *Maintenance: 3. Manipulator Structure.* ■ When installing the cover, be careful not to allow the cables to interfere with the cover mounting and do not bend these cables forcibly to push them into the cover. Unnecessary strain on 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. When routing the cables, observe the cable locations after removing the cover. Be sure to place the cables back to their original locations. ■ Be sure to connect the cables completely. Do not allow unnecessary strain on the cables. (Do not put heavy objects on the cables. Do not bend or pull the cables forcibly.) The unnecessary strain on the cables may result in damage to the cables, disconnection, and/or contact failure. Damaged cables, disconnection, or contact failure is extremely hazardous and may result in electric shock and/or improper function of the robot system.

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

When removing the Joint #2 motor unit, tilt the Arm #2 and press it against the Arm #1.
Reference: *Maintenance: 10.1 Joint #2 - Replacing the Motor, Removal step (2)*

When removing the Joint #3 motor unit, tilt the Arm #3 and press it against the Arm #2.
Reference: *Maintenance: 11.1 Joint #3 - Replacing the Motor, Removal step (2)*

Cable Unit Removal

(1) Move the Manipulator to the origin posture (0 pulse position).

(2) Turn OFF the Manipulator.

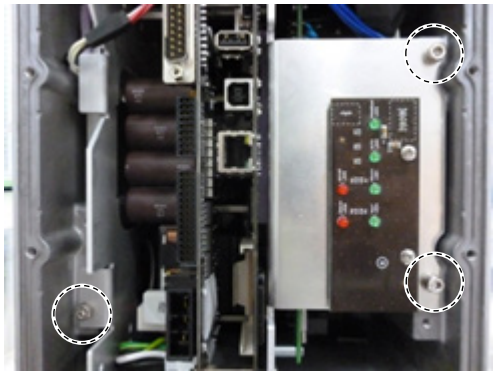
(3) Remove the following covers and plate.

Arm #1 Cover	Arm #2 Cover
Arm #3 Cover	Arm #4 Cover 1
Arm #4 Cover 2	Connector Plate

Reference: *Maintenance 7 Covers*

(4) Unscrew the mounting screws of the Controller Unit.

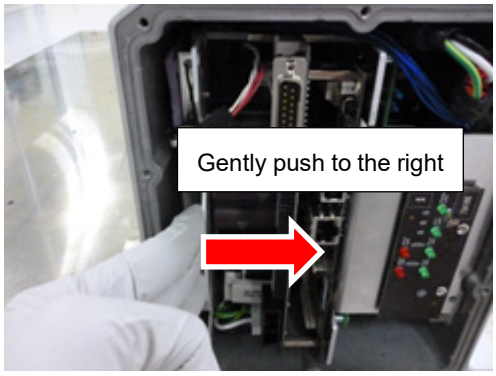
Hexagon socket head cap bolts:
3-M4×10 (with plain washer)

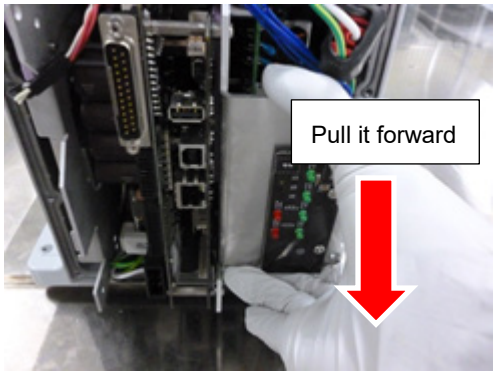


(5) Pull out the Controller Unit from the Manipulator base.

NOTE

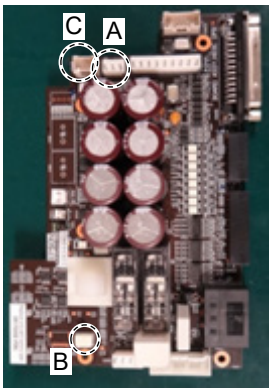
When pulling it out,
firstly push the plate of the Controller Unit to the right (see the picture) gently, then remove the thermal conductive sheet on the base and the Controller Unit. Next, pull the Controller Unit forward.

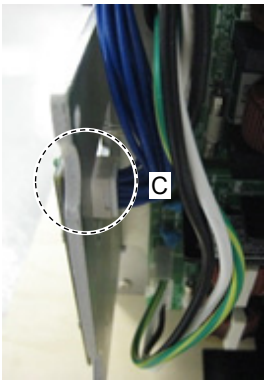




(6) Disconnect the following connectors of the Controller Unit.

A: Power cable connector
B: Signal cable connector
C: LED connectors × 2





(7) Remove the ground wire terminals inside the base.

Cross recessed head screws: M4×6



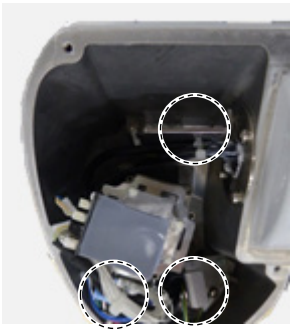
(8) Cut off the wire tie bound to the plate inside the base.

Wire tie: AB150



(9) Cut off the wire ties bound inside the Arm #1.

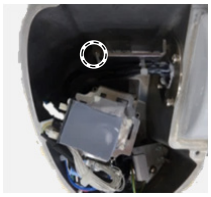
Wire ties : AB150 × 2
AB100 × 1



(10) Remove the ground wire terminals of Arm #1.

Cross recessed head screws: 2-M4× 6

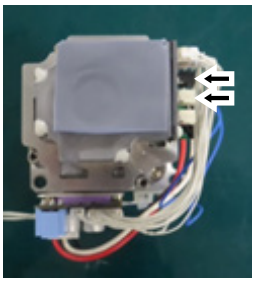




(11) Disconnect the power cable connecter from the AMP board of Joint #1 motor.



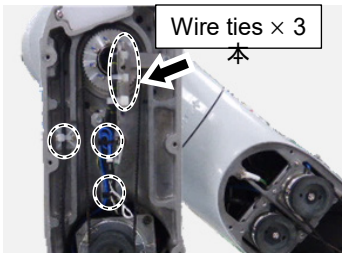
(12) Disconnect the signal cable connectors (for motor × 2) of Joint #1 motor.

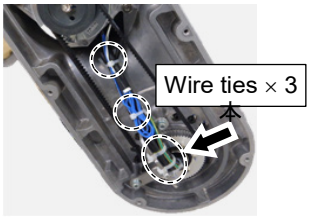


(13) Cut off the wire ties bound to inside the Arm #2.

Wire ties : AB150 ×6
AB100 ×5

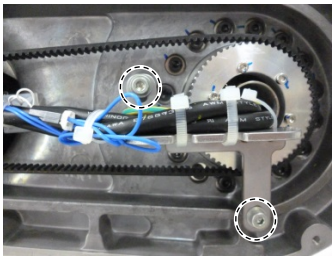
NOTE
Be careful not to cut the harness.

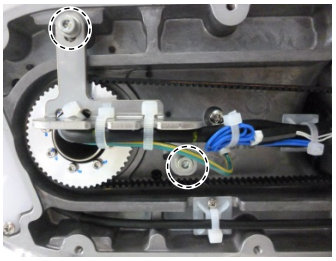




(14) Remove the cable fixing plate of Arm #2.

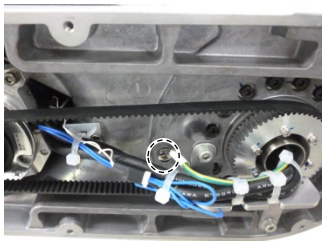
Hexagon socket head cap bolts with captive washer: 4-M4×12

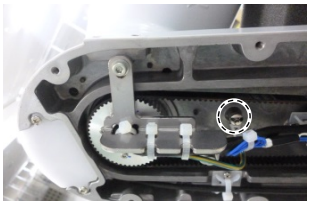




(15) Remove the ground wire terminals of Arm #2.

Cross recessed head screws: 2-M4×6





(16) Remove the Joint #2 motor.

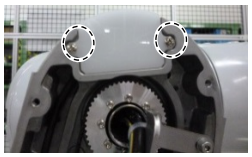
Reference: *Maintenance 10.1 Replacing Joint #2 Motor*

(17) Remove the Joint #3 motor.

Reference: *Maintenance 11.1 Replacing Joint #3 Motor*

(18) Remove the light guide plate.

Cross recessed head screws: 2-M3×10



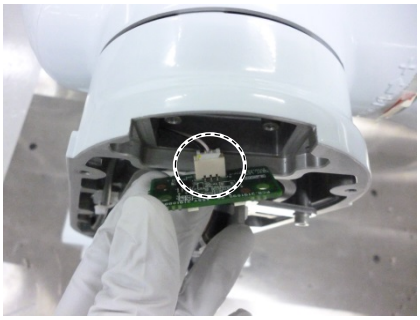
(19) Unscrew the cross recessed head screws fixing the LED board.

Cross recessed head screws: 2-M3×6

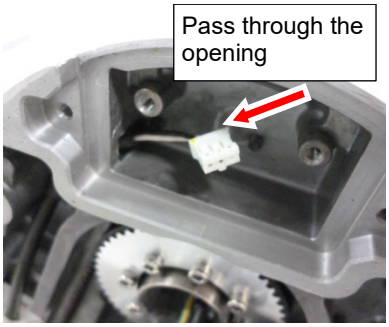


(20) Disconnect the connector which is connected to the LED board.

Connector: LED_CN1

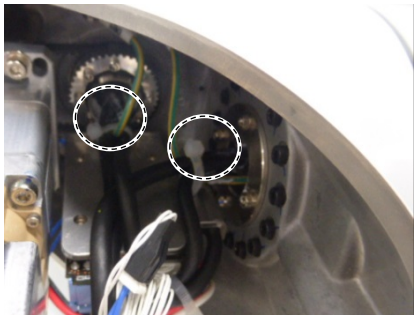


(21) Pass the LED cable through the opening of the Arm #2 and pull the LED cable out.



(22) Cut off the wire tie bound to the plate inside the Arm #3.

Wire ties: AB150 ×2

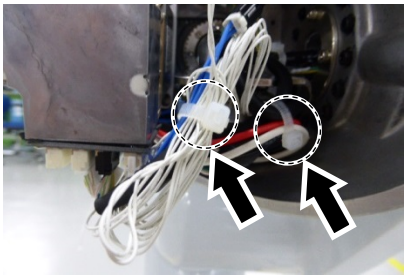


(23) Cut off the wire ties that bind the power cable and the signal cable of Joint #4 motor.

Wire ties: AB100 × 2

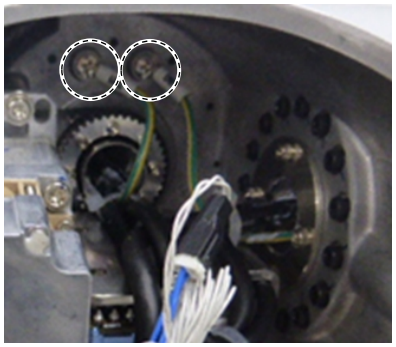
NOTE

Be careful not to cut the harness.

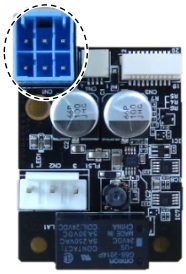


(24) Remove the ground wire terminals of Arm #3.

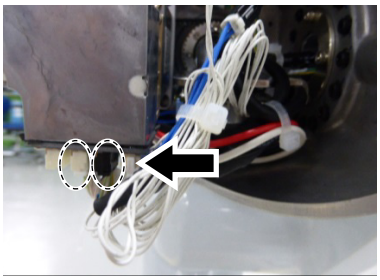
Cross recessed head screws: 2-M4×6



(25) Disconnect the power cable connecter from the AMP board of Joint #4 motor.

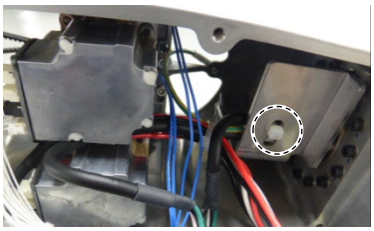


(26) Disconnect the signal cable connectors (for motor × 2) of Joint #4 motor.



(27) Cut off the wire ties bound to the plate inside the Arm #4.

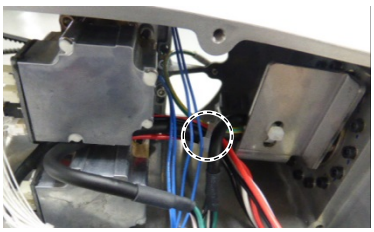
Wire tie: AB150



(28) Cut off the wire tie that binds the following cables and ground wire.

Wire tie: AB100

Joint #5 motor cable
Signal cable (for motor)
Joint #6 motor cable
Ground wire

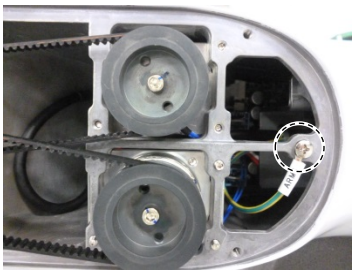


NOTE

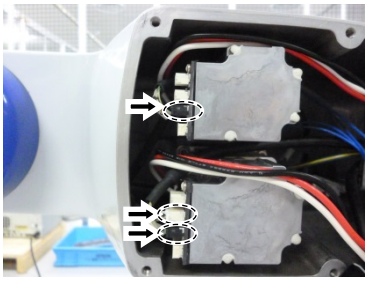
Be careful not to cut the harness.

(29) Remove the ground wire terminals of Arm #4.

Cross recessed head screws: M4×6



(30) Remove the signal cable connectors (for motor × 3) of the the Joint #5 motor and Joint #6 motor.



(31) Pass the ground wire and the following cables of each arm through the sleeve of each joint and pull them out.

Ground wires × 4
Signal cables (for motor × 5)
LED cable × 1

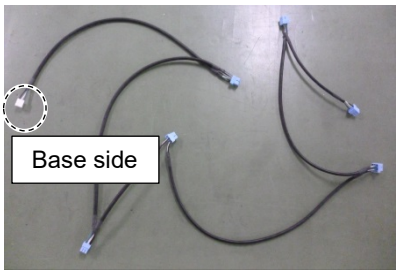
(32) Pass the power cable through the sleeve of each joint and pull it out in the following order.

Arm #4 → Arm #3 → Arm #2 → Arm #1 → Base

Cable Unit Installation

(1) Pass the new power cable in the following order.

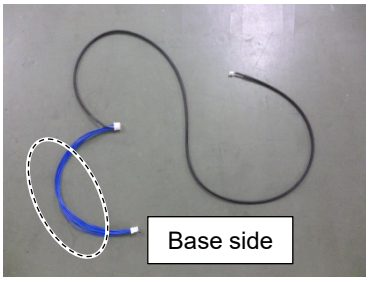
Base
→ Arm #1
→ Joint #1 Timing Belt
→ Arm #2
→ Arm #3
→ Joint #4 Timing Belt
→ Arm #4



NOTE When passing the cables between arms, be sure to pass them through the sleeve of each joint. The white connecter is the base side.

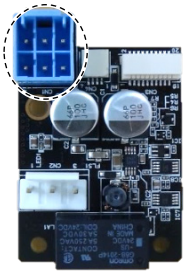
(2) Pass the new LED cables in the following order.

Base
→ Arm #1
→ Joint #1 Timing Belt
→ Arm #2

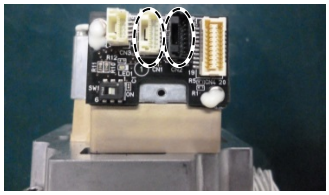


NOTE When passing the cables between arms, be sure to pass them through the sleeve of each joint. The blue cable is the base side.

(3) Connect the power cable connectors (× 6) of the Joint #1, 2, 3, 4, 5, 6 AMP board.



(4) Connect the signal cable connector (for motor) of the Joint #1, 2, 3, 4, 5, 6 motor unit.



NOTE When passing the cables between arms, be sure to pass them through the sleeve of each joint.

Confirm that the joint marked on the wire marker of the signal cable and the joint of the motor unit to be connected are the same.



Also, the same colored connecter is connected to each connector. (For the Joint #6 motor, only black colored connecter is connected.)

(5) Install the Joint #2 motor.

Reference: *Maintenance 10.1 Replacing Joint #2 Motor*

(6) Install the Joint #3 motor.

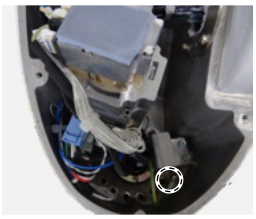
Reference: *Maintenance 11.1 Replacing Joint #3 Motor*

(7) Fix the ground wire between the base and the Arm #1.



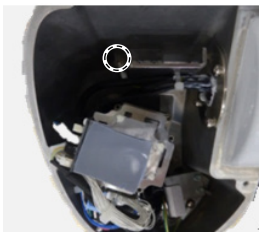
Cross recessed head screws: 2-M4×6
Tightening torque: 2.0 ± 0.1 N·m

Base side:
Ground wire terminal marked “BASE” on the wire marker.



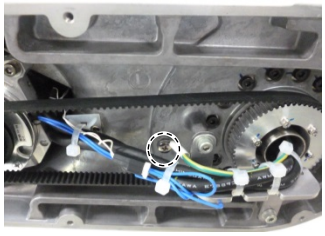
Arm #1 side:
Ground wire terminal marked “ARM1” on the wire marker.

(8) Fix the ground wire between the Arm #1 and the Arm #2.



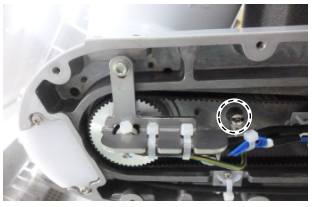
Cross recessed head screws: 2-M4×6
Tightening torque: 2.0 ± 0.1 N·m

Arm #1 side:
Ground wire terminal marked “ARM1” on the wire marker.



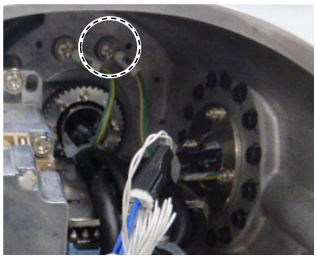
Arm #2 side:
Ground wire terminal marked “ARM2” on the wire marker.

(9) Fix the ground wire between the Arm #2 and the Arm #3



Cross recessed head screws: 2-M4×6
Tightening torque: 2.0 ± 0.1 N·m

Arm #2 side:
Ground wire terminal marked “ARM2” on the wire marker.

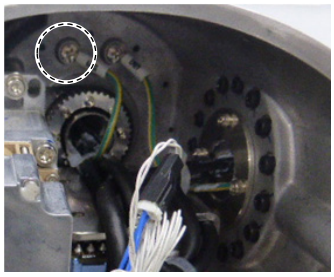


Arm #3 side:
Ground wire terminal marked “ARM3” on the wire marker.

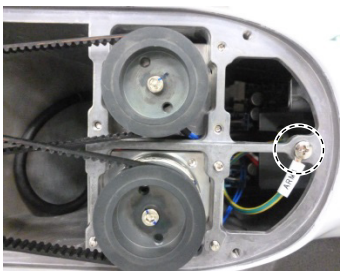
(10) Fix the ground wire between the Arm #3 and the Arm #4.

Cross recessed head screws: 2-M4×6
Tightening torque: 2.0 ± 0.1 N·m

Arm #3 side:
Ground wire terminal marked “ARM3” on the wire marker.

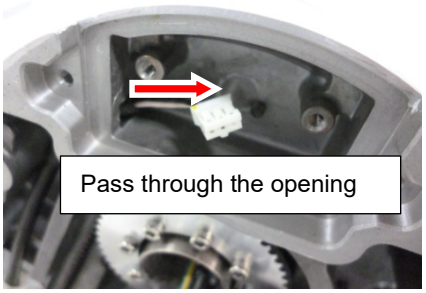


Arm #4 side:
Ground wire terminal marked “ARM4” on the wire marker.



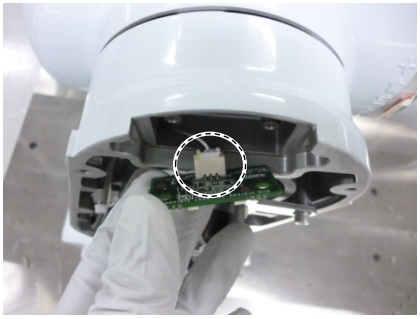
(11) Connect the LED cable connector to the opening of the end of Arm #2.

NOTE You can pass the connector through the opening easily by using the wire tie.



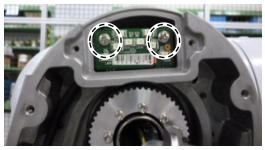
(12) Connect the LED cable connector to the LED board.

Connectors: LED_CN1



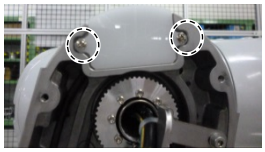
(13) Fix the LED board.

Cross recessed head screws: 2-M3×6
Tightening torque: 0.45 ± 0.1 N·m



(14) Fix the light guide plate.

Cross recessed head screws: 2-M3×10
Tightening torque: 0.45 ± 0.1 N·m



(15) Pass the wire tie through the hole inside the base.
Bind the following cables and the ground wire with the wire tie.

Wire tie: AB150

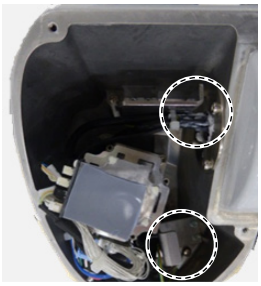
Power cable
LED cable
Signal cable (for motor)
Ground wire



(16) Pass the wire tie through the hole on the two plates of Arm #1. Bind the following cables and the ground wire with the wire tie.

Wire tie: AB150

Power cable
LED cable
Signal cable (for motor)
Ground wire



(17) Bind the following cables between the Joint #1 motor and the Controller Unit with the wire tie.

Wire tie: AB100

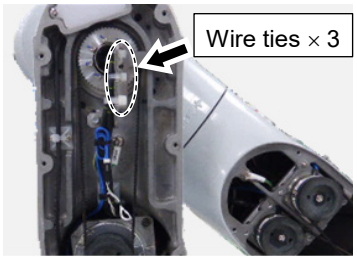
Signal cable (for motor)
Signal cable (for AMP board)

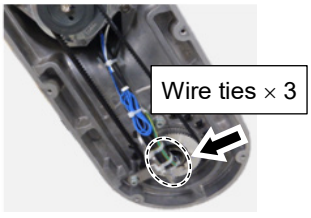


(18) Pass the wire tie through the plate inside the Arm #2.
Bind the following cables with the wire tie.

Wire tie : AB150 × 3
AB100 × 3

Power cable
LED cable (Joint #2 side only)
Signal cable (for motor)
Ground wire

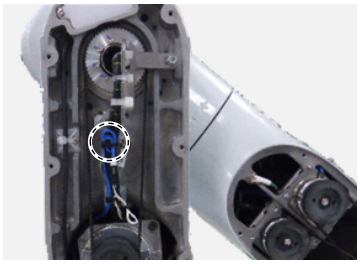




(19) Fold the each brake cable for Joint #2 and Joint #3 motors into the length of 40mm. Bind it with the following cables with the wire tie.

Wire tie : AB150 × 1
AB100 × 1

Power cable
Signal cable (for motor)
Brake cable

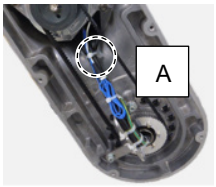


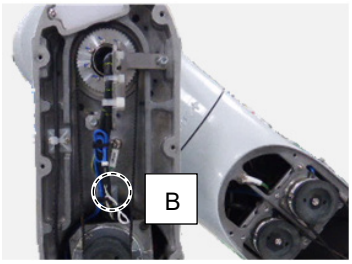


(20) Pass the wire tie through the mount base A and B inside Arm #2.
Bind the following cables with the wire tie.

Wire tie : AB150 × 1
AB100 × 1

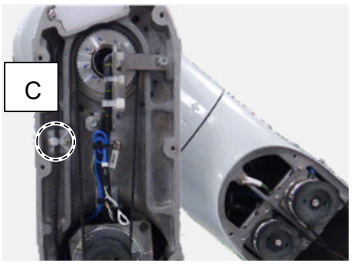
Power cable
Signal cable (for motor)
Brake cable
LED cable (mount base A only)

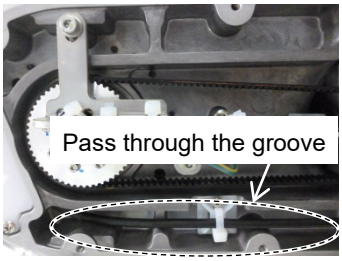




(21) Pass the LED cable through the groove for LED cable wiring of Arm #2.
Pass the wire tie through the mount base C and bind the LED cable with the wire tie.

Wire tie : AB150 × 1

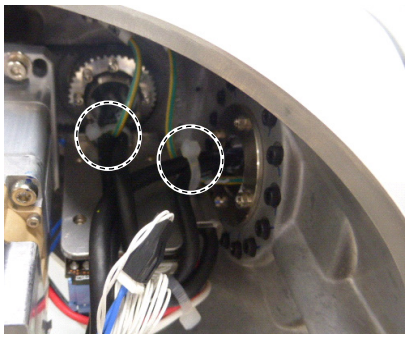




(22) Pass the wire tie through the hole inside the Arm #3.
Bind the following cables with the wire tie.

Wire tie: AB150

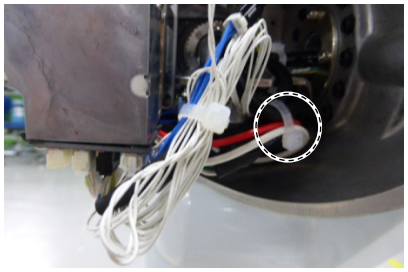
Power cable
Signal cable (for motor)
Ground wire



(23) Bind the following cables between the Joint #4 motor and the Joint #3 motor with the wire tie.

Wire tie: AB100

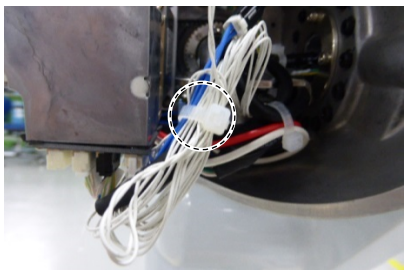
Power cable
Signal cable (for motor)
Motor cable



(24) Bind the following cables between the Joint #4 motor and the Joint #3 motor with the wire tie.

Wire tie: AB100

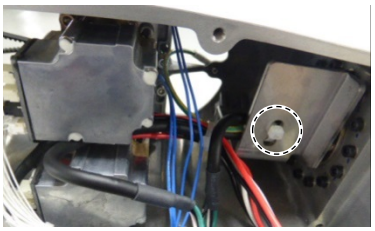
Signal cable(for AMP board)
Signal cable (for motor)
Brake cable



(25) Pass the wire tie through the hole inside the Arm #4. Bind the following cables and the ground wire with the wire tie.

Wire tie: AB150

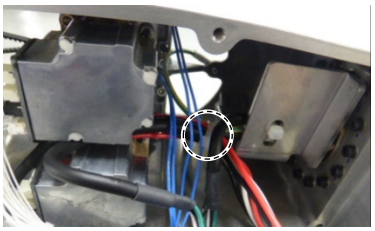
Power cable
Signal cable (for motor)
Ground wire



(26) Bind the following cables and the ground wire with the wire tie.

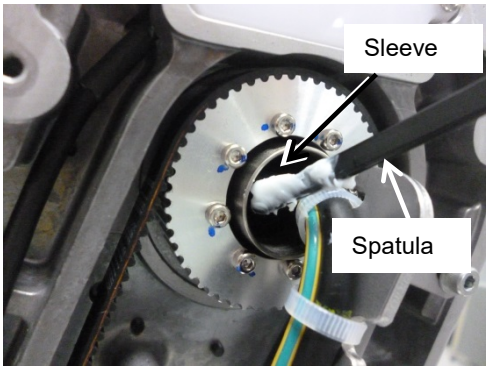
Wire tie: AB100

Motor cable (Joint #5)
Signal cable
Motor cable (Joint #6)
Ground wire



(27) Apply grease to the cables inside the each Joint sleeve.

Grease: GPL-224
Between Base-Arm #1 : 4.5±1g
Between Arm #1-Arm #2 : 4.5±1g
Between Arm #2-Arm #3 : 2.8±0.5g
Between Arm #3-Arm #4 : 2.8±0.5g

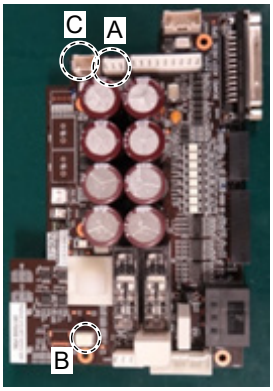


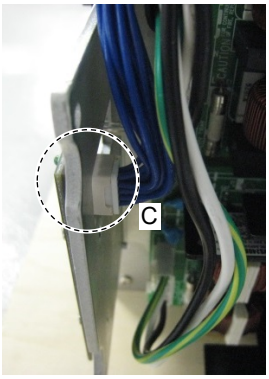
NOTE Apply grease evenly to the entire cable inside the sleeve and the end of the sleeve by using a slim spatula

When applying the grease, be careful not to attach the grease to the AMP board.

(28) Connect the following connectors to the Controller Unit.

A: Power cable connector
B: Signal cable connector
C: LED connectors × 2

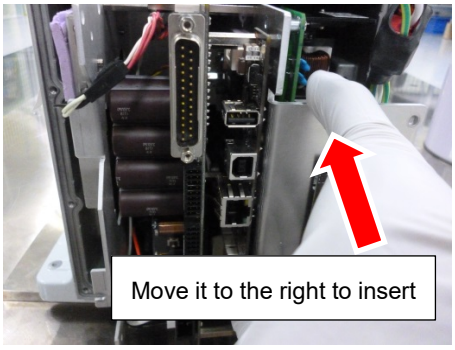


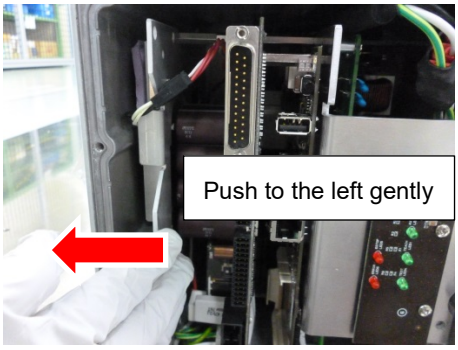


(29) Push the Controller Unit into the base.

NOTE Insert the Controller Unit while moving it to the right (see the picture).

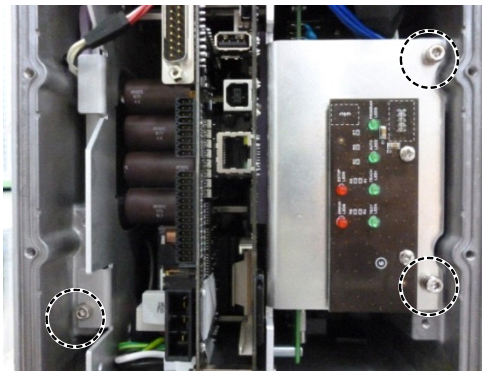
Then, gently move the plate of the Controller Unit to the left and let the thermal conductive sheet contacts with the wall inside the base.





(30) Tighten the mounting screws of the Controller Unit.

Hexagon socket head cap bolts: 3-M4×10 (with plain washer)
Tightening torque: 4.0 ± 0.2 N·m



(31) Install the following covers the plate.

Arm #1 Cover	Arm #2 Cover
Arm #3 Cover	Arm #4 Cover 1
Arm #4 Cover 2	Connector Plate

Reference: *Maintenance 7 Covers*

8.2 Insert or Pull out of Power Cable

NOTE
Protection model Manipulator cannot insert or pull out power cable.

	Name	Quantity	Note
Tool	Cross-point screwdriver (No. 2)	1	For cross-recessed screw

Power Cable Pull out

Standard Cleanroom

(1) Turn OFF the Manipulator.

(2) Remove the power cable cover.

Reference: *Maintenance 7.6 Power Cable Cover*

(3) Remove the power cable clamp.

(4) Disconnect the power cable connector.

NOTE
When removing the power cable connector, pull it out with pushing clips on both sides of the connector.

Power Cable Insertion

Standard Cleanroom

(1) Connect the power cable connector.

(2) Mount the power cable clamp.

(3) Mount the power cable cover.

Reference: *Maintenance 7.6 Power Cable Cover*

9. Joint #1

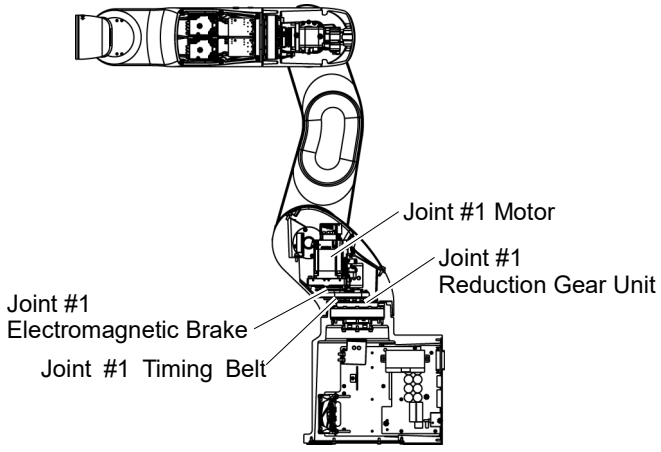
WARNING	■ Do not connect or disconnect the motor connectors while the power to the robot system is turned ON. Connecting or disconnecting the motor connectors with the power ON is extremely hazardous and may result in serious bodily injury as the Manipulator may move abnormally, and also may result in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

CAUTION	■ Be careful not to apply excessive shock to the motor shaft when replacing the motors. The shock may shorten the life cycle of the motors and encoder and/or damage them. ■ Never disassemble the motor and encoder. A disassembled motor and encoder will cause a positional gap and cannot be used again.

After parts have been replaced (motor units, reduction gear units, timing belts), the Manipulator cannot operate properly because a mismatch exists between the origin stored in each motor and its corresponding origin stored in the Robot system.
Because of that, it is necessary to perform calibration (encoder rest and calibration) to match these origins.

After replacing the parts, refer to the following section to perform calibration.

Maintenance 19. Calibration.



9.1 Replacing Joint #1 Motor

	Name		Quantity	Note
Maintenance parts	Joint #1 motor unit		1	2194596
	Thermal conductive sheet		1	1755573
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
	Torque wrench		1	For tightening torque control
	Nippers		1	For cutting wire tie
	Belt tension meter		1	Refer: Unitta U-505
Material	Wire tie		-	

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. The brake does not work during replacement. Be careful when performing maintenance work.

Joint #1 Motor Removal

(1) Turn OFF the Manipulator.

(2) Remove the Arm #1 Cover.

Reference: *Maintenance 7.1 Arm #1 Cover.*

(3) Cut off the wire tie that binds the following cables.

Signal cable and the signal cable for AMP board between the Joint #1 motor and the Controller Unit



NOTE

Be careful not to cut the harness.

(4) Cut off the wire tie on the plate (Arm #1 sleeve side) and remove the plate.

Hexagon socket head cap bolts: 2-M4×12 (with washer)



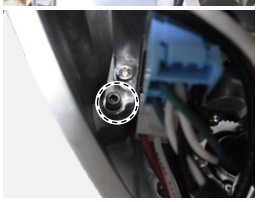
NOTE

Be careful not to cut the harness.

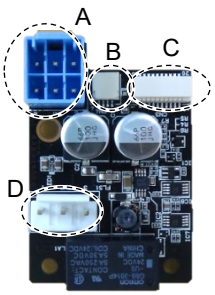
(5) Remove the motor unit from the Arm #1.

Hexagon socket head cap bolts: 3-M4×22 (with slotted hole washer)



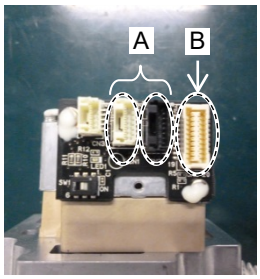


(6) Disconnect the following connectors from the AMP board.



A: Power cable connector
B: Brake connector
C: Signal cable connector (for AMP board)
D: Motor connector

(7) Disconnect the following connectors from the motor.



A: Signal cable connectors (for motor × 2)
B: Signal cable connector (for AMP board)

NOTE

The cables will be necessary again.
Be careful not to lose them.

(8) Remove the AMP board fixing plate (with AMP board) from the motor unit.

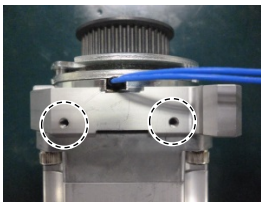


Hexagon socket head cap bolts: 2-M3×6

Joint #1 Motor Installation

(1) Fix the AMP board fixing plate (with AMP board) to a new motor unit.

Hexagon socket head cap bolts: 2-M3×6
Tightening torque: 2.0 ± 0.1 N·m

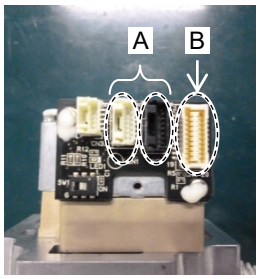


(2) Connect the following connectors of the motor.

A: Signal cable connectors (for motor × 2)
B: Signal cable connector (for AMP board)

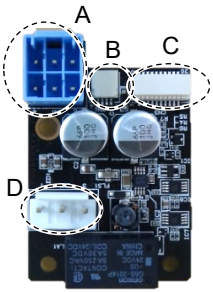
NOTE

Connector for the signal cable connector (for motor) is the same color.

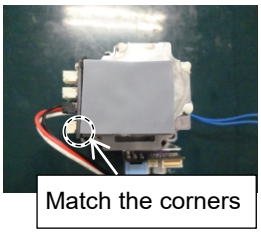


(3) Connect the following connectors of the AMP board.

A: Power cable connector
B: Brake connector
C Signal cable connector (for AMP board)
D: Motor connector

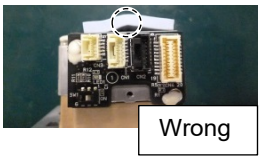


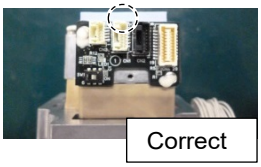
(4) Attach the thermal conductive sheet on the bottom of the motor unit. For the attaching position, refer to the picture on the right.



NOTE

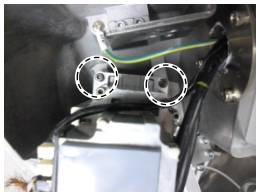
Make sure that the entire surface of the thermal conductive sheet contacts with the rear side of the motor unit without lifting up the center of the sheet.





(5) Pass the timing belt through the motor pulley and loosely secure to the Arm #1.

Hexagon socket head cap bolts: 3-M4×22
(with slotted hole washer)



NOTE

Make sure that the gear grooves of the timing belt are fit into those of the pulley completely.
When securing the motor unit loosely, make sure that the motor unit can be moved by hand and it does not tilt when being pulled. If the unit is secured too loose or too tight, the belt will not have proper tension.



(6) Apply proper tension to the motor unit and fix it.

Joint #1 timing belt tension: 34~70 N
Belt tension meter setting values
Weight: 2.5g/mm width×m span
Width: 9.0mm
Span: 60mm

Hexagon socket head cap bolts: 3-M4×22 (with slotted hole washer)
Tightening torque: 4.0 ± 0.2 N·m

NOTE

Regarding belt tension:
Jumping (position gap) may occur if the value is below the lower limit.
Vibration (abnormal noise) or reduction in life of the parts may occur if the value exceeds the upper limit.
When you replace with a new belt, belt extends and the belt tension may decrease in the initial stage. Make sure to operate the robot two to three days and check the belt tension again.

(7) Mount the plate of the Arm #1 sleeve side.
Hexagon socket head cap bolts: 2-M4×12 (with a washer)
Tightening torque: 4.0 ± 0.2 N·m



Pass the wire tie through the hole on the plate.
Bind the following cables and the ground wire with the wire tie.
Motor cable
Signal cable (for motor)
LED cable
Ground wire

(8) Bind the following cables between the Joint #1 motor and the Controller Unit with the wire tie.

Wire tie: AB100

Signal cable (for motor)
Signal cable (for AMP board)



(9) Mount the Arm #1 cover.

Reference: *Maintenance 7.1 Arm #1 Cover*

(10) Turn ON the Manipulator.

Reference: *Setup & Operation 6.5 LED*

NOTE

When starting the manipulator for the first time after replacing the motor unit, the motor unit firmware is automatically updated. DO NOT turn OFF the Manipulator until it starts.

(11) Calibrate the Joint #1.

Reference: *Maintenance 19. Calibration*

9.2 Replacing Joint #1 Reduction Gear Unit

Reduction gear unit is replaced by serviceman.

For replacement of the reduction gear unit, please contact the supplier of your region.

9.3 Replacing Joint #1 Timing Belt

	Name	Quantity	Note
Maintenance parts	Timing Belt	1	1751536
Tools	Hexagonal wrench (width across flats: 3 mm)	1	For M4 hexagon socket head cap bolts
	Torque wrench	1	For tightening torque control
	Cross-point screwdriver (No. 2)	1	For cross-recessed screw
	Nippers	1	For cutting wire tie
	Belt tension meter	1	Refer: Unitta U-505
Material	Wire tie	-	

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. The brake does not work during replacement.
Be careful when performing maintenance work.

Joint #1 Timing Belt Removal

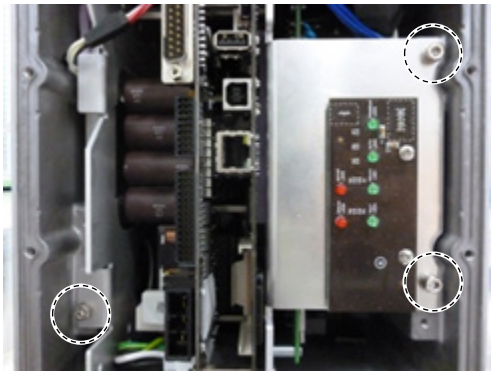
(1) Turn OFF the Manipulator.

(2) Remove the Arm #1 cover and the connector plate.

Reference: *Maintenance 7. Covers*

(3) Unscrew the mounting screws of the Controller Unit.

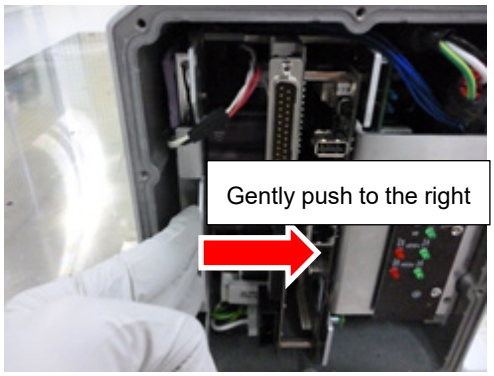
Hexagon socket head cap bolts:
3-M4×10 (with a plain washer)

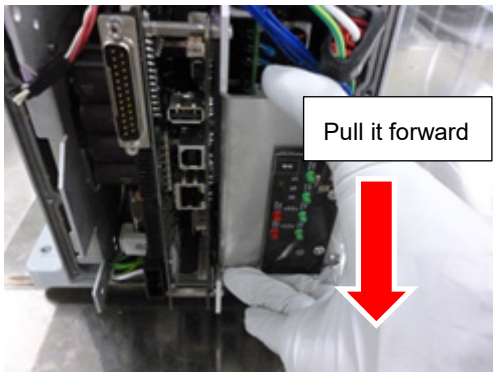


(4) Pull out the Controller Unit from the Manipulator base.

NOTE

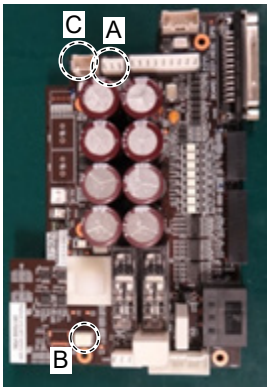
When pulling it out, firstly push the plate of the Controller Unit to the right (see the picture) gently, then remove the thermal conductive sheet on the base and the Controller Unit. Next, pull the Controller Unit forward.

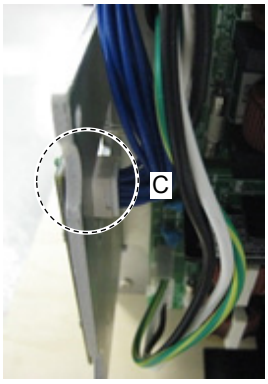




(5) Disconnect the following connectors of the Controller Unit.

A: Power cable connector
B: Signal cable connector
C: LED connectors × 2





(6) Remove the ground wire terminals inside the base.

Cross recessed head screws: M4×6



(7) Cut off the wire tie bound to the plate inside the base.

Wire tie: AB150



(8) Remove the Joint #1 motor unit.
Reference: *Maintenance 9.1 Replacing Joint #1 Motor*
Joint #1 Motor Removal (3) through (7)

(9) Pull out the following cables from the Arm #1 side and remove the Joint #1 timing belt.
Power cable
Signal cable (for motor)
LED cable
Ground wire

Joint #1 Timing Belt Installation

(1) Pass the following cables through a new Joint #1 timing belt.

Power cable
Signal cable (for motor)
LED cable
Ground wire

(2) Mount the Joint #1 motor unit.
Reference: *Maintenance 9.1 Replacing Joint #1 Motor*
Joint #1 Motor Installation (2) through (8)

(3) Connect the ground wire terminals inside the base.

Cross recessed head screws: M4×6
Tightening torque: 2.0 ± 0.1N m



(4) Pass the wire tie through the hole on the plate inside the base.
Bind the following cables with the wire tie.

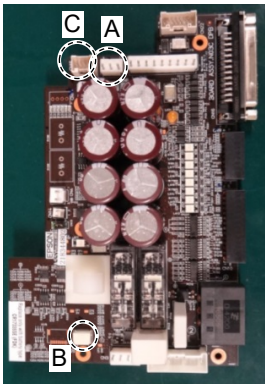
Wire tie: AB150

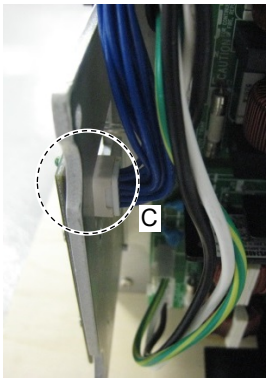
Power cable
LED cable
Signal cable (for motor)
Ground wire



(5) Connect the following connectors to the Controller Unit.

A: Power cable connector
B: Signal cable connector
C: LED connectors × 2

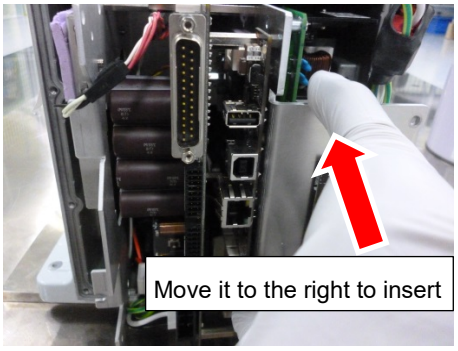


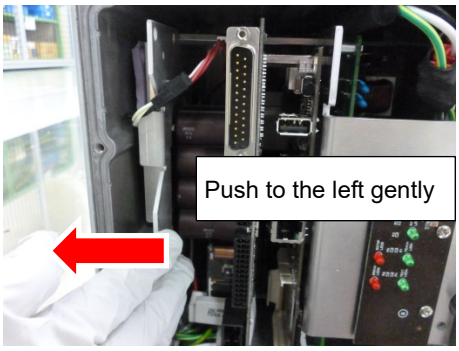


(6) Push the Controller Unit into the base.

NOTE Insert the Controller Unit while moving it to the right (see the picture).

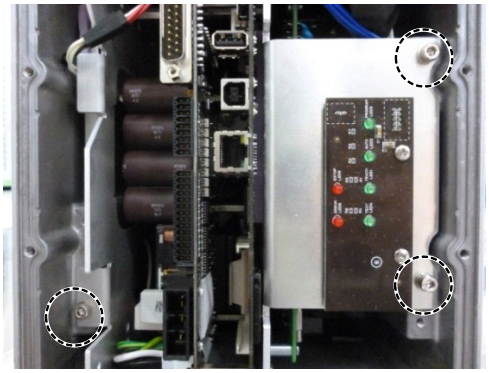
Then, gently move the plate of the Controller Unit to the left and let the thermal conductive sheet contacts with the wall inside the base.





(7) Tighten the mounting screws of the Controller Unit.

Hexagon socket head cap bolts: 3-M4×10 (with a plain washer)
Tightening torque: 4.0 ± 0.2 N·m



(8) Mount the Arm #1 cover and the connector plate.

Reference: *Maintenance 7. Covers*

(9) Turn ON the Manipulator.

Reference: *Setup & Operation 6.5 LED*

(10) Calibrate the Joint #1.

Reference: *Maintenance 19. Calibration*

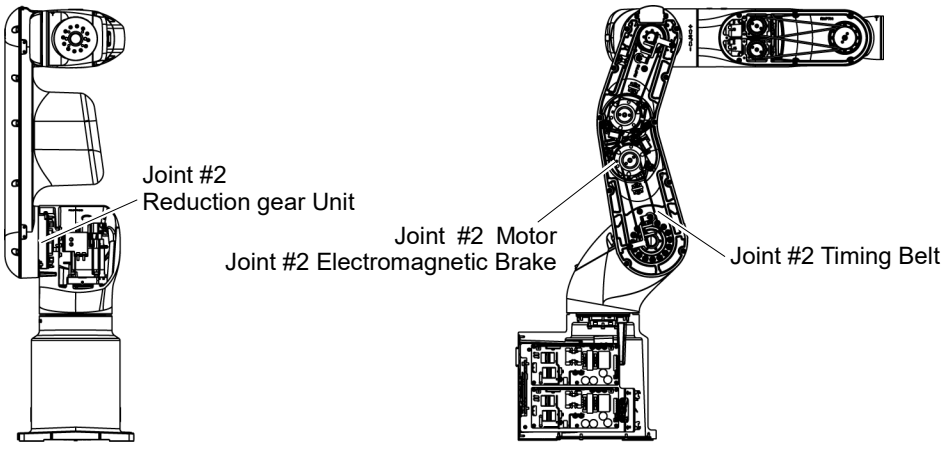
10. Joint #2

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

CAUTION	■ Be careful not to apply excessive shock to the motor shaft when replacing the motors. The shock may shorten the life cycle of the motors and encoder and/or damage them. ■ Never disassemble the motor and encoder. A disassembled motor and encoder will cause a positional gap and cannot be used again.

After parts have been replaced (motor units, reduction gear units, timing belts), the Manipulator cannot operate properly because a mismatch exists between the origin stored in each motor and its corresponding origin stored in the Robot system.
Because of that, it is necessary to perform calibration (encoder rest and calibration) to match these origins.

After replacing the parts, refer to the following section to perform calibration.
Maintenance 19. *Calibration*.



10.1 Replacing Joint #2 Motor

CAUTION	■ This procedure has possibility of damage or malfunction to the Manipulator. Be very careful when performing maintenance. ■ DO NOT loosen the bolts while the Arm #2 is not tilted. It may cause the belt come off and the Arm #2 falls down, and it is extremely hazardous. Be sure to do the Removal steps (1) and (2) before removing the motor.

	Name		Quantity	Note
Maintenance parts	Joint #2 motor unit		1	2194597
	Thermal conductive sheet		1	1755573
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
	Torque wrench		1	For tightening torque control
	Nippers		1	For cutting wire tie
	Belt tension meter		1	Refer: Unitta U-505
Material	Wire tie		-	

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the controller power is OFF or the motor is OFF status. The brake does not work during replacement. Be careful when performing maintenance work.

When removing the Joint #2 motor, tilt the Arm #2 and press it against the Arm #1.
Reference: *Maintenance: 10.1 Joint #2 - Replacing the Motor,* Removal step (2)

Joint #2 Motor Removal

(1) Turn ON the Manipulator.

(2) Release the Joint #2 brake. Tilt the Arm #2 and push it against the Arm #1.

The Arm #2 falls by its weight when the Joint #2 motor unit is removed. Therefore, release the brake and tilt the Arm #2 in advance.

EPSON RC+

Command

```
>brake off, 2
```

NOTE

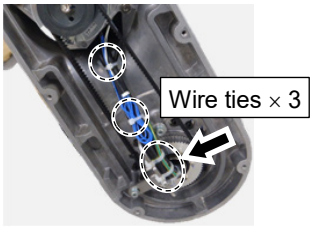
When pushing the arm, push the Arm #2 slowly to the Arm #1.
If a strong impact is applied to the joint, the Manipulator may get damage.

(3) Turn OFF the Manipulator.

(4) Remove the Arm #2 Cover.

For details, refer to *Maintenance: 7.2 Arm #2 Cover.*

(5) Cut off the wire tie bound inside the Arm #2.
Wire tie : AB150 × 3
AB100 × 2

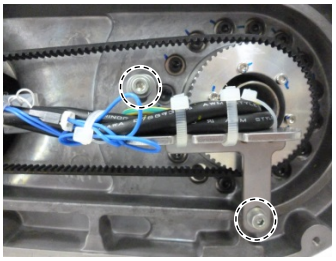


NOTE

Be careful not to cut the harness.

(6) Remove the cable fixing plate on the Arm #2. (Joint #2 side)

Hexagon socket head cap bolts with captive washer: 2-M4×12



(7) Loosen the mounting screws of the Joint #2 motor unit and remove the Joint #2 timing belt.

Hexagon socket head cap bolts: 3-M4×22 (with slotted hole washer)

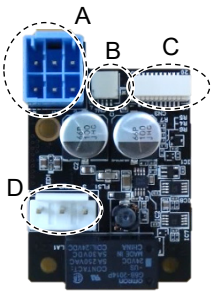
(8) Remove the motor unit from the Arm #2.

Hexagon socket head cap bolts: 3-M4×22 (with slotted hole washer)

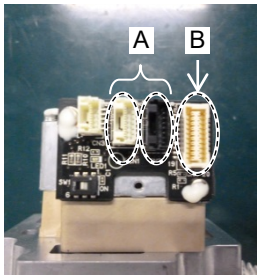


(9) Disconnect the following connectors from the AMP board.

A: Power cable connector
B: Brake connector
C: Signal connector (for AMP board)
D: Motor connector



(10) Disconnect the following connectors of the motor.



A: Signal cable connectors (for motor × 2)
B: Signal cable connector (for AMP board)

NOTE

The cables will be necessary again.
Be careful not to lose them.

(11) Remove the AMP board fixing plate (with AMP board) from the motor unit.

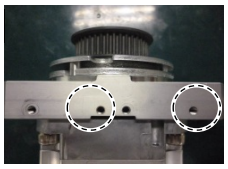


Hexagon socket head cap bolts: 2-M3×6

Joint #2 Motor Installation

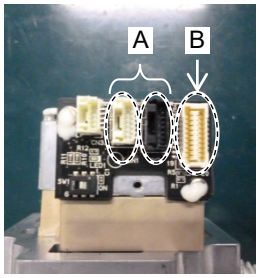
(1) Fix the AMP board fixing plate (with AMP board) to a new motor unit.

Hexagon socket head cap bolts: 2-M3×6
Tightening torque: 2.0 ± 0.1 N·m



(2) Connect the following connectors of the motor.

A: Signal cable connectors (for motor × 2)
B: Signal cable connector (for AMP board)

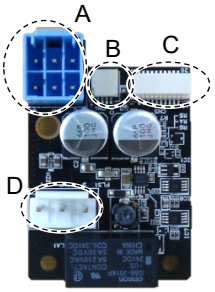


NOTE

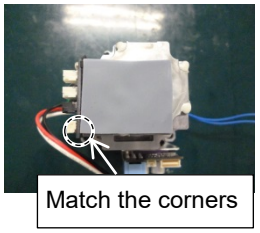
Connector for the signal cable connector (for motor) is the same color.

(3) Connect the connectors of the AMP board.

A: Power cable connector
B: Brake connector
C Signal cable connector (for AMP board)
D: Motor connector

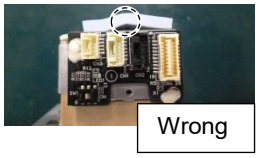


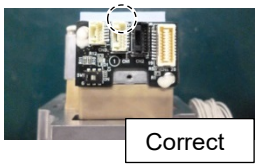
(4) Attach the thermal conductive sheet on the bottom of the motor unit. For the attaching position, refer to the picture on the right.



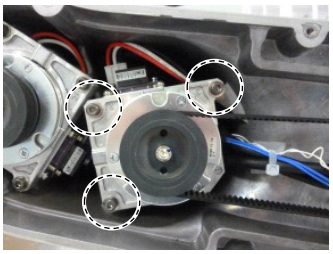
NOTE

Make sure that the entire surface of the thermal conductive sheet contacts with the rear side of the motor unit without lifting up the center of the sheet.





(5) Pass the timing belt through the motor pulley and loosely secure to the Arm #2.



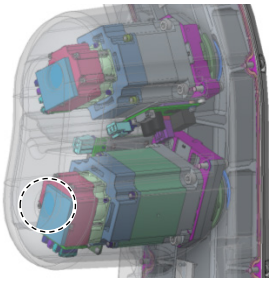
Hexagon socket head cap bolts: 3-M4×22
(with slotted hole washer)

NOTE Make sure that the gear grooves of the timing belt are fit into those of the pulley completely.
When securing the motor unit loosely, make sure that the motor unit can be moved by hand and it does not tilt when being pulled. If the unit is secured too loose or too tight, the belt will not have proper tension.

NOTE As shown on the picture, pass the cable through the rear side of the Arm #2 motor unit fixing part.
Before fixing the motor unit, make sure that the cables are not caught in the gap between the motor unit and Arm #2.



NOTE Press the thermal conductive sheet on the rear side of the motor unit to the round convex part at the end of the Arm #2.



(6) Apply proper tension to the motor unit and fix it.

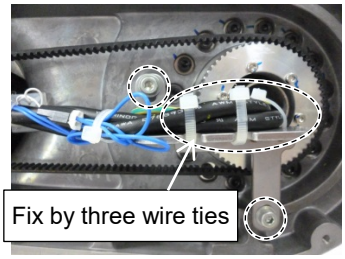
Joint #2 timing belt tension: 34 - 58 N
Belt tension meter setting values
Weight: 2.5g/mm width×m span
Width: 9.0mm
Span: 172mm

Hexagon socket head cap bolts: 3-M4×22 (with slotted hole washer)
Tightening torque: 4.0 ± 0.2 N·m

NOTE Regarding belt tension:
Jumping (position gap) may occur if the value is below the lower limit.
Vibration (abnormal noise) or reduction in life of the parts may occur if the value exceeds the upper limit.
When you replace with a new belt, belt extends and the belt tension may decrease in the initial stage. Make sure to operate the robot two to three days and check the belt tension again

(7) Mount the cable fixing plate on the Arm #2.
(Joint #2 side)

Hexagon socket head cap bolts: 2-M4×12
(with a washer)
Tightening torque: 4.0 ± 0.2 N·m



Pass the wire ties (×3) to the plate.
Fix the following cables and the ground wire with the wire tie.

Wire tie: AB150

Motor cable
Signal cable (for motor)
LED cable
Ground wire

(8) Fold the brake cable of Joint #2 motor into the length of 40mm. Bind it with the following cables with the wire tie.



Wire tie: AB100

Power cable
Signal cable (for motor)
Brake cable

(9) Pass the wire tie to the mount base inside the Arm #2.
Bind the following cables with the wire tie.



Wire tie: AB100

Power cable
Signal cable (for motor)
Brake cable
LED cable (mount base A only)

(10) Mount the Arm #2 cover.

Reference: *Maintenance 7.2 Arm #2 Cover*

(11) Turn ON the Manipulator.

Reference: *Setup & Operation 6.5 LED*

NOTE
When starting the Manipulator for the first time after replacing the motor unit, the motor unit firmware is automatically updated. DO NOT turn OFF the Manipulator until it starts.

(12) Calibrate the Joint #2.

Reference: *Maintenance 19. Calibration*

10.2 Replacing Joint #2 Reduction Gear Unit

Reduction gear unit is replaced by serviceman.

For replacement of the reduction gear unit, please contact the supplier of your region.

10.3 Replacing Joint #2 Timing Belt

CAUTION	■ This procedure has possibility of damage or malfunction to the Manipulator. Be very careful when performing maintenance. ■ DO NOT loosen the bolts while the Arm #2 is not tilted. It may cause the belt come off and the Arm #2 falls down, and it is extremely hazardous. Be sure to do the Removal steps (1) and (2) before removing the motor.

	Name	Quantity	Note
Maintenance parts	Timing Belt	1	1753920
Tools	Hexagonal wrench (width across flats: 3 mm)	1	For M4 hexagon socket head cap bolts
	Torque wrench	1	For tightening torque control
	Cross-point screwdriver (No. 2)	1	For cross-recessed screw
	Nippers	1	For cutting wire tie
	Belt tension meter	1	Refer: Unitta U-505
Material	Wire tie	-	

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the controller power is OFF or the motor is OFF status. The brake does not work during replacement.
Be careful when performing maintenance work.

When removing the Joint #2 motor, tilt the Arm #2 and press it against the Arm #1.
Reference: *Maintenance: 10.1 Joint #2 - Replacing the Motor*, Removal step (2)

Joint #2 Timing Belt Removal

(1) Remove the Joint #2 timing belt.

Reference: *Maintenance 10.1 Replacing Joint #2 Motor*
Joint #2 Motor Removal Step (1) through (7)

Joint #2 Timing Belt Installation

(1) Install the Joint #2 timing belt.

Reference: *Maintenance 10.1 Replacing Joint #2 Motor*
Joint #2 Motor Removal Step (5) through (11)

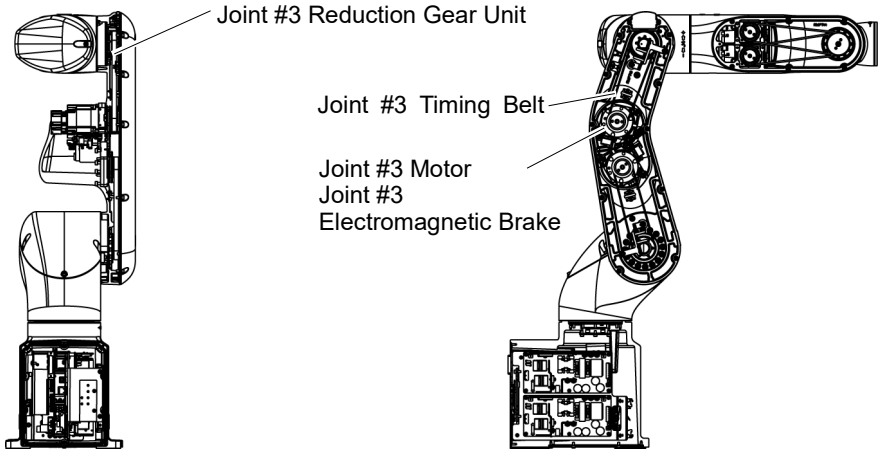
11. Joint #3

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

CAUTION	■ Be careful not to apply excessive shock to the motor shaft when replacing the motors. The shock may shorten the life cycle of the motors and encoder and/or damage them. ■ Never disassemble the motor and encoder. A disassembled motor and encoder will cause a positional gap and cannot be used again.

After parts have been replaced (motor units, reduction gear units, timing belts), the Manipulator cannot operate properly because a mismatch exists between the origin stored in each motor and its corresponding origin stored in the Robot system.
Because of that, it is necessary to perform calibration (encoder rest and calibration) to match these origins.

After replacing the parts, refer to the following section to perform calibration.
Maintenance 19. Calibration.



11.1 Replacing Joint #3 Motor

CAUTION	■ This procedure has possibility of damage or malfunction to the Manipulator. Be very careful when performing maintenance. ■ DO NOT loosen the bolts while the Arm #3 is not tilted. It may cause the belt come off and the Arm #3 falls down, and it is extremely hazardous. Be sure to do the Removal steps (1) and (2) before removing the motor.

	Name		Quantity	Note
Maintenance parts	Joint #3 motor unit		1	2194598
	Thermal conductive sheet		1	1755573
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
	Torque wrench		1	For tightening torque control
	Nippers		1	For cutting wire tie
	Belt tension meter		1	Refer: Unitta U-505
Material	Wire tie		-	

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the controller power is OFF or the motor is OFF status. The brake does not work during replacement. Be careful when performing maintenance work.

When removing the Joint #3 motor, tilt the Arm #3 and press it against the Arm #2.
Reference: *Maintenance: 11.1 Joint #3 - Replacing the Motor,* Removal step (2)

Joint #3 Motor Removal

(1) Turn ON the Manipulator.

(2) Release the Joint #3 brake. Tilt the Arm #3 and push it against the Arm #2.

The Arm #3 falls by its weight when the Joint #3 motor unit is removed. Therefore, release the brake and tilt the Arm #3 in advance.

EPSON RC+

Command

```
>brake off, 3
```

NOTE

When pushing the arm, push the Arm #3 slowly to the Arm #2.

If a strong impact is applied to the joint, the Manipulator may get damage.

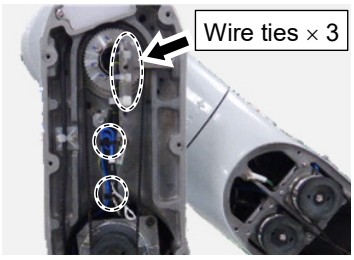
(3) Turn OFF the Manipulator.

(4) Remove the Arm #2 cover.

Reference: *Maintenance 7.2 Arm #2 Cover*

(5) Cut off the wire tie bound inside the Arm #2.

Wire tie : AB150 × 3
AB100 × 2

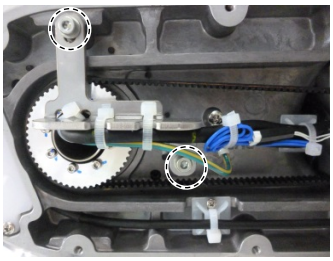


NOTE

Be careful not to cut the harness.

(6) Remove the cable fixing plate on the Arm #2. (Joint #3 side)

Hexagon socket head cap bolts with captive washer: 4-M4×12

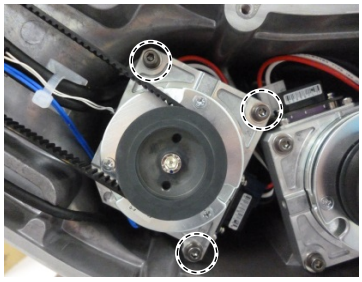


(7) Loosen the mounting screws of the Joint #3 motor unit and remove the Joint #3 timing belt.

Hexagon socket head cap bolts: 3-M4×22 (with slotted hole washer)

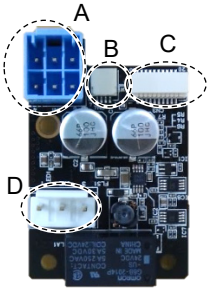
(8) Remove the Arm #2 from the motor unit.

Hexagon socket head cap bolts: 3-M4×22 (with slotted hole washer)

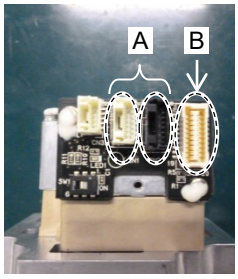


(9) Disconnect the following connectors from the AMP board.

A: Power cable connector
B: Brake connector
C: Signal cable connector (for AMP board)
D: Motor connector



(10) Disconnect the following connectors of the motor.



A: Signal cable connectors (for motor × 2)
B: Signal cable connector (for AMP board)

NOTE

The cables will be necessary again.
Be careful not to lose them.

(11) Remove the AMP board fixing plate (with AMP board) from the motor unit.

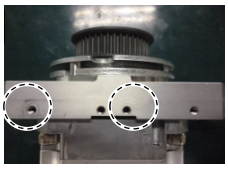
Hexagon socket head cap bolts: 2-M3×6



Joint #3 Motor Installation

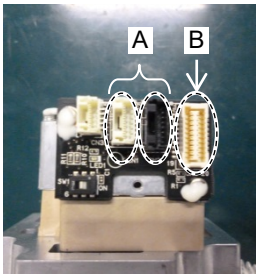
(1) Fix the AMP board fixing plate (with AMP board) to a new motor unit.

Hexagon socket head cap bolts: 2-M3×6
Tightening torque: 2.0 ± 0.1 N·m



(2) Connect the following connectors of the motor.

A: Signal cable connectors (for motor × 2)
B: Signal cable connector (for AMP board)

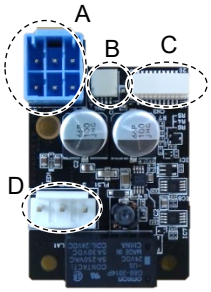


NOTE

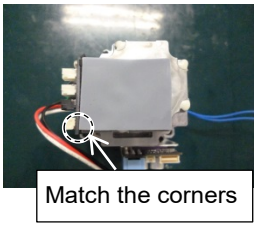
Connector for the signal cable connector (for motor) is the same color.

(3) Connect the connectors of the AMP board.

A: Power cable connector
B: Brake connector
C Signal cable connector (for AMP board)
D: Motor connector

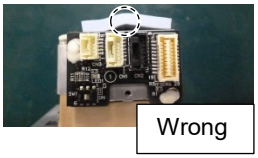


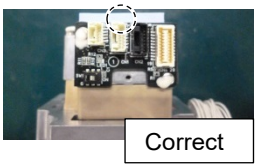
(4) Attach the thermal conductive sheet on the bottom of the motor unit. For the attaching position, refer to the picture on the right.



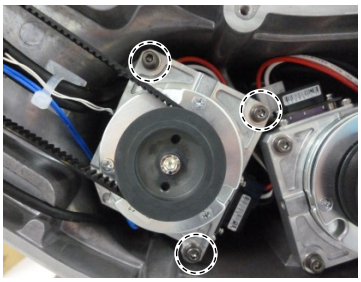
NOTE

Make sure that the entire surface of the thermal conductive sheet contacts with the rear side of the motor unit without lifting up the center of the sheet.





(5) Pass the timing belt through the motor pulley and loosely secure to the Arm #2.



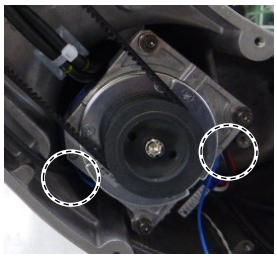
Hexagon socket head cap bolts: 3-M4×22
(with slotted hole washer)

NOTE

Make sure that the gear grooves of the timing belt are fit into those of the pulley completely.
When securing the motor unit loosely, make sure that the motor unit can be moved by hand and it does not tilt when being pulled. If the unit is secured too loose or too tight, the belt will not have proper tension.

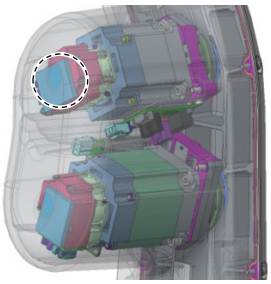
NOTE

As shown on the picture, pass the cable through the rear side of the Arm #2 motor unit fixing part.
Before fixing the motor unit, make sure that the cables are not caught in the gap between the motor unit and Arm #2.



NOTE

Press the thermal conductive sheet on the rear side of the motor unit to the round convex part at the end of the Arm #2.



(6) Apply proper tension to the motor unit and fix it.

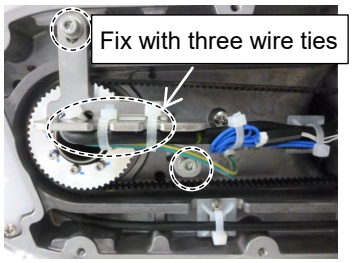
Joint #3 timing belt tension: 34 - 58 N
Belt tension meter setting values
Weight: 2.5g/mm width×m span
Width: 9.0mm
Span: 169mm

Hexagon socket head cap bolts: 3-M4×22 (with slotted hole washer)
Tightening torque: 4.0 ± 0.2 N·m

NOTE

Regarding belt tension:
Jumping (position gap) may occur if the value is below the lower limit.
Vibration (abnormal noise) or reduction in life of the parts may occur if the value exceeds the upper limit.
When you replace with a new belt, belt extends and the belt tension may decrease in the initial stage. Make sure to operate the robot two to three days and check the belt tension again

(7) Mount the cable fixing plate on the Arm #2. (Joint #3 side)



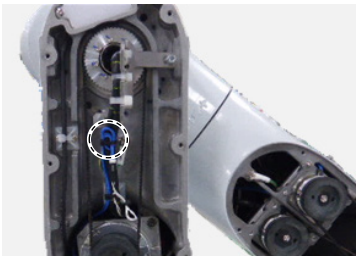
Hexagon socket head cap bolts: 2-M4×12 (with a washer)
Tightening torque: 4.0 ± 0.2 N·m

Pass the wire ties (×3) to the plate.
Bind the following cables and the ground wire with the wire tie.

Wire tie: AB150

Motor cable
Signal cable (for motor)
LED cable
Ground wire

(8) Fold the brake cable of Joint #3 motor into the length of 40mm. Bind it with the following cables with the wire tie.

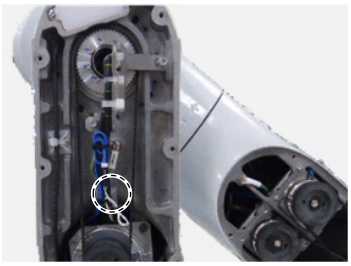


Wire tie: AB100

Power cable
Signal cable (for motor)
Brake cable

(9) Pass the wire tie to the mount base inside the Arm #2.

Bind the following cables with the wire tie.



Wire tie: AB100

Power cable
Signal cable (for motor)
Brake cable

(10) Mount the Arm #2 cover.

Reference: *Maintenance 7.2 Arm #2 Cover*

(11) Turn ON the Manipulator.

Reference: *Setup & Operation 6.5 LED*

NOTE ☞ When starting the Manipulator for the first time after replacing the motor unit, the motor unit firmware is automatically updated. DO NOT turn OFF the Manipulator until it starts.

(12) Calibrate the Joint #3.

Reference: *Maintenance 19. Calibration*

11.2 Replacing Joint #3 Reduction Gear Unit

Reduction gear unit is replaced by serviceman.

For replacement of the reduction gear unit, please contact the supplier of your region.

11.3 Replacing Joint #3 Timing Belt

CAUTION	■ This procedure has possibility of damage or malfunction to the Manipulator. Be very careful when performing maintenance. ■ DO NOT loosen the bolts while the Arm #3 is not tilted. It may cause the belt come off and the Arm #3 falls down, and it is extremely hazardous. Be sure to do the Removal steps (1) and (2) before removing the motor.

	Name	Quantity	Note
Maintenance parts	Timing Belt	1	1751537
Tools	Hexagonal wrench (width across flats: 3 mm)	1	For M4 hexagon socket head cap bolts
	Torque wrench	1	For tightening torque control
	Cross-point screwdriver (No. 2)	1	For cross-recessed screw
	Nippers	1	For cutting wire tie
	Belt tension meter	1	Refer: Unitta U-505
Material	Wire tie	-	

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the controller power is OFF or the motor is OFF status. The brake does not work during replacement. Be careful when performing maintenance work.

When removing the Joint #3 motor, tilt the Arm #3 and press it against the Arm #2.
Reference: *Maintenance: 11.1 Joint #3- Replacing the Motor*, Removal step (2)

Joint #3 Timing Belt Removal

(1) Remove the Joint #3 timing belt.

Reference: *Maintenance 11.1 Replacing Joint #2 Motor*
Joint #3 Motor Removal Step (1) through (7)

Joint #3 Timing Belt Installation

(1) Install the Joint #3 timing belt.

Reference: *Maintenance 11.1 Replacing Joint #2 Motor*
Joint #3 Motor Removal Step (5) through (11)

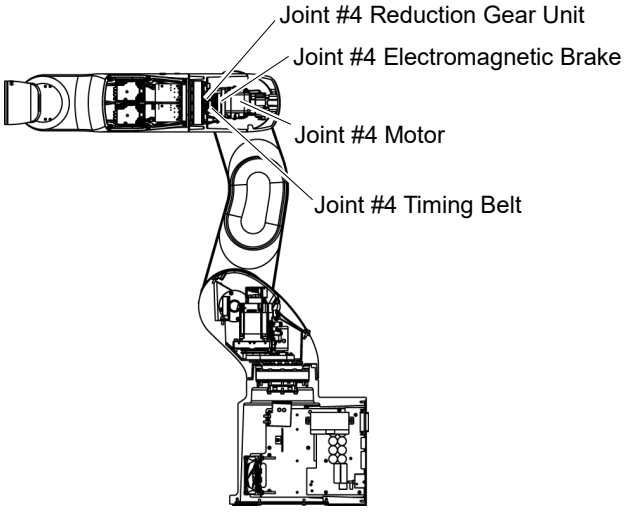
12. Joint #4

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

CAUTION	■ Be careful not to apply excessive shock to the motor shaft when replacing the motors. The shock may shorten the life cycle of the motors and encoder and/or damage them. ■ Never disassemble the motor and encoder. A disassembled motor and encoder will cause a positional gap and cannot be used again.

After parts have been replaced (motor units, reduction gear units, timing belts), the Manipulator cannot operate properly because a mismatch exists between the origin stored in each motor and its corresponding origin stored in the Robot system.
Because of that, it is necessary to perform calibration (encoder rest and calibration) to match these origins.

After replacing the parts, refer to the following section to perform calibration.
Maintenance 19. Calibration.



12.1 Replacing Joint #4 Motor

	Name	Quantity	Note
Maintenance parts	Joint #4 motor unit	1	2194599
Tools	Hexagonal wrench (width across flats: 3 mm)	1	For M4 hexagon socket head cap bolts
	Torque wrench	1	For tightening torque control
	Nippers	1	For cutting wire tie
	Belt tension meter	1	Refer: Unitta U-505
Material	Wire tie	-	

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. The brake does not work during replacement. Be careful when performing maintenance work.

Joint #4 Motor Removal

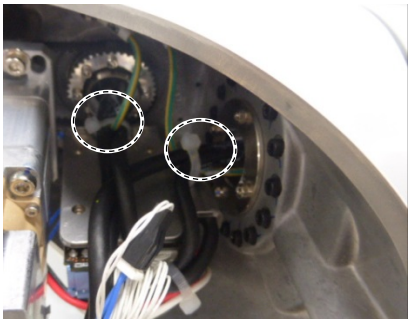
(1) Turn OFF the Manipulator.

(2) Remove the Arm #3 Cover.

For details, refer to *Maintenance: 7.3 Arm #3 Cover.*

(3) Cut off the wire tie bound inside the Arm #3

Wire tie: AB150 × 2



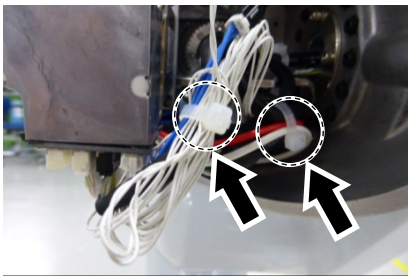
NOTE

Be careful not to cut the harness.

(4) Cut off the wire tie that binds the following cables of the Joint #4 motor.

Wire tie: AB100 × 2

Power cable
Signal cable

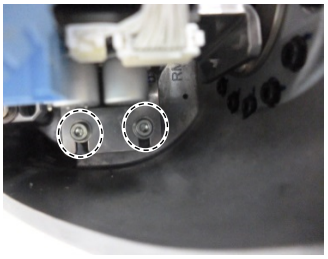


NOTE

Be careful not to cut the harness.

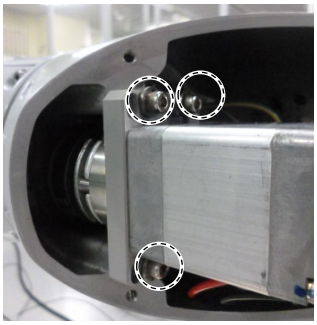
(5) Remove the plate (with AMP board) inside the Arm #3.

Hexagon socket head cap bolts with captive washer: 2-M4×12



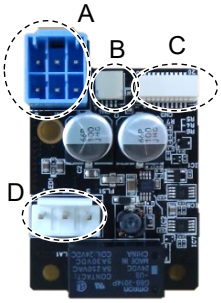
(6) Remove the Joint #4 motor unit.

Hexagon socket head cap bolts: 3-M4×18
(with slotted hole washer)



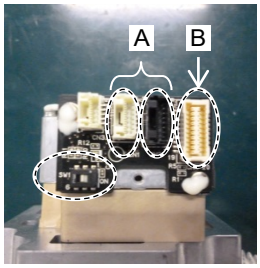
(7) Disconnect the following connectors from the AMP board.

A: Power cable connector
B: Brake connector
C: Signal cable connector (for AMP board)
D: Motor connector



(8) Disconnect the following connectors of the motor.

A: Signal cable connectors (for motor × 2)
B: Signal cable connector (for AMP board)

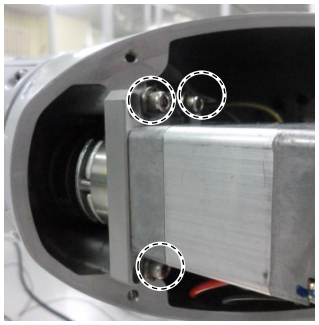


NOTE

The cables will be necessary again.
Be careful not to lose them.

Joint #4 Motor Installation

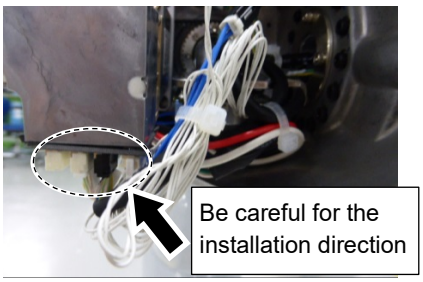
(1) Pass the timing belt through the motor pulley and loosely secure to the Arm #3.



Hexagon socket head cap bolts: 3-M4×18
(with slotted hole washer)

NOTE
Make sure that the gear grooves of the timing belt are fit into those of the pulley completely.
When securing the motor unit loosely, make sure that the motor unit can be moved by hand and it does not tilt when being pulled. If the unit is secured too loose or too tight, the belt will not have proper tension.

NOTE
The direction to install the motor is the direction in which the connector of the motor faces downward.



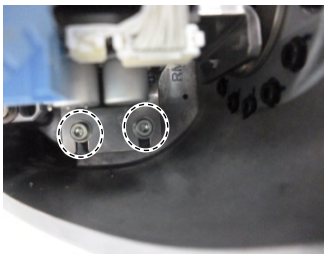
(2) Apply proper tension to the motor unit and fix it.

Joint #4 timing belt tension: 23 - 36 N
Belt tension meter setting values
Weight: 2.5g/mm width×m span
Width: 6.0mm
Span: 45mm

Hexagon socket head cap bolts: 3-M4×18 (with slotted hole washer)
Tightening torque: 4.0 ± 0.2 N·m

NOTE
Regarding belt tension:
Jumping (position gap) may occur if the value is below the lower limit.
Vibration (abnormal noise) or reduction in life of the parts may occur if the value exceeds the upper limit.
When you replace with a new belt, belt extends and the belt tension may decrease in the initial stage. Make sure to operate the robot two to three days and check the belt tension again

(3) Mount the plate on the Arm #3.

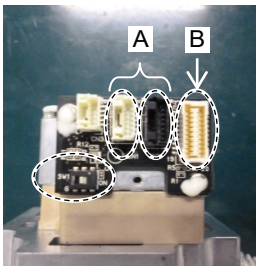


Hexagon socket head cap bolts with captive washer: 2-M4×12
Tightening torque: 4.0 ± 0.2 N·m

(4) Connect the following connectors of the motor.

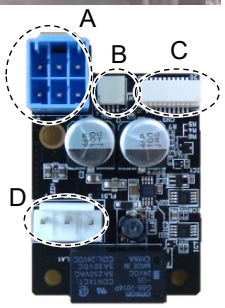
A: Signal cable connectors (for motor × 2)
B: Signal cable connector (for AMP board)

Connector for the signal cable connector (for motor) is the same color.



(5) Connect the connectors of the AMP board.

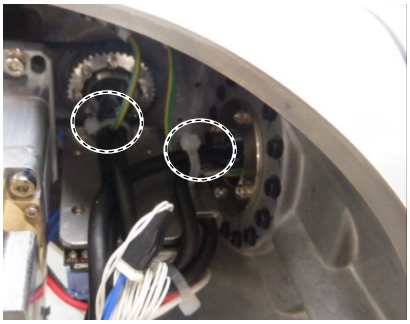
A: Power cable connector
B: Brake connector
C Signal cable connector (for AMP board)
D: Motor connector



(6) Pass the wire tie through the hole on the plate inside the Arm #3.
Bind the following cables with the wire tie.

Wire tie: AB150

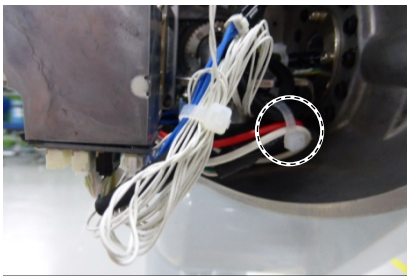
Power cable
Signal cable (for motor)
Ground wire



(7) Bind the following cables between the Joint #4 motor and the Joint #3 motor with the wire tie.

Wire tie: AB100

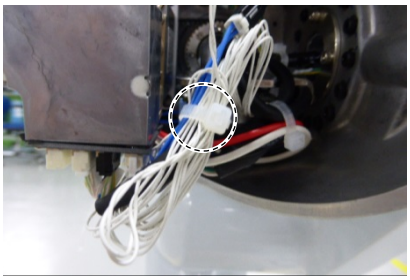
Power cable
Signal cable (for motor)
Motor cable



(8) Bind the following cables between the Joint #4 motor and the Joint #3 motor with the wire tie.

Wire tie: AB100

Signal cable (for AMP board)
Signal cable (for motor)
Brake cable



(9) Mount the Arm #3 cover.

Reference: *Maintenance 7.3 Arm #3 Cover*

(10) Turn ON the Manipulator.

Reference: *Setup & Operation 6.5 LED*

NOTE

When starting the Manipulator for the first time after replacing the motor unit, the motor unit firmware is automatically updated. DO NOT turn OFF the Manipulator until it starts.

(11) Calibrate the Joint #4.

Reference: Maintenance *19. Calibration*

12.2 Replacing Joint #4 Reduction Gear Unit

Reduction gear unit is replaced by serviceman.

For replacement of the reduction gear unit, please contact the supplier of your region.

12.3 Replacing Joint #4 Timing Belt

	Name	Quantity	Note
Maintenance parts	Timing Belt	1	1751538
Tools	Hexagonal wrench (width across flats: 3 mm)	1	For M4 hexagon socket head cap bolts
	Torque wrench	1	For tightening torque control
	Cross-point screwdriver (No. 2)	1	For cross-recessed screw
	Nippers	1	For cutting wire tie
	Belt tension meter	1	Refer: Unitta U-505
Material	Wire tie	-	

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. The brake does not work during replacement. Be careful when performing maintenance work.

Joint #4 Timing Belt Removal

(1) Turn OFF the Manipulator.

(2) Remove the following covers.

Arm #3 Cover
Arm #4 Cover 1
Arm #4 Cover 2

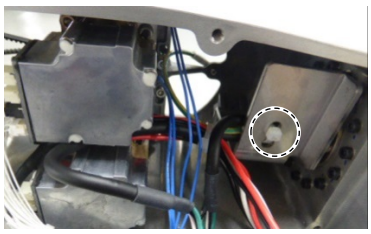
Reference: *Maintenance 7 Covers*

(3) Remove the Joint #4 motor.

Reference: *Maintenance 12.1 Replacing Joint #4 Motor*
Joint #4 Motor Removal step (3) through (7)

(4) Cut off the wire tie bound inside the Arm #4.

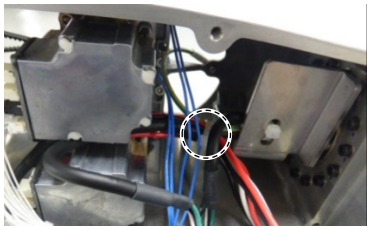
Wire tie: AB150



(5) Cut off the wire tie that binds the following cables and the ground wire.

Wire tie: AB100

Joint #5 motor cable
Signal cable (for motor)
Joint #6 motor cable
Ground wire

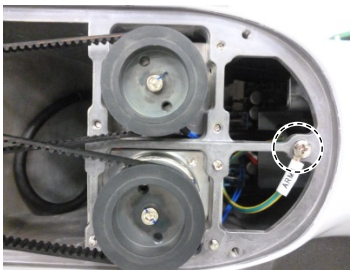


NOTE

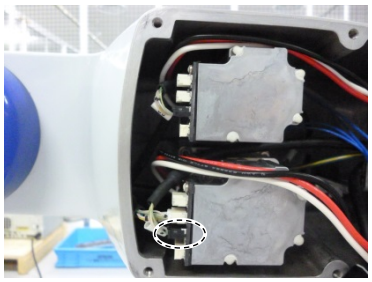
Be careful not to cut the harness.

(6) Remove the ground wire terminals of the Arm #4.

Cross-recessed screw: M4×6



(7) Disconnect the Joint #5 signal cable connector (for motor: black).



(8) Pass the Joint #4 sleeve and the Joint #4 timing belt so that the following cables and the ground wire will be Arm #3 side.

Cables disconnected connectors in the step (2) through (7)
- Power cable (Joint #5, 6 connector parts)
- Joint #5 signal cable (for motor)
- Ground wire

(9) Remove the Joint #4 timing belt.

Joint #4
Timing belt
Installation

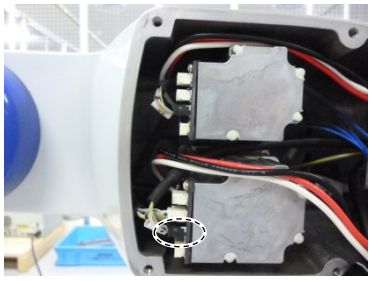
(1) Pass the following cables through a new Joint #4 timing belt.

Power cable (Joint #5, 6 connector part)
Joint #5 signal cable (for motor)
Ground wire

(2) Install the Joint #4 motor unit.

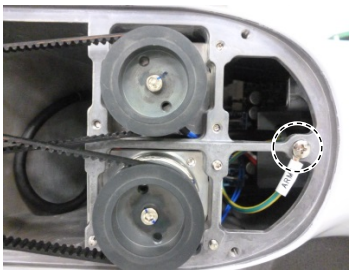
Reference: *Maintenance 12.1 Replacing Joint #4 Motor*
Joint #4 Motor Installation step (1) through (8)

(3) Connect the Joint #5 signal cable connector (for motor: black).



(4) Install the ground wire terminals of the Arm #4.

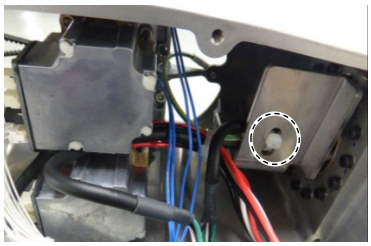
Cross-recessed screw: M4×6
Tightening torque: 2.0 ± 0.1 N·m



(5) Pass the wire tie through the hole on the plate inside the Arm #4.
Bind the following cables with the wire tie.

Wire tie: AB150

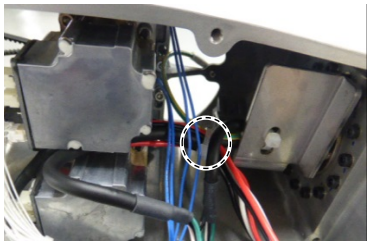
Power cable
Signal cable (for motor)
Ground wire



(6) Bind the following cables with the wire tie.

Wire tie: AB100

Motor cable(Joint #5)
Signal cable (Joint #5)
Motor cable (Joint #6)
Ground wire



(7) Mount the following covers.

Arm #3 Cover
Arm #4 Cover 1
Arm #4 Cover 2

Reference: *Maintenance 7 Covers*

(8) Turn ON the Manipulator.

Reference: *Setup & Operation 6.5 LED*

NOTE

When starting the Manipulator for the first time after replacing the motor unit, the motor unit firmware is automatically updated. DO NOT turn OFF the Manipulator until it starts.

(9) Calibrate the Joint #4.

Reference: *Maintenance 19. Calibration*

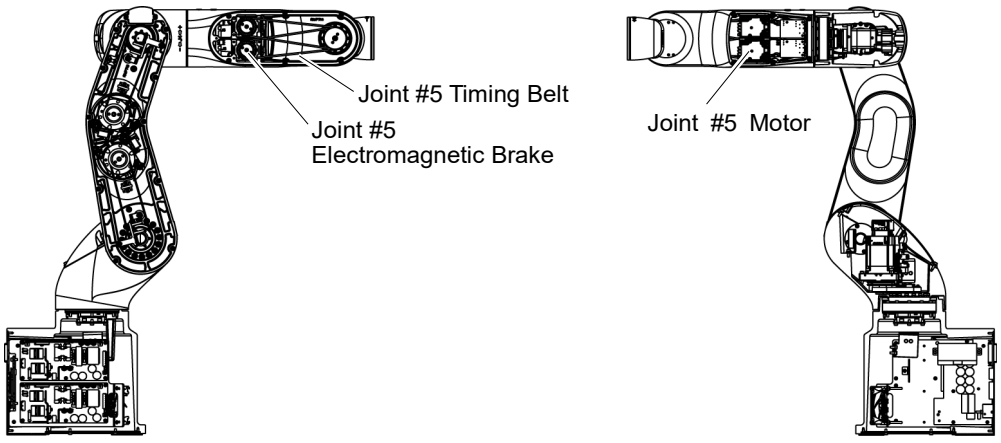
13. Joint #5

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

CAUTION	■ Be careful not to apply excessive shock to the motor shaft when replacing the motors. The shock may shorten the life cycle of the motors and encoder and/or damage them. ■ Never disassemble the motor and encoder. A disassembled motor and encoder will cause a positional gap and cannot be used again.

After parts have been replaced (motor units, reduction gear units, timing belts.), the Manipulator cannot operate properly because a mismatch exists between the origin stored in each motor and its corresponding origin stored in the Robot system.
Because of that, it is necessary to perform calibration (encoder rest and calibration) to match these origins.

After replacing the parts, refer to the following section to perform calibration.
Maintenance 19. Calibration.



13.1 Replacing Joint #5 Motor

	Name	Quantity	Note
Maintenance parts	Joint #5 motor unit	1	2194600
Tools	Hexagonal wrench (width across flats: 3 mm)	1	For M4 hexagon socket head cap bolts
	Torque wrench	1	For tightening torque control
	Nippers	1	For cutting wire tie
	Belt tension meter	1	Refer: Unitta U-505
Material	Wire tie	-	

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the controller power is OFF or the motor is OFF status. The brake does not work during replacement.
Be careful when performing maintenance work.

Joint #5 Motor Removal

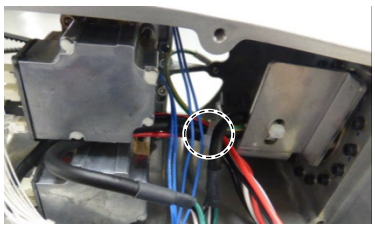
(1) Turn OFF the Manipulator.

(2) Remove the following covers.

Arm #4 Cover 1
Arm #4 Cover 2

Reference: *Maintenance 7. Covers*

(3) Cut off the wire tie that binds the following cables and the ground wire.



Wire tie: AB100

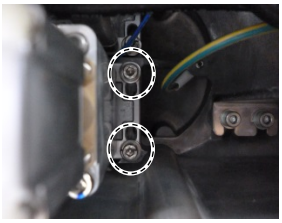
Joint #5 motor cable
Signal cable (for motor)
Joint #6 motor cable
Ground wire

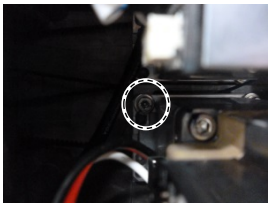
NOTE

Be careful not to cut the harness.

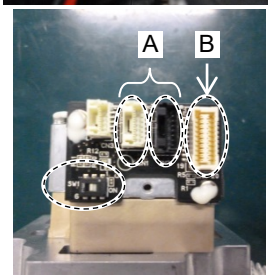
(4) Remove the Joint #5 motor unit.

Hexagon socket head cap bolts: 3-M4×20
(with slotted hole washer)





(5) Disconnect the following connectors of the motor.



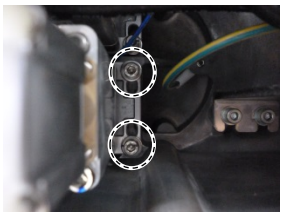
A: Signal cable connectors (for motor × 2)
B: Signal cable connector (for AMP board)

NOTE

The cables will be necessary again.
Be careful not to lose them.

Joint #5 Motor Installation

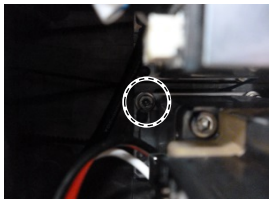
(1) Pass the timing belt through the motor pulley and loosely secure to the Arm #4.



Hexagon socket head cap bolts: 3-M4×20
(with slotted hole washer)

NOTE

Make sure that the gear grooves of the timing belt are fit into those of the pulley completely.
When securing the motor unit loosely, make sure that the motor unit can be moved by hand and it does not tilt when being pulled. If the unit is secured too loose or too tight, the belt will not have proper tension.



NOTE

The direction to install the motor is the direction in which the connector of the motor faces Joint #5 side.



(2) Apply proper tension to the motor unit and fix it.

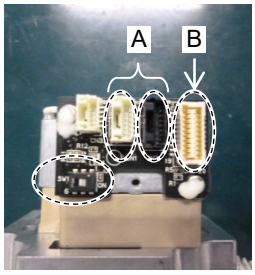
Joint #5 timing belt tension: 23 - 36 N
Belt tension meter setting values
Weight: 2.5g/mm width×m span
Width: 6.0mm
Span: 184mm

Hexagon socket head cap bolts: 3-M4×20 (with slotted hole washer)
Tightening torque: 4.0 ± 0.2 N·m

NOTE

Regarding belt tension:
Jumping (position gap) may occur if the value is below the lower limit.
Vibration (abnormal noise) or reduction in life of the parts may occur if the value exceeds the upper limit.
When you replace with a new belt, belt extends and the belt tension may decrease in the initial stage. Make sure to operate the robot two to three days and check the belt tension again

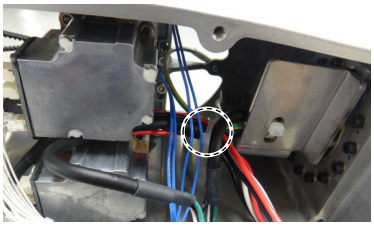
(3) Connect the following connectors of the motor.



A: Signal cable connectors (for motor × 2)
B: Signal cable connector (for AMP board)

Connector for the signal cable connector (for motor) is the same color.

(4) Bind the following cables and the ground wire with the wire tie.



Wire tie: AB100

Motor cable (Joint #5)
Signal cable (Joint #5)
Motor cable (Joint #6)
Ground wire

(5) Mount the following covers.

Arm #4 Cover 1
Arm #4 Cover 2

Reference: *Maintenance 7. Covers*

(6) Turn ON the Manipulator.

Reference: *Setup & Operation 6.5 LED*

NOTE When starting the Manipulator for the first time after replacing the motor unit, the motor unit firmware is automatically updated. DO NOT turn OFF the Manipulator until it starts.

(7) Calibrate the Joint #5 and the Joint #6.

Reference: Maintenance 19. Calibration

13.2 Replacing Joint #5 Reduction Gear Unit

Reduction gear unit is replaced by serviceman.

For replacement of the reduction gear unit, please contact the supplier of your region.

13.3 Replacing Joint #5 Timing Belt

	Name	Quantity	Note
Maintenance parts	Timing Belt	1	1762243
Tools	Hexagonal wrench (width across flats: 3 mm)	1	For M4 hexagon socket head cap bolts
	Torque wrench	1	For tightening torque control
	Cross-point screwdriver (No. 2)	1	For cross-recessed screw
	Nippers	1	For cutting wire tie
	Belt tension meter	1	Refer: Unitta U-505
Material	Wire tie	-	

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the controller power is OFF or the motor is OFF status. The brake does not work during replacement. Be careful when performing maintenance work.

Joint #5 Timing Belt Removal

(1) Remove the Joint #6 timing belt.

Reference: *Maintenance 14.3 Replacing Joint #6 Timing Belt*
Joint #6 Timing Belt Removal

(2) Remove the Joint #5 motor and the Joint #5 timing belt.

Reference: *Maintenance 13.1 Replacing Joint #5 Motor*
Joint #5 Motor Removal step (1) through (4)

Joint #5 Timing Belt Installation

(1) Remove the Joint #5 timing belt and the Joint #5 motor.

Reference: *Maintenance 13.1 Replacing Joint #5 Motor*
Joint #5 Motor Installation step (1) through (5)

(2) Install the Joint #6 timing belt.

Reference: *Maintenance 14.1 Replacing Joint #6 Motor*
Joint #6 Motor Installation step (1) through (5)

(3) Mount the following covers.
Arm #3 Cover
Arm #4 Cover 1
Arm #4 Cover 2

Reference: *Maintenance 7. Covers*

(4) Turn ON the Manipulator.

Reference: *Setup & Operation 6.5 LED*

NOTE When starting the Manipulator for the first time after replacing the motor unit, the motor unit firmware is automatically updated. DO NOT turn OFF the Manipulator until it starts.

(5) Calibrate the Joint #5 and the Joint #6.

Reference: *Maintenance 19. Calibration*

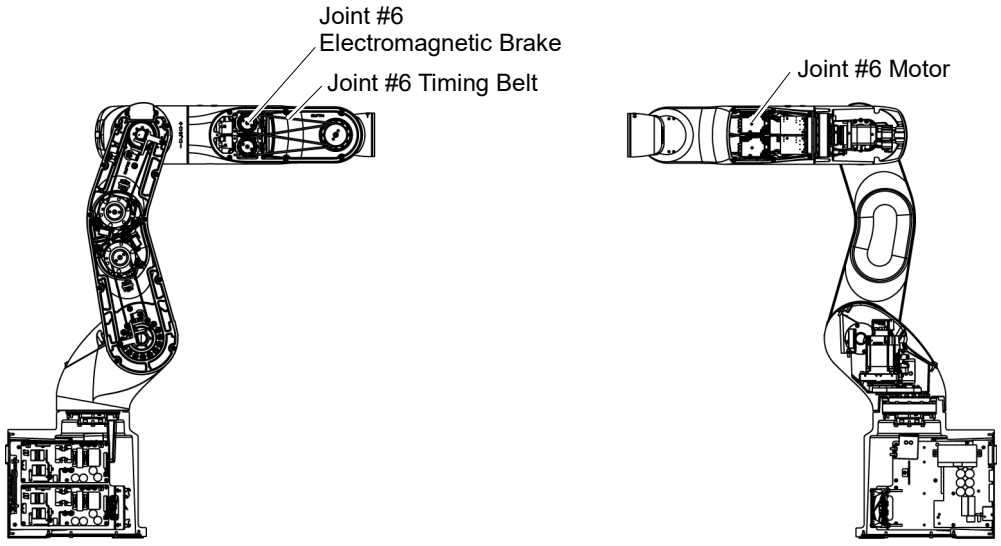
14. Joint #6

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

CAUTION	■ Be careful not to apply excessive shock to the motor shaft when replacing the motors. The shock may shorten the life cycle of the motors and encoder and/or damage them. ■ Never disassemble the motor and encoder. A disassembled motor and encoder will cause a positional gap and cannot be used again.

After parts have been replaced (motor units, reduction gear units, timing belts), the Manipulator cannot operate properly because a mismatch exists between the origin stored in each motor and its corresponding origin stored in the Robot system.
Because of that, it is necessary to perform calibration (encoder rest and calibration) to match these origins.

After replacing the parts, refer to the following section to perform calibration.
Maintenance 19. Calibration.



14.1 Replacing Joint #6 Motor

	Name		Quantity	Note
Maintenance parts	Joint #6 motor unit		1	2194601
Tools	Hexagonal wrench	width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
	Torque wrench		1	For tightening torque control
	Nippers		1	For cutting wire tie
	Belt tension meter		1	Refer: Unitta U-505
Material	Wire tie		-	

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the controller power is OFF or the motor is OFF status. The brake does not work during replacement.
Be careful when performing maintenance work.

Joint #6 Motor Removal

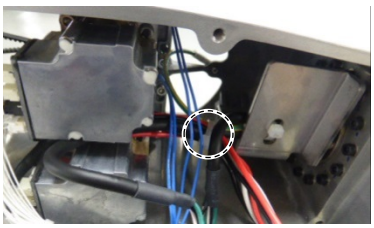
(1) Turn OFF the Manipulator.

(2) Remove the following covers.

Arm #4 Cover 1
Arm #4 Cover 2

Reference: *Maintenance 7. Covers*

(3) Cut off the wire tie that binds the following cables and the ground wire.



Wire tie: AB100

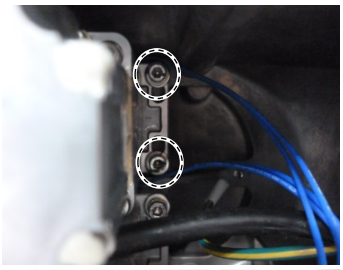
Joint #5 motor cable
Signal cable (for motor)
Joint #6 motor cable
Ground wire

NOTE

Be careful not to cut the harness.

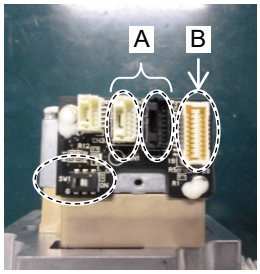
(4) Remove the Joint #6 motor unit.

Hexagon socket head cap bolts: 3-M4×20
(with slotted hole washer)





(5) Disconnect the following connectors of the motor.



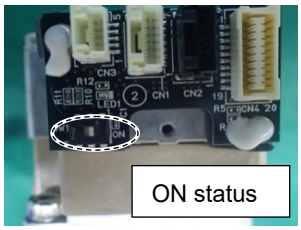
A: Signal cable connectors (for motor × 2)
B: Signal cable connector (for AMP board)

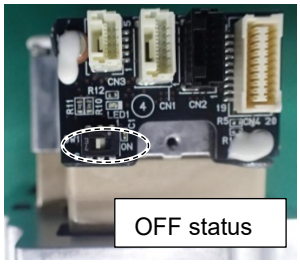
NOTE

The cables will be necessary again.
Be careful not to lose them.

Joint #6 Motor Installation

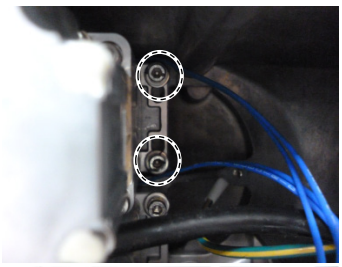
(1) Confirm that the terminating resistor switch of the Joint #6 motor is turned ON.
When the switch is OFF, push the tab to turn it ON.





(2) Pass the timing belt through the motor pulley and loosely secure to the Arm #4

Hexagon socket head cap bolts: 3-M4×20
(with slotted hole washer)



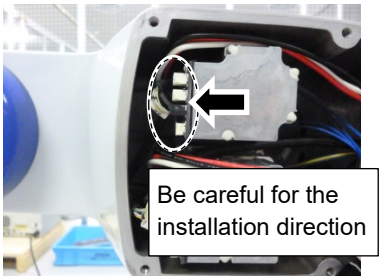
NOTE

Make sure that the gear grooves of the timing belt are fit into those of the pulley completely.
When securing the motor unit loosely, make sure that the motor unit can be moved by hand and it does not tilt when being pulled. If the unit is secured too loose or too tight, the belt will not have proper tension.



NOTE

The direction to install the motor is the direction in which the connector of the motor faces Joint #5 side



(3) Apply proper tension to the motor unit and fix it.

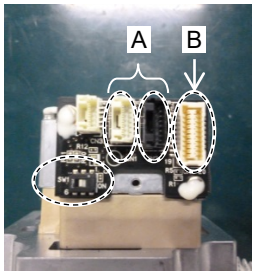
Joint #5 timing belt tension: 23 - 36N
Belt tension meter setting values
Weight: 2.5g/mm width×m span
Width: 6.0mm
Span: 184mm

Hexagon socket head cap bolts: 3-M4×20 (with slotted hole washer)
Tightening torque: 4.0 ± 0.2 N·m

NOTE

Regarding belt tension:
Jumping (position gap) may occur if the value is below the lower limit.
Vibration (abnormal noise) or reduction in life of the parts may occur if the value exceeds the upper limit.
When you replace with a new belt, belt extends and the belt tension may decrease in the initial stage. Make sure to operate the robot two to three days and check the belt tension again

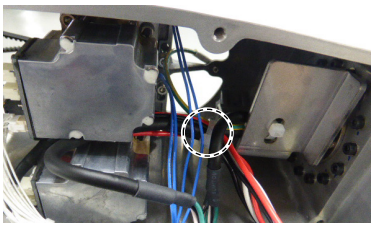
(4) Connect the following connectors of the motor.



A: Signal cable connectors (for motor × 2)
B: Signal cable connector (for AMP board)

Connector for the signal cable connector (for motor) is the same color.

(5) Bind the following cables and the ground wire with the wire tie.



Wire tie: AB100

Motor cable (Joint #5)
Signal cable (Joint #5)
Motor cable (Joint #6)
Ground wire

(6) Mount the following covers.

Arm #4 Cover 1
Arm #4 Cover 2

Reference: *Maintenance 7. Covers*

(7) Turn ON the Manipulator.

Reference: *Setup & Operation 6.5 LED*

NOTE

When starting the Manipulator for the first time after replacing the motor unit, the motor unit firmware is automatically updated. DO NOT turn OFF the Manipulator until it starts.

(8) Calibrate the Joint #6.

Reference: *Maintenance 19. Calibration*

14.2 Replacing Joint #6 Reduction Gear Unit

Reduction gear unit is replaced by serviceman.

For replacement of the reduction gear unit, please contact the supplier of your region.

14.3 Replacing Joint #6 Timing Belt

	Name	Quantity	Note
Maintenance parts	Timing Belt	1	1762243
Tools	Hexagonal wrench (width across flats: 3 mm)	1	For M4 hexagon socket head cap bolts
	Torque wrench	1	For tightening torque control
	Cross-point screwdriver (No. 2)	1	For cross-recessed screw
	Nippers	1	For cutting wire tie
	Belt tension meter	1	Refer: Unitta U-505
Material	Wire tie	-	

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the controller power is OFF or the motor is OFF status. The brake does not work during replacement. Be careful when performing maintenance work.

Joint #6 Timing Belt Removal

(1) Remove the Joint #6 motor and the Joint #6 timing belt.

Reference: *Maintenance 14.1 Replacing Joint #6 Motor*
Joint #6 Motor Removal step (1) through (4)

Joint #6 Timing Belt Installation

(1) Install the Joint #6 timing belt and the Joint # motor.

Reference: *Maintenance 14.1 Replacing Joint #6 Motor*
Joint #6 Motor Installation step (1) through (5)

(2) Mount the following covers.

Arm #3 Cover
Arm #4 Cover 1
Arm #4 Cover 2

Reference: *Maintenance 7. Covers*

(3) Turn ON the Manipulator.

Reference: *Setup & Operation 6.5 LED*

NOTE

When starting the Manipulator for the first time after replacing the motor unit, the motor unit firmware is automatically updated. DO NOT turn OFF the Manipulator until it starts.

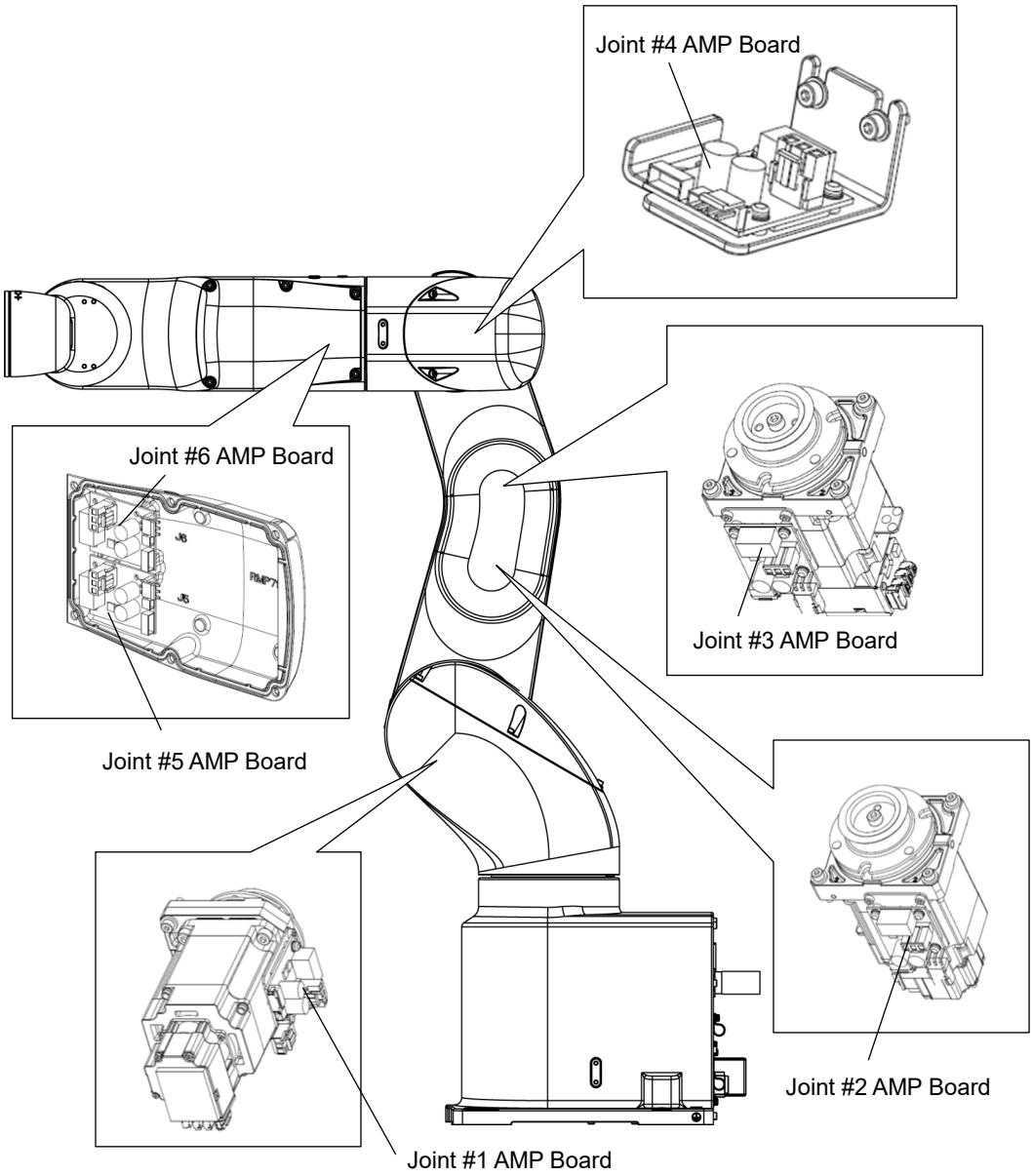
(4) Calibrate the Joint #5 and the Joint #6.

Reference: *Maintenance 19. Calibration*

15. AMP Board

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

 CAUTION	■ Be careful not to apply excessive shock to the motor shaft when replacing the motors. The shock may shorten the life cycle of the motors and encoder and/or damage them. ■ Never disassemble the motor and encoder. A disassembled motor and encoder will cause a positional gap and cannot be used again.


Joint #4 AMP Board
Joint #6 AMP Board
J6
J5
Joint #5 AMP Board
Joint #3 AMP Board
Joint #2 AMP Board
Joint #1 AMP Board

15.1 Replacing AMP Board on Joint #1, #2, and #3

	Name		Quantity	Note
Maintenance parts	AMP Board		1	2189027
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
	Torque wrench		1	For tightening torque control
	Cross-point screwdriver (No. 2)		1	For cross-recessed screw
	Nippers		1	For cutting wire tie
	Belt tension meter		1	Refer: Unitta U-505
Material	Wire tie		-	

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. The brake does not work during replacement. Be careful when performing maintenance work.

AMP Board Removal

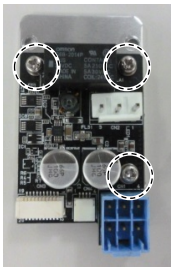
(1) Turn OFF the Manipulator.

(2) Remove the plate (with AMP board) from the motor unit.

Reference: *Maintenance 9.1 Joint #1 Motor Removal*
Maintenance 10.1 Joint #2 Motor Removal
Maintenance 11.1 Joint #3 Motor Removal

(3) Remove the AMP board from the plate.

Cross-recessed screws with a washer: 3-M3×6



NOTE

If the thermal conductive sheet is attached on the rear side of the AMP board, remove it. The thermal conductive sheet will be necessary again. Be careful not to lose it.

AMP Board Installation

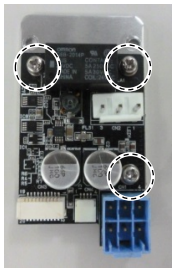
(1) If the thermal conductive sheet is removed in the Removal step (3), attach the sheet on the plate.



NOTE

Attach the thermal conductive sheet in the direction that the longer sides of the thermal conductive sheet and the plate are parallel. As shown in the picture, the attachment position is inside the range surrounded by three spacers of the AMP board fixing part.

(2) Mount the AMP board on the plate.



Cross-recessed screws with a washer: 3-M3×6
Tightening torque: 0.45 ± 0.1 N·m

(3) Fix the plate (with AMP board) to the motor unit and mount the motor unit.

Reference: *Maintenance 9.1 Joint #1 Motor Installation*
Maintenance 10.1 Joint #2 Motor Installation
Maintenance 11.1 Joint #3 Motor Installation

15.2 Replacing AMP Board on Joint #4

	Name		Quantity	Note
Maintenance parts	AMP Board		1	2189027
Tools	Hexagonal wrench	width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
	Torque wrench		1	For tightening torque control
	Cross-point screwdriver (No. 2)		1	For cross-recessed screw
	Nippers		1	For cutting wire tie
Material	Wire tie		-	

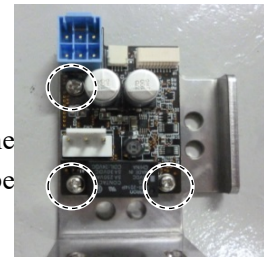
AMP Board Removal

(1) Turn OFF the Manipulator.

(2) Remove the plate (with AMP board) from the Arm #3.

Reference: *Maintenance 12.1 Joint #4 Motor Removal*

(3) Remove the AMP board from the plate.



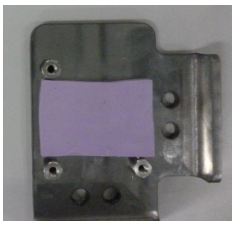
Cross-recessed screws with a washer: 3-M3×6

NOTE

If the thermal conductive sheet is attached on the rear side of the AMP board, remove it. The thermal conductive sheet will be necessary again. Be careful not to lose it.

AMP Board Installation

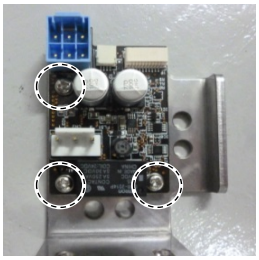
(1) If the thermal conductive sheet is removed in the Removal step (3), attach the sheet on the plate..



NOTE

Attach the thermal conductive sheet in the direction that the longer sides of the thermal conductive sheet and plate are vertical. As shown in the picture, the attachment position is inside the range surrounded by three spacers of the AMP board fixing part.

(2) Mount the AMP board on the plate.



Cross-recessed screws with a washer: 3-M3×6
Tightening torque: 0.45 ± 0.1 N·m

(3) Mount the plate (with AMP board) on the Arm #3.

Reference: *Maintenance 12.1 Joint #4 Motor Installation*

15.3 Replacing AMP Board on Joint #5 and #6

	Name		Quantity	Note
Maintenance parts	AMP Board		1	2189027
Tools	Hexagonal wrench	width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
	Torque wrench		1	For tightening torque control
	Cross-point screwdriver (No. 2)		1	For cross-recessed screw

AMP Board Removal

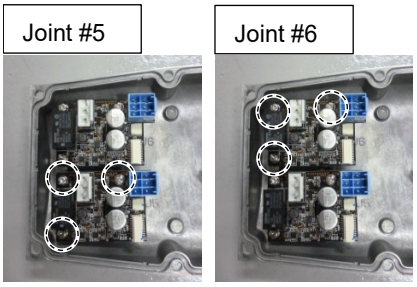
(1) Turn OFF the Manipulator.

(2) Remove the Arm #4 Cover 2.

Reference: *Maintenance 7.5 Arm #4 Cover 2*

(3) Remove the AMP board from the Arm #4 Cover 2.

Cross-recessed screws with a washer: 3-M3×6



AMP Board Installation

(1) Fix the AMP board on the Arm #4 Cover 2.

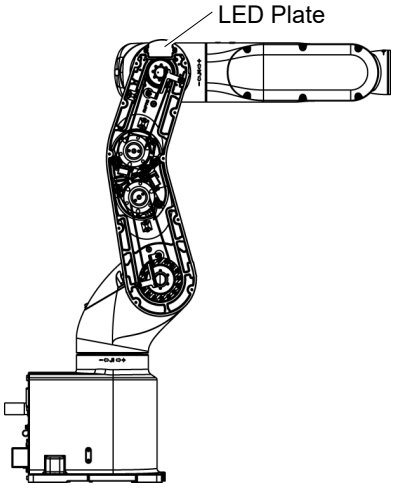
Cross-recessed screws with a washer: 3-M3×6
Tightening torque: 0.45 ± 0.1 N·m

(2) Mount the Arm #4 Cover 2.

Reference: *Maintenance 7.5 Arm #4 Cover 2*

16. LED Plate

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



16.1 Replacing LED Plate

	Name		Quantity	Note
Maintenance parts	LED Plate		1	1749496
Tools	Hexagonal wrench	width across flats: 2.5 mm	1	For M3 hexagon socket head cap bolts
		width across flats: 3 mm	1	For M4 hexagon socket head cap bolts
	Torque wrench		1	For tightening torque control
	Cross-point screwdriver (No. 2)		1	For cross-recessed screw
	Nippers		1	For cutting wire tie
	Belt tension meter		1	Refer: Unitta U-505
Material	Wire tie		-	

LED Plate Removal

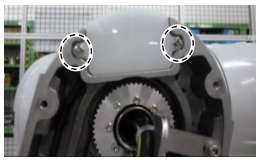
(1) Turn OFF the Manipulator.

(2) Remove the Arm #2 Cover.

Reference: *Maintenance 7.2 Arm #2 Cover*

(3) Remove the LED plate.

Cross-recessed screws: 2-M3×10



(4) Only for Protection model:

Remove the LED gasket.

LED Plate Installation

(1) Only for Protection model:

Mount the LED gasket in the groove of the Arm #2.

(2) Install the LED plate.

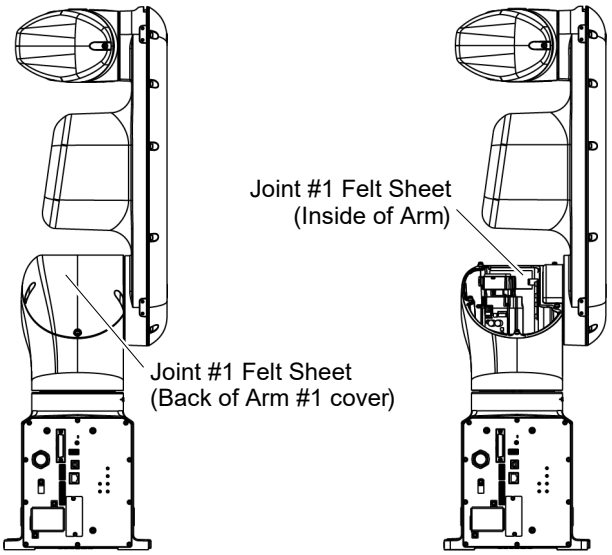
Cross-recessed screws: 2-M3×10
Tightening torque: 0.45 ± 0.1 N·m

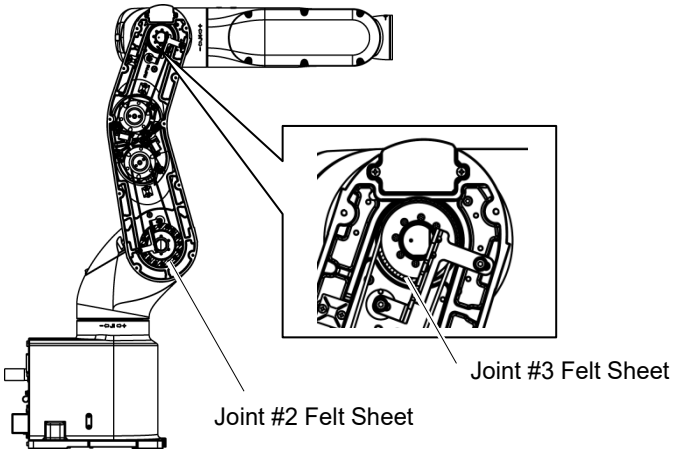
(3) Mount the Arm #2 Cover.

Reference: *Maintenance 7.2 Arm #2 Cover*

17. Felt Sheet

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





17.1 Replacing Joint #1 Felt Sheet

	Name	Quantity	Note
Maintenance part	Felt Sheet	2	1840429

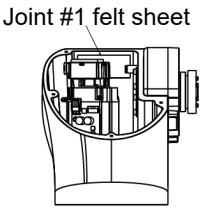
Joint #1 Felt Sheet Removal

(1) Turn OFF the Manipulator.

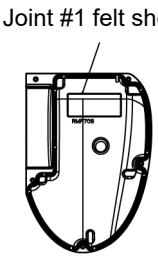
(2) Remove the Arm #1 Cover.

Reference: *Maintenance 7.1 Arm #1 Cover*

(3) Remove Joint #1 felt sheet from the Arm #1.



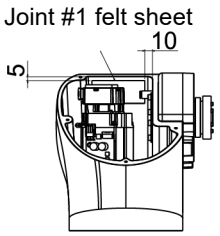
(4) Remove Joint #1 felt sheet from the Arm #1 Cover.



Joint #1 Felt Sheet Installation

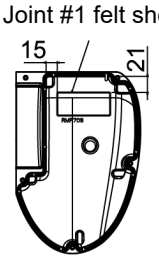
(1) Attach the felt sheet on the Arm #1.

One side of the felt sheet is a seal. See the position specified in the figure and attach the felt sheet on Arm #1.



(2) Attach the felt sheet on Arm #1 Cover.

One side of the felt sheet is a seal. See the position specified in the figure and attach the felt sheet on Arm #1 Cover.



(3) Mount the Arm #1 Cover.

Reference: *Maintenance 7.1 Arm #1 Cover*

17.2 Replacing Joint #2 Felt Sheet

	Name	Quantity	Note
Maintenance part	Felt Sheet	1	1755083

Joint #2 Felt Sheet Removal

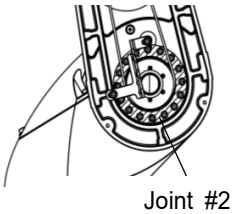
(1) Turn OFF the Manipulator.

(2) Remove the Arm #2 Cover.

Reference: *Maintenance 7.2 Arm #2 Cover*

(3) Remove Joint #2 felt sheet from the Arm #2.

Hold a slit on the one side of felt sheet to remove the sheet from the outside of the Joint #2.



Joint #2 Felt Sheet Installation

(1) Hold a slit on the one side of felt sheet to remove the sheet from the outside of the Joint #2.

One side of the felt sheet is a seal. Attach the felt sheet at the position where the Joint 2 screw holes and the holes of the Joint #2 felt sheet matches.

(2) Mount the Arm #2 Cover.

Reference: *Maintenance 7.2 Arm #2 Cover*

17.3 Replacing Joint #3 Felt Sheet

	Name	Quantity	Note
Maintenance parts	Felt Sheet	1	1755084

Joint #3 Felt Sheet Removal

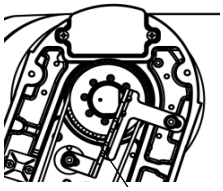
(1) Turn OFF the Manipulator.

(2) Remove the Arm #2 Cover.

Reference: *Maintenance 7.2 Arm #2 Cover*

(3) Remove Joint #3 felt sheet from the Arm #2.

Hold a slit on the one side of felt sheet to remove the sheet from the outside of the Joint #3.



Joint #3
Felt Sheet

Joint #3 Felt Sheet Installation

(1) Hold a slit on the one side of the Joint #3 felt sheet to remove the sheet from the outside of the Joint #3.

One side of the felt sheet is a seal. Attach the felt sheet so that it fits in the groove of the Joint #3 of Arm #2.

(2) Mount the Arm #2 Cover.

Reference: *Maintenance 7.2 Arm #2 Cover*

18. Controller Unit

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

WARNING	■ Take meticulous care when handling the lithium battery. Improper handling of the lithium battery as mentioned below is extremely hazardous and may result in heat generation, leakage, explosion, or inflammation. It also may cause serious safety problems. <Improper Handling> Attempting to charge Disassembling Connecting batteries improperly Exposing to fire Forcing discharge Deforming by pressure Short-circuit (Polarity; Positive/Negative) Heating (85 °C or more) Soldering the terminal of the lithium battery directly ■ When disposing the battery, consult with the professional disposal services or comply with the local regulation. Make sure that the battery terminal is insulated, even for a used buttery. If the terminal contacts with the other metals, it may short and result in heat generation, leakage, explosion, or inflammation.

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

NOTE

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

Reference: *Maintenance 4. Alarm*

The battery may run out if it passes the recommended replacement time.
If no warnings of voltage reduction occur, the calibration for all joints is not necessary. You need to perform calibration if the position moves from the originals after replaced the battery.
Be sure to use the designated parts for the lithium battery.

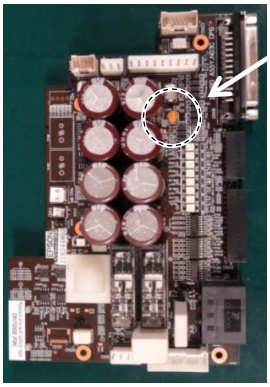
Reference: *Maintenance 22. Maintenance Parts List*

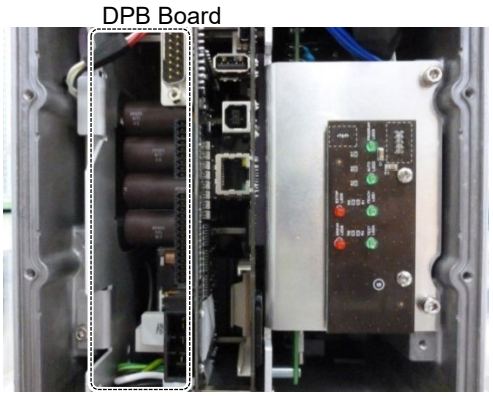
Be careful of the battery polarity to connect it correctly.

18.1 Replacing Controller Unit

WARNING

■ Make sure that orange colored charge confirmation LED on the DPB turns off when ejecting the Controller Unit. If operating without tuning off the LED, electric shock or other serious problems for safety may occur.





	Name		Quantity	Note
Maintenance parts	Controller Unit	AC specification	1	Standard, Cleanroom model: 2194603 Protection model: 2208039
		DC specification	1	2207771 (Standard model only)
Tools	Hexagonal wrench (width across flats: 3 mm)		1	For M4 hexagon socket head cap bolts
	Torque wrench		1	For tightening torque control
	Cross-point screwdriver (No. 2)		1	

The brake is mounted on each joint to prevent the arm from lowering due to its own weight while the Controller power is OFF or the motor is OFF status. The brake does not work during replacement.
Be careful when performing maintenance work.

18.1.1 Standard, Cleanroom Model

Controller Unit Removal

(1) Turn OFF the Manipulator.

(2) Remove the connector plate.

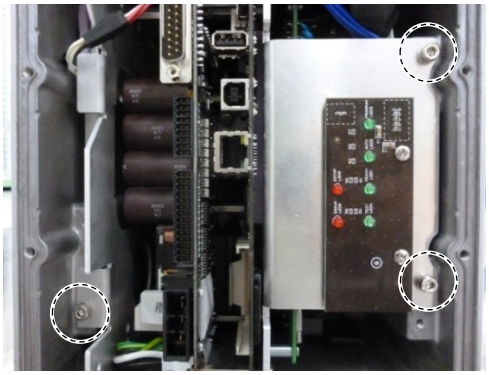
Reference: *Maintenance 7.7 Connector Plate*

Standard Cleanroom

(3) Disconnect the TP connector which is connected (inside) the connector plate.

(4) Unscrew the mounting screws of the Controller Unit.

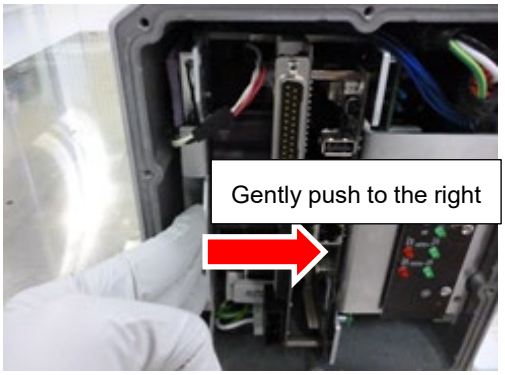
Hexagon socket head cap bolts:
3-M4×10 (with a plain washer)

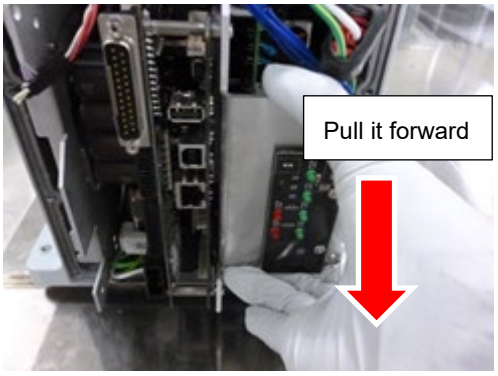


(5) Pull out the Controller Unit from the Manipulator base.

NOTE

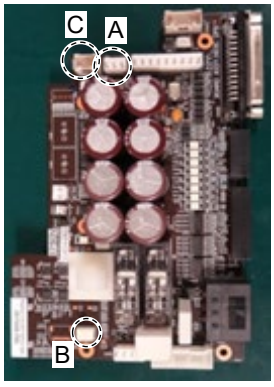
When pulling it out,
firstly push the plate of the Controller Unit to the right (see the picture) gently, then remove the thermal conductive sheet on the base and the Controller Unit.
Next, pull the Controller Unit forward.

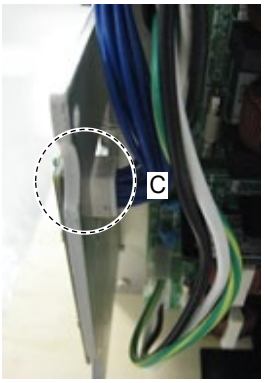




(6) Disconnect the following connectors of the Controller Unit.

A: Power cable connector
B: Signal cable connector
C: LED connectors × 2



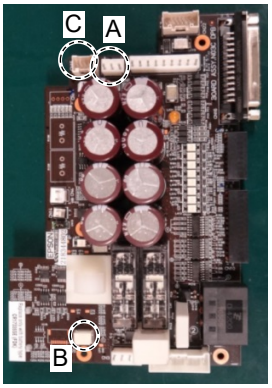


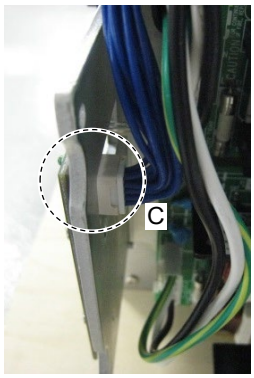
Controller Unit Installation

Standard Cleanroom

(1) Connect the following connectors to the Controller Unit.

A: Power cable connector
B: Signal cable connector
C: LED connectors × 2



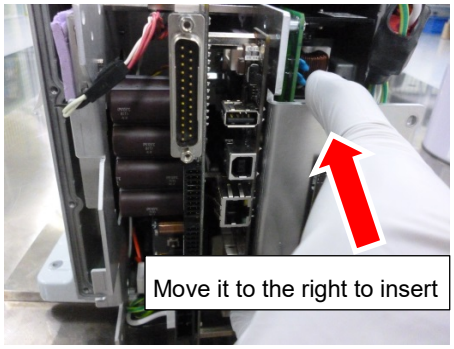


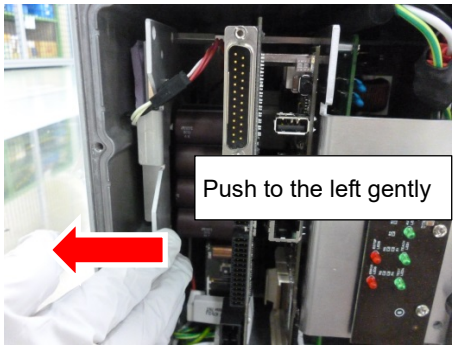
(2) Push the Controller Unit into the base.

NOTE

Insert the Controller Unit while moving it to the right (see the picture).

Then, gently move the plate of the Controller Unit to the left and let the thermal conductive sheet contacts with the wall inside the base.





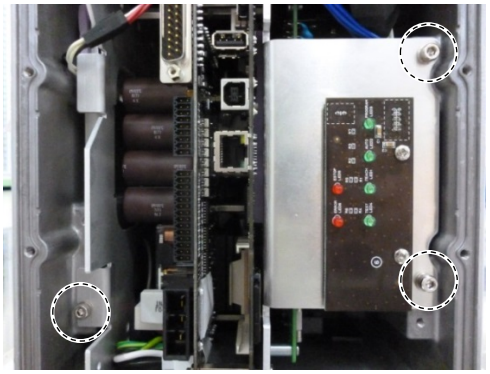
NOTE

Push the Controller Unit while fixing the cables from the Joint #1 motor at the base opening. Be careful not to push the cables to the back of the base.



(3) Fix the Controller Unit to the base.

Hexagon socket head cap bolts: 3-M4×10 (with a plain washer)
Tightening torque: 4.0 ± 0.2 N·m



(4) Connect the TP connector inside the connector plate.

(5) Mount the connector plate.

Reference: *Maintenance 7.7 Connector Plate*

18.1.2 Protection Model

Controller Unit Removal Protection

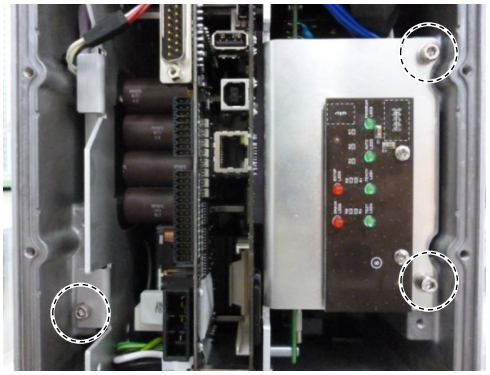
(1) Turn OFF the Manipulator.

(2) Remove the connector plate.

Reference: *Maintenance 7.7 Connector Plate*

(3) Unscrew the mounting screws of the Controller Unit.

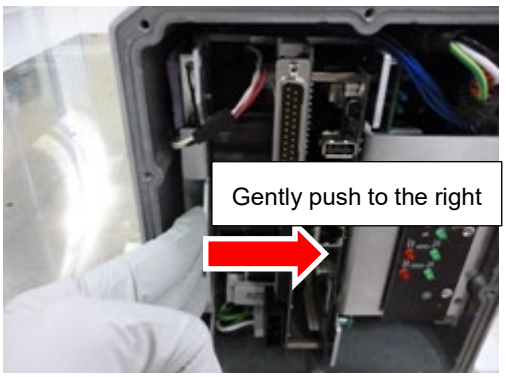
Hexagon socket head cap bolts:
3-M4×10 (with a plain washer)

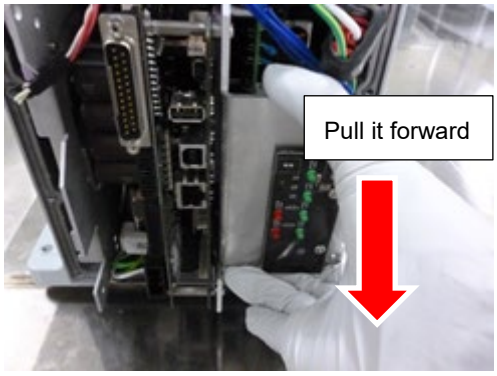


(4) Pull out the Controller Unit from the Manipulator base.

NOTE

When pulling it out,
firstly push the plate of the Controller Unit to the right (see the picture) gently, then remove the thermal conductive sheet on the base and the Controller Unit.
Next, pull the Controller Unit forward.





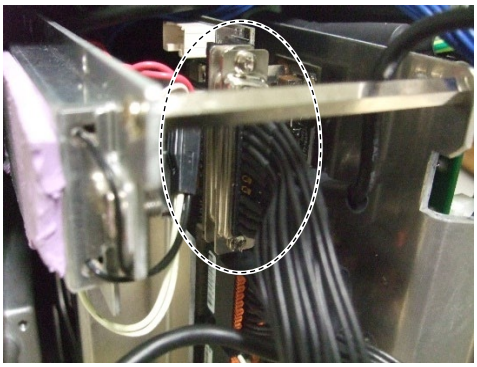
(5) Disconnect the TP connector which is connected (inside) the connector plate.



(6) Disconnect the following connectors.
USB type A connector
USB type B connector
LAN connector



(7) Disconnect the EMERGENCY connector.



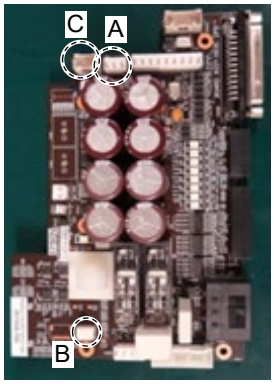
(8) Disconnect the two I/O connectors.

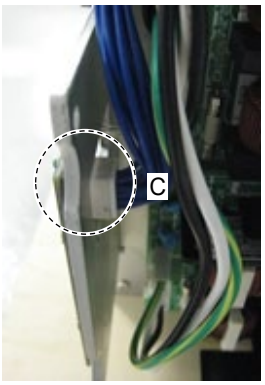
(9) Disconnect the power connector.



(10) Disconnect the following connectors of the Controller Unit.

A: Power cable connector
B: Signal cable connector
C: LED connectors × 2





D: USB type A connector
E: USB type B connector
F: LAN connector



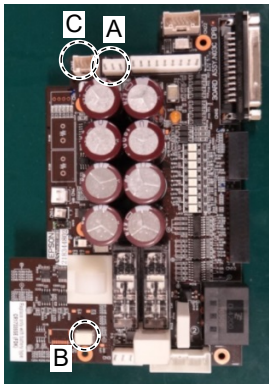
Controller Unit Installation

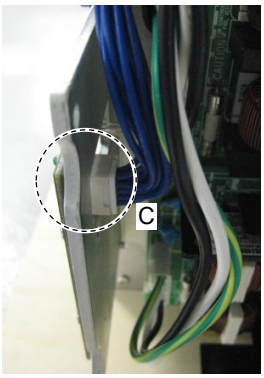
Protection

(1) Mount the base rear gasket in the groove on the back of the base.

(2) Connect the following connectors to the Controller Unit.

A: Power cable connector
B: Signal cable connector
C: LED connectors × 2
G: TP connector



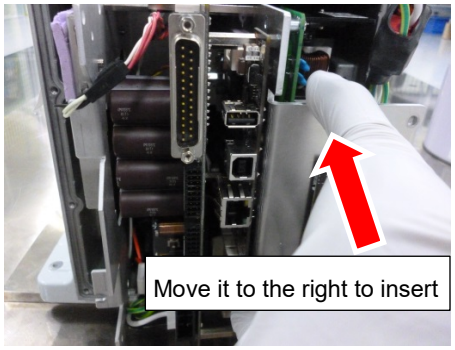


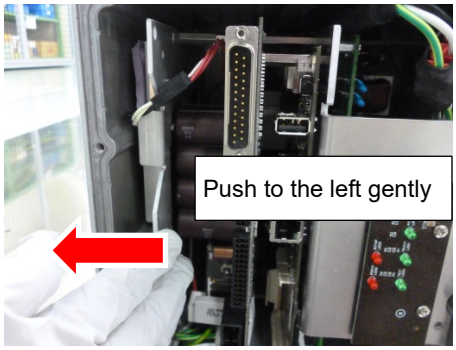
(3) Push the Controller Unit into the base.

NOTE

Insert the Controller Unit while moving it to the right (see the picture).

Then, gently move the plate of the Controller Unit to the left and let the thermal conductive sheet contacts with the wall inside the base.





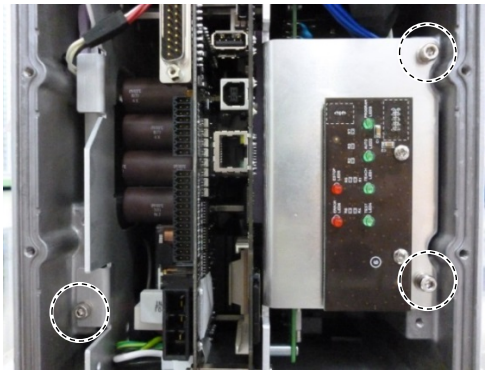
NOTE

Push the Controller Unit while fixing the cables from the Joint #1 motor at the base opening. Be careful not to push the cables to the back of the base.



(4) Fix the Controller Unit to the base.

Hexagon socket head cap bolts: 3-M4×10 (with a plain washer)
Tightening torque: 4.0 ± 0.2 N·m

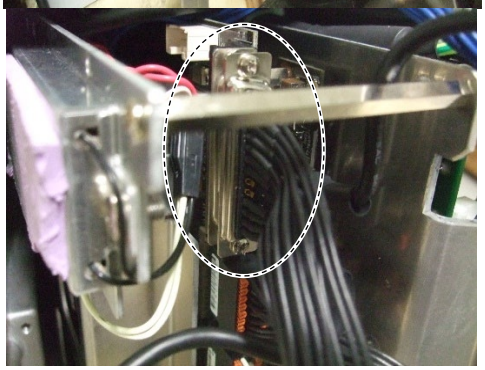


(5) Connect the power connector on the Controller Unit.

(6) Connect I/O connector on the Controller Unit.



(7) Connect EMERGENCY connector on the Controller Unit.



(8) Connect the following connectors on the Controller Unit.

D: USB (type A) connector
E: USB (type B) connector
F: LAN connector



(9) Mount the connector plate.

Reference: *Maintenance 7.7 Connector Plate*

18.2 Replacing Power Board

CAUTION	■ Heat sink has sharp part. Be sure to wear protective gloves when removing the power board or disconnecting cables.

	Name		Quantity	Note
Maintenance parts	Power Board	AC specification	2	2188638
		DC specifications	1	2207410
Tools	Cross-point screwdriver (No. 2)		1	

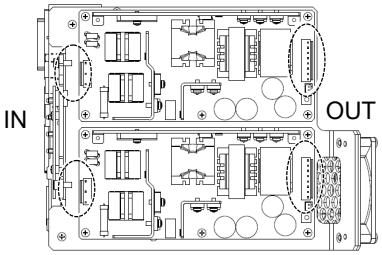
Power Board Removal

(1) Remove the Controller Unit.

Reference: *Maintenance 18.1 Replacing Controller Unit*

(2) Disconnect the connectors of the power board.

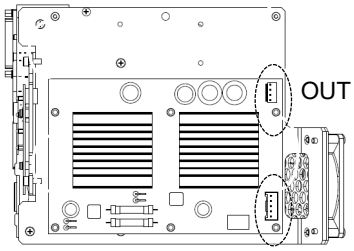
Power connectors
AC specification: (IN/OUT ×2 for each)
DC specification : (IN/OUT ×1)



AC specification

(3) Remove the power board.

Pan head screws:
AC specification: 10-M3×8 Sems
DC specification: 6-M3×8 Sems



DC specification

Power Board Installation

(1) Mount a new power board.

Pan head screws:
AC specification: 10-M3×8 Sems
DC specification: 6-M3×8 Sems

Tightening torque: 0.45 ± 0.1N·m

(2) Connect the connectors of the power board.

Power connectors:
AC specification: (IN/OUT ×2 for each)
DC specification: (IN/OUT ×1 for each)

(3) Mount the Controller Unit.

Reference: *Maintenance 18.1 Replacing Controller Unit*

18.3 Replacing CPU/DPB Board

	Name		Quantity	Note
Maintenance parts	CPU/DPB Board	AC specification	1	2193553
		DC specification	1	2207409
Tools	Cross-point screwdriver (No. 2)		1	

CPU/DPB Board Removal

(1) Remove the power board.

Reference: *Maintenance 18.2 Replacing Power Board*

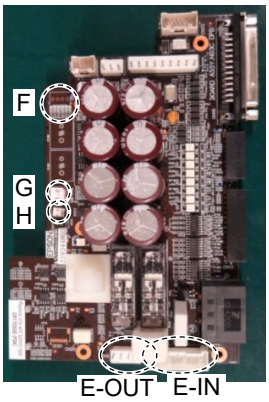
(2) Disconnect the CPU/DPB board connectors.

E: Power connector (IN/OUT ×1 for each)
F: Cooling fan connector
G: Regenerative resistor connector 1
H: Regenerative resistor connector 2

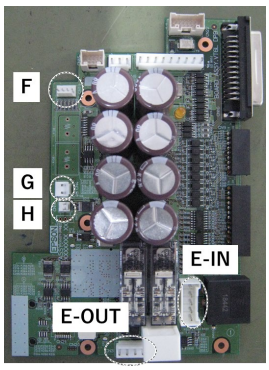
NOTE

Remember the cable layout for reconnecting after replacement.

AC specification



DC specification

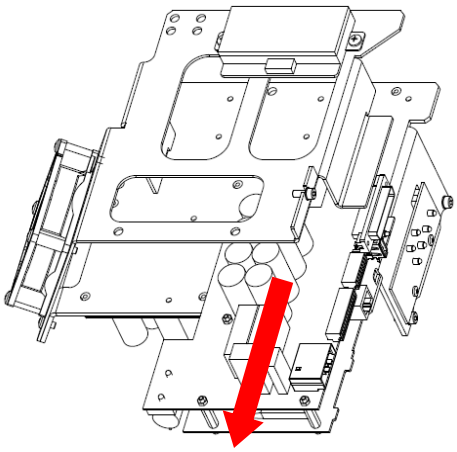


(3) Remove the CPU/DPB board.

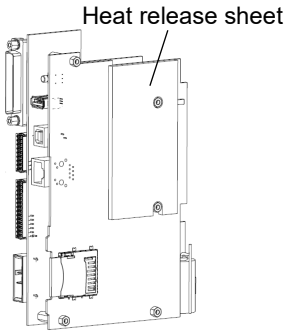
Binding head screws: 5-M3×6

NOTE

Firstly, unscrew the mounting screws. Next, pull the CPU/DPB board to the arrow direction.



(4) Remove the heat release sheet attached on the CPU board.



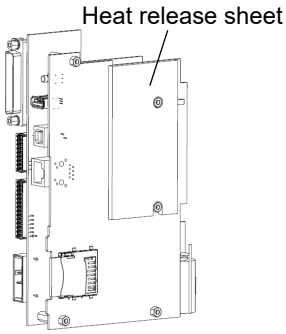
NOTE

The heat release sheet will be necessary again.
Be careful not to lose them.

Be careful not to break the heat release sheet.

CPU/DPB Board Installation

(1) Attach the heat release sheet on the surface (the side with no connectors) of the new CPU/DPB board.



NOTE

Make sure not to attach the sheet on the wrong surface.

(2) Mount the CPU/DPB board and fix it by the mounting screws.

Binding head screws: 5-M3×6
Tightening torque: 0.45 ± 0.1N·m

NOTE

Mounting position of CPU/DPB board differs between Standard, Cleanroom model and Protection model.

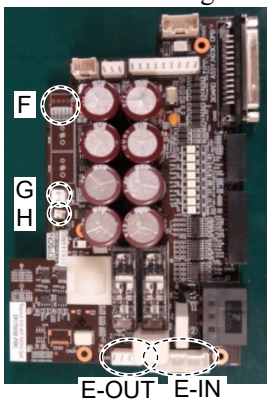
(3) Connect the CPU/DPB board connectors.

E: Power connector (IN/OUT ×1 for each)
F: Cooling fan connector
G: Regenerative resistor connector 1
H: Regenerative resistor connector 2

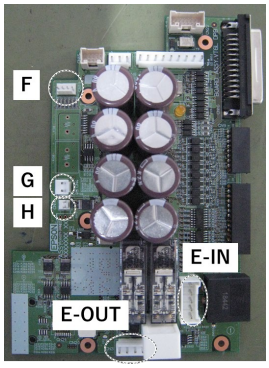
NOTE

Be careful not to connect the wrong connectors or forget to connect it.

AC specification



DC specification



(4) Mount the power board.

Reference: *Maintenance 18.2 Replacing Power Board*

18.4 Replacing Lithium Battery

	Name	Quantity	Note
Maintenance parts	Lithium Battery	1	2113554 (R13B060003)

NOTE
Replace the battery within 30 minutes after turning OFF.
If more than 30 minutes pass after removing the battery, voltage of the capacitor lower and time may be reset.

Lithium Battery Removal

(1) Remove the CPU/DPB board from the base.

Reference: *Maintenance 18.3 Replacing CPU/DPB Board*

(2) Remove the battery from the battery connector.



Lithium Battery Installation

(1) Connect a new battery to the battery connector.

(2) Mount the CPU/DPB board to the base.

Reference: *Maintenance 18.3 Replacing CPU/DPB Board*

18.5 Replacing Cooling Fan

	Name	Quantity	Note
Maintenance parts	Cooling Fan	1	2191301
Tools	Cross-point screwdriver (No. 2)	1	

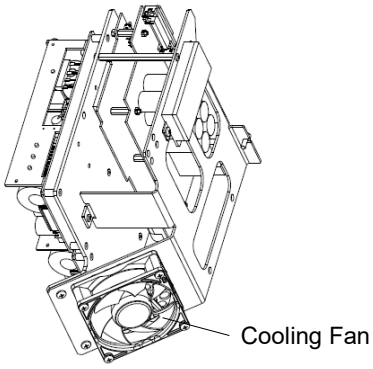
Cooling Fan Removal

(1) Remove the Controller Unit.

Reference: *Maintenance 18.1 Replacing Controller Unit*

(2) Remove the cooling fan.

Binding head screws: 4-M4×30



Cooling Fan Installation

(1) Mount a new cooling fan.

Binding head screws: 4-M4×30
Tightening torque: 0.45 ± 0.1N·m

(2) Mount the Controller Unit.

Reference: *Maintenance 18.1 Replacing Controller Unit*

18.6 Replacing SD Card

	Name	Quantity	Note
Maintenance parts	SD Card	1	2182748
Tools	Cross-point screwdriver (No. 2)	1	

NOTE

Remove the SD card after removing the fieldbus I/O module if fieldbus I/O module is inserted to the optional slot. Also, install fieldbus I/O module after installing the SD card.

For more details about fieldbus I/O module, refer to the following.

Setup & Operation 17: Fieldbus I/O.

18.6.1 Standard, Cleanroom Model

SD Card Removal

Standard, Cleanroom

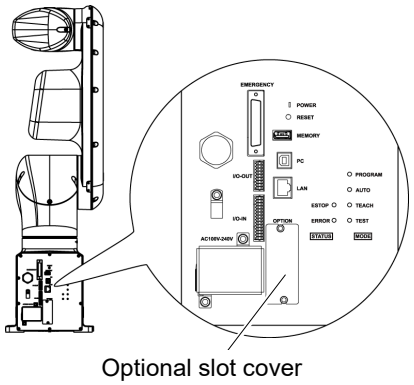
(1) Turn OFF the Manipulator.

(2) Remove the power plug.

(3) Remove the optional slot cover.

Pan head screws: 2-M3×6 Sems

(4) Push the SD card which is inserted near the optional slot to eject.



Optional slot cover

SD Card Installation

Standard, Cleanroom

(1) Push the SD card and inset to the SD card slot near the optional slot.

(2) Mount the optional slot cover.

Pan head screws: 2-M3×6 Sems
Tightening torque: 0.45 ± 0.1 N·m

18.6.2 Protection Model

SD Card Removal

Protection

(1) Turn OFF the Manipulator.

(2) Remove the power plug.

(3) Remove the connector plate.

Reference: *Maintenance 7.7 Connector Plate*

(4) Push the SD card which is inserted near the optional slot to eject.

SD Card Installation

Protection

(1) Push the SD card and inset to the SD card slot near the optional slot.

(2) Mount the connector plate.

Reference: *Maintenance 7.7 Connector Plates*

19. Calibration

19.1 Overview

After parts have been replaced (motors, reduction gear units, timing belts, etc.), the Manipulator cannot perform positioning properly because a gap exists between the origin stored in each motor encoder and its corresponding origin stored in the Controller.
Therefore, it is necessary to match these origins after replacing the parts.
The process of aligning the two origins is called “Calibration”. Note that calibration is not the same as teaching*.

* “Teaching” means to teach the Controller coordinate points (including poses) anywhere in the operating area of the Manipulator.

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

In EPSON RC+, a coordinate point including the arm pose is defined as “point” and its data is called “point data”.

There are two methods to move the Manipulator during calibration.
- Releasing the electromagnetic brake and moving the arms manually.
  For details, refer to the *Setup & Operation 1.5 How to Move Arms with the Electromagnetic Brake*.
- Moving the Manipulator using Jog & Teach.

Moving the Manipulator while releasing the electromagnetic brake involves risk as described below.
It is recommended to move the Manipulator using Jog & Teach.

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.

Also, pay attention to the following points at the encoder initialization.

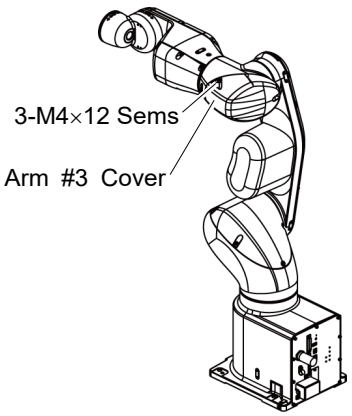
CAUTION	■ Joint #4 have no mechanical stops and they may be rotated more than 360 degrees. If the encoder initialization is performed with improper posture, the Manipulator moves outside the operation range. If the Manipulator was moved outside the operation range, the internal wiring may be damaged by being twisted or pinched and it may result in Manipulator malfunction.

When the origin position of the Joint #4 is uncertain, check torsion of the internal cables. The origin position is where the Manipulator has the internal cables not twisted at the basic orientation described in *Setup & Operation 3.9 Checking the Basic orientation*.

NOTE

Torsion of the internal cables can be checked by removing the following cover.

Joint #4 : Arm #3 Cover



For details on Jog & Teach, refer to the following manual.

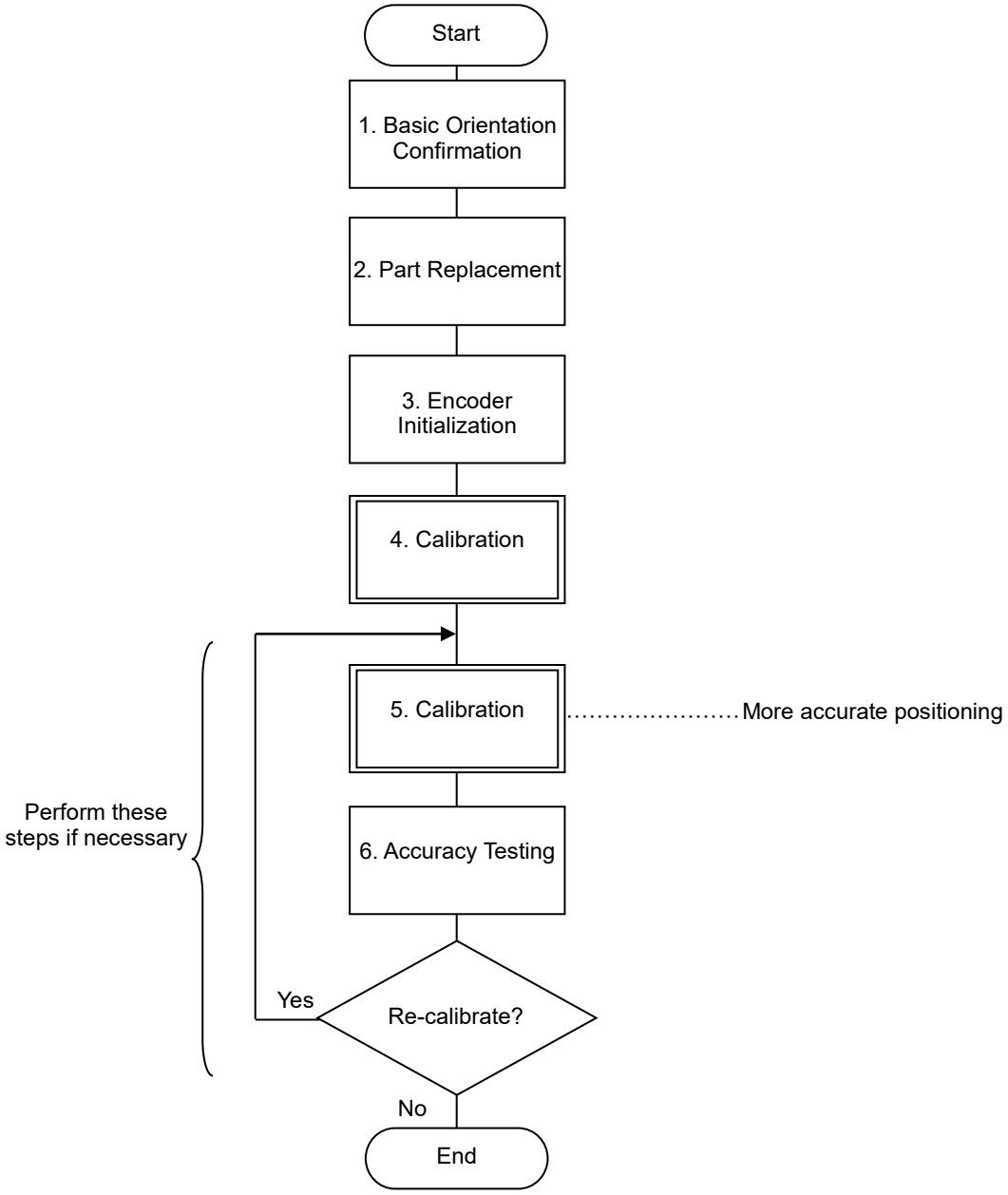
EPSON RC+ User's Guide

5.11.1 [Tools]-[Robot Manager]-[Jog and Teach] Page

NOTE

- For details about the basic orientation, refer to *Setup & Operation 3.9 Checking the Basic orientation.*
- Calibrate one joint at a time. (Also, replace parts of one joint at a time.) If you calibrate the origins for multiple joints simultaneously, it will be more difficult to verify their origins and obtain the origin correct positions.

Calibration Flowchart



19.2 Calibration Procedures

Command Input

Command execution is required in some calibration procedures.
Select the EPSON RC+ menu-[Tools]-[Command Window].

This step is omitted in the calibration procedures.

Jog Motion

Setting of the jog motion is required in some calibration procedures.
Select EPSON RC+ menu-[Tools]-[Robot Manager] and select the [Jog & Teach] page.

The page above is indicated as [Jog & Teach] in the calibration procedures.

Follow steps 1 to 6 to calibrate the Manipulator.

1. Basic Orientation Confirmation

   Calibration is performed with the basic orientation of the Manipulator.
   For details about the basic orientation, refer to Setup & Operation 3.9 Checking the Basic Orientation.

   When the Manipulator cannot have the basic orientation, define the reference orientation in advance, and record the point data. Also, put the “match marks” to indicate the orientation.

   The coordinate points including the Arm orientation are referred to as “points”, and the data of the points are called “point data” in EPSON RC+.

2. Part Replacement

   Replace the parts as instructed in this manual.
   Be careful not to injure yourself or damage parts during part replacement

3. Encoder Initialization

   Follow the procedures below to initialize the encoder.

   Execute the following command in the [Command Window].

   EPSON RC+

   `>Encreset` [The joint number (1 to 6) of the encoder to be reset]

   Select EPSON RC+ menu-[Tools]-[Controller], then click <Reset Controller>.

4. Calibration

4-1 Visually move the calibrating Joint of the Manipulator to the basic orientation

EPSON RC+

Set the jog mode to “Joint” in the [Jog & Teach] panel from EPSON RC+ menu - [Tools] - [Robot Manager], and then move the Manipulator in Jog motion so that the target joint matches the basic orientation as much as possible.

When the Manipulator cannot have the basic orientation, move the Manipulator so that the “marks” depending on the predetermined reference orientation are aligned.

4-2 Initialize the Encoder

EPSON RC+

Execute the command in the [Command Window] from EPSON RC+ menu - [Tools] according to the joint to adjust as follows.

Joint #1 `>Encreset 1`
Joint #2 `>Encreset 2`
Joint #3 `>Encreset 3`
Joint #4 `>Encreset 4`
Joint #5 `>Encreset 5, 6`
Joint #6 `>Encreset 6`

4-3 Reboot the Controller

EPSON RC+

Click EPSON RC+ menu-[Tool]-[Controller]-<Reset Controller>.

4-4 Specify a pulse value set as an origin point

EPSON RC+

Execute the command in the [Command Window] from EPSON RC+ menu - [Tools] according to the joint to adjust as follows.

```
>calpls J1 pulse, J2 pulse, J3 pulse, J4 pulse, J5 pulse, J6 pulse
```

* Manipulator will not move.

Specify the pulse values “0” when the Manipulator is aligned to the basic orientation, or the values recorded at the predetermined reference orientation (where the match marks are aligned) to the command parameters (pulse values).

If the point data for the reference orientation is “P1”, the command parameters can be specified as follows

```
>calpls ppls(P1,1), ppls(P1,2), ppls(P1,3),
  ppls(P1,4), ppls(P1,5), ppls(P1,6)
```

4-5 Set the specified pulse value to the encoder

EPSON RC+

Execute the command in the [Command Window] from EPSON RC+ menu - [Tools] according to the joint to adjust as follows.

Joint #1 `>calib 1`
Joint #2 `>calib 2`
Joint #3 `>calib 3`
Joint #4 `>calib 4`
Joint #5 `>calib 5,6`
Joint #6 `>calib 6`

NOTE

When the origin of the Joint #5 is calibrated, the Joint #6 will be out of position. (Due to the structure of the Manipulator, any offset in the position of the Joint #5 affects the Joint #6.) Calibrate the origin of the Joint #6 together when calibrating the Joint #5.

Move the arm to several points to check if the arm moves to the original positions properly.
Teach points if fine adjustment is necessary.

5. Calibration (More accurate positioning)

EPSON RC+

Move the Manipulator to the selected point data by jogging in [Jog & Teach].

Move the joint* which is not calibrated to the specified point by motion command.

*When the Joint #5 is calibrated, adjust the Joints #1 - #4.

For example, when the selected point data is “P1”, execute “Motor On” in [Control Panel] and execute “Go P1” in [Jog & Teach].

Adjust the calibrated joints accurately by jog command so that the end effector is aligned to the selected point data position.

*When the Joint #5 is calibrated, adjust the Joint #5 and #6.

Select the “Joint” jog mode from [Jog & Teach] to change and adjust the angle of the calibrated joint.

Set the pulse values again at the adjusted point.

Execute the following command in the [Command Window] from EPSON RC+ menu - [Tools] to specify the pulse values to set.

```
>calpls J1 pulse, J2 pulse, J3 pulse, J4 pulse, J5 pulse, J6 pulse
```

* Manipulator will not move.

Specify the pulse values of the selected point data to the command parameters.
If the point data for the reference orientation is “P1”, the command parameters can be specified as follows

```
>calpls ppls(P1,1), ppls(P1,2), ppls(P1,3), ppls(P1,4),
ppls(P1,5), ppls(P1,6)
```

* Manipulator will not move.

Then, execute the following command in the [Command Window] to set the specified pulse values to the encoder according to the joint to set the origin point.

Joint #1 : `>Calib 1`
Joint #2 : `>Calib 2`
Joint #3 : `>Calib 3`
Joint #4 : `>Calib 4`
Joint #5 : `>Calib 5,6`
Joint #6 : `>Calib 6`

6. Accuracy Testing

Move the Manipulator to a different pose (point) to verify whether it moves back to the original position. If accuracy is inadequate, it is necessary to re-calibrate the origin using a different pose (point). You must set the pose (point) again if the Manipulator does not move back to the original position after re-calibration.

20. 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.

20.1 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.

20.2 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.

20.3 Commands Cause Error

20.3.1 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_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 of the robot
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_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.

20.3.2 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.

20.3.3 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

20.3.4 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.

20.3.5 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)

20.3.6 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.

20.3.7 Other (ChDisk)

You cannot specify USB option to the command: ChDisk

20.4 Restrictions of Functions

Some of the following functions are not available.

20.4.1 TP3

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

20.4.2 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
```

20.4.3 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 7.0 Hardware & Setup
Setup: 2.3.2 CV1/CV2 Camera Configuration

20.4.4 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.

20.5 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.

21. Error Code Table

For error code, refer to the following manual.

EPSON RC+7.0 SPEL+ Language Reference SPEL+ Error Messages

22. Maintenance Parts List

Part Name			Code	Note		Reference: Maintenance	Overhaul *1
Cover	Arm #1		1774549			7.1	
	Arm #2		1774548			7.2	
	Arm #3		1774547			7.3	
	Arm #4	1	1774546			7.4	
		2	1774550			7.5	
Cable unit			2191349			8.1, 8.2	
AC servo motor	Joint #1		2194596	300 W unit		9.1	✓
	Joint #2		2194597			10.1	✓
	Joint #3		2194598	200 W unit		11.1	✓
	Joint #4		2194599	100W unit		12.1	✓
	Joint #5		2194600			13.1	✓
	Joint #6		2194601			14.1	✓
Timing belt	Joint #1		1751536	Width 9 mm	255mm	9.1, 9.3	✓
	Joint #2		1753920		501mm	10.1, 10.3	✓
	Joint #3		1751537		480 mm	11.1, 11.3	✓
	Joint #4		1751538	Width 6 mm	210 mm	12.1, 12.3	✓
	Joint #5, #6		1762243		495 mm	13.1, 13.3 14.1, 14.3	✓
Thermal conductive sheet			1755573	For motor		9.1, 10.1, 11.1	
AMP board			2189027	For motor		15.1, 15.2, 15.3	
LED plate			1749496	Arm #2		16	
Felt sheet	Joint #1		1840429	Arm #1		17.1	
	Joint #2		1755083	Arm #2		17.2	
	Joint #3		1755084			17.3	
Controller Unit	Standard Cleanroom		2194603	CPU board, DPB board, Cooling fan unit		18.1	
	Protection		2208039				
Controller Unit	AC specification		2194603	Standard Cleanroom	CPU board, DPB board, Cooling fan unit	18.1	
			2208039	Protection			
	DC specification		2207771	Standard			
Power board	AC specification		2188638			18.2	
	DC specification		2207410				
CPU/DPB board	AC specification		2193553	With: battery Without: SD, Heat release sheet		18.3	
	DC specification		2207409				
Lithium battery			2113554	(Code 2: R13B060003)		18.4	
Cooling fan			2191301			18.5	
SD card			2182748			18.6	

Part Name			Code	Note	Reference: Maintenance	Overhaul *1
Gasket	Base	Rear gasket	1804004 1825359	Protection model		
		Subplate gasket	1822684			
		LED gasket	1804010			
	Arm #1	Cover gasket	1804011 1825378			
	Arm #2	Cover gasket	1804013			
		LED gasket	1804014			
	Arm #3	Cover gasket	1804016			
	Arm #4	Cover gasket (Left)	1804018			
		Cover gasket (Right)	1804019			
Seal washer		M3	1803975			
		M4	1665882			
		M22	1666016			

Part Name			Code	Note	Reference: Maintenance
Grease *2	SK-1A	Joint #1, #2, #3, #4	-	For purchasing grease, and adhesive, please the supplier of your region	9.2, 10.2, 11.2, 12.2
	SK-2	Joint #5, #6, Bevel gear	-		13.2, 14.2
	GPL-224	Cable	-		8.1, 8.2
Adhesive *2	LOCTITE641		-		9.2, 10.2, 11.2, 12.2, 13.2 14.2
Wire tie	AB100		1675753	1 bag (100 pcs: white)	8.1, 8.2
	AB150		1675754	1 bag (100 pcs: white)	

*1 Overhaul:

As a rough indication, perform the overhaul (parts replacement) before reaching 20,000 operation hours of the Manipulator. The operation hours can be checked in [Controller Status Viewer] dialog box - [Motor On Hours]. For details, refer to *Maintenance 2.2 Overhaul*.

*2 Regarding purchase of grease and adhesive:

Due to the chemicals regulations of individual countries (the UN GHS), we are requesting our customers to purchase grease and other materials required for maintenance from the manufacturers listed in the table below as of April 2015.

Regarding purchase of grease and other materials, please contact the following manufacturers. If there is anything unclear, please contact the suppliers of your region.

Product name	Manufacturer	URL
Harmonic Grease SK-1A Harmonic Grease SK-2	Harmonic Drive Systems Inc.	http://www.harmonicdrive.net/
Krytox®GPL-224	DuPont	http://www2.dupont.com/Our_Company/en_US/worldwide/us_country.html
LOCTITE641 LOCTITE243	LOCTITE	http://loctite.com/

23. Option Parts List

Part Name		Code	Note	Reference Setup & Operation
Camera plate unit		R12NZ900ZZ		11.1
Tool Adapter (ISO flange)		R12NZ900ZX		11.2
Adjustable Mechanical Stops	J1	R12NZ90101		11.3
	J2	R12NZ90102		
	J3	R12NZ90103		
External Wiring Kit		R12NZ900ZW		11.4

Appendix A: Open Source Software License

(VT series Manipulator)

(1) The VT series product includes open source software programs listed in Section (6) according to the license terms of each open source software program.

(2) We provide the source code of the Open Source Programs (each is defined in Section (6)) until five (5) years after the discontinuation of same model of this option product. If you desire to receive the source code above, please contact the "SUPPLIER" in the first pages of the *Robot System Safety and Installation* manual. You shall comply with the license terms of each open source software program.

(3) The open source software programs are WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. See the license agreements of each open source software program for more details, which are described on Section (7).

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

(5) The license terms of each open source software program are described on Section (7).

(6) The list of open source software programs which the VT series product includes are as follows.

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

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

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