

EPSON

Robot Controller RC700-E Manual

Original instructions
Control Unit RC700-E

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Rev.10
ENM25ZC8112F

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1. Introduction

1.1 Introduction

Thank you for purchasing this Epson robot system. This manual provides the information necessary for correctly using the robot system.

Before using the system, please read this manual and related manuals to ensure correct use.

After reading this manual, store it in an easily accessible location for future reference.

Epson conducts rigorous testing and inspection to ensure that the performance of our robot systems meets our standards. Please note that if the Epson robot system is used outside the operating conditions described in the manual, the product will not perform up to its basic performance.

This manual describes potential hazards and problems that are foreseen. To use the Epson robot system safely and correctly, be sure to follow the safety information contained in this manual.

1.2 Trademarks

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

1.3 Notation

Microsoft® Windows® 10 operating system

Microsoft® Windows® 11 operating system

In this manual, the above operating systems are referred to as Windows 10 and Windows 11, respectively. Windows 10 and Windows 11 are sometimes collectively referred to as Windows.

1.4 Terms of Use

No part of this instruction manual may be reproduced or reprinted in any form without express written permission.

The information in this document is subject to change without notice.

Please contact us if you find any errors in this document or if you have any questions about the information in this document.

1.5 Manufacturer

SEIKO EPSON CORPORATION

1.6 Contact Information

Contact information details are listed in the "Supplier" section in the following manual.

Note that the contact information may vary depending on your region.

"Safety Manual - Contact Information"

The Safety Manual is also available at the following site.

URL: <https://download.epson.biz/robots/>



1.7 Disposal

When disposing of this product, please do so in accordance with the laws and regulations of your country.

1.8 Disposal of Batteries

Refer to the following manual for the battery removal and replacement procedures.

"Service Manual"

1.8.1 For Customers in the European Union



The crossed out wheeled bin label that can be found on your product indicates that this product and incorporated batteries should not be disposed of via the normal household waste stream.

To prevent adverse effects on the environment and human health, the product and its batteries should be separated from other waste and recycled in an environmentally responsible manner. Contact your local government or product distributor for information on collection facilities.

The Pb, Cd, or Hg symbol means that these metals are used in the battery.

KEY POINTS

This information only applies to customers in the European Union, according to Directive 2006/66/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL OF 6 September 2006 on batteries and accumulators and waste batteries and accumulators and repealing Directive 91/157/EEC and legislation transposing and implementing it into the various national legal systems, and to customers in countries in Europe, Middle East and Africa (EMEA) where they have implemented equivalent regulations.

For information on recycling products in other countries, please contact your local government.

1.8.2 For Customers in the Taiwan Region



Used batteries should be separated from other waste and recycled in an environmentally responsible manner. Contact your local government or product distributor for information on collection facilities.

1.8.3 For California Customers

The lithium battery used in this product contains perchlorate material that requires special handling. Refer to the following document.

<https://dtsc.ca.gov/perchlorate/>

1.9 Before Use

CAUTION

- Regarding the necessity for organizational measures for cyber security

Organizational measures like those described below should be taken to address cybersecurity risks:

- Perform risk analysis based on security threats and vulnerabilities related to your organization's assets.
- Establish a security policy to address risks and educate and train appropriate personnel.
- Establish guidelines for how to respond when security issues arise and make them known throughout your organization.

- Security measures for network connections

Epson robot systems are designed to be used within a closed local area network. Please refrain from connecting to networks with Internet access. If a connection to the Internet is required, please implement the necessary technical measures* to protect from malicious attacks and vulnerabilities over the Internet.

*: These measures include, but are not limited to, access controls, firewalls, data diodes, and so on.

KEY POINTS

- Do not connect the following devices to the TP port of RC700-E. The different signal arrangement could cause a breakdown in the device.
 - Dummy plug (optional device)
 - Operation Pendant OP500
 - Operator Pendant OP500RC
 - Jog Pad JP500
 - Teaching Pendant TP-3**
 - Operator Panel OP1
 - Teach Pendant TP1
- For RC700-E, be sure to install Epson RC+ to the development PC first, and then connect the development PC and RC700-E with the USB cable.

If RC700-E and the development PC are connected without installing Epson RC+ to the development PC, the [Add New Hardware Wizard] appears. If this wizard appears, click the [Cancel] button.

- Security measures for USB memory devices

Make sure that any USB memory device that will be connected to the Controller is not infected with a virus.

1.10 Robot System Configuration

Connection of the Controller RC700-E is supported from the following versions.

- EPSON RC+ 7.0 Ver.7.5.4 or later
- Epson RC+ 8.0

Connection of the Manipulator is supported from the following versions.

- GX4-B and GX8-B series: Epson RC+ 7.0 Ver.7.5.4, Epson RC+ 8.0
- GX10-B, GX20-B series: EPSON RC+ 7.0 Ver.7.5.4A, Epson RC+ 8.0
- C-B Series: EPSON RC+ 7.0 Ver.7.5.4C, Epson RC+ 8.0

1.11 Setting by Using Software

This manual contains setup procedures using the software.

Those sections are indicated by the following symbols.

EPSON
RC+ 7.0

Epson
RC+ 8.0

1.12 Manual Types for This Product

This describes the typical types of manuals for this product and presents an overview of their content.

■ **Safety Manual**

This manual contains safety-related information intended for all people who use this product. It also guides the user through the process from unpacking to usage and the manuals that should be referred to next.

Please read this manual first.

- Safety information and residual risks of robot systems
- Declaration of Conformity
- Training
- Process from unpacking to usage

■ **Robot Controller Safety Function Manual**

This describes the procedures for configuring the safety functions of this product and the configuration software. It is primarily intended for those who design robot systems.

■ **RC700-E Manual**

This manual describes the installation of the entire robot system and explains the specifications and functions of the Controller. It is primarily intended for those who design robot systems.

- Robot system installation procedure (specific details on the process from unpacking to usage)
- Controller daily inspection points
- Controller specifications and basic functions

■ **GX Series Manual, C-B Series Manual**

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

- Manipulator installation, technical information needed for design, function and specification tables, etc.
- Manipulator daily inspection points

■ **Status Code/Error Code List**

This provides the code numbers displayed on the Controller and messages displayed in the message area of the software. It is primarily intended for those who design and program robot systems.

■ **Epson RC+ User's Guide**

This manual presents an overview of the program development software.

■ **Epson RC+ SPEL+ Language Reference**

This manual explains the robot programming language SPEL+.

Other manuals

Manuals are available for each option.

Maintenance and servicing manuals

Manuals for maintenance and servicing are not included with the product.

Maintenance should be performed by people who have received maintenance training provided by Epson and the suppliers. For more information, please contact the supplier.

2. Safety

2.1 Safety

Before using the robot system, be sure to check the basic safety information by referring to the following manual.
"Safety Manual"

After reading this manual, store it in an easily accessible location for future reference.

This product is intended for transporting and assembling parts in a safely isolated area and dedicated to Epson robots used in industrial environments.

Conventions used in this manual

The following symbols are used in this manual to indicate important safety information. Be sure to read the descriptions shown with each symbol.

WARNING

This symbol indicates an imminently hazardous situation which, if operation is not performed properly, will result in death or serious injury.

WARNING

This symbol indicates a potentially hazardous situation which, if operation is not performed properly, could result in an injury due to electric shock.

CAUTION

This symbol indicates a potentially hazardous situation which, if operation is not performed properly, may result in an injury or in property damage only.

2.2 Safety Compliance

Specific tolerances and conditions of use for ensuring safety are described in the manuals for the Manipulators and Controllers. Be sure to also read these manuals.

Observe the safety standards of the respective country and region when installing and operating the robot system. The following are examples of safety standards related to robot systems and other safety standards.

Please refer not only to this chapter but also to these standards and take adequate safety measures.

Note: These standards are not intended to include all of the required safety standards.

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

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

2.3 Role for Safety Managers

Safety managers should perform the following:

- Password management
- Training implementation

2.3.1 Password Management

Safety managers should manage the following passwords:

- Epson RC+ security user password
- Safety function password
- Controller Ethernet connection password
- Teach Pendant TP3 T2 mode password
- Teach Pendant TP4 T2 mode password

2.3.2 Training Implementation

Safety managers should ensure that personnel responsible for programming, operating, and maintaining the Manipulator and robot system undergo proper training. Also, they should make sure that personnel have the ability to safely perform that work.

Training should include at least the following items:

- Description of standard safety procedures and safety recommendations by robot manufacturers and robot system designers
- Description of the response to an emergency or abnormal situation (e.g., means of escape if caught in a Manipulator)
- Clear description of the work
- Description of all control devices required for the work and their functions
- Description of hazards associated with the work
- Specific methods to avoid foreseeable hazards, including safe work procedures
- Description of the method for testing the functions of safety devices and interlocks or description of the method to check that they are functioning properly
- Description of the method for checking safety function parameters and of the method for setting safety function parameters correctly

2.4 Knowledge and Training Required to Work with Robot Systems

▪ **Work with robot systems**

People who work with robot systems must receive safety training for workers engaged in work related to industrial robots* as required by the laws and regulations of the respective country.

* The safety training for workers engaged in work related to industrial robots must include the following content.

- Knowledge of industrial robots
 - Knowledge of industrial robot operation, teaching, etc.
 - Knowledge of inspection and other work
 - Education on relevant laws and regulations
-
- **Transportation work (slinging, crane operation, forklift operation, etc.)**
Workers must be qualified in slinging, crane operation, forklift operation, etc.
 - **Power plug installation (e.g., when installing a power plug to match a factory power socket)**
Workers must have expertise and skill in installing factory power plugs.
 - **Power cable installation work**
Workers must have expertise and skill in installing power cables.
 - **Design, unpacking, and installation of robot systems**
Workers must have received the installation training provided by Epson and the supplier.
 - **Installation of optional circuit boards on Controllers/Installation of wall-mounted options**
Workers must have received the maintenance training provided by Epson and the supplier.
 - **Maintenance work on robot systems**
Workers must have received the maintenance training provided by Epson and the supplier.

3. Installation of Robot System

This section describes the process from unpacking to operation of the robot system and the design of the robot system. It is primarily intended for those who carry in and install the robot system and for those who connect to the development PC and perform setup.

3.1 System Configuration Example

Refer to the following section for details.

[System Configuration Example](#)

3.2 Unpacking and Transportation

The robot and robotic equipment must be unpacked and transported by staff who has received installation training conducted by Epson or its suppliers. Also, the laws and regulations of the installation country must be followed.

Before using the robot system, be sure to check the basic safety information by referring to the following manual.
"Safety Manual"

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

When transporting the Manipulator over long distances, secure it directly to transporting equipment so that it will not fall. If necessary, pack the Manipulator using the same packaging as delivery.

For the transportation procedure for the Manipulator, refer to the following manual.
"Manipulator Manual"

3.3 Manipulator Installation

The robot and robotic equipment must be installed by staff who has received installation training conducted by Epson or its suppliers. Also, the laws and regulations of the installation country must be followed.

Before using the robot system, be sure to check the basic safety information by referring to the following manual.
"Safety Manual"

For the installation environment and installation procedure for the Manipulator, refer to the following manual.
"Manipulator Manual"

3.4 Controller Installation

Refer to the following section for details.

[Installation](#)

3.5 Designing a Safe Robot System

In addition to ensuring safe operation of the robot, it is also important that robot users give careful consideration to safety for the entire robot system that is designed.

This section explains the minimum requirements that must be observed when using Epson robots in your robot systems.

Please design and manufacture robot systems by following the principles described in this manual.

3.5.1 Environmental Requirements

Be sure that the environment where the robot and robot system are installed meets the requirements contained in the manuals for all equipment used in the system.

3.5.2 System Layout

When designing the layout for a robot system, be sure to fully take into account the possibility of interference between robots and peripheral equipment. Particular attention must be paid to emergency stops because a robot will stop after following a path that is different from its normal movement path. The layout design should provide adequate margins for safety. The layout should also ensure adequate space for maintenance and inspection.

When using high speed manual mode (T2), maintain a clearance of 500 mm between the robot and surrounding buildings, structures, perimeter protection, and other equipment.

When designing a robot system to restrict the area of motion of the robots, do so by following the methods described in the Manipulator manual. Limiting is done either by Soft Axis Limiting or by mechanical stops. For Soft Axis Limiting, refer to the following manual.

"Robot Controller Safety Function Manual"

For limiting by mechanical stops, refer to the following manual.

"Manipulator Manual"

Ensure to install the emergency stop switch at a location near the operation unit for the robot system where the operator can easily access the switch to immediately press it in an emergency.

Do not install the Controller at a location where water or other liquids could enter the Controller. Never use water or other liquids to clean the Controller.

To ensure that lockouts are implemented safely during servicing and maintenance, disconnectors should be located outside the safety barriers wherever possible.

3.5.3 Disabling Power to the System Using Lockout/Tagout

Disconnect the Controller's power supply using the lockout/tagout procedure to ensure a third party does not accidentally turn on the robot while a worker is inside the safety barriers for maintenance or repair. For more information on lockout, refer to the following section.

[Part Names and Their Functions](#)

3.5.4 Hand Design

Perform the wiring and piping work so that the robot hand will not release the workpiece (object being grasped) even when the robot system power is shut off.

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

Be sure to select the size of the hand with care because the robot body and robot hand could interfere with each other.

3.5.5 Peripheral Equipment Design

When designing equipment that removes and supplies parts and materials to the robot system, ensure that the design enables adequate safety for the operator. If it is necessary to remove or supply materials without stopping the robot, install a shuttle device, use SLP, or take other measures to ensure that the operator does not need to enter a potentially hazardous zone.

For details on SLP, refer to the following section.

[Safety Functions](#)

Ensure that an interruption to the power supply (power shutoff) of peripheral equipment will not lead to a hazardous situation. In addition to taking measures to prevent release of held workpieces as mentioned in "Hand Design," measures must also be

taken to ensure peripheral equipment other than the robots can stop safely. Verify equipment safety to ensure that no hazardous situations will occur if the power is cut off.

3.5.6 Remote Control

For the safety of the overall robot system, safety measures must be implemented to eliminate the risks associated with the starting and stopping of peripheral equipment by remote control.

With this product, the robot system can be operated remotely by assigning a remote function to the Controller I/O. Refer to the following section.

I/O Remote Settings

When the remote function is enabled, motion command execution and I/O output are available only from a remote source.

3.5.7 Power Off During Manipulator Operation

Do not turn off the Controller while the Manipulator is operating.

If the Manipulator is stopped by turning off the Controller while it is operating, the following problems may occur.

- Reduced life and damage to reduction gear
- Position shift at the joints

Also, if the Controller power was cut off due to a power outage or similar situation while the Manipulator is operating, be sure to check for any of the following points after power is restored.

- Damage in reduction gear
- Shifting of the joints from their proper positions
If there is any position shift, perform zero position adjustment.

3.5.8 Emergency Stop

Each robot system needs equipment that will allow the operator to immediately stop the system's operation. Install an emergency stop device by using emergency stop input from the Controller or other equipment.

Refer to the following section.

Emergency Stop Input Connector

Safety I/O Connector

Before using the emergency stop switch, be aware of the following points.

- The emergency stop switch should be used to stop the Manipulator only in case of emergencies.
- Besides pressing the emergency stop switch when an emergency occurs, to stop the Manipulator during program operation, use the Pause or STOP (program stop) statements assigned to a standard I/O.
The Pause and STOP statements do not turn off motor energization, and so the brake is not locked.

To place the robot system in emergency stop mode in a non-emergency (normal) situation, press the emergency stop switch while the Manipulator is not operating.

Do not press the emergency stop switch unnecessarily while the Manipulator is operating normally.

It could shorten the lifespan of the following components.

- Brakes
The brakes will be locked, which will shorten the lifespan of the brakes due to worn brake friction plates.
 - Normal brake lifespan:
About 2 years (when the brakes are used 100 times/day)
or about 20,000 times

- Reduction gears

An emergency stop applies an impact to the reduction gear, which can shorten its life.

Stopping distance of emergency stop

The Manipulator during operation cannot stop immediately after the emergency stop switch is pressed. Also, the stopping time and movement distance vary depending on the following factors.

- Hand weight, WEIGHT setting, ACCEL setting, workpiece weight, SPEED setting, movement posture, etc.

For the stopping time and movement distance of the Manipulator, refer to the following manual.

"Manipulator Manual - Appendix B. Stopping Time and Stopping Distance at Emergency Stop"

3.5.9 Safeguard (SG)

To maintain a safe working zone, safety barriers must be set up around the Manipulator, and safeguards must be installed at the entrance and exit of the safety barriers.

The term "safeguard" as used in this manual refers to a safety device with an interlock that allows entry into the safety barriers. Specifically, this includes safety door switches, safety barriers, light curtains, safety gates, safety floor mats, and so on. The safeguard is an input that informs the Robot Controller that an operator may be inside the safety barriers. You must assign at least one Safeguard (SG) in Safety Function Manager. Refer to the following section.

Safety I/O Connector

When the safeguard is opened, Protective Stop operates to change to the safeguard open state (display: SO).

- Safeguard open
Operations are prohibited. Further robot operation is not possible until either the safeguard is closed, the latched state is released, and a command is executed, or the TEACH or TEST operation mode is turned on and the enable circuit is activated.
- Safeguard closed
The robot can operate automatically in an unrestricted (high power) state.

WARNING

- If a third party accidentally releases the safeguard while an operator is working inside the safety barriers, this may result in a hazardous situation. To protect the operator working inside the safety barriers, implement measures to lock out or tag out the latch release switch.
- To protect operators working near the robot, be sure to connect the safeguard and make sure that it works properly.

Installing safety barriers

When installing safety barriers within the maximum range of the Manipulator, combine safety functions such as SLP. Carefully take into account the size of the hand and the workpieces to be held so that no interference occurs between the operating parts and the safety barriers.

Installing safeguards

Design the safeguards so that they satisfy the following requirements:

- When using a key switch type safety device, use a switch that forcibly opens the interlock contacts. Do not use switches that open their contacts using the spring force of the interlock.
- When using an interlock mechanism, do not disable the interlock mechanism.
- When you use light curtains, keep the safeguard open until the latched state is released.

Considering the stopping distance

During operation, the Manipulator cannot stop immediately even if the safeguard is opened. Also, the stopping time and

movement distance vary depending on the following factors.

Hand weight, WEIGHT setting, ACCEL setting, workpiece weight, SPEED setting, movement posture, etc.

For the stopping time and movement distance of the Manipulator, refer to the following manual.

"Manipulator Manual - Appendix C. Stopping Time and Stopping Distance When the Safeguard is Open"

Please refer to the above values and ISO13855 when performing calculations.

To reduce the distance, use SLS or SLP to apply the necessary restrictions.

Precautions for safeguard operation

Do not open the safeguard unnecessarily while the motor is energized. Frequent safeguard inputs will reduce the life of the relay.

- Normal relay lifespan: About 20,000 times

3.5.10 Presence Sensing Device

The above-mentioned safeguard interlock is a type of presence sensing device because it indicates the possibility of somebody being inside the safety barriers. When installing a separate presence sensing device, perform a full risk assessment, and pay careful attention to its reliability.

Take note of the following points.

- Design the system so that an operator cannot enter inside the safety barriers or cannot reach it unless the presence sensing device is activated or the hazard situation has ended.
- Design the presence sensing device so that it ensures fail-safe operation regardless of the system state.
- If the robot stops operating when the presence sensing device is activated, ensure that the robot will not restart operation until the detected object has been removed. Make sure that the robot cannot automatically restart by any operation.

3.5.11 Resetting Safeguards

Ensure that the robot system can only be restarted by operation from outside the safety barriers. The robot must never restart by simply resetting the safeguard. Apply this concept to the interlocks and presence sensing devices for the entire system.

3.5.12 Robot Operation Panel

If a robot operation panel is installed, be sure to install at a position where it can be operated from outside of the safety barriers.

3.6 Connections

3.6.1 Connection of Interlocked Guard Switch (Safety Device) and Emergency Stop Switch

To ensure safety, connect a safeguard switch, emergency stop switch, or similar safety device to the safety I/O connector or emergency stop input connector of the Controller. Refer to the following sections for details.

[Emergency Stop Input Connector](#)

[Safety I/O Connector](#)

If nothing is connected to the safety I/O connector, the Controller does not operate normally.

The default assignments are as follows:

- EMERGENCY connector: Short plug

- Safety I/O 1ch: Emergency stop (Estop)
- Safety I/O 2ch: Safeguard (SG)

3.6.2 Controller Power Supply

Connect the Controller power supply. For details on the power supply specifications and how to connect the AC power cable, refer to the following section.

Power Supply

3.6.3 Connection of Manipulator and Controller

3.6.3.1 Connection Notes

- **Before connection**

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

- **Connection procedure**

Before performing any connection procedure, turn off the Controller and related equipment, and then unplug the power cable from the outlet. Performing any work procedure with the power turned on is extremely dangerous and may result in electric shock and/or malfunction of the robot system.

- **Cables**

Be sure to connect the cables properly.

The cables should be connected at all times. Use a guard cover to protect the cables. Do not put heavy objects on the cables, bend or pull on the cables forcibly, or allow the cables to be pinched. Damaged cables, broken wires, or contact failure is extremely hazardous and may result in electric shock and/or malfunction of the robot system.

- **Connection-related information**

When connecting the Manipulator and the Controller, check that the serial numbers match for each device. Improper connection between the Manipulator and the Controller may not only lead to malfunction of the robot system but also safety problems.

The serial number of the supported Manipulator is labeled on the Controller.

- **Wiring**

Only authorized or certified personnel should perform wiring. Wiring by unauthorized or uncertified staff may result in bodily injury and/or malfunction of the robot system. Install the wirings in a way that prevents tripping or falling.

- **For cleanroom-models**

When the Manipulator is a cleanroom model, an exhaust system must be connected. For details on the exhaust system, refer to the following manual.

"Manipulator Manual"

The Controller is not designed with cleanroom specifications, and so it should be placed outside the cleanroom or other measures should be taken.

- **For protected-model**

Connect the power cable connector and the signal cable connector to the connector plate on the Manipulator immediately after Manipulator installation. Leaving the Manipulator unconnected may result in electric shock and/or malfunction of the robot system because protection at IP65 cannot be ensured.

3.7 Saving the Default Settings

The Controller has already been configured with the purchased robot(s) at shipment. However, in case of data loss, we recommend saving the default Controller settings. A USB memory device is required to save the Controller settings. Refer to the following section.

Memory Port

3.8 Power On

3.8.1 Power On Notes

- **Check of Manipulator**

Before operating the Manipulator, be sure that no parts of the Manipulator are missing and that it has no damage or other external defects. Missing parts or damage may cause malfunction of the Manipulator, is extremely hazardous, and may result in serious injury to operators and/or severe equipment damage.
- **Check of transportation fixtures before power on**

Before turning on the power after installation is completed, be sure to remove the transportation fixtures from the Manipulator. Turning on the power while the transportation fixtures are attached may result in damage to the main drive unit of the Manipulator.
- **Anchoring of Manipulator**

Anchor the Manipulator before turning on the power or operating it. Turning on the power to or operating the Manipulator while it is not anchored may cause the Manipulator to fall over, which is extremely hazardous and may result in serious injury to operators and/or severe equipment damage.
- **Initial operation**

Be sure to always check at low speed when operating the Manipulator for the first time and when executing an operation program for the first time. Suddenly performing operation at high speed is extremely hazardous because the Manipulator may be unable to respond to unexpected movements, resulting in collision with the Manipulator or other situations where serious injury or severe damage occurs.
- **When turning on the power again**

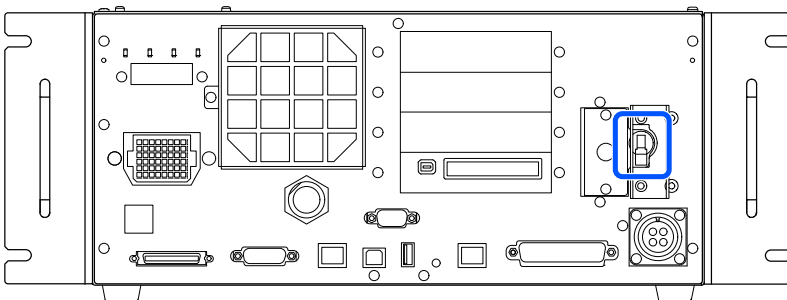
When turning the Controller off and on again, turn off the Controller and wait for at least five seconds before turning it on again.

3.8.2 Power On Procedure

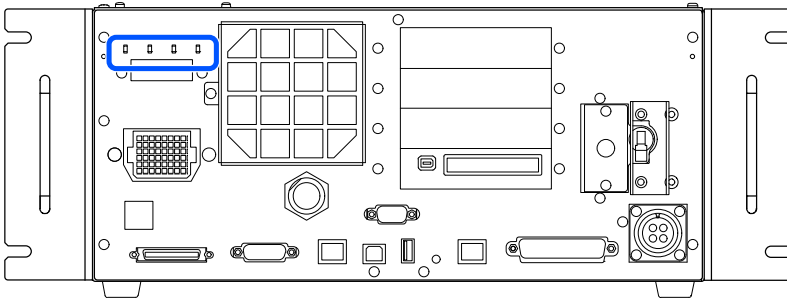
For details on the names and functions of the various parts of the Controller, refer to the following section.

Part Names and Their Functions

1. Check the connection with the Manipulator.
Check the connection between the M/C POWER connector and the M/C SIGNAL connector.
2. Check the connection between the safety I/O connector and the emergency stop input connector.
3. Connect the TP bypass plug to the TP port.
4. Connect the AC power cable to the power socket.
5. Turn on the POWER switch of the Controller.



6. If the Controller starts up normally, the 7-segment LED blinks as shown below after approximately 30 seconds since the power is turned on.



If an error is displayed, check the connections in steps (1) to (5), and turn the power off and on again. If an error is displayed even after checking the connections and turning the power off and on again, please contact the supplier.

⚠ CAUTION

Turning the power off before the 7-segment LED flashes "----" may lead to a malfunction of the Controller.

7. Once the Controller successfully starts, perform the following checks.

Check	Procedure	Results
Emergency stop operation	Press the emergency stop button with the motor energized.	EP is displayed on the Controller's 7-segment LED. Emergency stop is displayed on the Epson RC+.
Safeguard operation	Operate the safeguard with the motor energized.	SO is displayed on the Controller's 7-segment LED. Safeguard is displayed on the Epson RC+.

🔑 KEY POINTS

If the results are different, perform the following checks. If there is still no improvement, please contact the supplier.

- Check wiring.
- Check functions assigned to safety I/O.

8. If various safety functions are set, check the assigned safety functions.

Check	Procedure	Results
SLS	Switch SLS operating status by switching safety input	On I/O monitor, SLS enable and disable will switch in conjunction with input
SLP	Switch SLP operating status by switching safety input	On I/O monitor, SLP enable and disable will switch in conjunction with input
Soft axis limiting	Intentionally enter the area by using jog or other means*1	Changes to STO state

Check	Procedure	Results
STO output	Operate emergency stop button or safeguard to change to STO state	Input of connected safety device changes
Emergency stop output	Press the emergency stop button	Input of connected safety device changes
Enable output	Grip the enable switch	Input of connected safety device changes
SLS output	Switch SLS operating status by switching safety input	Input of connected safety device changes
SLP output	Switch SLP operating status by switching safety input.	Input of connected safety device changes.

*1 To escape from the restricted area, switch to TEACH mode by using TP.

3.9 First Step

This section presents the procedure for installing Epson RC+ to the development PC, connecting the development PC and the Controller by USB, and executing a simple program.

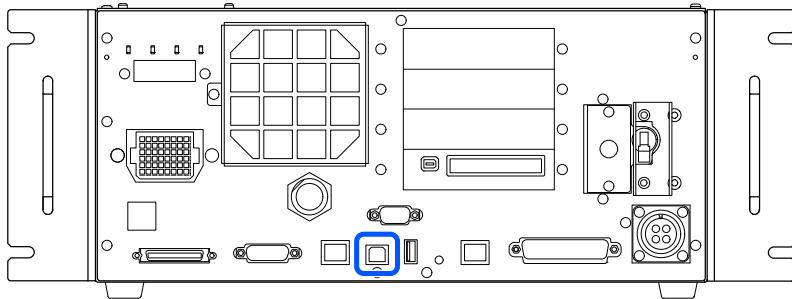
First, make sure that the robot system is installed safely by following the information provided in "Safety" and "Installation." Then, operate the robot system by following the procedures in this chapter.

3.9.1 Installing Epson RC+ Software

Install Epson RC+ software on your development PC.
For the software installation procedure, refer to the following manual.
"Epson RC+ User's Guide"

3.9.2 Connecting the Development PC and the Controller

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



KEY POINTS

- For other details on the connection between the development PC and the Controller, refer to the following manual.
"Epson RC+ User's Guide - [PC and Controller Communications] (Setup Menu)"
- For RC700-E, be sure to install Epson RC+ to the development PC first, and then connect the development PC and RC700-E with the USB cable.
If RC700-E and the development PC are connected without installing Epson RC+ to the development PC, the [Add New Hardware Wizard] appears. If this wizard appears, click the [Cancel] button.

3.9.2.1 What is Development PC Connection USB Port?

The development PC connection port supports the following USB standards:

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

Interface standard: USB specification version 2.0 compliant (USB version 1.1 upward compatibility)

Connect the Controller and development PC by a USB cable to enable development of the robot system and setting of the Controller configuration with the Epson RC+ software installed in the development PC.

The development PC connection port supports hot plugging, and so cables can be inserted and removed while the development PC and the Controller are turned on. However, the robot stops when the USB cable is removed while the Controller and the development PC are connected.

3.9.2.2 Notes

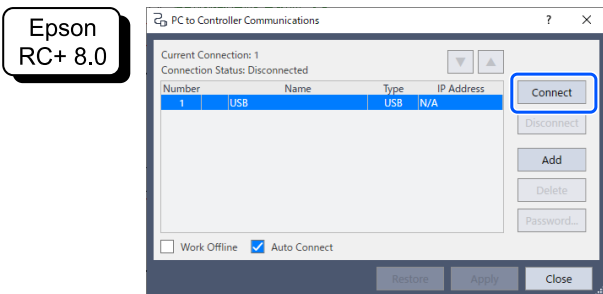
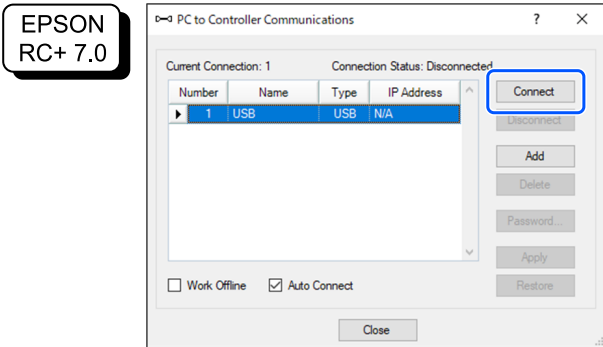
Pay attention to the following points when connecting the development PC and the Controller.

- Connect the development PC and the Controller using a USB cable with length of 5 meters or less, and do not use a USB hub or extension cable.
- Do not connect any device other than the development PC to the development PC connection port.
- To operate in USB 2.0 HighSpeed mode, use a PC or USB cable that supports USB 2.0 HighSpeed mode.
- Do not pull on or bend the cable excessively.
- Do not apply excessive force to the connector.
- While the development PC and the Controller are connected, do not connect or disconnect other USB devices from the development PC. This could cause the Controller to disconnect.

3.9.2.3 Connecting the PC and the Controller Using the Development PC Connection USB Port

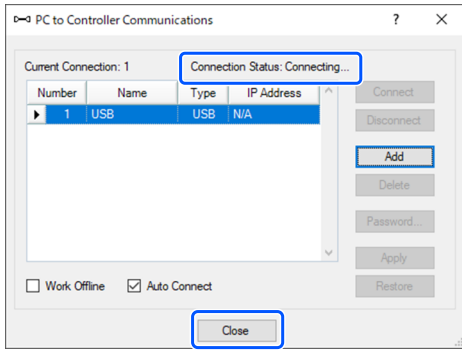
This explains the procedure for connecting the development PC and the Controller.

1. Make sure that the Epson RC+ software is installed on the development PC connected to the Controller.
(Install the software if it is not installed.)
2. Connect the development PC and the Controller by a USB cable.
3. Turn on the Controller.
4. Start the Epson RC+ software.
5. From the Epson RC+ menu, select [Setup] - [PC to Controller Communications] to display the [PC to Controller Communications] dialog box.

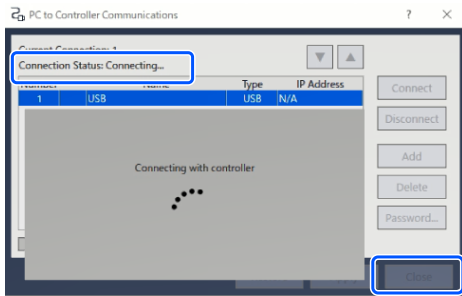


6. Select No.1, and click the [Connect] button.
7. After connection of the development PC and the Controller is completed, "Connected" is displayed in the [Connection Status:] field. Check that "Connected" is displayed, and click the [Close] button to close the [PC to Controller Communications] dialog box.

EPSON
RC+ 7.0



Epson
RC+ 8.0



This completes the connection of the development PC and the Controller. The robot system can now be used from Epson RC+.

3.9.2.4 Backing Up the Controller Initial Status

Back up the Controller setting data that was configured at shipment.


Backup procedure for project and system settings:

1. From the Epson RC+ menu, select [Project] - [Copy].
2. In the [Copy Project] dialog box, change the [Destination Drive] box to the desired drive.
3. Click the [OK] button. The project is copied to the external media.
4. From the Epson RC+ menu, select [Tools] - [Controller].
5. Click the [Backup Controller] button.
6. In the [Drive] box, select the desired drive.
7. Click the [OK] button. The system settings are backed up to the external media.

3.9.2.5 Disconnecting the Development PC and the Controller

This explains the procedure for disconnecting the development PC and the Controller.

1. From the Epson RC+ menu, select [Setup] - [PC to Controller Communications] to display the [PC to Controller Communications] dialog box.
2. Click the [Disconnect] button.
After the [Disconnect] button is clicked, the Controller and the development PC are disconnected, and the USB cable can be removed.

 **KEY POINTS**

If the USB cable is removed while the Controller and the development PC are connected, the robot will be stopped. Be sure to click the [Disconnect] button in the [PC to Controller Communications] dialog box before removing the USB cable.

3.9.3 Checking Safety Function Parameters

This section describes the procedure for checking safety function parameters on a development PC.

1. Connect the development PC and the Controller.
Connecting the PC and the Controller Using the Development PC Connection USB Port
2. In Epson RC+, select [Setup] - [System Configuration] to display the [System Configuration] dialog box.
3. Under [Controller] - [Safety Functions], click [Safety Function Manager].
Safety Function Manager starts.
4. Check the safety function parameters set for the Controller in the Safety Function Manager.
For details, refer to the following manual.
"Robot Controller Safety Function Manual"

3.9.4 Initial Settings for Safety Function Parameters

This procedure is only for customers who wish to change the safety function settings.

This section describes the procedure for making initial settings for safety function parameters on a development PC.

1. Start Safety Function Manager.
For the startup procedure, see steps 1 to 3 of "Checking Safety Function Parameters."
2. Change the safety function parameters in the Safety Function Manager.
For details on how to operate the Safety Function Manager, refer to the following manual.
"Robot Controller Safety Function Manual"
3. Confirm that the safety functions operate properly.
To check safety function operation, refer to the following manual.
"Robot Controller Safety Function Manual"

3.9.5 Checking Operation of Safety Functions (Emergency Stop Switch and Safeguard)

1. Refer to the following to check the operation of the emergency stop switch.
Connecting an Emergency Stop Switch
Connecting as Emergency Stop
2. Refer to the following to check the operation of the safeguard.
Connecting as Safeguard

3.9.6 Moving the Robot to Initial Posture

In addition to creating and executing programs, the robot can also be operated by the following methods.

- Manual operation
- Jog operation by the Teach Pendant
- Command execution from Epson RC+
- Jog operation from Epson RC+

This section explains the following operation methods.

A: Manual operation

B: Command execution from Epson RC+

C: Jog operation from Epson RC+

A: Manual operation

Move the robot by hand while it is in a non-energized state.

Joints without electromagnetic brakes can be moved directly by hand.

Joints with brakes (Joints #3 and #4) can be moved manually while the brake release switch on the robot is held down with the Controller main power turned on.

CAUTION

- Normally, release the brakes of joints one at a time. If the brakes of two or more joints must be released simultaneously due to unavoidable reasons, use extreme care. Releasing the brakes of two or more joints simultaneously may cause the arm to fall in an unexpected direction, resulting in hands or fingers getting caught or Manipulator damage or breakdown.
- Be careful of the arm falling when releasing the brake.

While the brake release switch is being pressed, the robot arm will fall by its own weight.

The arm falling may result in hands or fingers getting caught or robot damage or breakdown.
- Before releasing the brake using the software, be sure to keep the emergency stop switch in an easily accessible location so that you can immediately press it if necessary. Otherwise, if the emergency stop switch is not easily accessible, you will be unable to immediately stop the arm falling due to an erroneous operation, which could lead to robot damage or breakdown.
- The brake signal is not IEC 61800-5-2 Safe brake Control (SBC) certified. As such, be aware of the potential for the robot arm to fall due to a malfunctioning brake signal when approaching the robot.

1. Start Epson RC+.

Double click the <Epson RC+> icon on the Desktop.

2. Open the command window.

From the Epson RC+ menu, select [Tools] - [Command Window].

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

For a SCARA robot:

```
>Reset
>Brake Off, [Arm # (1 to 4) whose brake is released]
```

Execute the following command to activate the brake again.

```
>Brake On, [Arm # (1 to 4) whose brake is activated]
```

For a 6-Axis robot:

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

Execute the following command to activate the brake again.

```
>Brake On, [Arm # (1 to 6) whose brake is activated]
```

B: Command execution from Epson RC+

Once the robot motors are energized, execute the command to move the robot.

This presents an example of moving all joints to the 0 pulse positions by specifying the pulse for each joint.

1. Start Epson RC+.
Double click the <Epson RC+> icon on the Desktop.
2. Open the command window.
From the Epson RC+ menu, select [Tools] - [Command Window].
3. Execute the following command in [Command Window].
For a SCARA robot:

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

For a 6-Axis robot:

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

For the position and posture of the Manipulator at the 0 pulse position, refer to the following manual.

"Manipulator Manual - Motion Range"

C: Jog operation from Epson RC+

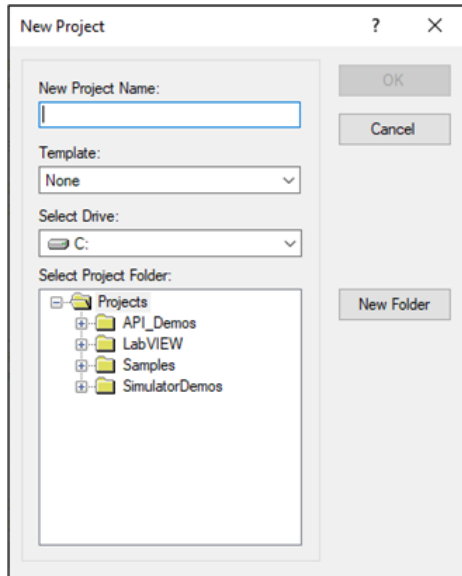
Energize the robot motors, operate the robot from the Jog & Teach window of Epson RC+.

1. Start Epson RC+.
Double click the <Epson RC+> icon on the Desktop. Or select from the Windows menu.
2. Create a new project.

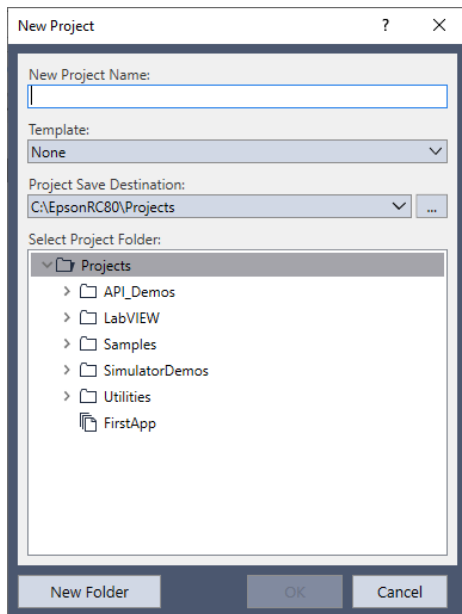
- i. From the Epson RC+ menu, select [Project] - [New].

The [New Project] dialog box is displayed.

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RC+ 7.0



Epson
RC+ 8.0



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

- iii. Click the [OK] button to create the new project.

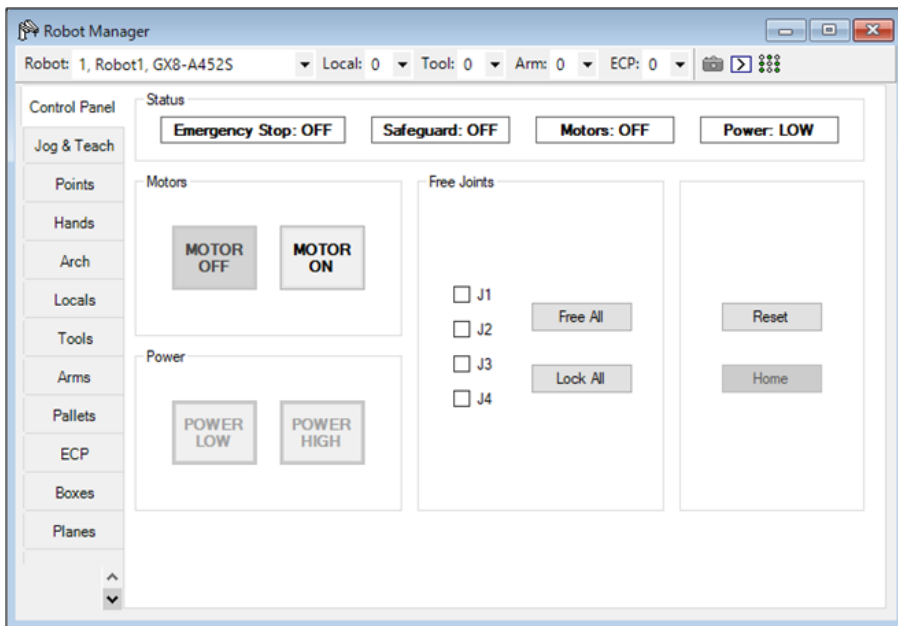
3. Open the robot manager.

From the Epson RC+ menu, select [Tools] - [Robot Manager].

4. Turn on the motors.

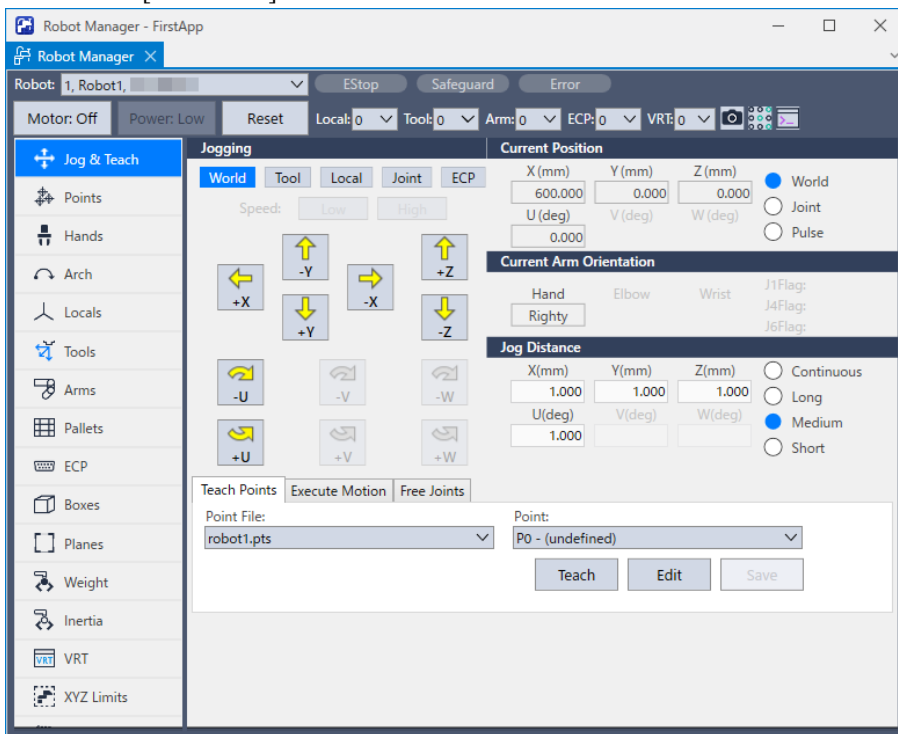
EPSON RC+ 7.0: Check that the [Control Panel] tab is open, and click the [MOTOR ON] button.

EPSON
RC+ 7.0



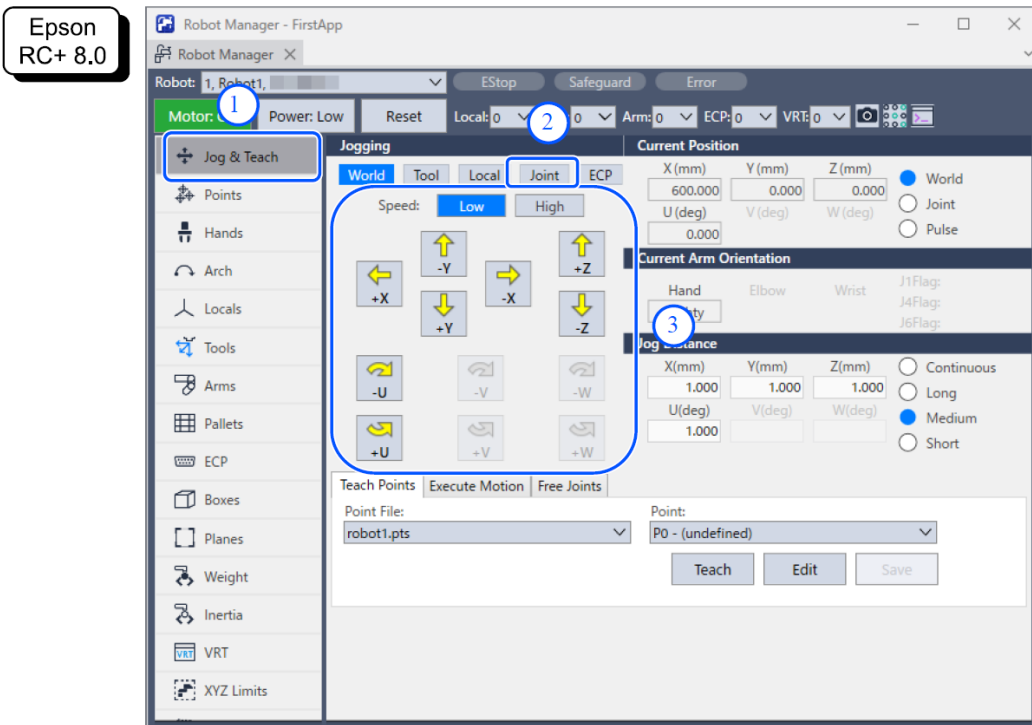
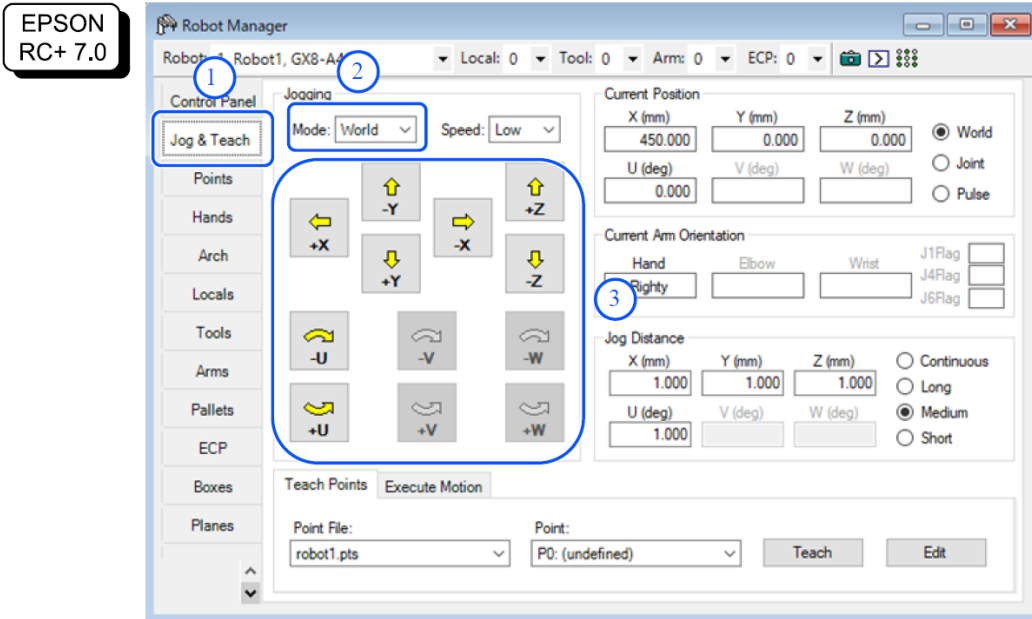
Epson RC+ 8.0: Click the [Motor: Off] button.

Epson
RC+ 8.0



5. Perform jog operation.

i. Select the [Jog & Teach] tab.



ii. From [Jogging] - [Mode], select "Joint."

iii. Click jog keys J1-J6 to operate the selected joint.

Movement is possible by setting to other modes or setting the movement distance.

3.9.7 Writing Your First Program

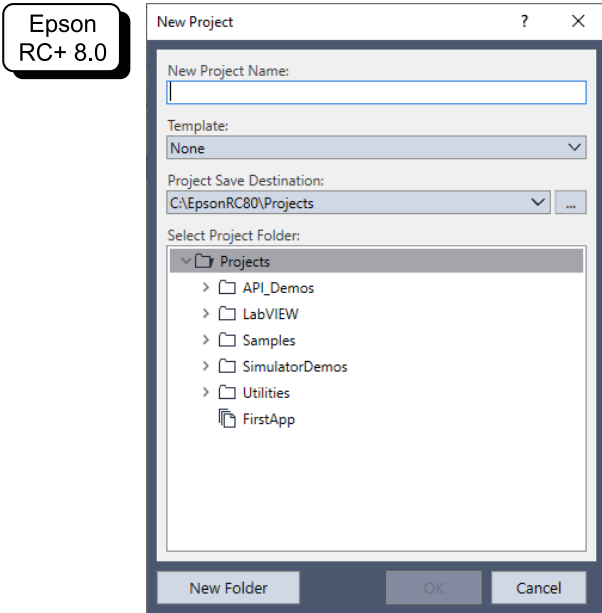
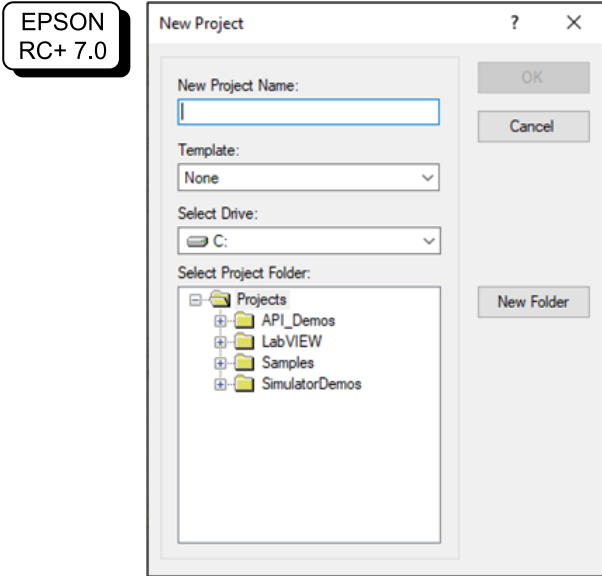
After installing the Controller and robot, and installing the Epson RC+ software on the PC, follow the procedure below to create a simple application program so that you will become more familiar with the Epson RC+ development environment.

1. Start Epson RC+.

Double click the <Epson RC+> icon on the Desktop. Or select from the Windows menu.

2. Create a new project.

i. From the Epson RC+ menu, select [Project] - [New]. The [New Project] dialog box is displayed.



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

iii. Click the [OK] button to create the new project.

When the new project is created, a program called Main.prg is also created.

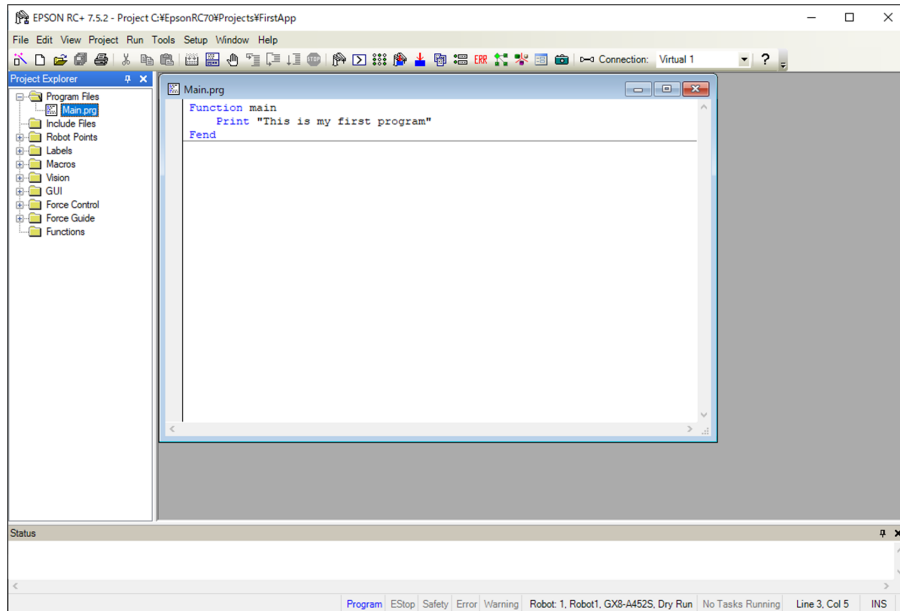
A window titled Main.prg is displayed with a cursor flashing in the upper left corner. Now you are ready to start entering your first program.

3. Edit the program.

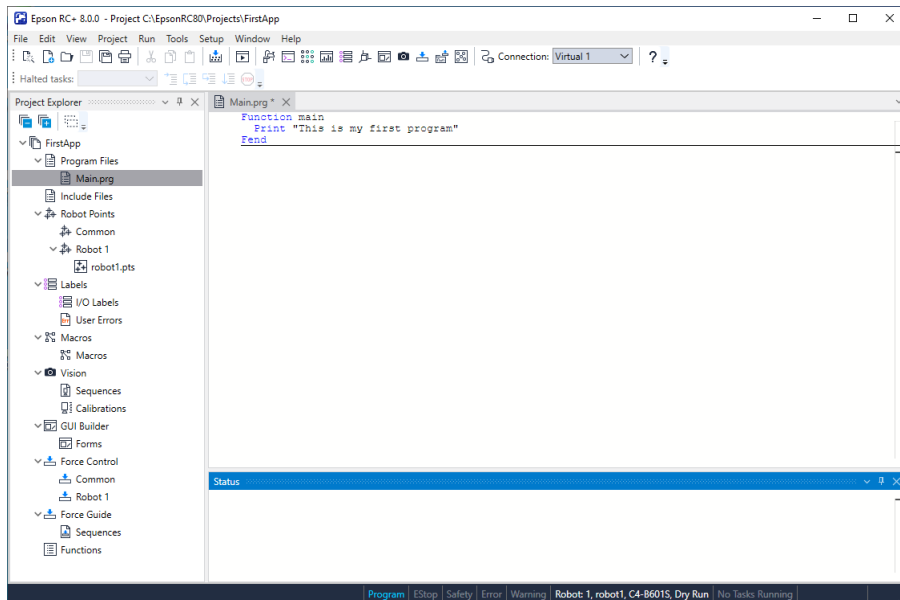
Type the following program lines in the Main.prg edit window.

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

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RC+ 7.0



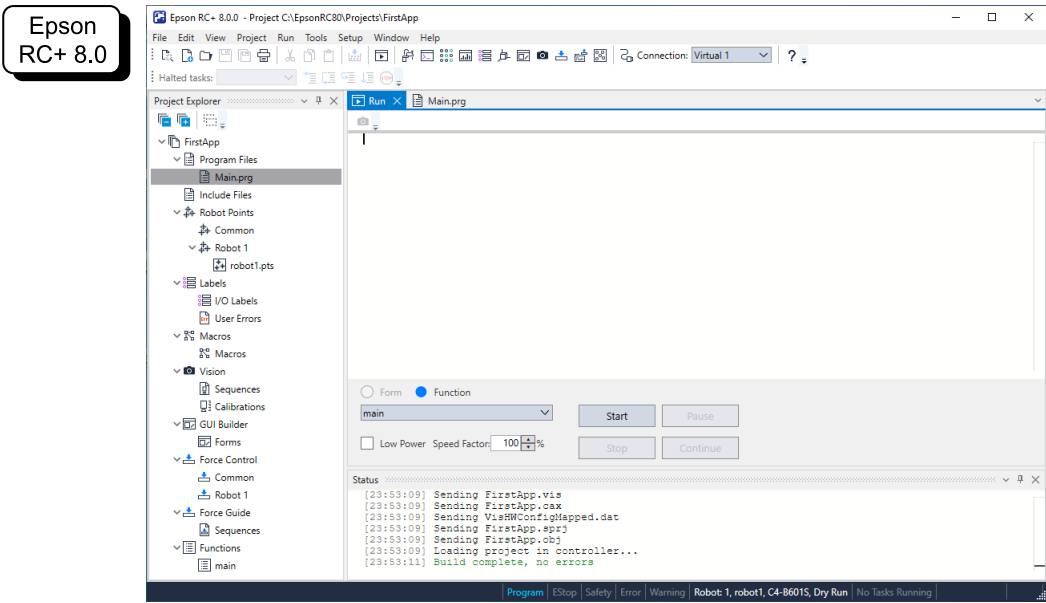
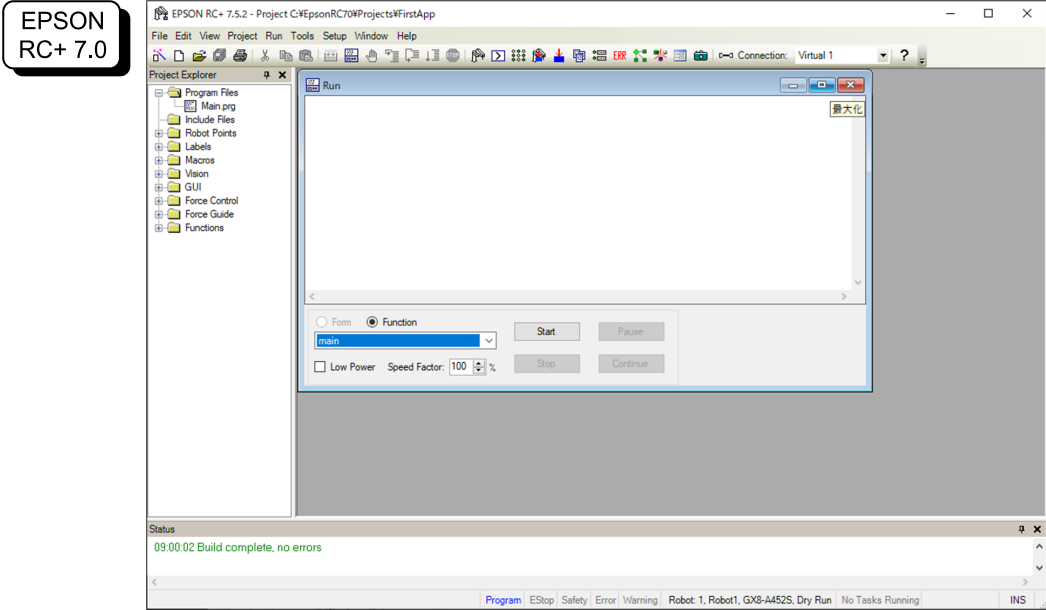
Epson
RC+ 8.0



4. Run the program.

- i. Press F5 to display the Run window. (F5 is the shortcut key for selecting [Run] - [Run Window] in the Epson RC+ menu.) At the bottom of the main window, the Status window appears indicating the build operation status.

ii. During the project building process, your program is loaded into the memory and compiled. Then, the program and project files are sent to the Controller. If there are no errors during the building process, the Run window appears.



iii. Click the [Start] button in the Run window to run the program.

iv. Messages like the following are displayed in the Status window.

Task main started
All tasks stopped

The Run window shows the statement output.

Now let's teach some robot points to create a program that moves the robot.

KEY POINTS

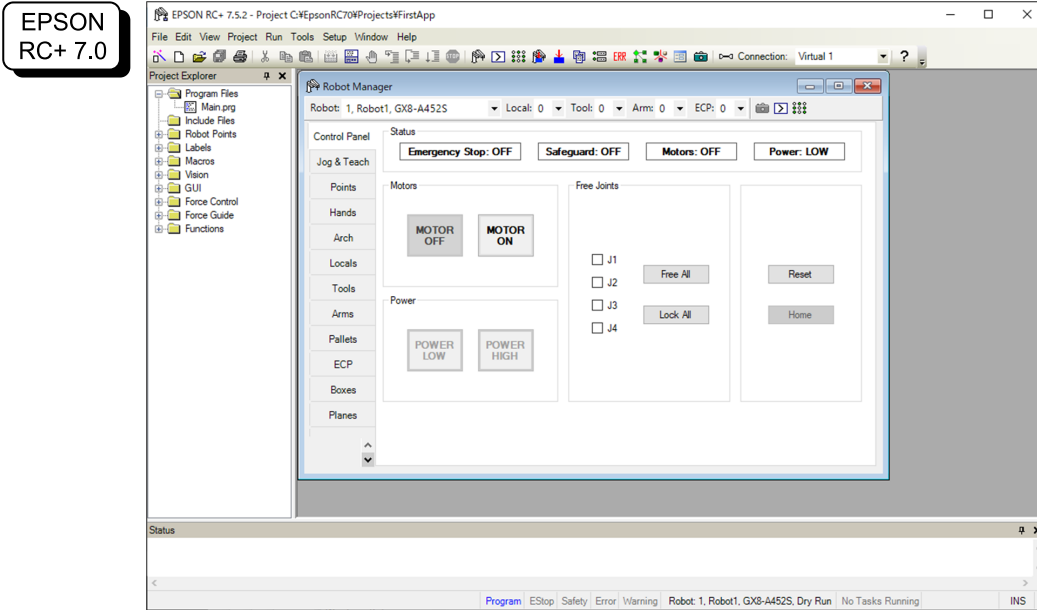
Teaching of this procedure should be done outside the safeguard.

5. Teach robot points.

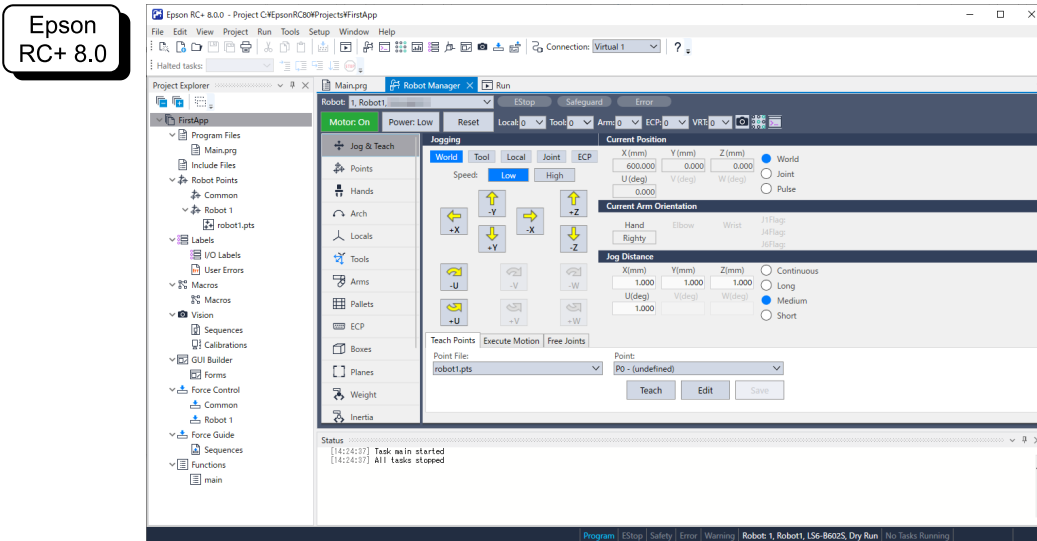
i. Confirm whether safe robot operation is possible. Click the [Robot Manager] button on the toolbar to display the [Robot Manager] window.

ii. Turn ON the motors.

EPSON RC+ 7.0: Click the [Control Panel] tab. Then, click the [MOTOR ON] button to turn on the robot motors. You are prompted to confirm the operation.



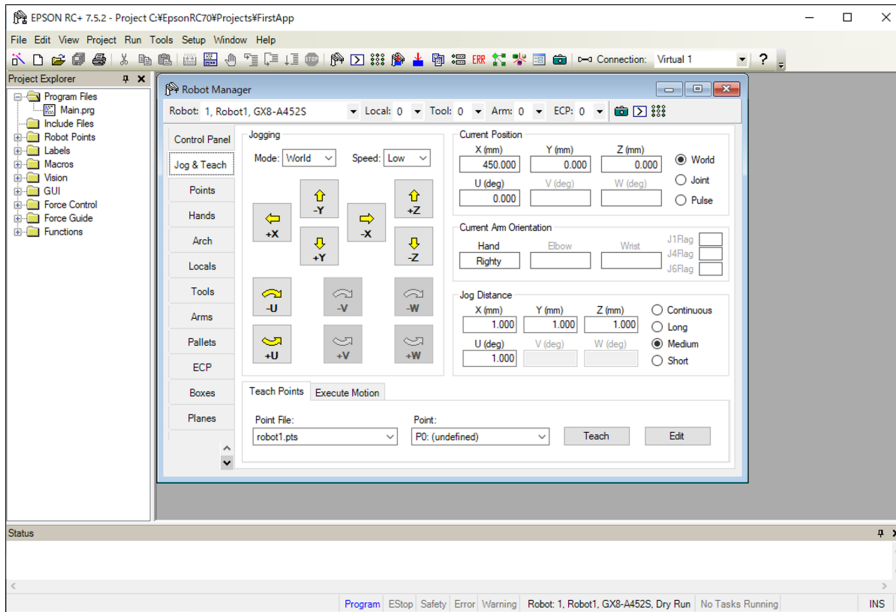
Epson RC+ 8.0: Click the [Motor: Off] button.



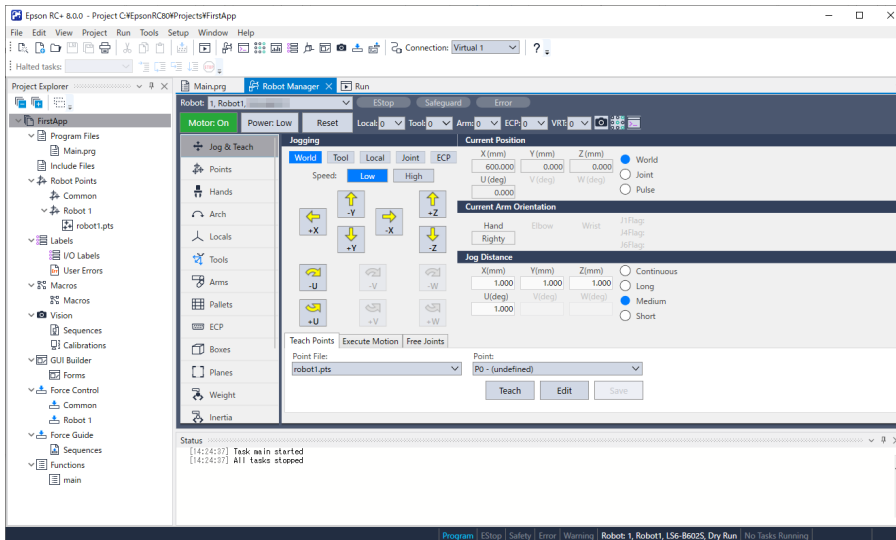
iii. Click the [Yes] button.

iv. Click the [Jog & Teach] tab.

**EPSON
RC+ 7.0**



**Epson
RC+ 8.0**



- v. Click the [Teach] button in the lower right corner of the screen to teach point P0. You are prompted for a point label and description.
- vi. Click the [+Y] jog button to jog the robot in the +Y direction. Hold the button down to keep jogging. Move the robot until it reaches around the middle of the work envelope.
- vii. Click the [-Z] button to lower the Z-axis of the robot.
- viii. Select "P1" in the [Point:] dropdown list, which is next to the [Teach] button. The current point is set to P1.
- ix. Click the [Teach] button. A confirmation message for teaching the point appears.
- x. Click the [Yes] button.
- xi. Click the [+X] button to jog the robot in the +X direction.
- xii. Select "P2" in the [Point:] dropdown list, which is next to the [Teach] button. The current point is set to P2.
- xiii. Click the [Teach] button. A confirmation message for teaching the point appears.
- xiv. Click the [Yes] button.

xv. Click the [Save Project] button on the toolbar to save the changes.

6. Modify the program to include robot motion commands.

i. Insert Go statements into the Main.prg program.

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

ii. Press F5 to display the Run window.

iii. Click the [Start] button to execute the program.

The robot will move to the points that were taught.

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

i. Insert the Power, Speed, and Accel commands as shown in the program below.

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

ii. Press F5 to display the Run window.

iii. Click the [Start] button to execute the program.

iv. The robot will move to each of the points that were taught at 20% acceleration, and deceleration. The Power High statement executes the program to operate the robot with increased speed and acceleration/deceleration.

8. Back up the project and system settings.

Back up the project and the Controller settings of the created program. Backups can be made easily using Epson RC+. It is important to make and store regular backups of your applications onto external media such as a USB memory device.

Backup procedure for project and system settings:

i. From the Epson RC+ menu, select [Project] - [Copy].

ii. In the [Copy Project] dialog box, change the [Destination Drive] box to the desired drive.

iii. Click the [OK] button. The project is copied to the external media.

iv. From the Epson RC+ menu, select [Tools] - [Controller].

v. Click the [Backup Controller] button.

vi. In the [Drive] box, select the desired drive.

vii. Click the [OK] button. The system settings are backed up to the external media.

3.10 Second Step

After actually operating the robot system, make any required settings.

This chapter shows the manuals containing information on the necessary settings and setting procedures.

3.10.1 Connecting with External Equipment

3.10.1.1 Remote Control

Refer to the following section.

[I/O Remote Settings](#)

"Epson RC+ User's Guide - Remote Control"

I/O

Refer to the following section.

[I/O Connector](#)

[Expansion I/O Boards](#)

"Epson RC+ User's Guide - I/O Setup"

Fieldbus I/O (Option)

Refer to the following section.

"Robot Controller Option Fieldbus I/O"

3.10.1.2 Ethernet

Refer to the following section.

[LAN \(Ethernet Communication\) Port](#)

"Epson RC+ User's Guide"

- "Security for Controller Ethernet Connection"
- "Security for Compact Vision CV2-A Ethernet Connection"
- "Security for Feeder Ethernet Connection"
- "Ethernet Communication"

3.10.1.3 RS-232C (Option)

Refer to the following section.

[RS-232C Board](#)

"Epson RC+ User's Guide - RS-232C Communications"

3.10.1.4 Analog I/O Board (Option)

Refer to the following section.

[Analog I/O Board](#)

3.10.1.5 Force Sensor I/F Board (Option)

Refer to the following section.

[Force Sensor I/F Board](#)

3.10.2 Connecting the Development PC and Controller via Ethernet

Refer to the following section.

LAN (Ethernet Communication) Port

"Epson RC+ User's Guide"

- "Security for Controller Ethernet Connection"
- "Security for Compact Vision CV2-A Ethernet Connection"
- "Security for Feeder Ethernet Connection"
- "Ethernet Communication"

3.10.3 Connecting the Teach Pendant (Option)

Refer to the following section.

TP Port

"Robot Controller Option Teach Pendant TP2 manual, Functions & Installation: Installation"

"Robot Controller Option Teach Pendant TP3 manual, Functions & Installation: Installation"

"Robot Controller Option Teach Pendant TP4 manual, Functions & Installation: Installation"

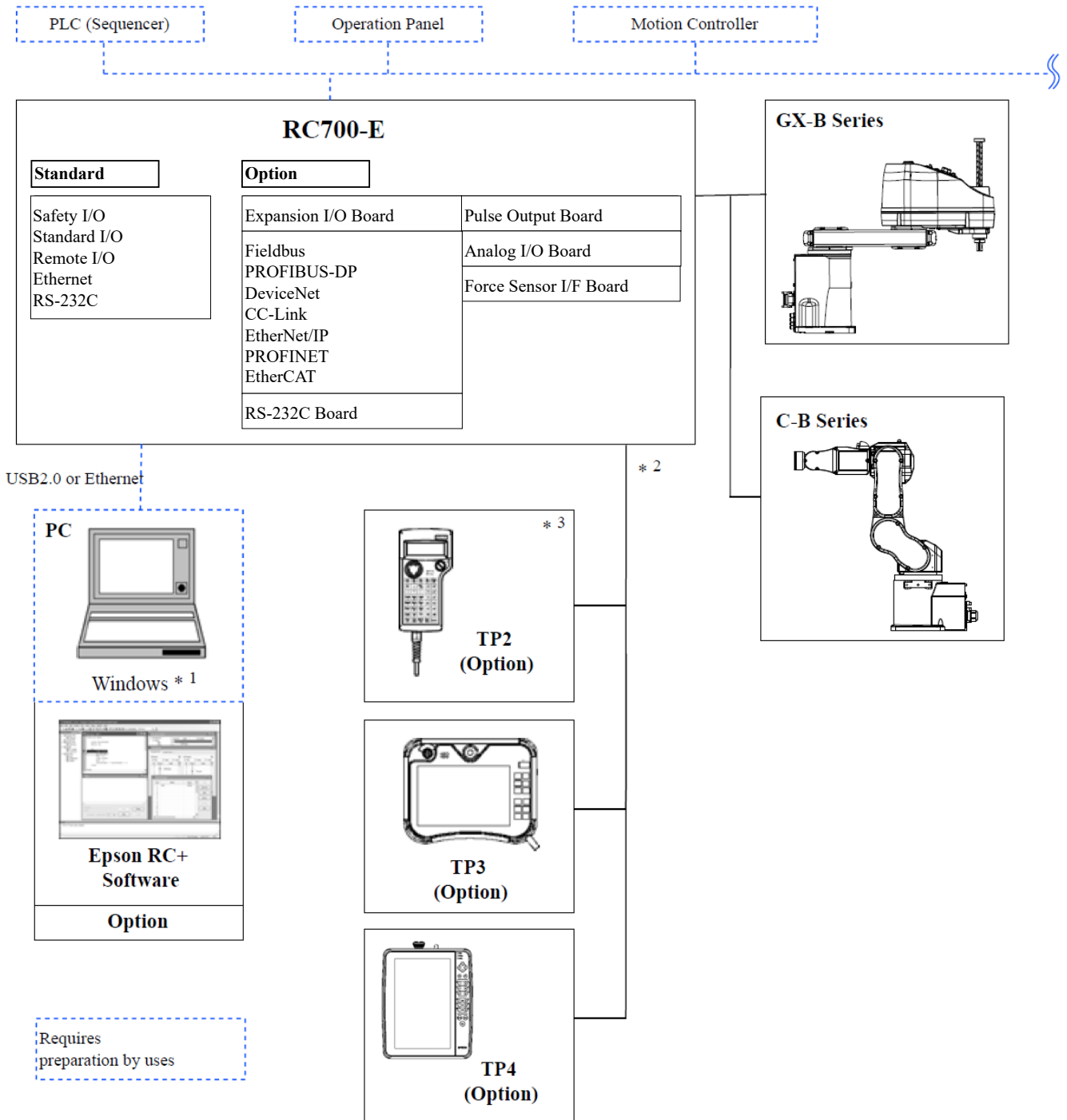
4. Function Information

This section describes each function of the Robot Controller.

This is primarily intended for those who want to learn more about Robot Controllers.

4.1 Specifications

4.1.1 System Configuration Example



*1 For the system requirements, refer to the following manual.
 "Epson RC+ User's Guide"
 *2 One of the Teach Pendants is controlled.
 *3 When connecting to RC700-E, a dedicated conversion cable is required.

4.1.2 Safety Functions

4.1.2.1 Types of Safety Functions

This Controller has third-party certification. The certified safety functions are combined and defined as the following safety functions of Epson.

The safety functions in this manual are described under Controller Safety Function Name.

Controller Safety Function Name		Safety Function Certified by IEC 61800-5-2
STO		STO
Emergency Stop	E-Stop,TP	Emergency Stop
	Safety Input	Safety Input SS1-r & SS1-t
Safeguard (SG)/Safety Door (Protective Stop)		Safety Input SS1-r & SS1-t
Enable		Enable Switch Stop
Soft Axis Limiting		SLP
Safety Outputs	STO	Safety Output
	Emergency Stop	
	Enable	
	SLS (SLS_T, SLS_T2, SLS1-3)	
	SLP (SLP_A-C)	
SLS (SLS_T, SLS_T2, SLS1-3)		SLS
SLP (SLP_A-C)		SLP

4.1.2.2 Safety Functions

The robot system has the following safety functions. Because of their particular importance for safety, always make sure that they are working before using the robot system.

Some safety features are paid options.

Controller Safety Function standard functions:

- **Safe Torque OFF (STO)**
 A signal input from the Robot Controller opens a relay to cut off the power supply to the motors and stop the robot. This is a safe state for the Robot Controller.
 STO is operated indirectly from an emergency stop or protective stop. It will also operate when the Safety board detects abnormalities. It cannot operate directly.
- **Emergency Stop**
 This function allows the robot to perform an emergency stop by a signal input from a safety relay or from an emergency stop switch attached to the emergency stop input connector or safety I/O connector. After the signal is input, an SS1 is executed, and after the motor stops, the robot is in an emergency stop status. During the emergency stop status, EP is

displayed on the 7-segment LED of the Robot Controller.

There are three emergency stop circuits for the Robot Controller:

- Emergency stop input connector (E-Stop)
- Port of the safety I/O connector configured for the emergency stop (Safety Input)
- Emergency stop switch attached to Teach Pendant (E-Stop, TP)

■ **Safeguard (SG) (protective stop)**

This function allows the robot to perform a protective stop by a signal input from a safety peripheral device attached to the safety I/O connector. After the signal is input, the SS1 is executed, and after the motor stops, the robot is in a protective stop status. SO is displayed on the 7-segment LED of the Robot Controller.

The Robot Controller safeguard (SG) circuit is as follows.

- Port of the safety I/O connector configured for the safeguard (SG)

■ **Enable**

Enable is the path connected to the enable switch when the Teach Pendant is connected. Only Epson Teach Pendants can be connected, and customer enable switches cannot be connected.

When the system detects that the enable switch of the Teach Pendant is not in the middle position, the SS1 is executed, and the robot is in an STO state.

■ **Soft Axis Limiting**

This monitors that each axis of the robot is within its operating range. If the system detects that an axis of the robot exceeded the limiting range, the robot emergency stop and STO are immediately executed, putting the Robot Controller in the emergency stop status.

The restricted range for each axis of the robot is set in the dedicated software (Safety Function Manager).

■ **Safety outputs**

External safety devices can be connected to the safety outputs of the Robot Controller to perform notifications of the ON/OFF status of the safety functions.

By assigning settings in the dedicated software (Safety Function Manager), the following safety signals can be output:

- STO state
- Status of the emergency stop switch
- Status of the enable switch
- Enabled/disabled status of the Safety Limited Speed (SLS)
- Enabled/disabled status of the Safety Limited Position (SLP)

Controller Safety Function charged optional functions:

■ **Safety Limited Speed (SLS)**

This monitors the operating speed of the robot. If the system detects that the robot exceeded the Maximum Speed, the robot emergency stop and STO are immediately executed, putting the Robot Controller in the emergency stop status.

The safety speed limit of the robot is set in the dedicated software (Safety Function Manager).

KEY POINTS

The speed monitoring function during teaching can be used as a standard function.

■ **Safety Limited Position (SLP)**

This monitors the robot's position and joint angles. If the system detects that the robot exceeded the monitored areas or joint angle limit, the robot emergency stop and STO are immediately executed, putting the Robot Controller in the emergency stop status.

The Monitored Areas and Joint Angle Limit of the robot are set in the dedicated software (Safety Function Manager).

4.1.2.3 Safety Parameters

The equipment manufacturer should select peripherals that can meet Cat. 3 PLd using the following values.

Common parameters

Safety Status	Type of Element	Proof Test Interval	DC	PL and Category	SIL and HFT
STO	B	20 years	Medium	PLd, Cat.3	SIL2, HFT1

Parameters for safety functions (for a SCARA robot)

Controller Safety Function Name		Enable Mode	Stop Category	SFF	PFHd 10 ⁻⁷	Response Time (ms)	
Emergency Stop	E-Stop, TP	ALL	1	98.6%	1.9	690	
	Safety Input	ALL	1	98.6%	2.0	690	
Safeguard (SG)/Safety Door (Protective Stop)		AUTO	1	98.6%	2.0	700	
Enable		TEACH TEST	1	98.6%	1.9	690	
Soft Axis Limiting		AUTO	1	98.6%	1.9	80	
Safety Outputs	STO	ALL	-	99.4%	1.4	680	
	Emergency Stop	E-Stop, TP	ALL	-	99.4%	1.1	20
		Safety Input	ALL	-	99.4%	1.1	20
	Enable	ALL	-	99.4%	1.1	20	
	SLS	ALL	-	99.4%	1.1	50	
	SLP	ALL	-	99.4%	1.1	50	
SLS		ALL	1	98.6%	1.9	80	
SLP		AUTO TEST	1	98.6%	1.9	80	

The B10D values for switches provided by Epson are as follows:

- Emergency Stop switch (Option and TP): 250,000
- Enable switch: 1,000,000

Parameters for safety functions (for a 6-Axis robot)

Controller Safety Function Name		Enable Mode	Stop Category	SFF	PFHd 10 ⁻⁷	Response Time (ms)	
Emergency Stop	E-Stop, TP	ALL	1	98.7%	2.1	690	
	Safety Input	ALL	1	98.8%	2.1	690	
Safeguard (SG)/Safety Door (Protective Stop)		AUTO	1	98.8%	2.1	700	
Enable		TEACH TEST	1	98.7%	2.1	690	
Soft Axis Limiting		AUTO	1	98.7%	2.1	80	
Safety Outputs	STO		ALL	-	99.5%	1.5	680
	Emergency Stop	E-Stop, TP	ALL	-	99.4%	1.1	20
		Safety Input	ALL	-	99.5%	1.1	20
	Enable		ALL	-	99.4%	1.1	20
	SLS		ALL	-	99.5%	1.1	50
	SLP		ALL	-	99.5%	1.1	50
SLS		ALL	1	98.7%	2.1	80	
SLP		AUTO TEST	1	98.7%	2.1	80	

The B10D values for switches provided by Epson are as follows:

- Emergency Stop switch (Option and TP): 250,000
- Enable switch: 1,000,000

4.1.3 Specifications Table

Item	Specifications			
Machine name	Robot Controller			
Product series	RC700-E			
Model	R114A: For GX4 Series R114B: For GX8 Series, GX10 Series, GX20 Series R114D: For C4-B Series R114E: For C8-B Series, C12-B Series			
Number of control axes	AC servomotor 6 axes			
Robot Manipulator control	Programming language and robot control software	Epson RC+ (multitasking robot language)		
	Joint control	Up to 6 axes simultaneously Software AC servo control		
	Speed control	During PTP control	Programmable from 1 to 100%	
		During CP control	Can be programmed by specifying actual speed	
	Acceleration/deceleration control	During PTP control	Programmable from 1 to 100% and auto acceleration	
		During CP control	Can be programmed by specifying actual acceleration	
Operation method	PTP (Point-To-Point) method CP (Continuous Path) method			
Storage capacity	Maximum object size	4 MB		
	Point data area	1,000 points/file		
	Backup variable area	Max. 100 kB (including management table area) About 1,000 variables can be used However, this varies depending on the size of array variables and other factors		
External I/O signals (standard)	Safety I/O	Inputs	5, redundant path	Assigned functions can be changed by the "Safety Function Manager"
		Outputs	3, redundant path	
	Standard I/O	Inputs	24	8 inputs/8 outputs have remote function assignments Assignments can be changed
		Outputs	16	

Item	Specifications			
	R-I/O	Inputs	2	-
Communication interface (standard)	Ethernet	1 channel		
RS-232C port	1 port			
Options (up to 3 slots)	Expansion I/O	Inputs	24/board	3 boards can be added
		Outputs	16/board	
	Communication interface	RS-232C	2ch/board	2 boards can be added* ¹
		Fieldbus I/O	1ch/board	One board can be added from those at left
		PROFIBUS-DP DeviceNet CC-Link EtherNet/IP PROFINET EtherCAT		
		Force sensor I/F	1ch/board	
	Pulse output	Number of control axes: 4 axes/board		3 boards can be added
Analog I/O	SKU1	Output 1ch	3 boards can be added from those at left	
	SKU2	Output 2ch		
		Input 2ch		
Protective functions *2	Low power mode, dynamic braking, overload detection, torque error detection, speed error detection, position deviation overflow detection, CPU error detection, speed deviation overflow detection, overheat detection, memory error detection, fan error detection, relay melting detection, overvoltage detection, low AC power voltage detection, temperature abnormality detection			
Power supply	200 VAC to 240 VAC Single phase 50/60 Hz			
Maximum rated capacity	2.5 kVA (varies depending on Manipulator model)			
Full load current	15.0 A			
Short-circuit current rating	5 kA			
Maximum allowable fault loop impedance	TN: 0.32 Ω TT: 200 Ω			

Item	Specifications	
Insulation resistance	100 MΩ min.	
Ambient temperature	Installation	5 to 40°C
	Transportation, storage	- 20 to 60°C
Ambient relative humidity	Installation	20 to 80% (with no condensation)
	Transportation, storage	10 to 90% (with no condensation)
Weight *3	12 kg	
Protection class	IP20 (top surface IP3X *4)	
Vibration resistance	Frequency: 10 to 57 Hz Amplitude: 0.075 mm Frequency: 57Hz to 150 Hz Acceleration: 9.8 m/s ² 10 times each in X, Y, and Z directions	
Shock resistance	Acceleration: 50 m/s ² Applied time: 30 ms 3 times each in X, Y, and Z directions	
Overvoltage category	2	
Pollution level	2	

*1 When using the force sensor I/F board, the RS-232C board can be expanded to a maximum of one board and two ports.

*2 Thermal memory function is not provided.

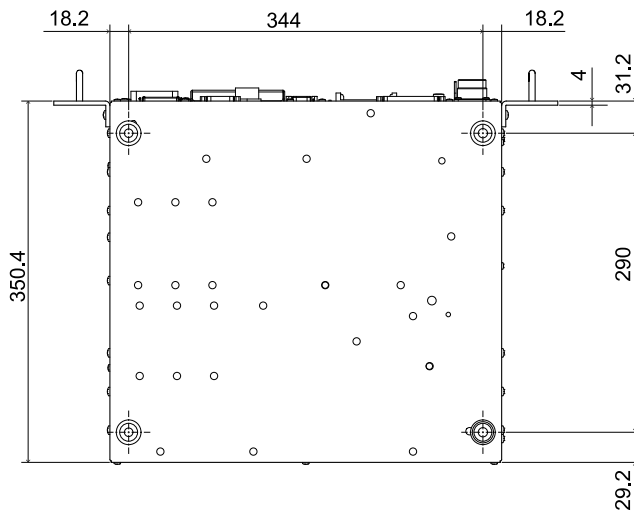
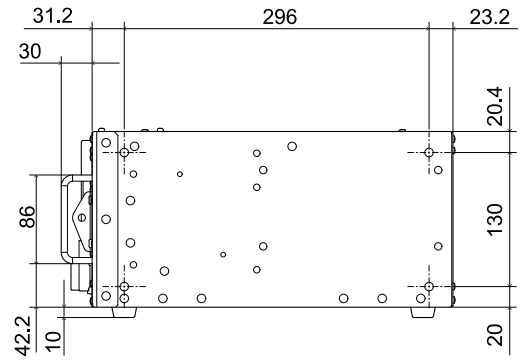
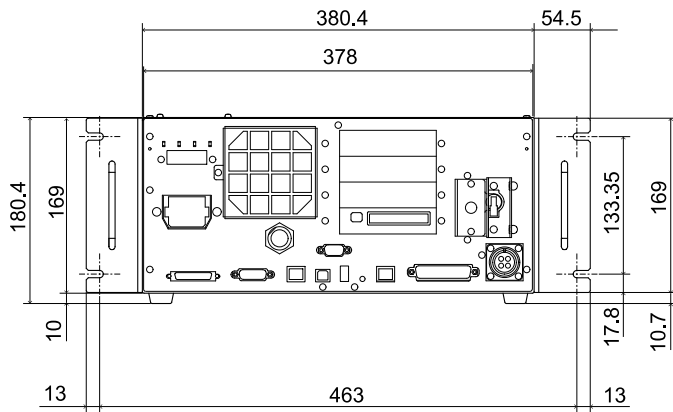
*3 The Controller body is labeled with the weight.

When transporting or relocating the Controller, check the weight and be careful not to hurt your back when lifting it. Also, be careful not to pinch or injure your hands, feet, or other body part due to dropping it.

*4 No restrictions on installation method.

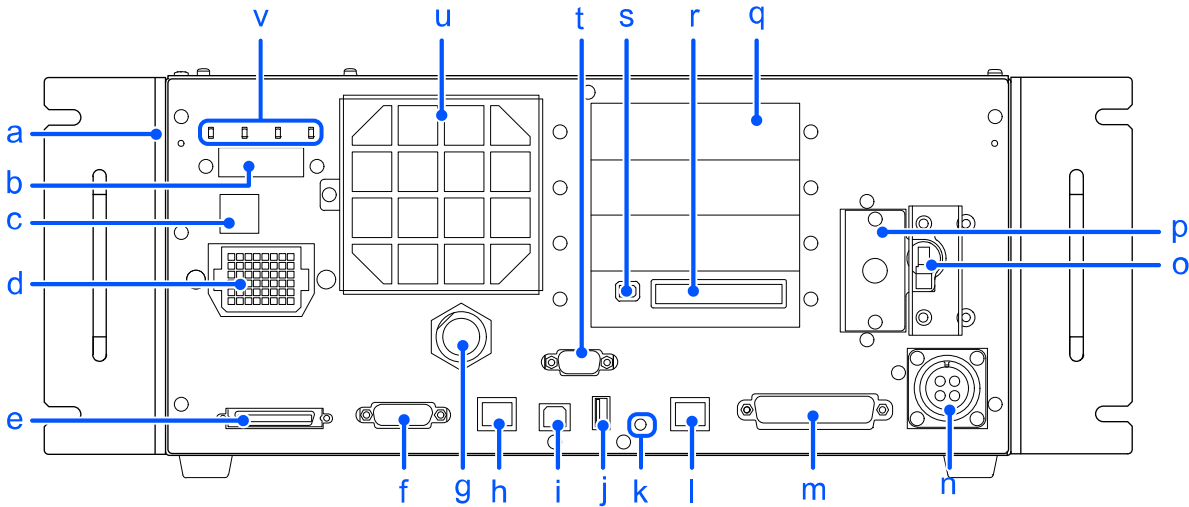
4.1.4 Dimensions

(Units: mm)



4.2 Part Names and Their Functions

RC700-E



[a] Face plate label

This label contains the Controller's serial number and other information.

[b] 7-segment display

This is a 4-digit, 7-segment LED that is used to indicate the line number, and the Controller status (error number, warning number, emergency stop, or safeguard status).

Refer to the following section.

LED and 7-segment LED

[c] Serial number label for connected Manipulator

This label indicates the Manipulator to be connected.

It contains the Manipulator model and serial number.

MANIPULATOR	
GXxxxxx	00001

[d] M/C POWER connector

This is the power supply connector for the Manipulator.

Connect the power cable supplied with the Manipulator to this connector.

[e] M/C SIGNAL connector

This connector is for signals such as a motor position detector for Manipulators.

Connect the signal cable supplied with the Manipulator.

[f] R-I/O connector

This connector is for connecting input signals required for real-time I/O functions.

[g] TP port

This port is for connecting the optional Teach Pendant (TP2, TP3, TP4) or the Teach Pendant (TP) bypass plug.

Refer to the following section.

TP Port

KEY POINTS

Do not connect the following devices to the TP port of RC700-E. The different signal arrangement could cause a breakdown in the device.

- Dummy plug (optional device)
- Operation Pendant OP500
- Operator Pendant OP500RC
- Jog Pad JP500
- Teaching Pendant TP-3**
- Operator Panel OP1
- Teach Pendant TP1

[h] OUT connector

This connector is used to connect a force sensor (option).

[i] Development PC connection USB port

This port is for connecting the Controller and development PC with a USB cable.

Do not connect any device other than the development PC.

Refer to the following section.

[Development PC Connection USB Port](#)

[j] Memory port

This port is for connecting a USB memory device (commercially available) and using the Controller Backup function. Do not connect any USB devices other than USB memory devices.

Refer to the following section.

[Memory Port](#)

[k] Trigger switch

This switch is for the "Controller Backup" function to a USB memory device.

Refer to the following section.

[Memory Port](#)

[l] LAN (Ethernet communication) port

This port is for connecting the Controller and development PC with an Ethernet cable.

Communication is possible by 100BASE-TX/10 BASE-T.

Refer to the following section.

[LAN \(Ethernet Communication\) Port](#)

[m] I/O connector

This connector is used for connecting external input/output devices. Up to 24 inputs and 16 outputs can be connected.

Refer to the following section.

[I/O Connector](#)

[n] AC power supply

This connector is used to input a 200 VAC power supply.

Refer to the following section.

[Power Supply - AC Power Cable](#)

[o] POWER switch

This is the power switch for the Controller.

[p] Battery

This is the lithium battery for data backup.

[q] Option slots

These slots are for mounting dedicated optional boards (expansion I/O board, Fieldbus I/O board, RS-232C board, pulse generator board, analog I/O board, and force sensor I/F board). Three slots are available.

Refer to the following section.

[Option Slots](#)**[r] Safety I/O connector**

These connectors are for safety-related input signals such as emergency stop and safeguard and for output signals that can be connected to safety PLCs and similar devices.

Refer to the following section.

[Safety I/O Connector](#)**[s] Emergency stop input connector**

This port is a dedicated connector for emergency stop signal input.

Refer to the following section.

[Emergency Stop Input Connector](#)**[t] Standard RS-232C connector**

This connector is for RS-232C communication with external devices.

Refer to the following section.

[Standard RS-232C Connector](#)**[u] Cooling fan filter**

This is the dust filter. It is mounted in front of the cooling fan.

Filters should be inspected periodically for dirtiness and cleaned as necessary.

Leaving the filter dirty may cause the inside of the Controller to overheat or may cause a malfunction of the robot system.

[v] LED

The LED corresponding to the current operation mode is turned on.

(TEST, TEACH, AUTO, PROGRAM)

Refer to the following section.

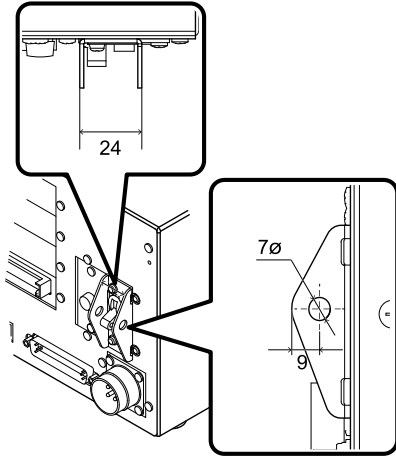
[LED and 7-segment LED](#)

Lockout mechanism

A mechanism is provided to lock out the power switch when the Controller is turned off for maintenance or other work. Provide a padlock of a size that can be attached to the lockout plates.

Lockout plate hole diameter: 7 mm

Lockout plate width: 24 mm

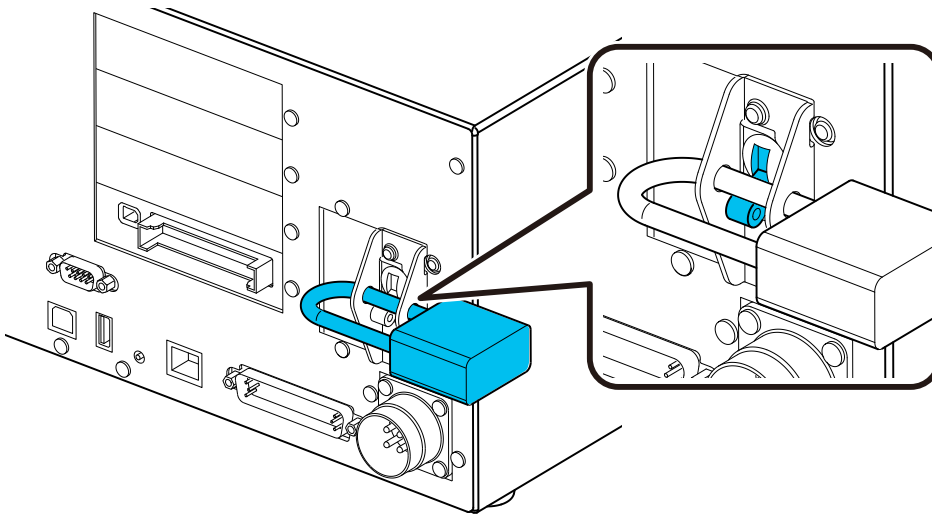


Follow the following steps to perform a lockout.

1. With the power off, insert the padlock into the holes in the lockout plates. As shown in the figure, the padlock should be above the POWER switch.

CAUTION

Do not lock out with power on. It is very dangerous because the power cannot be turned off.



2. Keep the padlock locked.

4.2.1 LED and 7-segment LED

4.2.1.1 LED and 7-segment LED Display

The Controller has 4 LEDs and a 4-digit, 7-segment LED

- LED
The LEDs (TEST, TEACH, AUTO, PROGRAM) corresponding to the current operation mode (TEST, TEACH, AUTO, PROGRAM) turn on.

- 7-segment LED

This displays line numbers and the Controller status (error number, warning number, emergency stop, and safeguard status).

From immediately after power-on until Controller startup

- LED

All four LEDs blink.

- 7-segment LED

All 4-digit 7 segments are turned off.

After Controller startup

- LED

The LEDs (TEST, TEACH, AUTO, PROGRAM) corresponding to the current operation mode (TEST, TEACH, AUTO, PROGRAM) turn on.




- 7-segment LED

The displayed information changes depending on the Controller status.

If several Controller conditions occur at the same time, the displayed information on the top row takes precedence. For example, if an "emergency stop state" and "safeguard open state" occur simultaneously, the display will be as shown below.



Controller State	7-segment LED Display	
Executing Controller state save to USB memory device	The following two are displayed repeatedly 	
Saving of Controller state to USB memory device was successful	00 is displayed (for two seconds) 	
Saving of Controller state to USB memory device failed	EE is displayed (for two seconds) 	
Error state	4-digit error number (0.5 second) and EEEE are displayed (0.5 second) repeatedly 	*1
Warning state	4-digit warning number (0.5 second) and HELP are displayed (0.5 second) repeatedly 	*1
Emergency stop state	EP is displayed 	Blinking display
Safeguard open state	SO is displayed 	Blinking display

Controller State	7-segment LED Display		
READY state		Blinking display	
START state	L and Line number 	Blinking display	*2
PAUSE state	P and Line number 	Blinking display	*2

*1 For error numbers, please refer to the following manual or online help.

"Status Code/Error Code List"

*2 In the initial state, the execution line of task number 1 is displayed in 3 digits.






The task number that is displayed can be changed with a Ton statement.

For details, refer to the following manual or online help.

"Epson RC+ SPEL+ Language Reference"

4.2.1.2 Displays of Special States

When the 7-segment display shows the following details, it indicates a special state.

7-Seg Display	State	Remedy
	Controller startup process failed	When Initialize Error occurs, restart the Controller. If the Initialize Error is still displayed even after restarting the Controller, please contact the supplier.
	Controller startup process failed	When Initialize Error occurs, restart the Controller. If the Initialize Error is still displayed even after restarting the Controller, please contact the supplier.
	Display: 9999 The Controller is in recovery mode	Refer to the following to do the recovery. Appendix B: Troubleshooting-Controller Recovery
	Display: 9998 AC power drop detected, Controller software was ended	Check the AC power voltage. If this occurs after maintenance, confirm that each harness is properly connected to the board.
	Display: 9997 Epson RC+ (software) or the Teach Pendant (optional) issued a command to exit the software.	-

4.2.2 Protective Functions

The robot system is equipped with protective functions operated by the software to protect peripheral devices and the robot system itself. However, these functions are only intended for unexpected events.

- **Low power mode**

This mode keeps a low motor output.

Execution of a power mode change command allows changing to a restricted state (low power mode) regardless of whether

the safeguard is opened or closed and regardless of the operation mode. Low power mode ensures operator safety and reduces the risk of destruction and damage to peripheral equipment due to careless operation.

- **Dynamic braking**

The dynamic brake circuit consists of a relay that short-circuits the motor power wire at the motor side (brake action).

When an emergency stop is input, or when the following abnormalities are detected, the dynamic brake is activated to stop motor rotation. (Encoder disconnection detection, overload detection, torque error detection, speed error detection, position deviation overflow detection, speed deviation overflow detection, CPU error detection, memory error detection, overheat detection)

- **Overload detection**

This detects a motor overload state.

- **Torque error detection**

This detects abnormalities in the motor torque.

- **Speed error detection**

This detects abnormalities in the motor speed.

- **Position deviation overflow detection**

This detects abnormalities in the difference between the motion command and the current position.

- **Speed deviation overflow detection**

This detects abnormalities in the difference between the speed command and actual speed.

- **CPU error detection**

A watchdog timer is used to detect abnormalities in the CPU that controls the motor. Also, the CPU that manages the system in the Controller and the CPU that controls the motor constantly monitor each other's status.

- **Memory error detection**

This detects checksum errors in memory.

- **Overheat detection**

This detects temperature abnormalities in the motor driver module.

- **Relay melting detection**

This detects melting or open failure of relay contacts.

- **Overvoltage detection**

This detects overvoltage errors in the Controller.

- **AC power voltage drop detection**

This detects a drop in the power supply voltage.

- **Temperature error detection**

This detects abnormalities in the Controller temperature.

- **Fan error detection**

This detects abnormalities in the fan speed.

4.3 Installation

4.3.1 Bundled Accessories

- Teach Pendant (TP) bypass plug: 1
- EMERGENCY connector short plug: 1
- Safety I/O connector: 1
- I/O port 50-pin (female connector shell): 1 set
- Rack mount plate (for left and right side): 1 set
- Power cable: 1
- USB cable fixing bracket: 1

4.3.2 Installation Requirements

WARNING

- Do not disassemble the product in areas not described in the manual or perform maintenance in a manner different from these procedures. Improper disassembly or maintenance may not only lead to a malfunction in the robot system, but can also cause serious safety issues.

CAUTION

- Manipulators and Controllers should be used under the environmental conditions described in the respective manual. This product is designed and manufactured for use in a normal indoor environment. Use of the product in an environment that does not meet the operating environmental conditions will not only shorten the product life, but may also cause serious safety issues.

4.3.2.1 Installation Environment

A suitable environment is necessary to maintain the functionality of the robot system and ensure its safe use. The Controller should be installed in a location that meets the following conditions.

CAUTION

- The Controller is not designed with cleanroom specifications. If it must be installed in a cleanroom, adequate measures must be taken for the environment, such as by enclosing the Controller in a cabinet with adequate ventilation and cooling.
- Install the Controller in a location near an outlet that allows easy connection and disconnection of power cables.
- Install the Controller outside the safety barriers.
- If there are conductive objects such as fences or ladders within 2.5 meters of the Controller, these objects must be grounded.
- This product should be used in an overvoltage category 2, pollution degree 2 environment.

- **Ambient temperature**
5 to 40°C
- **Ambient relative humidity**
20 to 80% (with no condensation)
- **Fast transient burst noise**
2 kV or less (power supply wire)
1 kV or less (signal wire)
- **Electrostatic noise**
4 kV or less
- **Base table**
 - The Controller should be installed 0.4 to 2 meters above the floor for ease of maintenance.
 - The power shut-off switch should be installed at a height of 0.6 to 1.9 meters from the floor.
- **Installation surface**
Inclination 0.5° or less
(If installed vertically, the Controller may fall over when touched.)
- **Altitude**
2,000 m or less

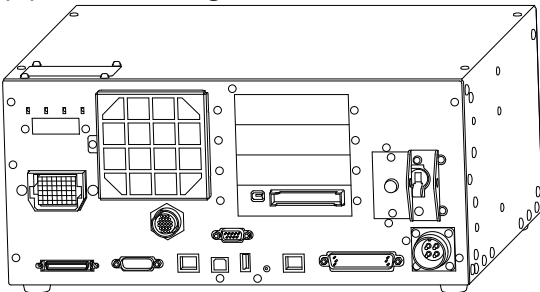
If the Controller must be installed in an environment that does not satisfy the conditions below, adequate countermeasures must be taken for the environment, such as by enclosing the entire Controller in a cabinet with adequate ventilation and cooling.

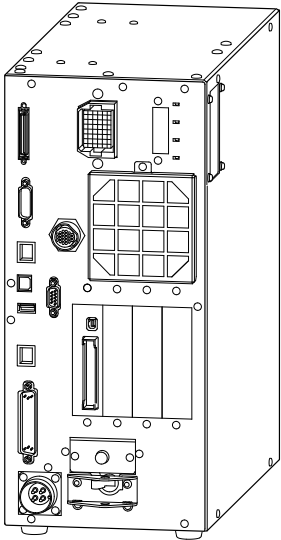
- Indoor, well-ventilated area
- Not exposed to direct sunlight
- Not exposed to radiant heat
- Not exposed to air that contains dust, oily mist, oil smoke, salt, metal powder, corrosive gas, or other contaminants
- Not exposed to splashing of water
- Not exposed to impacts or vibrations
- Not exposed to relays, contactors, or other sources of electronic noise
- Not exposed to strong electric or magnetic fields

4.3.2.2 Installation Method and Space

Install the Controller on a flat surface (such as a wall, base table, and Controller box) in the orientation shown in (A) to (C).

(A) Flat mounting

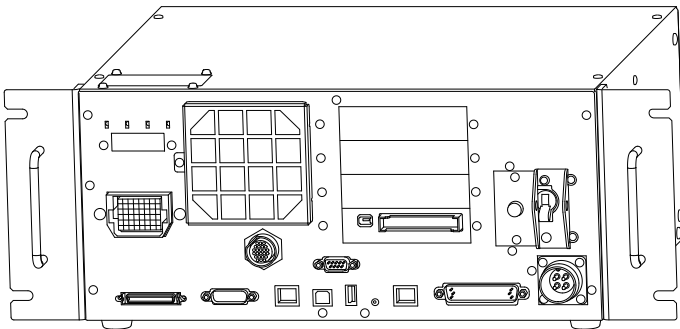


(B) Vertical mounting

* The rubber feet on the bottom need to be replaced. Attach the rubber feet with the flat side facing the Controller. Remove the screws that contact the rubber feet.

The size of the screws securing the rubber feet is M4 × 8.

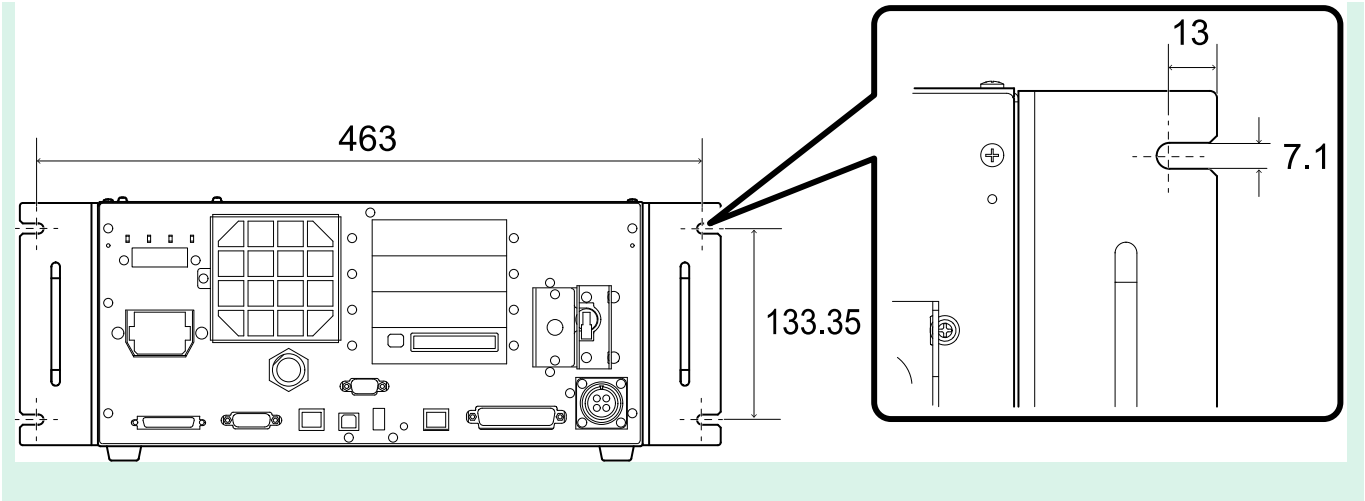
Be careful to not lose the screws when replacing the rubber feet. Do not use screws with a different size.

(C) Rack mounting

* A plate for rack mounting is required.

 KEY POINTS

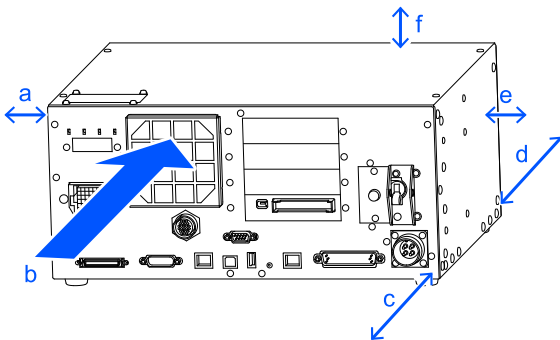
To install the Controller to a Controller box or the base table, drill screw holes with the dimensions shown in the figure below.



- To ensure proper ventilation around the supply and exhaust ports, install the Controller at a position that is the following distance away from other equipment and walls.

(A) Flat mounting, (C) Rack mounting

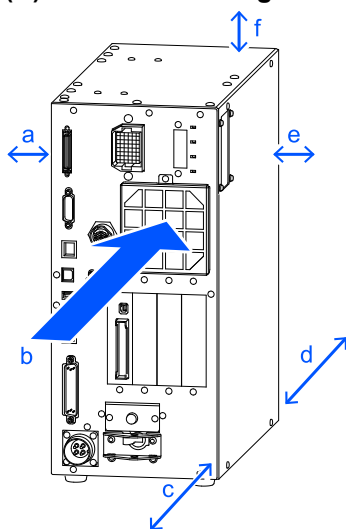
(Illustration shows flat mounting.)



Symbol	Description
a	50 mm
b	Controller fan air direction
c	200 mm (excluding mounting surfaces such as base tables)
d	100 mm
e	50 mm
f	50 mm *

* Leave a space of at least 200 mm to ensure easy access for maintenance.

(B) Vertical mounting



Symbol	Description
a	50 mm
b	Controller fan air direction
c	200 mm (excluding mounting surfaces such as base tables)
d	100 mm
e	50 mm *
f	50 mm

* Leave a space of at least 200 mm to ensure easy access for maintenance.

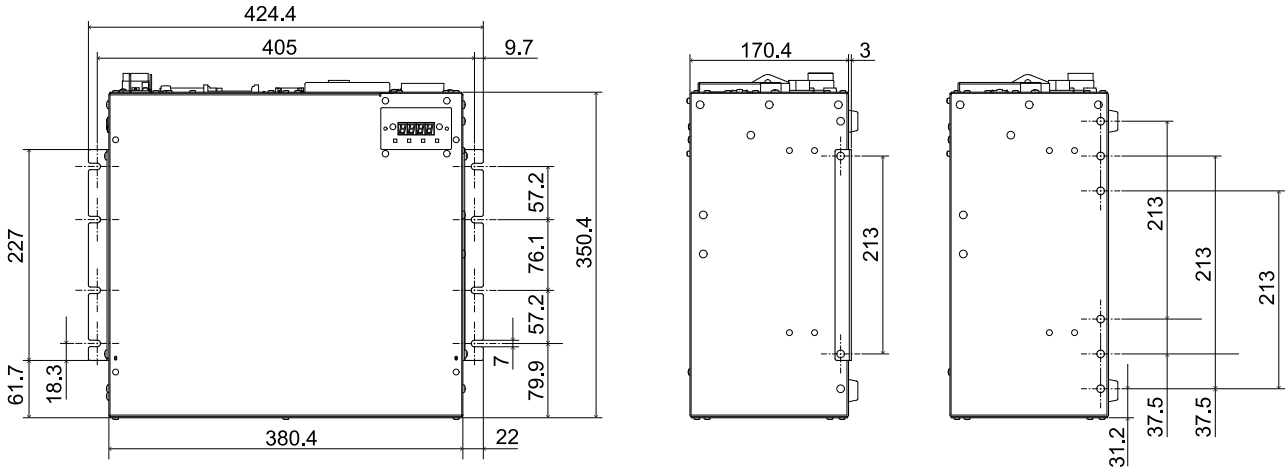
- The Controller's exhaust port blows out air at a temperature about 10°C higher than the ambient temperature. Make sure that heat-sensitive devices are not placed near the exhaust port.
- Route the cables so that the Controller can be pulled out in the forward direction.

4.3.2.3 Wall Mounting Option

The Controller has a wall mounting option. For more information, please contact the supplier.

Controller dimensions after using the wall mounting option

Dimensions of mounting holes for the wall

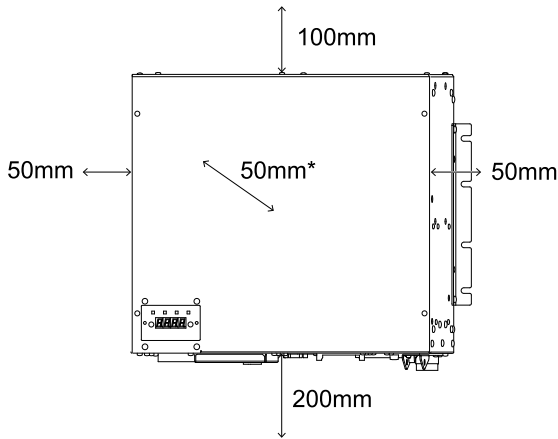


(Units: mm)

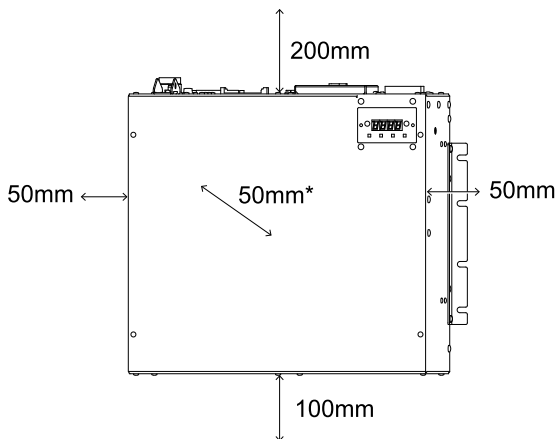
To ensure proper ventilation around the supply and exhaust ports, install the Controller at a position that is the following distance away from other equipment and walls.

* Leave a space of at least 200 mm to ensure easy access for maintenance.

Wall mounting with the front side down



Wall mounting with the front side up



4.3.3 Power Supply

4.3.3.1 Power Supply Specifications

Prepare an AC power supply that meets the following specifications.

Item	Specifications
Rated voltage	200 to 240 VAC ($\pm 10\%$)
Number of phases	Single phase
Frequency	50/60 Hz
Guaranteed time for momentary power interrupt	10 ms or less
Rated capacity *1	Maximum: 2.5 kVA The actual rated capacity depends on the type of Manipulator and its operation and load. For the approximate rated capacity of each model, refer to the following values. GX4: 1.2 kVA GX8: 2.2 kVA GX10: 2.4 kVA GX20: 2.4 kVA C4-B: 1.7 kVA C8-B: 2.5 kVA C12-B: 2.5 kVA For the rated capacity of the Manipulator motor, refer to the following manual. " "Manipulator Manual"
Rated current	R114A, R114B: 6.9 A R114D, R114E: 8.5 A
Full load current	15 A
Short-circuit current rating	5 kA
Inrush current	At power-on: Approx. 85 A (2 ms) At motor on: Approx. 75 A (2 ms)
Leakage current	Less than 3.5 mA
Overvoltage category	2

*1 This is calculated based on the peak current during cycle operation.

Install a circuit breaker (double-pole interruption type) with a rated current of 15 A or less in the AC power line.

If installing a circuit breaker, be sure to use an inverter type that is insensitive to leakage currents at frequencies above 10 kHz.

If installing a circuit breaker, select one that can withstand the above inrush current.

The power receptacle should be installed as close as possible to the equipment and where the plug can be easily connected and disconnected.

This product should be used in overvoltage category 2 or pollution degree 2 environments.

When installing a transformer, select one that meets the following specifications Refer to the following for connections.

AC Power Cable

Item	Specifications
Capacity	3.5 kVA or less
% Impedance	2.1% or more

If installed in North America, the transformer overload protection should be in accordance with NFPA 70.

The requirements of EN 60364-4-41 must be satisfied under the following conditions.

TN

Product name	CB, CP, NFB Rated current	System voltage
RC700-E	15A	200V

When connecting the controller and Manipulator, use the MC cable specified by Epson.

TT *1, *2

Product name	Circuit breaker *3 Rated current	Circuit breaker *3 Rated sensitivity current ($I\Delta n$)	System voltage	Maximum allowable fault loop impedance *4
RC700-E	15A	30mA	200V	200 Ω

*1 The rated sensitivity current and maximum allowable fault loop impedance may be specified by the regulatory authorities.

Follow their instructions if any.

*2 Type B circuit breakers may be required.

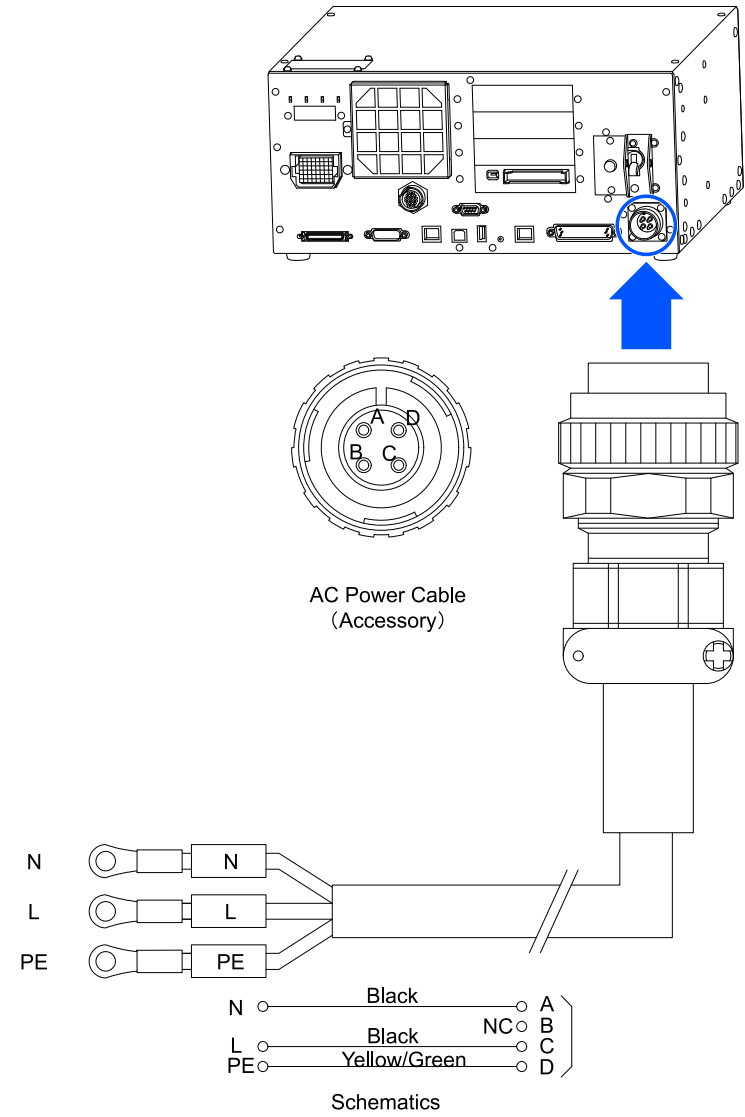
*3 A circuit breaker is required outside of the Controller. Evaluated using the NV50-SVFU. An equivalent product can also be used.

*4 Including ground resistance.

4.3.3.2 AC Power Cable

- ⚠ WARNING**
- All work operations should be performed by people with specialized knowledge and skills in the field.
 - The ground wire (green/yellow) of the AC power cable must be connected to the ground terminal of the power distribution system. If the ground wire is improperly connected to ground, it may result in the electric shock.
 - Always use a power plug or a disconnecting device for the power connection cable. Never connect the Controller directly to the factory power supply.
 - Select a plug or disconnecting device which complies with the safety standards of the respective country.
 - When connecting to a transformer, connect the N and PE terminals of the AC power cable to the neutral terminal of the transformer.

When connecting the plug of the AC power cable to the Controller, insert until it clicks into place as shown in the figure below.



Connect the power supply as shown in the table below.

Identification Label	Connection Point
N	Neutral
L	Live
PE	Protective earth

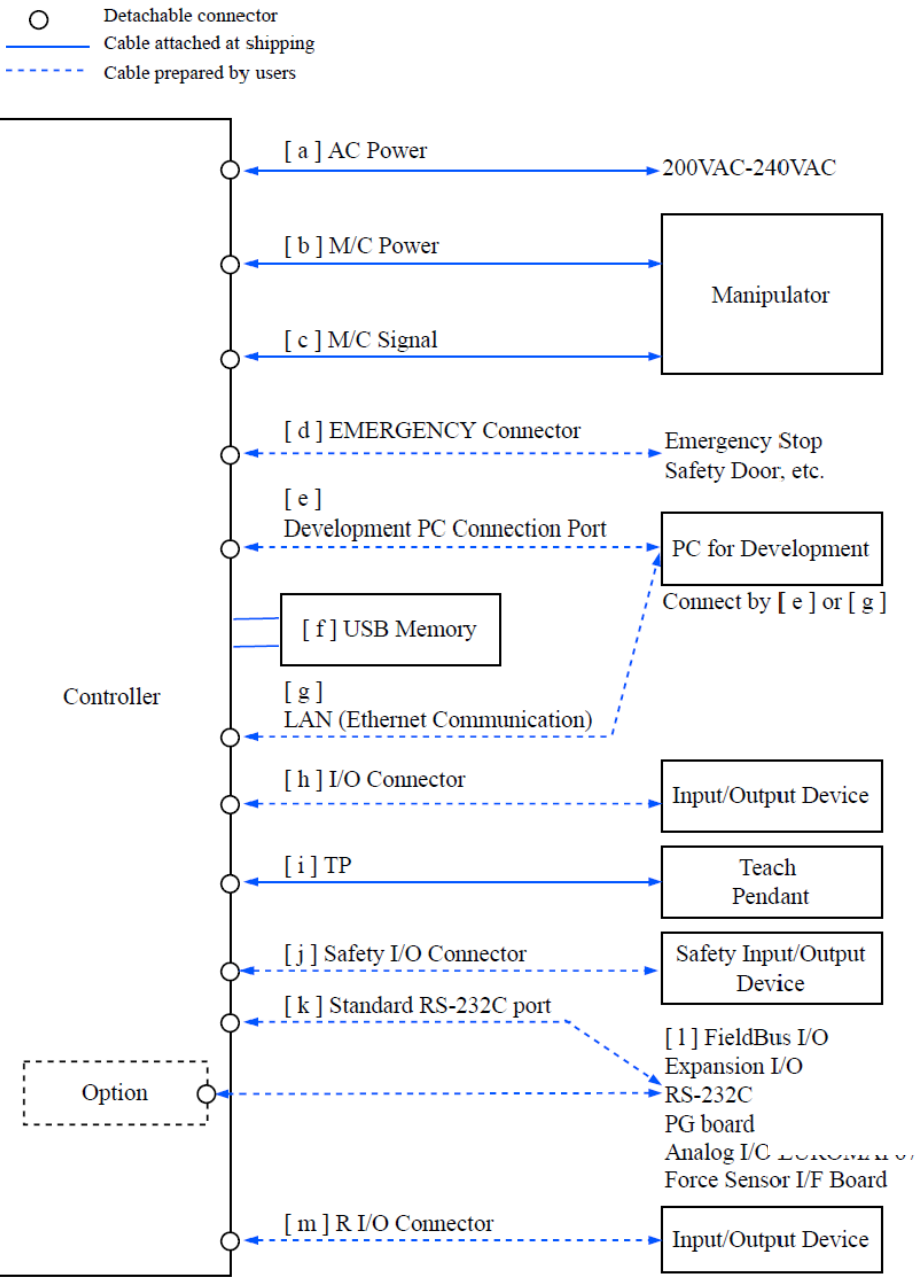
Specifications

Item	Specifications
Cable length	3 m
Wire diameter	AWG 14 / 2.5 mm ²
Terminal	M4 round terminal
Recommended tightening torque	1.2 N·m *

*: The tightening torque should be determined after checking the specifications of the plug to be used.

4.3.4 Connecting the Cables

4.3.4.1 Connection Example



[a] AC power supply
 This connector supplies 200 VAC power to the Controller.

[b] M/C power
 The Controller side of the cable has a connector.
 Connect to the M/C POWER connectors on the Manipulator and the Controller. Insert the Controller connector until it clicks into place.

[c] M/C signal
 The Controller side of the cable has a connector.
 Connect to the M/C SIGNAL connectors on the Manipulator and the Controller.

[d] Emergency stop input connector

This port is used to connect an emergency stop switch.

For safety reasons, be sure to connect the appropriate switch to the emergency stop input connector or safety I/O connector.

Refer to the following section.

[Emergency Stop Input Connector](#)

[Safety I/O Connector](#)

[e] Development PC port

This port is used to connect the development PC.

Refer to the following section.

[Development PC Connection USB Port](#)

[f] USB memory device

This port is used to connect a USB memory device.

Refer to the following section.

[Memory Port](#)

[g] LAN (Ethernet communication)

Connect the Ethernet cable.

Refer to the following section.

[LAN \(Ethernet Communication\) Port](#)

[h] I/O connector

This port is used to connect user input/output devices.

An external input/output device is connected to this connector.

I/O connectors include I/O cables (option) and terminal blocks (option).

Refer to the following section.

[I/O Connector](#)

[i] TP

This port connects the optional Teach Pendant.

Refer to the following section.

[TP Port](#)

[j] Safety I/O connector

This port connects safety input/output devices. The safety I/O connector is a push-in type connector.

Refer to the following section.

[Safety I/O Connector](#)

[k] Standard RS-232C connector

This connector is for RS-232C communication with external devices.

Refer to the following section.

[Standard RS-232C Connector](#)

[l] Fieldbus I/O

Fieldbus I/O cables should be provided with EMC protection if necessary.

Refer to the following section.

[Key Points for Noise Reduction](#)

[m] R-I/O connector

This connector is for connecting input signals required for real-time I/O functions.

This port is used to connect user input/output devices.

Refer to the following section.

[R-I/O Connector](#)

4.3.4.2 Connecting Controllers and Manipulators

A power cable and signal cable are used to connect the Controller to the Manipulator.

WARNING

- Before connecting or disconnecting cables, be sure to turn off the Controller and unplug the power cable. Connecting or disconnecting cables while the power is on may result in an electric shock or malfunction.
- Be sure to connect the cables properly. Also, protect cables by using strong cable covers, and do not place heavy objects on the cables, bend them to extreme angles, pull them forcibly, or allow them to get pinched. Damaged cables, broken wires, or contact failure is extremely hazardous and may result in electric shock and/or malfunction of the robot system.

CAUTION

- The serial number of the supported Manipulator is labeled on the Controller. Check that the serial number matches for each device. Improper connection between the Manipulator and the Controller may not only lead to malfunction of the robot system but also safety problems.
- When connecting the Manipulator and the Controller, check that the serial numbers match for each device. Improper connection between the Manipulator and the Controller may not only lead to malfunction of the robot system but also serious safety problems. The connection method between the Manipulator and the Controller varies depending on the Controller.

The Manipulator model and various setting values are stored in the Controller. For this reason, connection must be performed to the Manipulator with the serial number indicated on the serial number label on the front face of the Controller.

KEY POINTS

The serial number of the Manipulator is shown on the Manipulator's face plate. For details, refer to the following manual.

"Manipulator Manual"

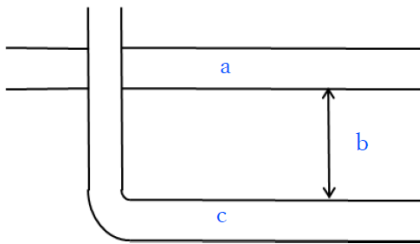
4.3.5 Key Points for Noise Reduction

Our robot controller and Manipulator is a product designed with the premise of being incorporated into mechanical devices. The EMC compatibility of mechanical devices, that has our products incorporated into them, changes depending on the structure of the device, wiring, and positioning in the customer’s environment. Therefore, evaluation of the EMC compatibility as a final product should be done by the customer.

Below describes things to be careful about regarding the structure, wiring, and location of the device, in order to not be affected by noise as possible or not cause them at all.

AC Power Cable

- The power supply must be grounded to a class D ground (grounding resistance of 100 Ω or less).
Grounding of the Controller frame is important not only for the purpose of preventing electric shock, but also to reduce the effects of electrical disturbances from the surrounding area. The ground wire (green/yellow) of the Controller power cable must be connected to the ground terminal of the power distribution system.
- Power should be supplied as far as possible away from power lines connected to equipment which may be a source of noise.
- If the Controller and single-phase AC motor are powered from the same power line, change the phase.
- Power lines should be twisted pair.
- AC and DC lines should be housed in different ducts and as far apart as possible.
For example, AC motor power lines and Controller power lines should be as far away as possible from I/O lines for devices such as sensors and valves, and both should not be bundled together with cable ties.
If the lines are crossed, they should be crossed perpendicularly.



Symbol	Description
a	Dedicated AC line duct
b	Keep as far apart as possible
c	Dedicated DC line duct

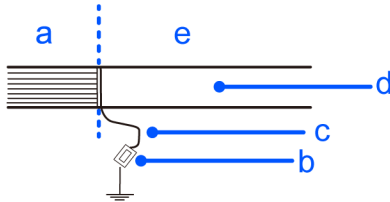
Communication Signal Cables

- Make sure to always use cables with shields for communication signal cables such as I/O, safety I/O, USB, Ethernet, RS-232C, and fieldbus, and keep them as far away as possible from noise sources in the surrounding area.
- When using inductive load components such as relays and solenoid valves for Controller I/O, use components that have noise protection.
If the component is not protected from noise, be sure to attach a diode or other noise-protection component immediately before the inductive load. Select noise protection components that match the withstand voltage and current according to the inductive load.

- For AC motors such as conveyors (induction motors, 3-phase induction motors, etc.), be sure to insert a spark suppressor between the wires when starting, switching forward/reverse rotation, and so on. Putting it between the lines and as close as possible to the motor will also increase its effectiveness.
- The following EMC measures should be implemented for the MC cable, and each communication cable (Ethernet, fieldbus, etc.) if necessary. Below are some examples:

- Lead wire countermeasure example

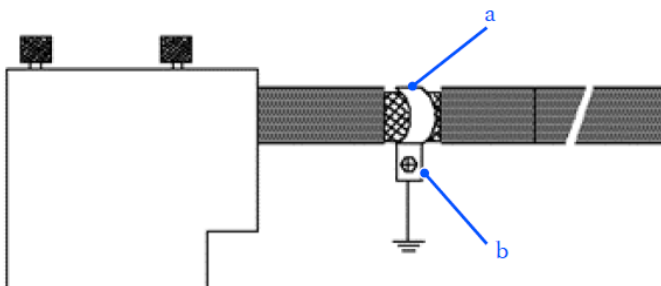
Partially remove the external cover of the cable near the connector and let the shield be revealed.
 Reveal the shield near the connector as possible.
 Ground the part of the shield that is revealed and the chassis with a lead wire.
 Use lead wires that is less than 5 cm.
 When performing grounding, do so near the connector rather than the strain relief side.



Symbol	Description
a	Connector side
b	Crimp terminal
c	lead wire (5cm or less)
d	Shielded cable
e	Strain relief side

- Clamp countermeasure example

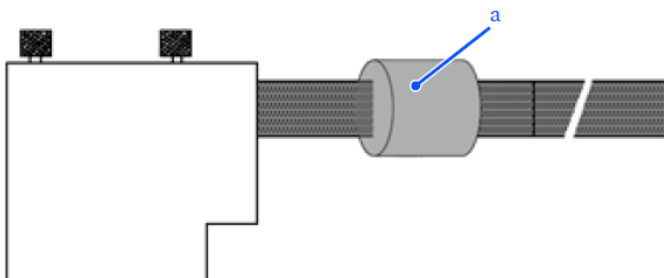
Partially remove the external cover of the cable near the connector and let the shield be revealed.
 Reveal the shield near the connector as possible.
 Put the part of the shield that is revealed between the conductivity clamp and secure it to the chassis with a screw.
 Implementing on both sides of the cable enhances the effect.



Symbol	Description
a	Seiwa Electric earth clamp (E0808A, E0817AD)
b	Screw into the Controller and ground it

- Ferrite core countermeasure example

Insert the ferrite core near the connector as possible.
 If necessary, increase the number of turn when inserting the ferrite core. Implementing on both sides of the cable enhances the effect.



Symbol	Description	Countermeasure Cables
a	Kitagawa industry: GTFC-41-27-16	Fieldbus, LAN
	Kitagawa industry: RFC-20 Kitagawa industry: MRFC-13 Takeuchi industry: NFT-20-20DK	MC power
	Kitagawa industry: NRFC-6 Kitagawa industry: MRFC-8 Takeuchi industry: NFT-8	MC signal

Manipulator

- To secure the Manipulator to the base table, refer to the following:
“Manipulator Manual” -Base table
- Ground one or multiple parts of the base table with a lead wire.
Use short lead wires as much as possible.

4.4 Operation Modes (TEACH, AUTO, TEST)

4.4.1 Overview of Operation Modes

The robot system has three modes.

WARNING

- When teaching, a supervisor should be positioned outside the safety barriers so that the robot can be stopped immediately if an anomaly occurs.

Before teaching, visually confirm that there are no hazards, such as the presence of a third party inside the safety barriers.

▪ **TEACH mode**

This mode is used to approach the robot and teach or check point data using a Teach Pendant.

In this mode, the robot always operates in a low-power state.

In addition, speed at 250 mm/s or less is monitored.

▪ **AUTO mode**

This mode is for automatic operation (program execution) of the robot system during factory operation.

In this mode, robot operation and program execution are prohibited when the safeguard is open.

▪ **TEST mode**

• (T1)

In this mode, program verification is performed with the enable switch held down and the safeguard open.

It is a low-speed program verification function (T1: Manual deceleration mode) as defined in the safety standard.

In this mode, the specified function can be executed at low speed with multitasking/single-tasking.

In addition, speed at 250 mm/s or less is monitored.

• (T2)

In this mode, program verification is performed with the enable switch held down and the safeguard open.

Unlike TEST/T1, the program can be verified at high speed.

In this mode, the specified function can be executed at high speed with multitasking/single-tasking.

KEY POINTS

- To use the low-speed program verification function (T1: Manual deceleration mode) and the high-speed program verification function (T2: Manual high-speed mode) defined in the safety standard, a Teach Pendant that supports the function is required.

For more information on Teach Pendants, refer to the following manuals.

"Robot Controller Option Teach Pendant TP2"

"Robot Controller Option Teach Pendant TP3"

"Robot Controller Option Teach Pendant TP4"

4.4.2 Switching Operation Modes

WARNING

- Operation is switched between TEACH mode and AUTO mode by the mode selector keyswitch on the Teach Pendant. When switching modes, be sure to switch when outside the safety barriers to avoid hazards.
- Before selecting AUTO mode, restore any paused safeguard functions.

▪ **TEACH mode**

When the mode selector keyswitch is switched to "TEACH," operation is set to TEACH mode.

Switching to TEACH mode during program execution aborts program execution.

Also, if the robot is operating, it will come to an immediate stop. (Quick Pause)

▪ **AUTO mode**

After closing the safeguard, switch the mode selector keyswitch to "AUTO," and turn on the latch release input signal to set to AUTO mode.

▪ **TEST mode**

• **TP3, TP4 T1**

Set the mode selector keyswitch to "TEACH/T1" to enter TEACH mode. Tap the [Test] tab to enter T1 mode.

• **TP3, TP4 T2**

Set the mode selector keyswitch to "TEACH/T2" to enter TEACH mode. Tap the [Test] tab to enter T2 mode. If a password has been set, enter the password.

WARNING

- When the mode is switched from TEACH to AUTO, the message "Workers must leave the safeguard area" appears on the Teach Pendant display. Please ensure safety when performing work operations.

KEY POINTS

- The TEACH mode status is latched by software.

To switch mode from TEACH to AUTO, a latch release input is required.

Refer to the following section.

Connecting as Safeguard

- When the mode is switched using the mode selector keyswitch, the motor is turned off. When switching from TEACH mode to AUTO mode, the latch must be released.
- To switch modes using the mode selector keyswitch, set the enable switch to OFF.

An error occurs when the mode is switched using the mode change keyswitch and the motor is turned on while the enable switch is turned on. If this happens, turn off the enable switch once, turn on the enable switch again, and then turn on the motor.

4.4.3 Program Mode (AUTO)

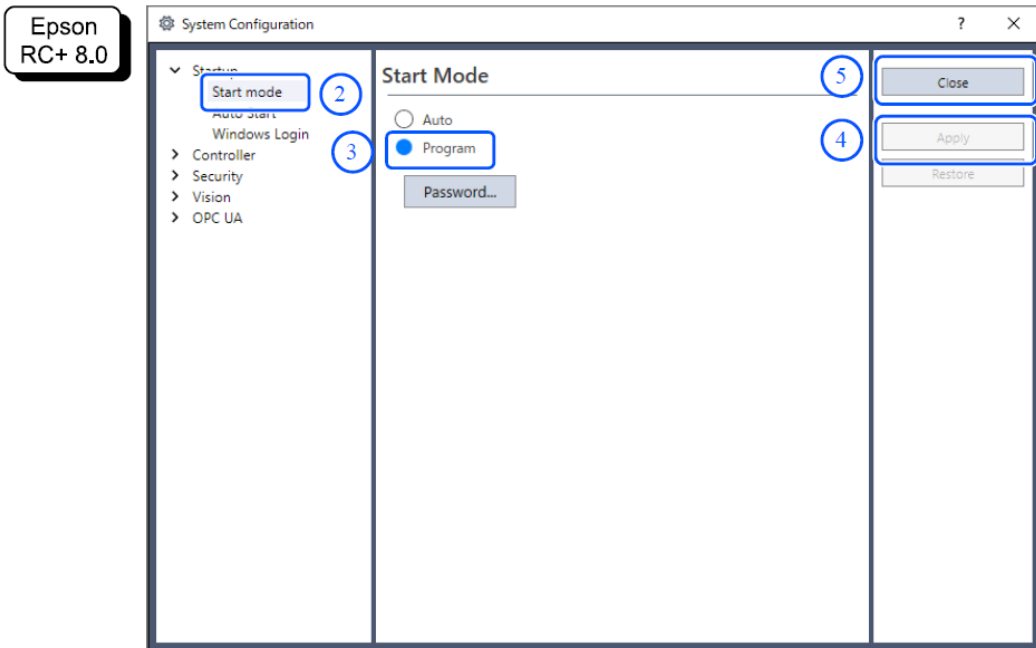
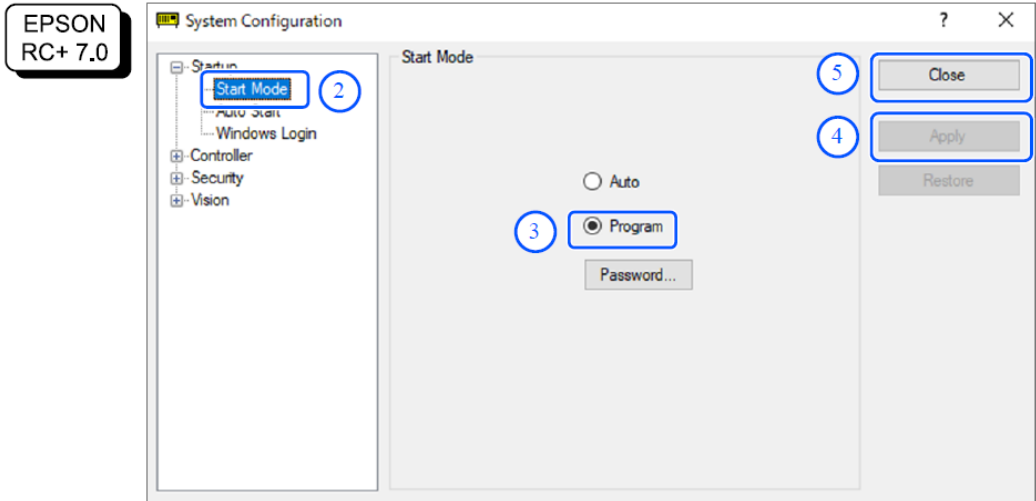
4.4.3.1 What is Program Mode (AUTO)?

Program mode is for programming, debugging, adjusting, and conducting maintenance on the robot system. The following procedure is used to enter program mode.

4.4.3.2 Settings from Epson RC+

This section describes the procedure for entering program mode from Epson RC+.

1. In the Epson RC+ menu, select [Setup] - [System Configuration] to display the [System Configuration] dialog box.



2. Select [Startup] - [Start Mode].
3. Select the [Program] button.
4. Click the [Apply] button.
5. Click the [Close] button.

4.4.4 Automatic Operation Mode (AUTO)

4.4.4.1 What is Automatic Operation Mode (AUTO)?

Automatic operation mode is for automatic operation of the robot system.

There are two ways to enter automatic operation mode.

- A
Set the start mode of Epson RC+ to "Operator mode," and start Epson RC+. (Settings from Epson RC+)
- B
Set Epson RC+ to offline.

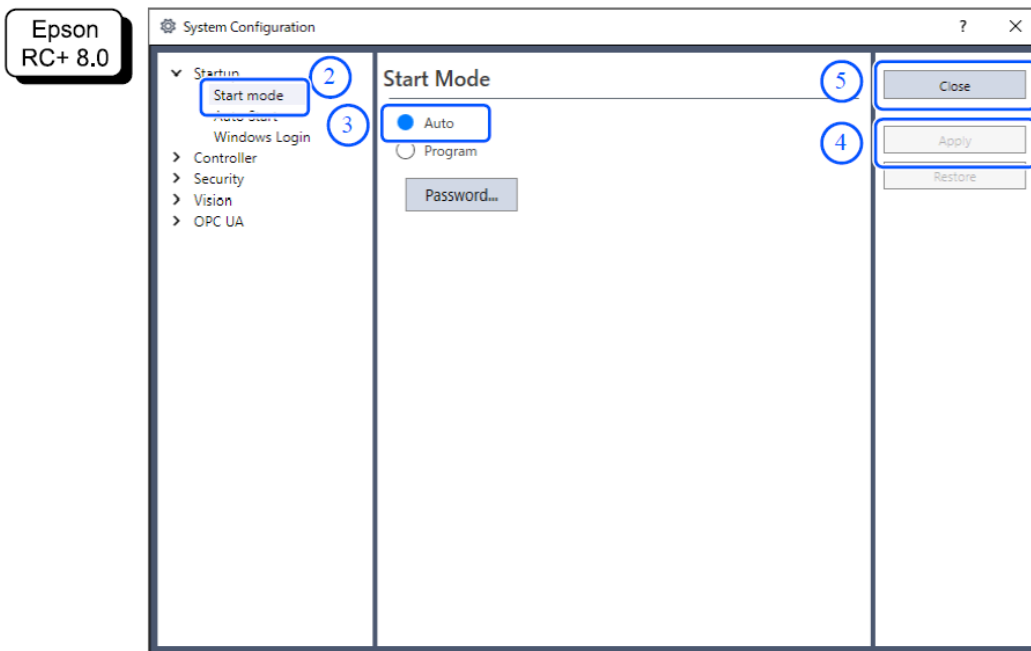
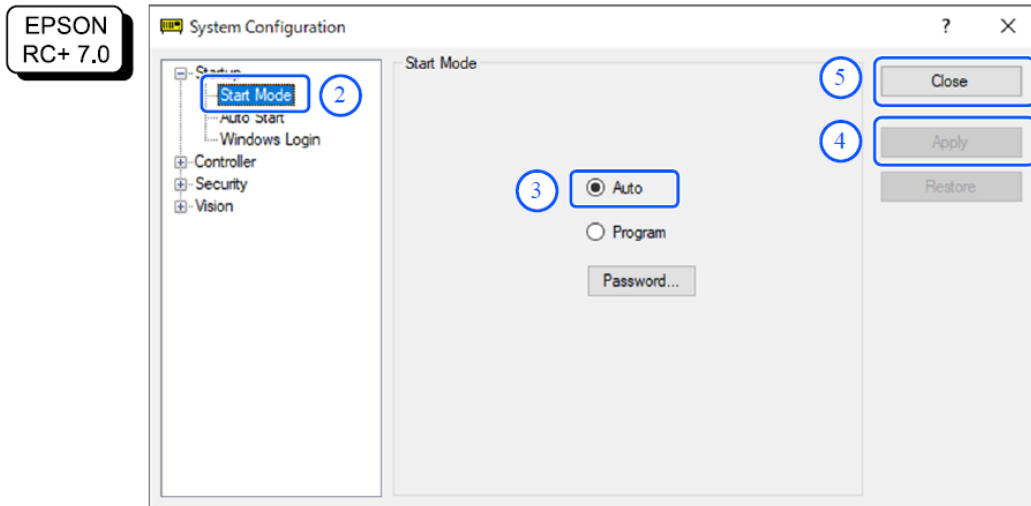
KEY POINTS

Programs can be executed and stopped by the control device specified from Epson RC+. (Control device settings)

4.4.4.2 Settings from Epson RC+

This section describes the procedure for entering automatic operation mode from Epson RC+.

1. In the Epson RC+ menu, select [Setup] - [System Configuration] to display the [System Configuration] dialog box.



2. Select [Startup] - [Start Mode].

3. Select the [Auto] button.

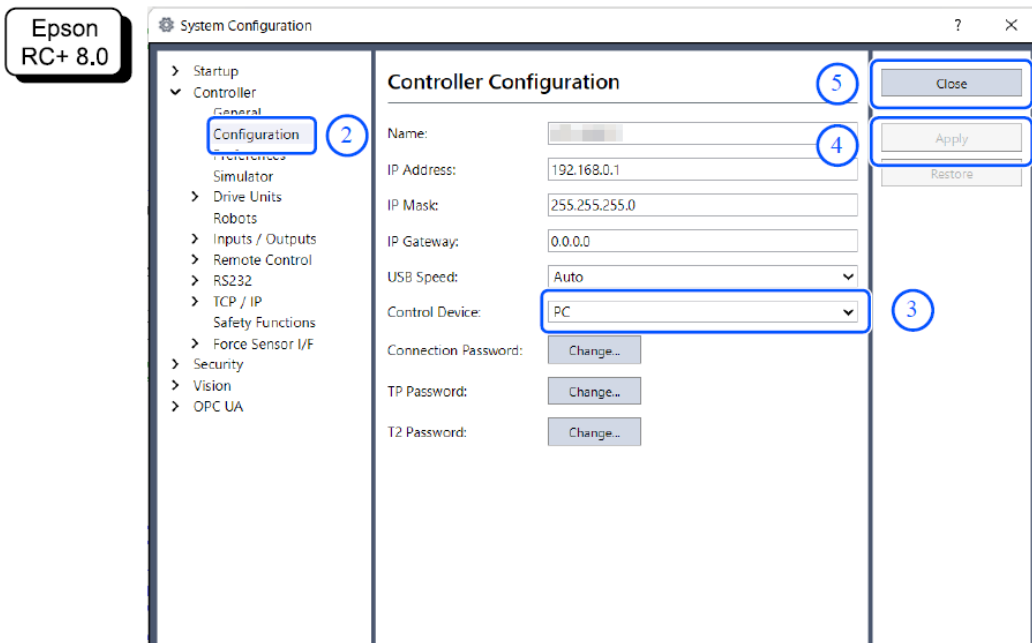
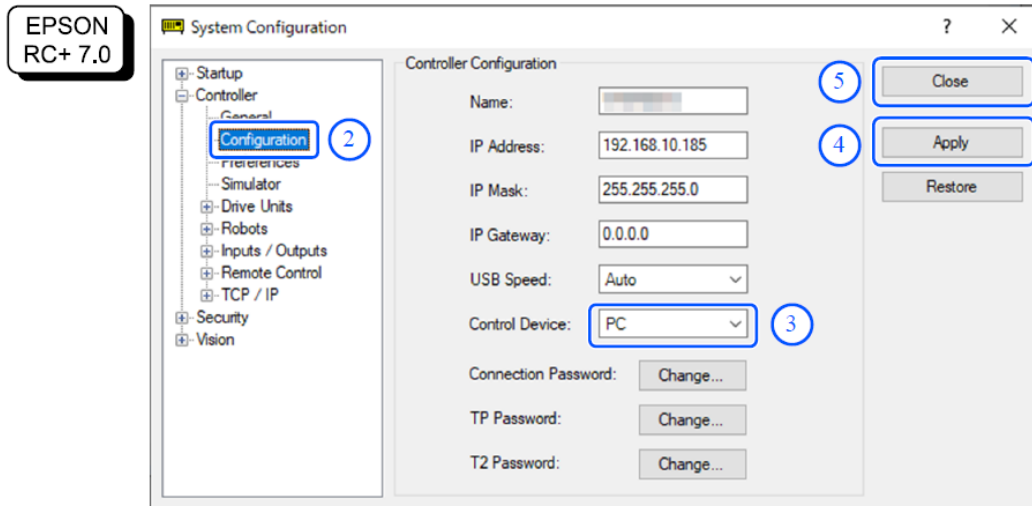
4. Click the [Apply] button.

5. Click the [Close] button.

4.4.4.2.1 Control Device Settings

This section describes the procedure for setting up a control device from Epson RC+.

1. In the Epson RC+ menu, select [Setup] - [System Configuration] to display the [System Configuration] dialog box.



2. Select [Controller] - [Configuration].

3. From [Controller Configuration] - [Control Device], select one of the following two types.

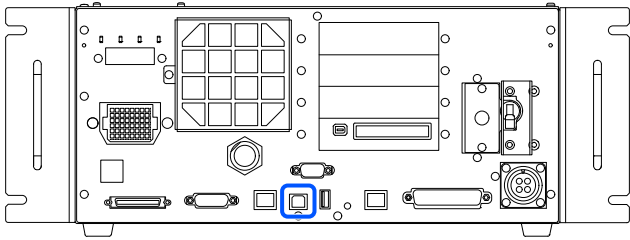
- PC
- Remote I/O

4. Click the [Apply] button.

5. Click the [Close] button.

4.5 Development PC Connection USB Port

Development PC connection USB port (USB type B series connector)



KEY POINTS

- For other details on the connection between the development PC and the Controller, refer to the following manual.
"Epson RC+ User's Guide - [PC and Controller Communications] (Setup Menu)"
- For RC700-E, be sure to install Epson RC+ to the development PC first, and then connect the development PC and RC700-E with the USB cable.
If RC700-E and the development PC are connected without installing Epson RC+ to the development PC, the [Add New Hardware Wizard] appears. If this wizard appears, click the [Cancel] button.

4.5.1 What is Development PC Connection USB Port?

The development PC connection port supports the following USB standards:

- USB 2.0 HighSpeed/FullSpeed (speed auto selection or Full Speed mode)
- USB1.1 FullSpeed

Interface standard: USB specification version 2.0 compliant (USB version 1.1 upward compatibility)

Connect the Controller and development PC by a USB cable to enable development of the robot system and setting of the Controller configuration with the Epson RC+ software installed in the development PC.

The development PC connection port supports hot plugging, and so cables can be inserted and removed while the development PC and the Controller are turned on. However, the robot stops when the USB cable is removed while the Controller and the development PC are connected.

4.5.2 Notes

Pay attention to the following points when connecting the development PC and the Controller.

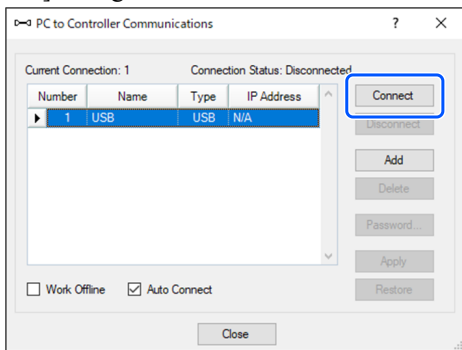
- Connect the development PC and the Controller using a USB cable with length of 5 meters or less, and do not use a USB hub or extension cable.
- Do not connect any device other than the development PC to the development PC connection port.
- To operate in USB 2.0 HighSpeed mode, use a PC or USB cable that supports USB 2.0 HighSpeed mode.
- Do not pull on or bend the cable excessively.
- Do not apply excessive force to the connector.
- While the development PC and the Controller are connected, do not connect or disconnect other USB devices from the development PC. This could cause the Controller to disconnect.

4.5.3 Connecting the PC and the Controller Using the Development PC Connection USB Port

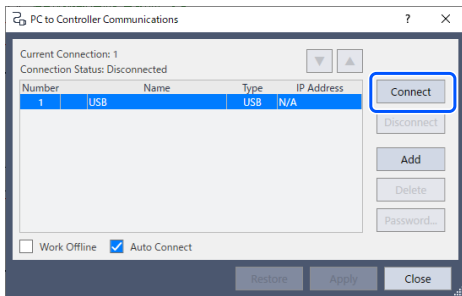
This explains the procedure for connecting the development PC and the Controller.

1. Make sure that the Epson RC+ software is installed on the development PC connected to the Controller.
(Install the software if it is not installed.)
2. Connect the development PC and the Controller by a USB cable.
3. Turn on the Controller.
4. Start the Epson RC+ software.
5. From the Epson RC+ menu, select [Setup] - [PC to Controller Communications] to display the [PC to Controller Communications] dialog box.

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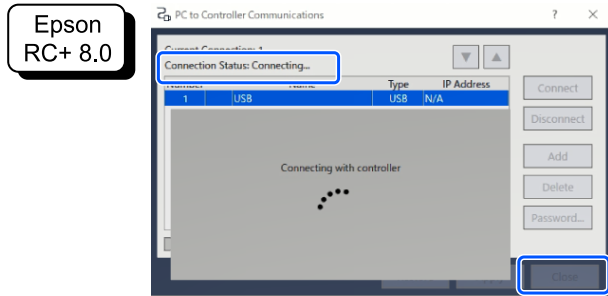
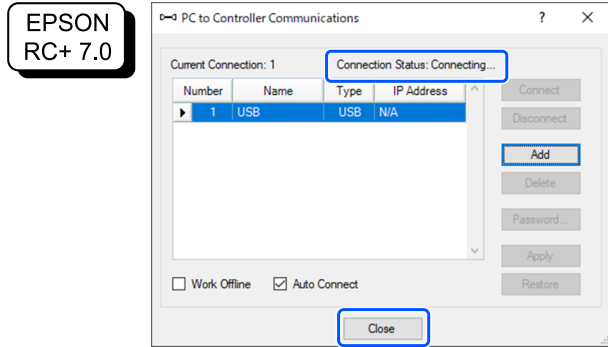


Epson RC+ 8.0



6. Select No.1, and click the [Connect] button.
7. After connection of the development PC and the Controller is completed, "Connected" is displayed in the [Connection Status:] field. Check that "Connected" is displayed, and click the [Close] button to close the [PC to Controller

Communications] dialog box.



This completes the connection of the development PC and the Controller. The robot system can now be used from Epson RC+.

4.5.4 Disconnecting the Development PC and the Controller

This explains the procedure for disconnecting the development PC and the Controller.

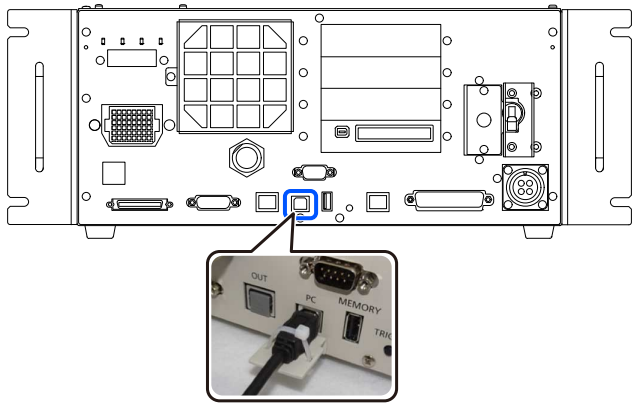
1. From the Epson RC+ menu, select [Setup] - [PC to Controller Communications] to display the [PC to Controller Communications] dialog box.
2. Click the [Disconnect] button.
After the [Disconnect] button is clicked, the Controller and the development PC are disconnected, and the USB cable can be removed.

KEY POINTS

If the USB cable is removed while the Controller and the development PC are connected, the robot will be stopped. Be sure to click the [Disconnect] button in the [PC to Controller Communications] dialog box before removing the USB cable.

4.5.5 USB Cable Locking Method

This section describes how to lock the USB cable into place.



1. Remove the screw under the USB port.
2. Attach the fixture (supplied separately) using the screw in step 1.
3. Connect the USB cable to the USB port.
4. Lock the USB cable in place by passing the cable tie (included) through the hole in the fixture in step 2.
5. Cut off any excess length of the cable tie.

4.6 Memory Port

The "Controller Backup" function to a USB memory device can be used by inserting a USB memory device (commercially available) into the Controller's memory port.

4.6.1 What is Controller Backup?

This function allows various information (data) of the Controller to be saved to a USB memory device at the push of a button. Data saved on a USB memory device can be loaded by Epson RC+ to accurately and easily determine the status of the Controller and program.

The saved data can also be used when restoring data to the Controller.

4.6.2 Before Using the Controller Backup Function

4.6.2.1 Notes

CAUTION

- Regardless of the Controller status, the Controller Backup function can be executed at any time after the Controller is started.
However, no operations from the console, including aborting or pausing, are accepted while this function is running.
This function also affects the cycle time of the robot and communication with Epson RC+. In particular, if it is not necessary, do not execute the Controller Backup function while the robot is operating.
- Although the memory port is physically a general-purpose USB port, never connect any USB devices other than USB memory devices.
- The USB memory device should be inserted directly into the memory port of the Controller. Operation is not guaranteed when there is a cable or hub between the Controller and the USB memory device.
- If a bootable USB is inserted to the memory port, the Controller will not start. Use a non-bootable USB.
- Insert and remove the USB memory device slowly and securely.
- Do not modify the saved files with editors or other software. Operation of the robot system is not guaranteed when data is restored to the Controller.

4.6.2.2 Supported USB Memory Devices

Use a USB memory device that meets the following requirements.

- USB 2.0 compatible
- No installed security features
 - * Memory devices that require password entry cannot be used.
- Usable in Windows 8, Windows 10, and Windows 11 without installing any drivers or software
- FAT32 format
- MBR format
 - * By using Microsoft's "Media Creation Tool", the USB memory will be in GPT format. Therefore, you will need to convert it to MBR format.

4.6.3 Using the Controller Backup Function

4.6.3.1 Controller Backup by Trigger Button

This section describes the procedure for backing up the Controller settings to a USB memory device.

1. Insert the USB memory device into the memory port.
2. Wait approximately 10 seconds for the Controller to recognize the USB memory device.
3. Press the trigger button on the Controller.
4. When data transfer is started, the following display is repeated.



Wait until this display ends, and the original display appears again. (The transfer time varies depending on the size of the project and other factors.)


5. If the save is successful, the following will be appears on the 7-segment LED for two seconds.



If the save has failed, the following will be appears on the 7-segment display for two seconds.



6. Remove the USB memory device from the Controller.

 **KEY POINTS**

- It is recommended that the USB memory device include an LED that enables the user to check the status change in step 2.
- If saving is executed with the motor turned on, saving may fail in rare cases. Either use another USB memory device, or perform the save with the motor turned off.

4.6.3.2 Data Loading by Epson RC+


For details on the procedure for using Epson RC+ to load data saved on a USB memory device and to display the Controller status, refer to the following manual.

"Epson RC+ User's Guide - [Controller] Command (Tools Menu)"

4.6.3.3 Forwarding by E-mail

This section describes the procedure for transferring data saved on a USB memory device by e-mail.

1. Insert the USB memory device into a PC capable of sending e-mail.
2. Make sure the following folder is on the USB memory device.
"BU_Controller type name_Serial number_Date and time"
3. Compress the folder identified in step 2, attach it to an email, and send it.

 **KEY POINTS**

- If you do not want to transfer files related to your project, such as program files, delete them before transferring.
- This function can be used by end-users to send data to Epson or to a system integrator for analysis of a problem.

4.6.4 Details of Saved Data

The following files are created by the Controller Backup.

File Name	Description
Backup.txt	Information file for restoring data: This file contains the information needed when restoring the Controller.
CurrentMnp01.PRM	Robot parameters: This file stores the ToolSet and other information.
CurrentStatus.txt	Status save data: This file contains the program status and I/O status.
ErrorHistory.csv	Error history
InitFileSrc.txt	Default settings: This file stores the various settings of the Controller.
MCSys01.MCD	Robot settings: This file stores information about the connected robot.
SrmeStat.txt	Hardware information: This file contains the hardware installation information.
Project name.obj	OBJ file: Project build results. Prg files are not included.
GlobalPreserves.dat	Backup variables: This file stores the values of the backup variables (Global Preserve variables).
MCSRAM.bin MCSYSTEMIO.bin MCTABLE.bin MDATA.bin SERVOSRAM.bin VXDWORK.bin	Internal information on robot operation
WorkQueues.dat	Work queue information: This file stores the work queue information.
SFConfig.txt	Safety board related files: Safety board information is stored.
All files related to the project except project name.obj *1	Project related files: From the Epson RC+ menu, select [Setup] - [System Configuration] to display the [System Configuration] dialog box. The project is saved when the [Include project files when status exported] box is selected in the menu - [Controller] - [Preferences] dialog box. Program files are included.

*1 You can choose not to save "All files related to the project except project name.obj" by deselecting the setting option.

4.7 LAN (Ethernet Communication) Port

KEY POINTS

- For other details on the connection between the development PC and the Controller, refer to the following manual.
"Epson RC+ User's Guide - [PC and Controller Communications] (Setup Menu)"
- For information on how to use the Ethernet (TCP/IP) communication function from the robot application software, refer to the following manual or online help.
"Epson RC+ User's Guide - TCP/IP Communications"

4.7.1 What is a LAN (Ethernet Communication) Port?

This port is used for 100BASE-TX/10 BASE-T compatible Ethernet communication.

This port serves two purposes.

■ **Connecting to the development PC**

This port can be used to connect the Controller to the development PC.

This enables the same operations as when connecting the Controller and development PC by the dedicated development PC connection port.

Refer to the following section.

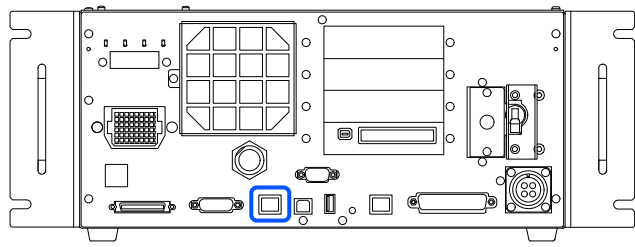
[Development PC Connection USB Port](#)

■ **Connecting to other Controllers and PCs**

By creating robot application software, Ethernet (TCP/IP) communication between multiple Controllers is possible.

CAUTION

- The OUT connector is not a LAN (Ethernet communication) port. Do not connect a cable here.



4.7.2 IP Addresses

Starting from the following firmware version, password authentication was added for greater security when connecting Controllers and PCs.

- F/W: Ver.7.4.8.x

KEY POINTS

For details on the password settings, refer to the following manual.

"Epson RC+ User's Guide - Setting Password for PC Ethernet Controller Connection"

Epson robot systems are designed to be used within a closed local area network. To ensure security, the setting of a global IP address is now considered as access to the Internet, and so a password is required to authenticate the connection. Note that password authentication is not performed for a USB connection.

Use the private IP addresses in the following ranges:

- 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 Controller is factory set to the default values.

- IP address: 192.168.0.1
- Subnet mask: 255.255.255.0
- Default gateway: 0.0.0.0

The PC and the Controller should be configured with separate IP addresses within the same subnet.

- PC: 192.168.0.10
- Controller: 192.168.0.1

4.7.3 Controller IP Address Change Procedure

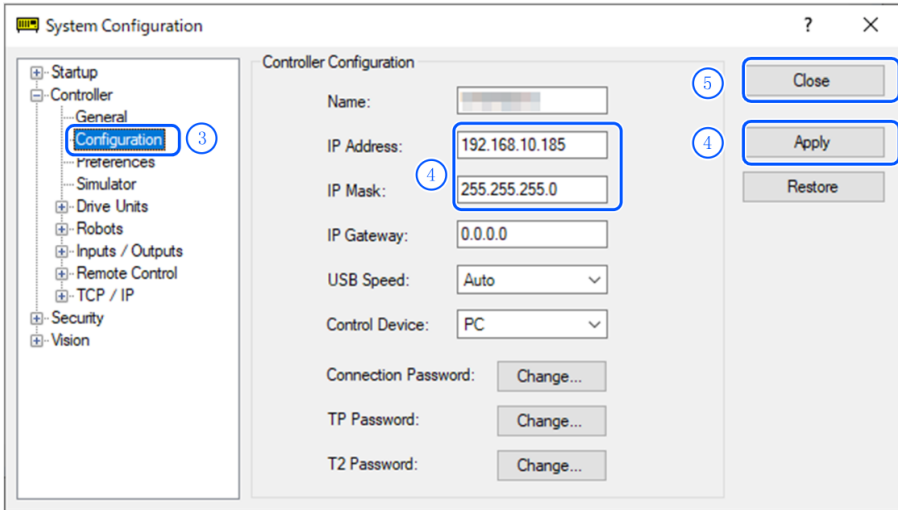
This section describes the procedure for changing the IP address of the Controller.

1. Connect the development PC and the Controller by a USB cable.
Refer to the following section.

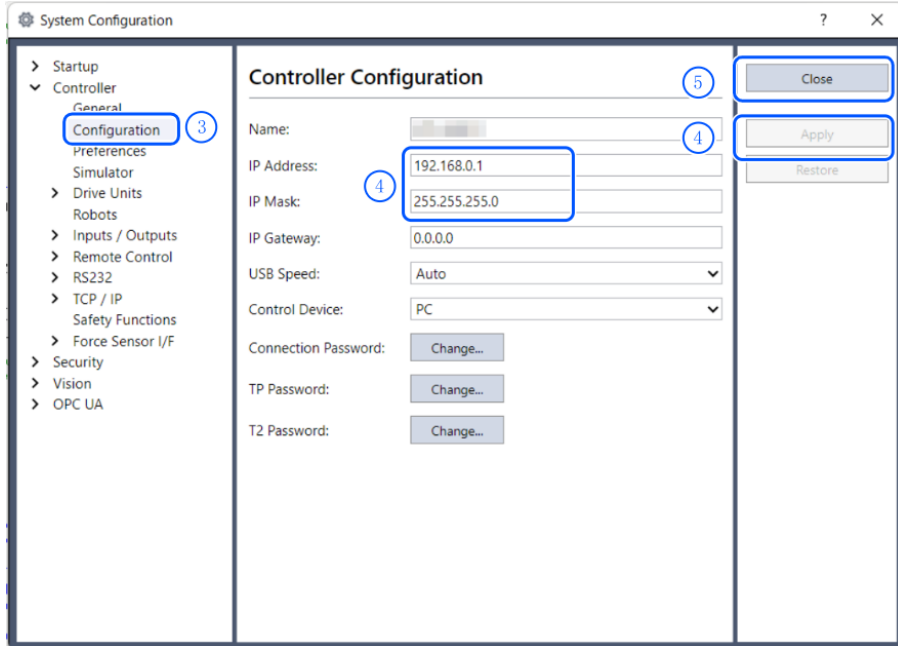
[Development PC Connection USB Port](#)

2. In the Epson RC+ menu, select [Setup] - [System Configuration] to display the [System Configuration] dialog box.

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3. Select [Controller] - [Configuration].

4. Set appropriate values for the IP address and subnet mask, and click the [Apply] button.

5. Click the [Close] button. The Controller is automatically restarted.

When the Controller restart dialog box no longer appears, setting of the IP address is complete.

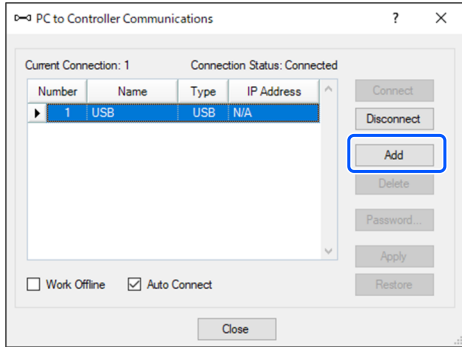
4.7.4 Connecting the Development PC and Controller via Ethernet

This explains the procedure for connecting the development PC and Controller over an Ethernet connection.

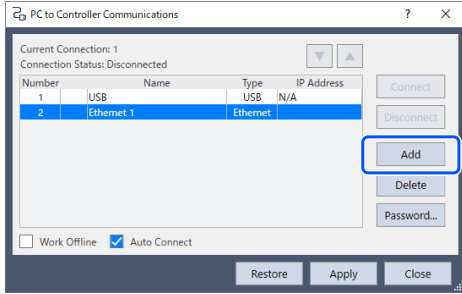
1. Connect an Ethernet cable to the development PC and Controller.
2. Turn on the Controller.
3. Start the Epson RC+ software.
4. From the Epson RC+ menu, select [Setup] - [PC to Controller Communications] to display the [PC to Controller Communications] dialog box.

5. Click the [Add] button.

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RC+ 7.0



Epson
RC+ 8.0

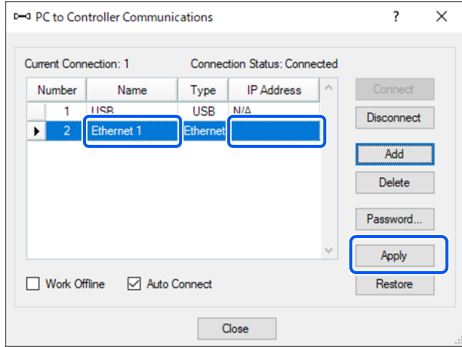


6. No. 2 is added. Make the following settings, and click the [Apply] button.

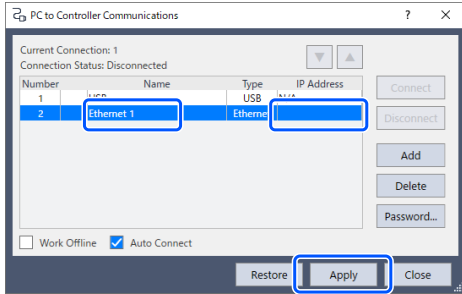
Name: Valid value for identifying the Controller to be connected

IP Address: IP address of the Controller to be connected

EPSON
RC+ 7.0

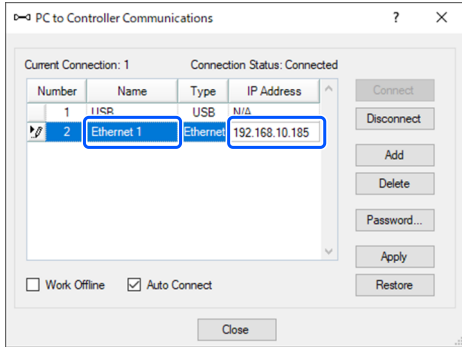


Epson
RC+ 8.0

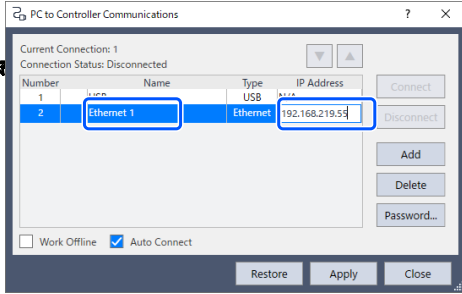


7. The [Name] and [IP Address] that were set in step 6 are displayed.

EPSON RC+ 7.0

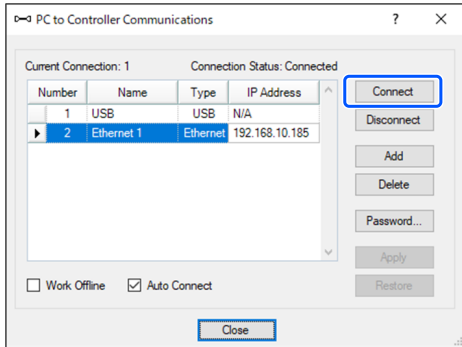


Epson RC+ 8.0

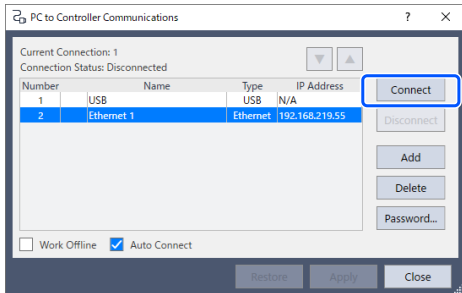


8. Confirm that "No. 2" is selected, and click the [Connect] button.

EPSON RC+ 7.0

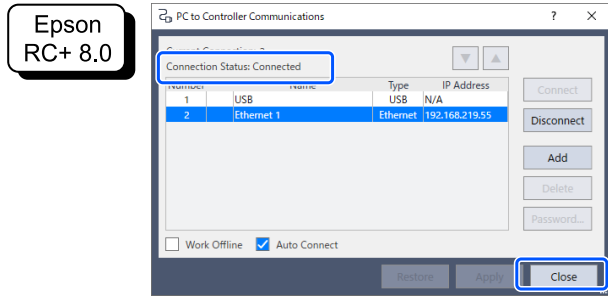
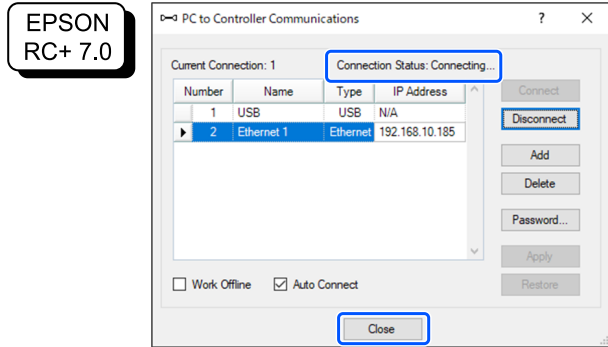


Epson RC+ 8.0



9. After connection of the development PC and the Controller is completed, "Connected" is displayed in the [Connection Status:] field. Check that "Connected" is displayed, and click the [Close] button to close the [PC to Controller

Communications] dialog box.



This completes the connection of the development PC and the Controller. The robot system can now be used from Epson RC+ over an Ethernet connection.

4.7.5 Disconnecting the Development PC and Controller via Ethernet

This explains the procedure for disconnecting the development PC and the Controller.

1. From the Epson RC+ menu, select [Setup] - [PC to Controller Communications] to display the [PC to Controller Communications] dialog box.
2. Click the [Disconnect] button.
After the [Disconnect] button is clicked, the Controller and development PC are disconnected and the Ethernet cable can be removed.

KEY POINTS

If the Ethernet cable is removed while the Controller and development PC are still connected, the robot will stop. Click the [Disconnect] button in the [PC to Controller Communications] dialog box before removing the Ethernet cable.

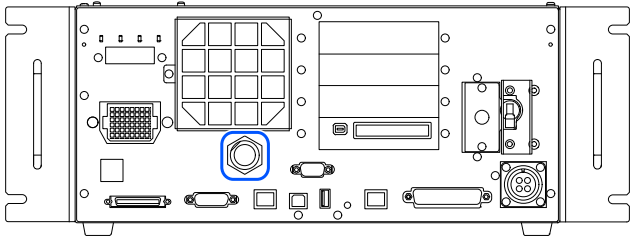
4.8 TP Port

4.8.1 What is a TP Port?

This port is used to connect a Teach Pendant. Teach Pendants TP2, TP3 and TP4 can be used.

When connecting TP2 to RC700-E, a conversion cable* for RC700-A/RC700-D/RC700-E is required. If only a conversion cable is required, please contact the supplier.

* RC700-A TP Exchange Cable: R12NZ900L6



KEY POINTS

If nothing is connected to the TP port, the Controller enters an emergency stop state. When not connecting a Teach Pendant, connect the TP bypass plug.

Do not connect the following devices to the TP port of RC700-E. The different signal arrangement could cause a breakdown in the device.

- Dummy plug (optional device)
- Operation Pendant OP500
- Operator Pendant OP500RC
- Jog Pad JP500
- Teaching Pendant TP-3**
- Operator Panel OP1
- Teach Pendant TP1

An external enable switch cannot be connected to the TP port. Use the enable switch provided with the Teach Pendant.

4.8.2 Connecting a Teach Pendant

The Teach Pendants come with a dedicated cable for the RC700-A, RC700-D, and RC700-E Controllers. Connect the connector of this cable to the TP port.

The communication settings are configured automatically. The Teach Pendant can be used by either of the following methods.

- A: Plug the Teach Pendant connector into the Controller, and turn on the Controller.
- B: With the Controller turned on, plug in the Teach Pendant connector.

WARNING

- The Teach Pendant can be connected and disconnected while the Controller power is turned on.
- When the Teach Pendant connector is disconnected from the Controller while the Teach Pendant mode selector keyswitch is set to "Teach," the Teach Pendant remains in TEACH mode. The Teach Pendant cannot

be switched to AUTO mode. Before disconnecting the Teach Pendant connector, switch the operation mode to "Auto."

- When switching from TEACH mode to AUTO mode, the latch must be released.
- The disconnection and storage of the Teach Pendant should be supervised by a manager. Only people authorized by the manager are allowed to touch the Teach Pendant.
- To prevent confusion between enabled and disabled emergency stop devices, keep the Teach Pendant connected to the Controller and the disconnected Teach Pendant in separate locations.
- When entering inside the safety barriers for teaching or other operations, set the Teach Pendant mode to TEACH mode, remove the mode selector key, and enter inside the safety barriers while holding that key. If the key is left in the Teach Pendant without removing it, a third party could accidentally switch to automatic operation, which is extremely dangerous and could lead to serious safety issues.
- Teach Pendants should be installed in such a way as to reduce the risk of tripping and falling due to cables.

For more information on Teach Pendants, refer to the following manuals.

"Robot Controller Option Teach Pendant TP2"

"Robot Controller Option Teach Pendant TP3"

"Robot Controller Option Teach Pendant TP4"

4.9 Emergency Stop Input Connector

KEY POINTS

Details about the safety requirements in this section are provided in the following manual. Read together with this manual to ensure safety.

"Epson RC+ User's Guide - Safety"

CAUTION

- Before use, confirm that the emergency stop and safeguard functions work properly not only when starting up but also when any changes are made from the previous usage state, such as after the safety function settings are changed, options are added, or parts are replaced for maintenance.

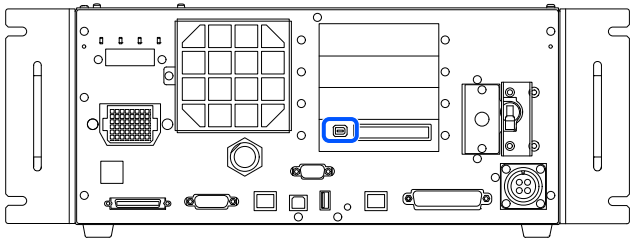
To ensure safety, connect the emergency stop switch and other safety devices to the Controller.

Two types of connectors can connect emergency stop switches: the emergency stop input connector and safety I/O connector. This section describes the emergency stop input connector.

CAUTION

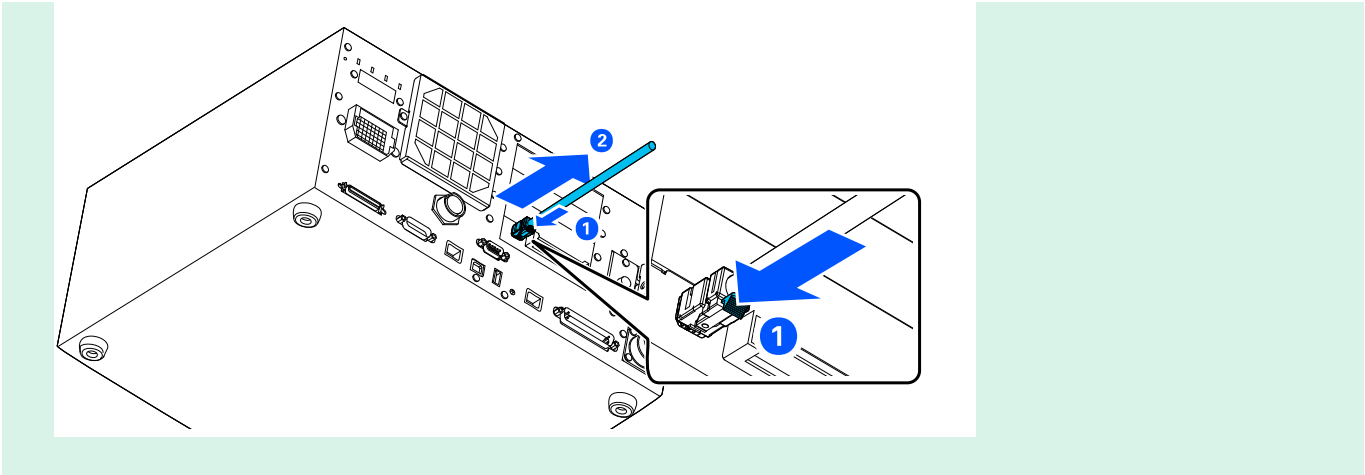
- Before connecting a connector, check that the connector is not damaged. Connecting with a damaged connector may lead to a breakdown or malfunction of the robot system.

Emergency stop input connector



KEY POINTS

- If nothing is connected to the emergency stop input connector, the Controller enters an emergency stop state. When this connector is not used, connect the EMERGENCY connector short plug.
- When unplugging the cable, pull it out while pressing down the lever on the cable-side connector.



4.9.1 Connecting an Emergency Stop Switch

4.9.1.1 Connection Locations for Emergency Stop Switch

An emergency stop switch can be connected to the following locations:

- Emergency stop switch attached to Teach Pendant
- Emergency stop input connector
- Port configured for emergency stop for safety I/O connector (default: configured)

Refer to the following section.

Connections: [Safety I/O Connector](#)

Configurations: "Robot Controller Safety Function Manual"

4.9.1.2 Emergency Stop Switch

Use an emergency stop switch that satisfies the following conditions and complies with the relevant safety standards (such as IEC 60947-5-5).

- Normally closed pushbutton switch
- Switch that cannot reset automatically
- Red mushroom type switch
- Switch with two form B contacts

KEY POINTS

The emergency stop input has a redundant circuit design. If the status of these redundant circuits differs by two seconds or longer, the system recognizes it as an error in the emergency stop circuit. For this reason, be sure that the emergency stop switch has two form B contacts, and connect by referring to the following section.

Wiring Examples

All locations with startup capabilities should have an emergency stop function.

4.9.1.3 Emergency Stop Switch Function Check

After the emergency stop switch is connected to the emergency stop input connector, be sure to use the following procedure to check the function of the switch to ensure safety before operating the Manipulator.

1. With the emergency stop switch pressed down, turn on the power to start the Controller.

2. Check that the 7-segment LED on the Controller displays as shown below.



3. Check that [EStop] is displayed on the Epson RC+ status bar.

4. Release the emergency stop switch.

5. From the Epson RC+ menu, select [Tools] - [Robot Manager] - [Control Panel], click the [Reset] button, and execute the RESET statement.

6. Check that the LED shown below is turns off and [EStop] is no longer displayed on the status bar.



4.9.1.4 Recovering from an Emergency Stop State

Before recovering from an emergency stop state, follow the safety check procedure specified for the system.

After the safety check is completed, perform the following operations to reset the emergency stop state.

- Resetting the emergency stop switch
- Executing the RESET statement

4.9.2 Signal Arrangement and Electrical Specifications

The signal arrangement of the emergency stop input connector is shown in the following table.

Pin Number	Signal Name	Function
1	24V for emergency stop	Internal 24V output
2	Emergency stop input M *1	Emergency input 1
3	N.C. *2	Not used
4	24V for emergency stop	Internal 24V output
5	Emergency stop input S *1	Emergency input 2
6	N.C. *2	Not used
7	N.C. *2	Not used
8	N.C. *2	Not used

*1 An error occurs if the input times of emergency stop input M and emergency stop input S differ by two seconds or more. Connect a switch having two identical contacts.

*2 Do not connect anything to these pins.

Electrical characteristics of EMERGENCY connector

- 24V rated load for emergency stop: +24 V 0.4 A or less
- Emergency stop input voltage range: +24 V ±10%
- Emergency stop input current: 37.5 mA ±10% at +24 V input

⚠ CAUTION

- The 24 V output for emergency stop is for connecting to emergency stop switches, relays, MOS-FETs, and other switches. Do not use it for other purposes. Doing so may result in system breakdown.

✍ KEY POINTS

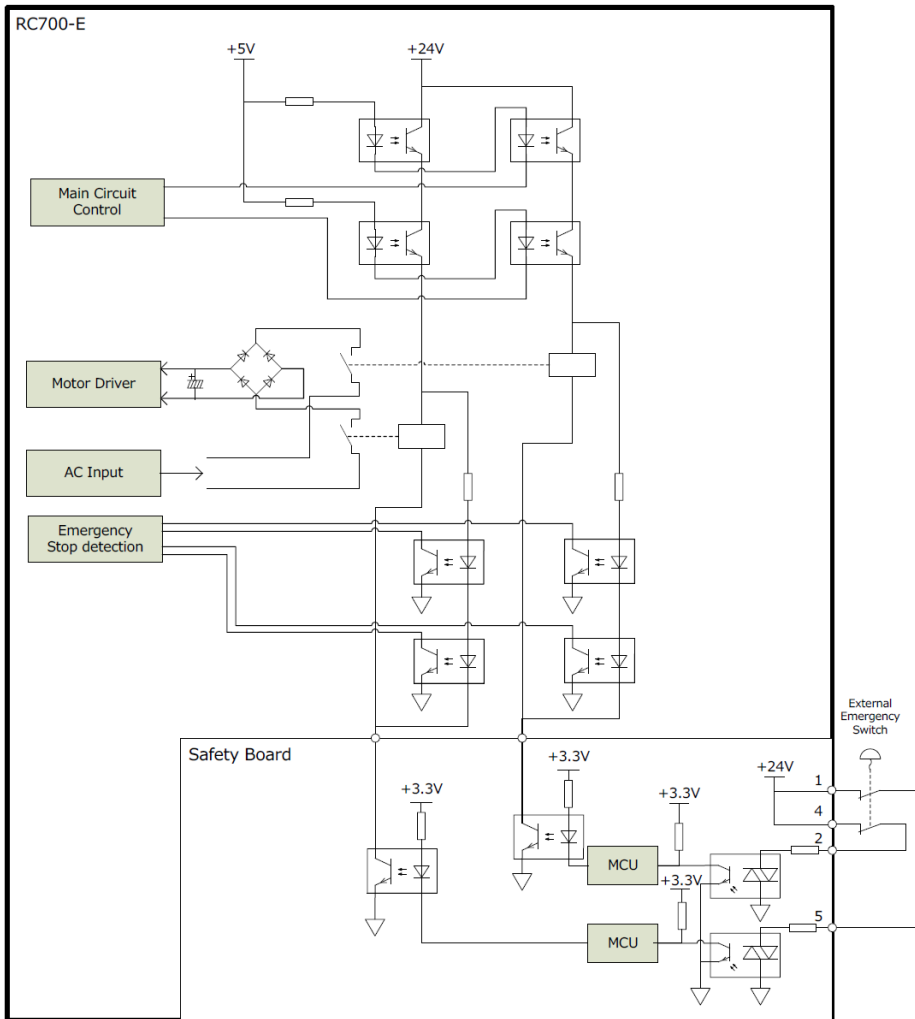
The total electrical resistance of the emergency stop switches and their circuit should not exceed 1 Ω.

⚠ WARNING

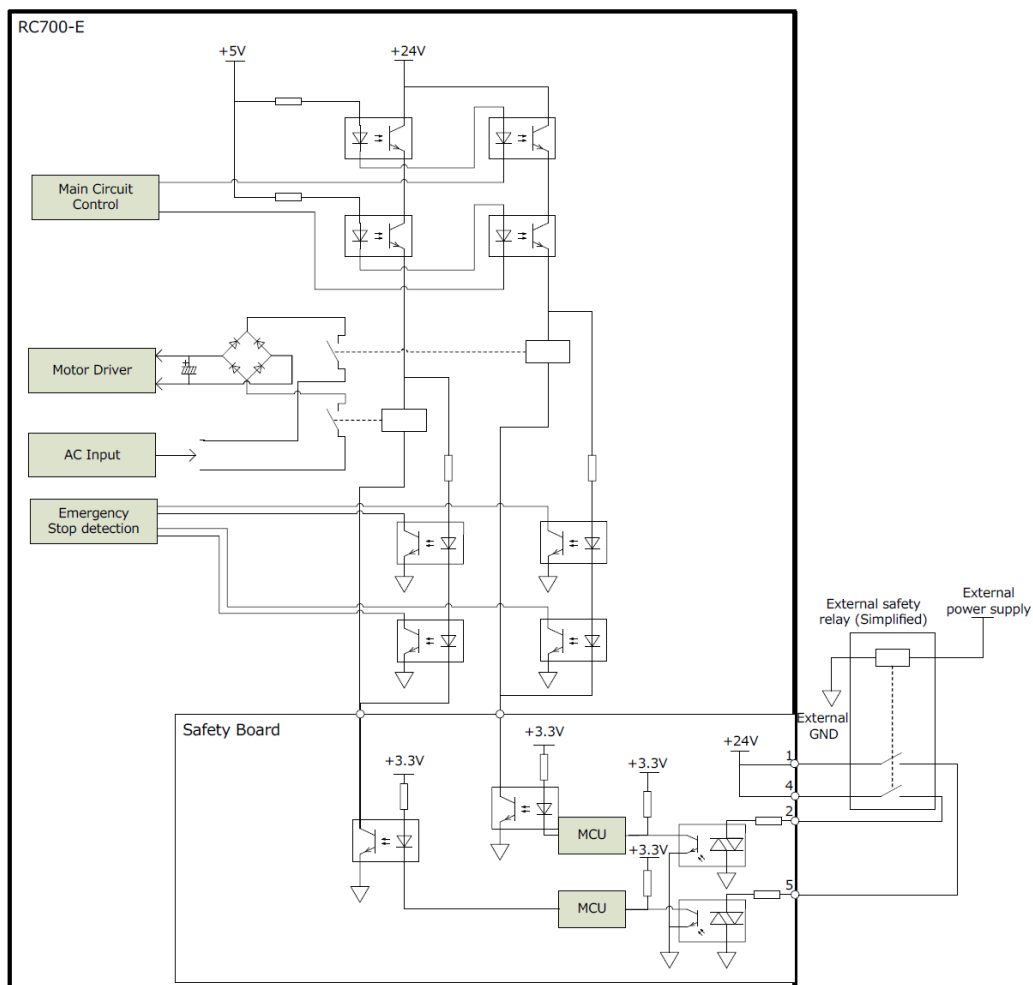
Cables should be connected at all times. Use a guard cover to protect the cables. Do not put heavy objects on the cables, bend or pull on the cables forcibly, or allow the cables to be pinched. Damaged cables, broken wires, or contact failure is extremely hazardous and may result in electric shock and/or malfunction of the robot system.

4.9.3 Wiring Examples

4.9.3.1 Example 1: When External Emergency Stop Switch is Connected



4.9.3.2 Example 2: When External Safety Relay is Connected



4.10 Safety I/O Connector

4.10.1 Safety I/O

This Controller has safety-compliant safety inputs (5ch) and safety outputs (3ch).

- Safety inputs (category 3 PLd)
- Safety outputs (category 3 PLd)

Emergency stop switches, safeguards, laser curtains, and similar devices can be connected to the safety inputs.

Safety PLCs and similar devices can be connected to the safety outputs.

The safety inputs and outputs have a redundant design, and an error occurs if the redundant circuits are mismatched for two seconds. If an error occurs, the Controller must be restarted.

An external power supply is required to use the safety I/O. Also, various settings must be configured using the "Safety Function Manager" to use the safety I/O. For details on the setting procedure, refer to the following manual.

"Robot Controller Safety Function Manual"

Turn off the power before connecting to the safety I/O connectors.

WARNING

Cables should be connected at all times. Use a guard cover to protect the cables. Do not put heavy objects on the cables, bend or pull on the cables forcibly, or allow the cables to be pinched. Damaged cables, broken wires, or contact failure is extremely hazardous and may result in electric shock and/or malfunction of the robot system.

4.10.2 Signal Arrangement



Check the orientation of the connectors before connecting them.

Signal Arrangement of Safety I/O Connector (XW4N-28D2 Male)

Pin Number	Signal Name	Function	Pin Number	Signal Name	Function
A1	Ex-GND	External GND connection	B1	SAFETY_IN_COM-M	Safety input common 1
A2	Ex-24V	External 24 V connection	B2	SAFETY_IN5-M	Safety input 5-1
A3	SAFETY_OUT3-M	Safety Output 3-1	B3	SAFETY_IN4-M	Safety input 4-1
A4	SAFETY_OUT2-M	Safety Output 2-1	B4	SAFETY_IN3-M	Safety input 3-1
A5	SAFETY_OUT1-M	Safety Output 1-1	B5	SAFETY_IN2-M	Safety input 2-1
A6	Not used	*1	B6	SAFETY_IN1-M	Safety input 1-1
A7	Not used	*1	B7	Not used	*1
A8	Latch signal1	Latch release signal *2	B8	Not used	*1
A9	Not used	*1	B9	SAFETY_IN1-S	Safety input 1-2
A10	Latch signal2	Latch release signal *2	B10	SAFETY_IN2-S	Safety input 2-2
A11	Not used	*1	B11	SAFETY_IN3-S	Safety input 3-2
A12	SAFETY_OUT1-S	Safety Output 1-2	B12	SAFETY_IN4-S	Safety input 4-2
A13	SAFETY_OUT2-S	Safety Output 2-2	B13	SAFETY_IN5-S	Safety input 5-2
A14	SAFETY_OUT3-S	Safety Output 3-2	B14	SAFETY_IN_COM-S	Safety input common 2

*1: Do not connect anything to these pins.

*2: The latch signal is not a safety signal. Connect 24V and GND. Since it is bipolar, it does not matter which way it is connected.

4.10.3 Safety Inputs

The safety inputs have a redundant circuit design, and an error occurs if the inputs are mismatched for two or more seconds. The safety inputs have five channels, with independent input terminals and one 24 V/GND terminal (COM) common to all five channels.

When connecting the wires, check the safety I/O connector pin assignments in the signal arrangement.

4.10.3.1 Safety Input Specifications

Interface specifications

To use the safety inputs, a SELV-certified external power supply is required.

The connection wires should be AWG24 to 16 or processed with a ferrule terminal, and the length should not exceed 20 meters.

For details on connectors and connections, check the XW4M/XW4N specifications.

Available functions

The following functions are available when configured in "Safety Function Manager." For details on the settings, refer to the following manual.

"Robot Controller Safety Function Manual"

- Emergency stop
- Safeguard (SG)
- SLS function ON/OFF
- SLP function ON/OFF

Safety input electrical specifications

Input voltage range: +12 to 24 V ±10%

ON voltage: +11 V (Min.)

OFF voltage: +5 V (Max.)

Input current: Typ. 11 mA at +24 V

The input circuit uses a bidirectional photocoupler, so two types of connections are possible. Refer to the connection examples.

Connected peripherals

The safety models that can be connected to safety inputs are shown in the following table.

Safety devices with diagnostic pulses should have a maximum pulse width of 500 us and a minimum diagnostic pulse interval of 20 ms.

Device Name	Certification
Laser curtain	IEC 61496-1 Type 4
Laser scanner	IEC 61496-1 Type 3
Safety PLC	IEC 61131-2
Safety switch	IEC 60947-5-1

4.10.3.2 Connecting as Emergency Stop

In addition to the emergency stop input connector, an emergency stop switch can also be used with the safety I/O connector. An external power supply is required when using an emergency stop switch with the safety I/O connector.

Checking operation of the emergency stop switch that is set to the safety input

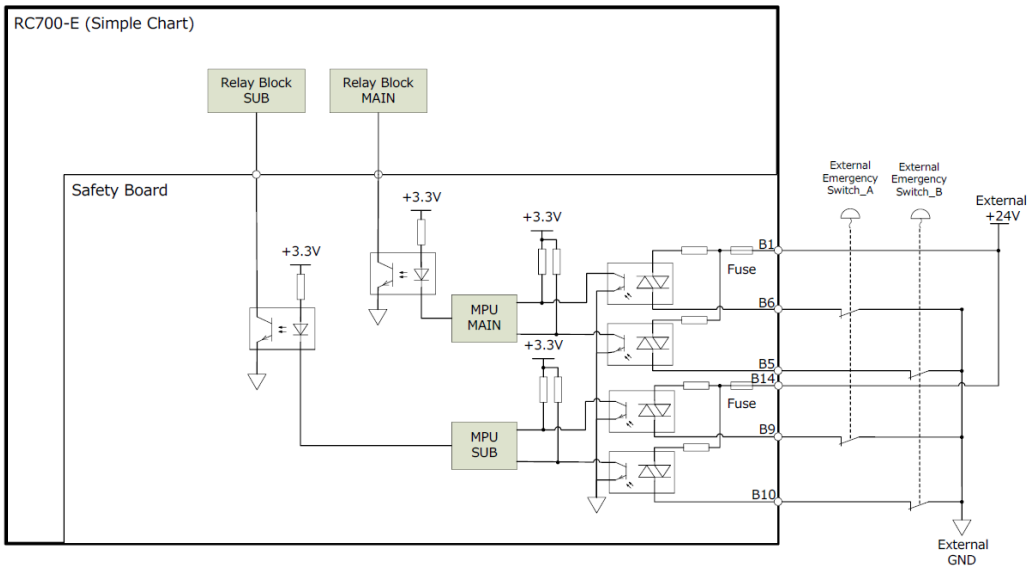
Check using the same procedure as the emergency stop input connector.

Recovering from an emergency stop state

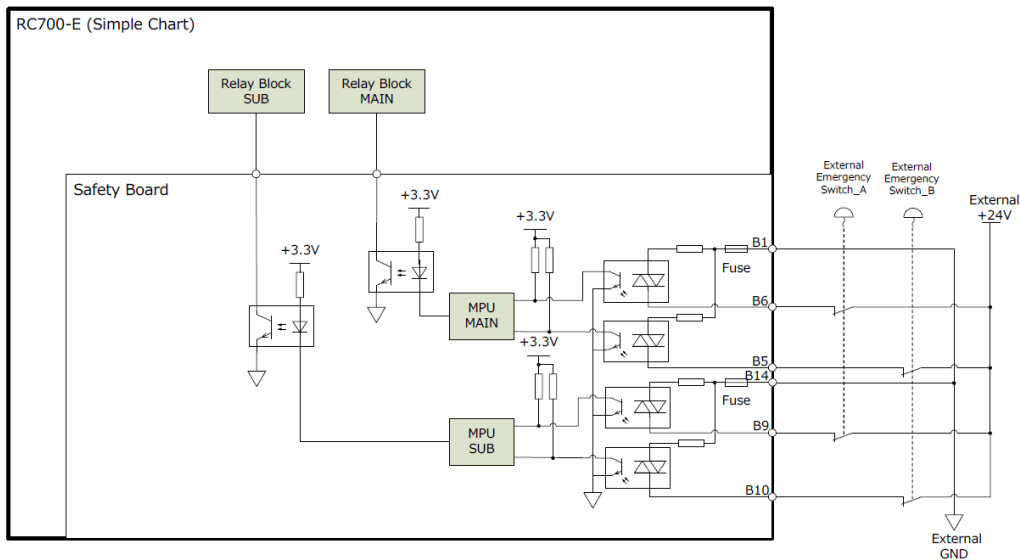
Recover using the same procedure as the emergency stop input connector.

Connection examples

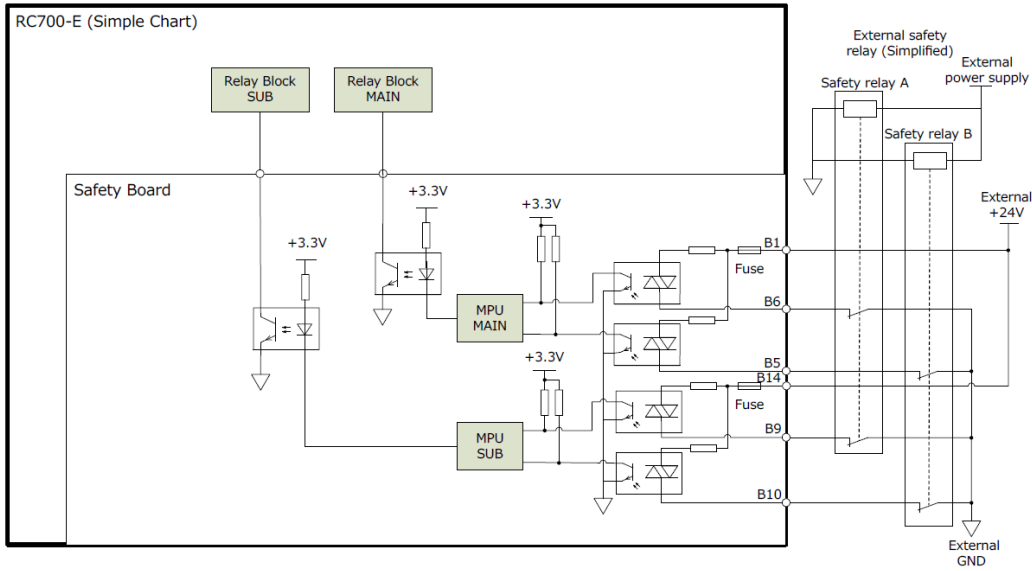
Emergency stop switch: Connection pattern 1



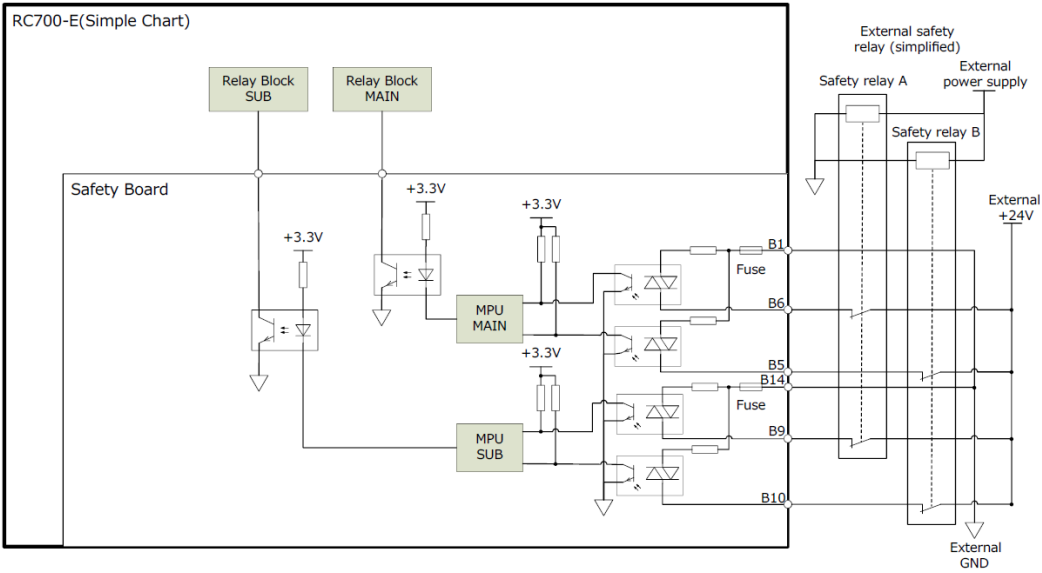
Emergency stop switch: Connection pattern 2



Safety relay: Connection pattern 1



Safety relay: Connection pattern 2



4.10.3.3 Connecting as Safeguard

To maintain a safe working zone, safety barriers must be set up around the Manipulator. The safety barriers must have an safety devices at the entrance and exit to the working zone. The term "safeguard" as used in this manual refers to a safety device with an interlock that allows entry into the safety barriers. Specifically, this includes safety door switches, safety barriers, light curtains, safety gates, safety floor mats, and so on. You must assign at least one Safeguard (SG) in Safety Function Manager.

Connection conditions

Design the safeguards so that they satisfy the following conditions:

- When using a key switch type safety device, use a switch that forcibly opens the interlock contacts. Do not use switches that open their contacts using the spring force of the interlock.
- When using an interlock mechanism, do not disable the interlock mechanism.
- The safety I/Os have redundant circuits. Safeguard switches with two contacts should be used, and each contact should be connected to a redundant circuit.

KEY POINTS

The safeguard input has a redundant circuit design. If the status of these redundant circuits differs by two seconds or longer, the system recognizes it as an error in the safeguard circuit. Ensure that the safeguard input has redundant circuits.

Latch release input

The safeguard state and TEACH mode state are latched by software. The safety I/O connector has a latch release input for releasing these latched states. (The term "latch" means "hold.")

This signal is a single signal type because it is a non-safety signal.

When connecting switches, use normally open switches.

- Latch release input open (switch OFF)
The safeguard open state and TEACH mode state are latched.
- Latch release input close (switch ON)
The latched state is released.

KEY POINTS

When the latched state of TEACH mode is released while the safeguard is open, operation is prohibited because the safeguard is open. To start the Manipulator, close the safeguard and then close the latch release input.

When connecting, maintain the following electrical characteristics for latch release input.

The latch release input uses bipolar components, so it does not matter whether the power supply is connected to Pin A8 or A10.

Voltage: +24 V ±10%

Current: 10 mA/+24 V input

CAUTION

Because the latch release input terminal has only one channel, if it is assigned to multiple safeguards, they will operate together. Therefore, if you wish to place a latch release switch on each safeguard, connect the switches in series.

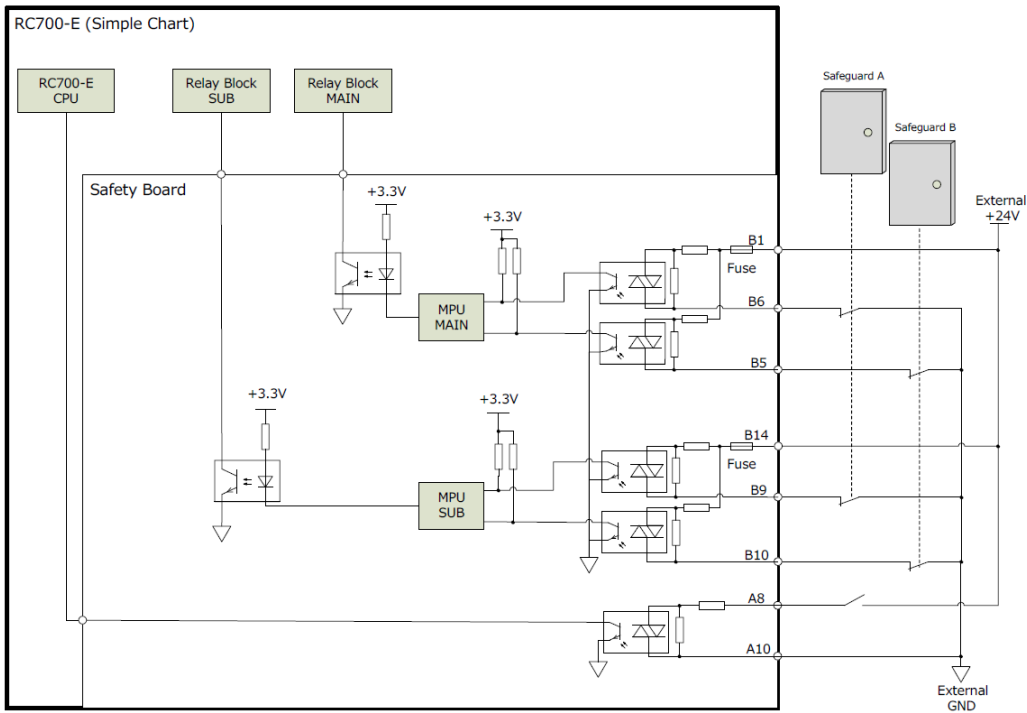
Checking the switch function

After connecting the safeguard switch and latch release switch to the safety I/O connector, a safety check must be performed. Use the following procedure to check the function of the switch before operating the Manipulator.

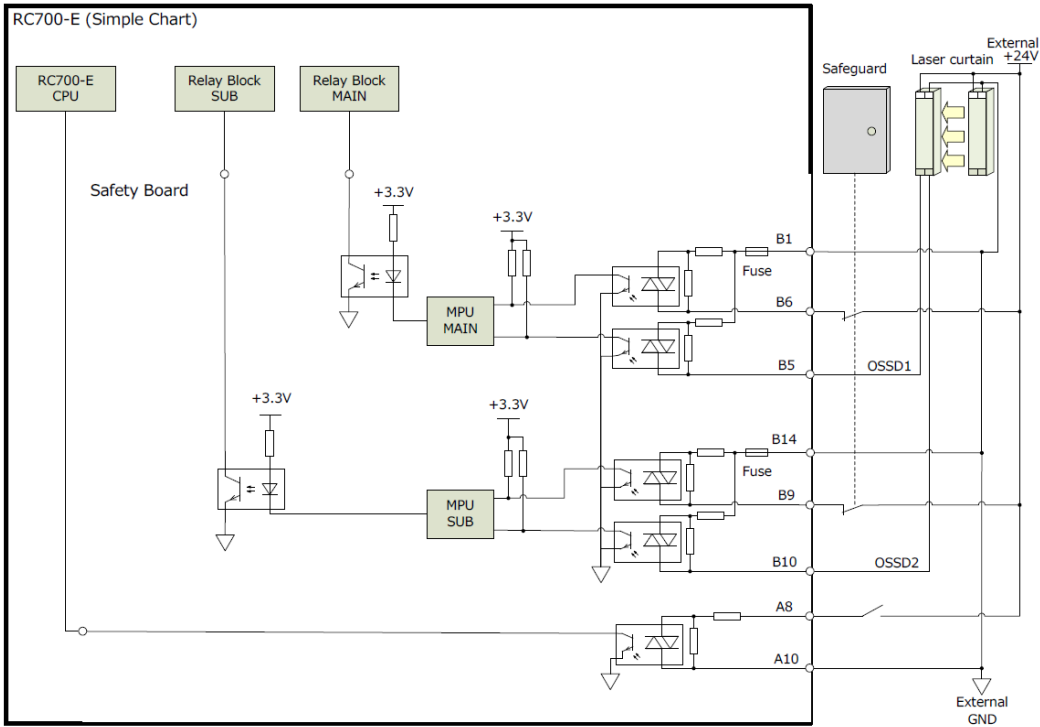
1. While the safeguard is open, turn on the power to start up the Controller.
2. Make sure that "Safety" is displayed on the status bar on the screen. Or confirm that "SO" is displayed on the Controller's 7-segment LED.
3. Close the safeguard and turn on the switch connected to the latch release input.
4. Make sure that "Safety" no longer appears on the status bar. Or confirm that "SO" is no longer displayed on the Controller's 7-segment LED.

Connection examples

When two safeguards are connected



When a safeguard and laser curtain are connected

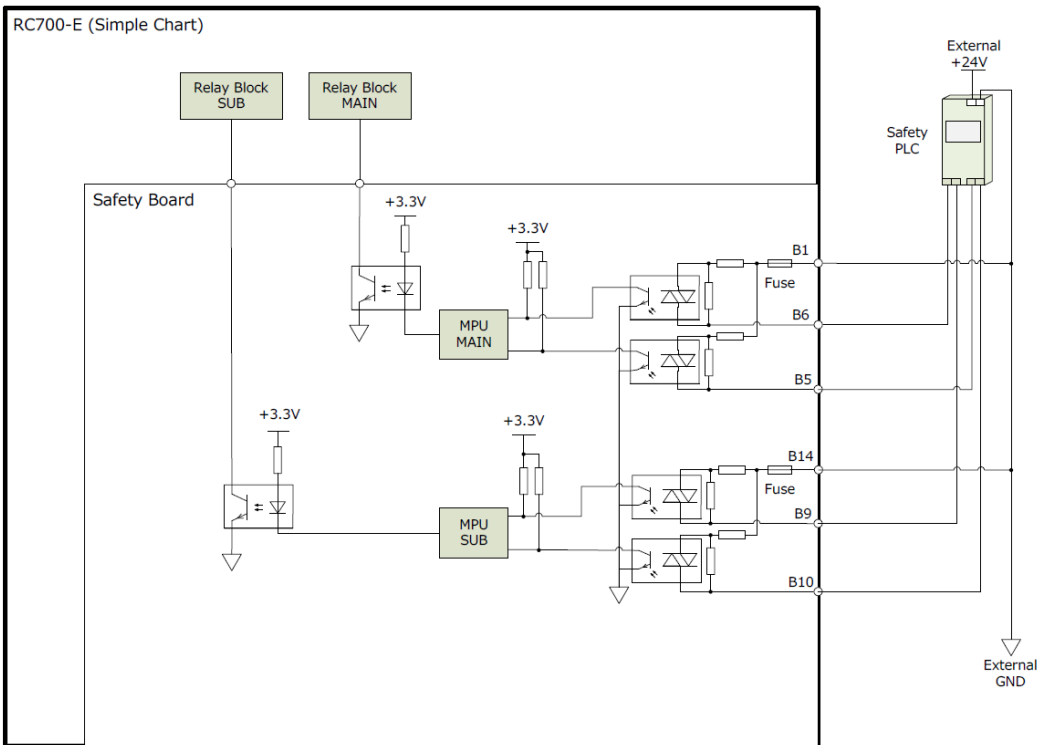


4.10.3.4 Connecting as Safety Function Switching Device

The SLS and SLP settings need to be switched to match the customer's usage environment. The safety input can be used as the switching function. Safety PLCs and laser curtains are assumed as input signals. For details, refer to the following manual. "Robot Controller Safety Function Manual"

Connection example (when connected to a safety PLC)

Because the safety PLC has PNP outputs, only the following combinations are available.



4.10.4 Safety Outputs

The safety outputs have a redundant circuit design, and an error occurs if the inputs are mismatched for two or more seconds. There are three channels for safety outputs, each with independent output terminals. To use the output terminals, external 24 V and GND power must be supplied.

When connecting the wires, check the safety I/O connector pin assignments in the signal arrangement.

4.10.4.1 Safety Output Specifications

Interface specifications

To use the safety outputs, a SELV-certified external power supply is required. The connection wires should be AWG26 and should not exceed 20 meters in length.

Available functions

The following functions are available when configured in "Safety Function Manager." For details on the settings, refer to the following manual.

"Robot Controller Safety Function Manual"

- Enable ON/OFF
- Emergency ON/OFF
- STO State ON/OFF
- SLS State ON/OFF
- SLP State ON/OFF

Safety output electrical specifications

Rated output voltage: +24 V ±10%

Maximum output current: Max. 100 mA per output

On-resistance: Typ. 5.5 Ω

The output circuit can only output Source. Do not connect in reverse.

Connect the power supply to 24 V (A2) and GND (A1), and use the output of each terminal as Source output. Refer to the connection examples.

Connected peripherals

This device can be connected to a safety output.

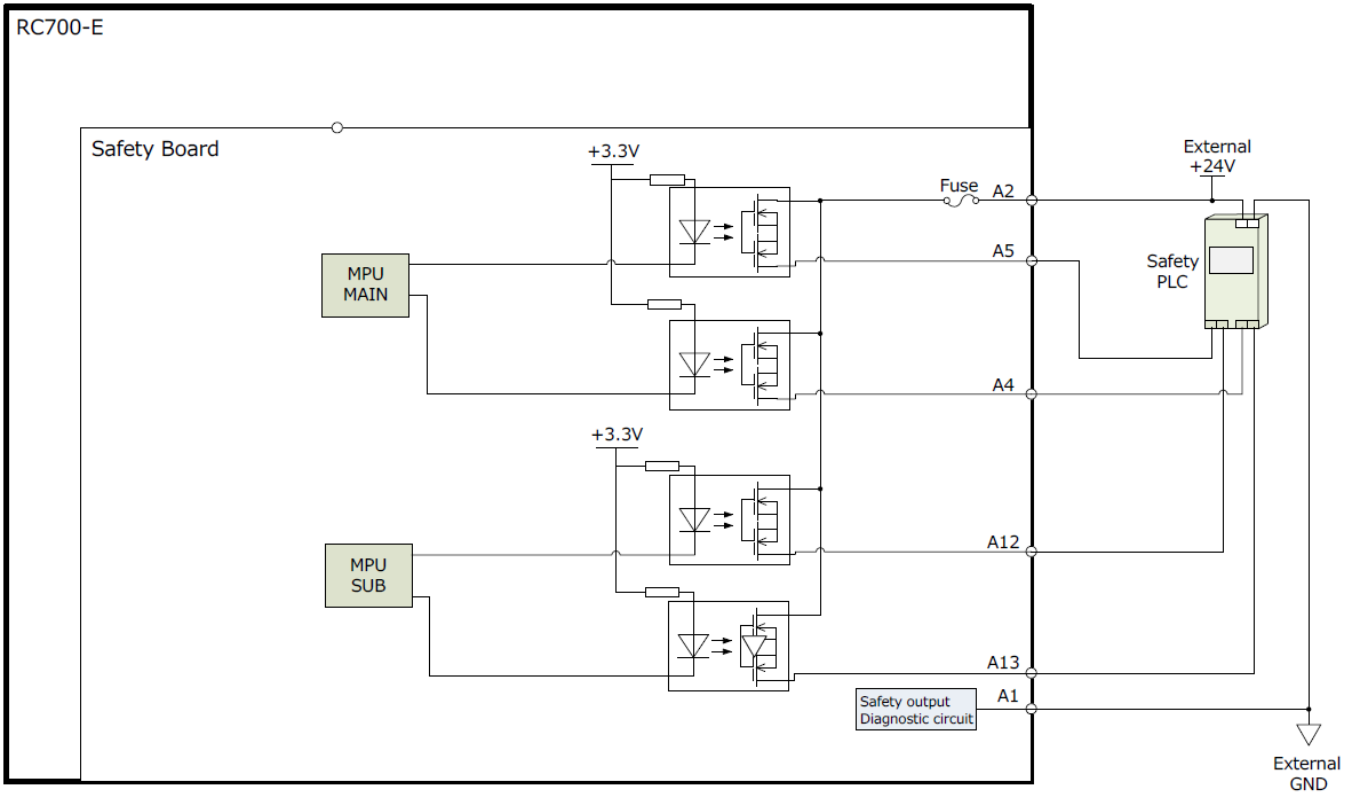
Device Name	Certification
Safety PLC	IEC 61131-2
Safety Relay	IEC 61801-3

4.10.4.2 Connecting Safety Outputs

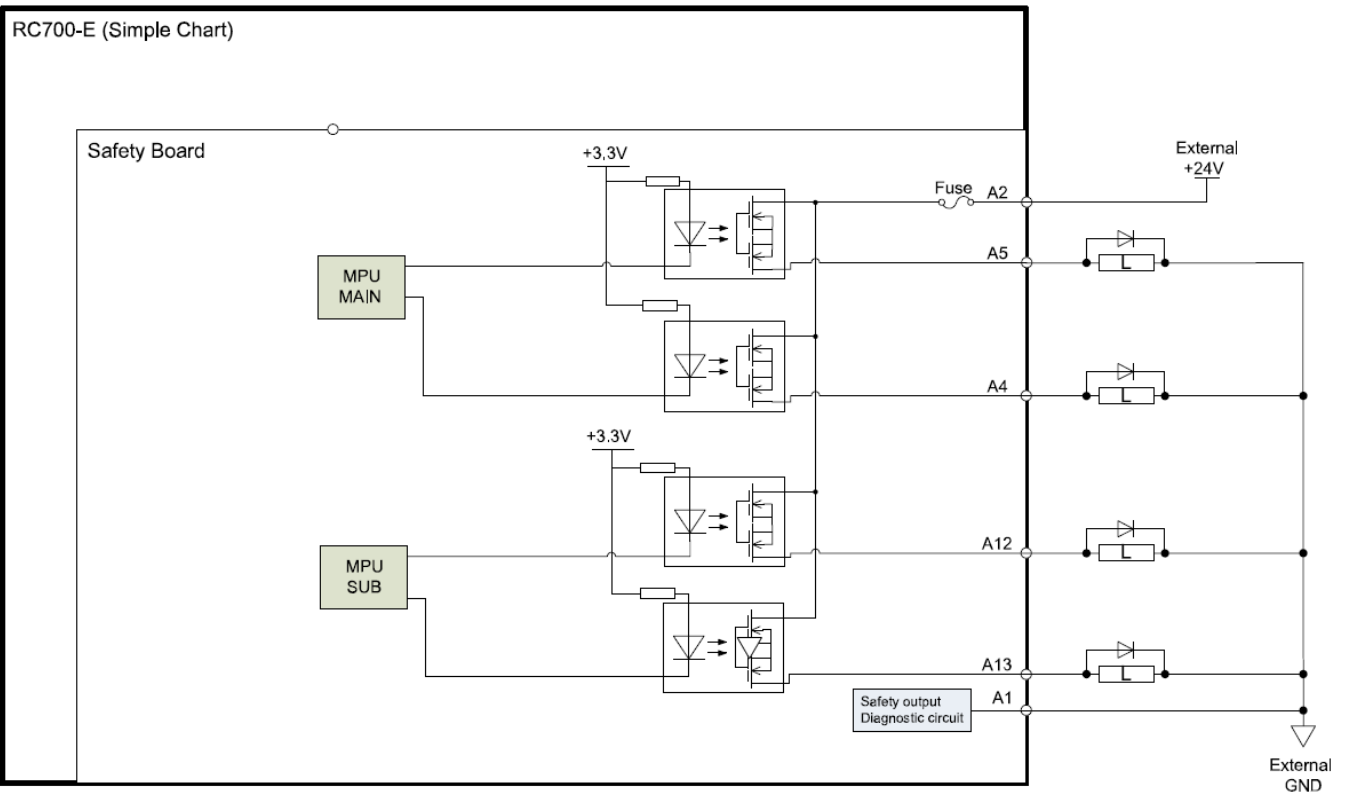
The safety outputs support Source outputs only.

Connection examples

When Safety PLC is connected



When Safety Relay is connected
Insert a diode for circuit protection.



4.11 Standard RS-232C Connector

4.11.1 RS-232C Port

The Controller is equipped with one standard RS-232C port.

To communicate with external devices using two or more RS-232C ports, an RS-232C board must be installed in an option slot.

For details on the expansion ports, refer to the following section.

[RS-232C Board](#)

Port numbers

Port numbers are assigned as shown in the following table.

Port Number	Supported Hardware
#1	Standard RS-232C connector
#2	Expansion RS-232C board, 1st board, CH1
#3	Expansion RS-232C board, 1st board, CH2
#4	Expansion RS-232C board, 2nd board, CH1
#5	Expansion RS-232C board, 2nd board, CH2

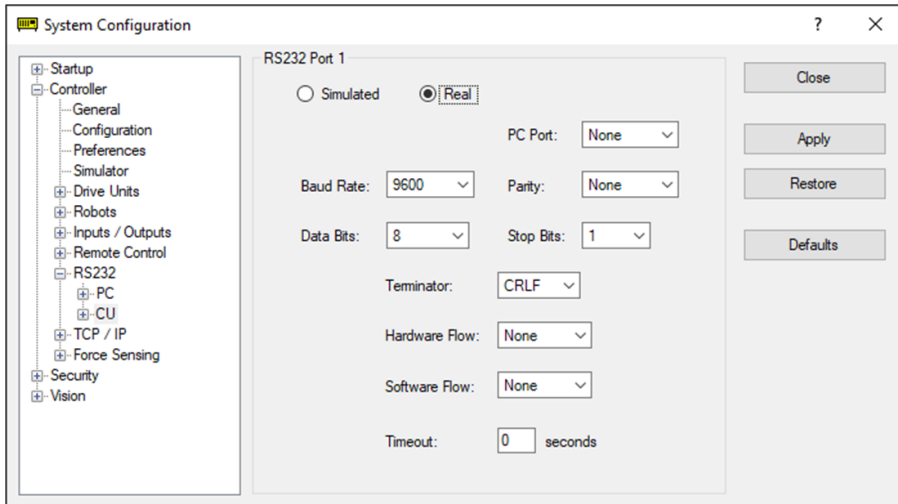
4.11.2 Checking from Epson RC+ (RS-232C)

When an RS-232C board is installed in the Controller's option unit, the Controller software automatically recognizes the RS-232C board. Therefore, no software configuration is required.

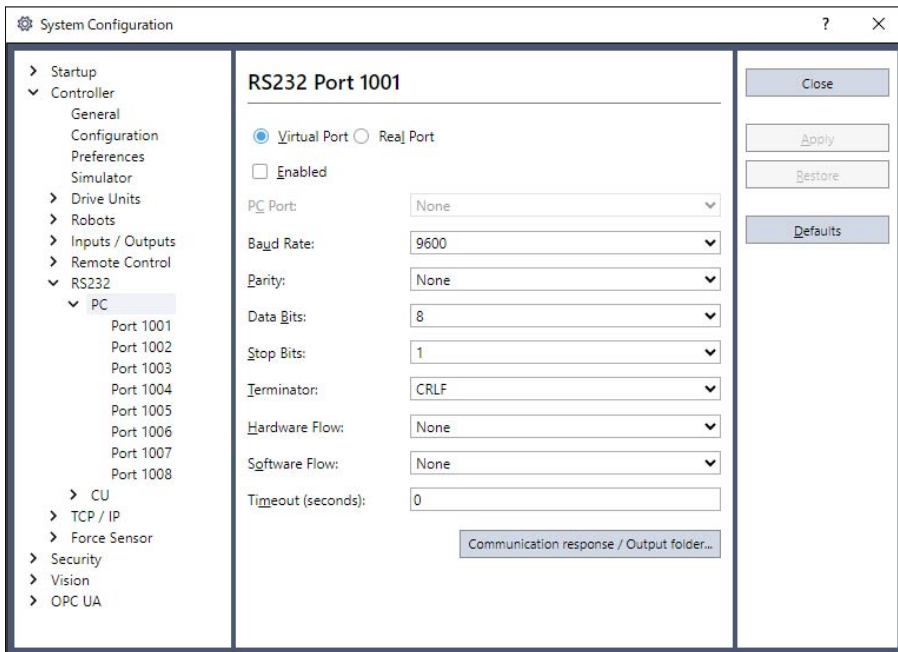
You can confirm on the Epson RC+ screen that the board was correctly recognized.

1. In the Epson RC+ menu, select [Setup] - [System Configuration] to display the [System Configuration] dialog box.

EPSON RC+ 7.0



Epson RC+ 8.0



2. Select [RS232] - [CU].

4.11.3 Communication Settings (RS-232C)

The available communication settings are shown in the following table.

Item	Specifications
Communication speed	110, 300, 600, 1200, 2400, 4800, 9600, 14400, 19200, 38400, 57600, 115200
Data bit length	7, 8
Stop bit length	1, 2
Parity	odd, even, none
Terminator	CR, LF, CRLF

For details on how to use the RS-232C communication function from the robot application, refer to the following manual or online help.

"Epson RC+ User's Guide - RS-232C Communications"

4.11.4 Communication Cable (RS-232C)

Communication cables must be provided by the customer.

Connector Name	Standard
RS-232C connector (Controller side)	D-Sub 9-pin male Mating screw lock part #4 - 40

KEY POINTS

Use twisted pair shielded wires for cables.

The shield should be clamped to the hood for noise reduction.

The pin assignment of the RS-232C connector is shown in the following table.

Pin Number	Signal	Function	Signal Direction
1	DCD	Carrier send	Inputs
2	RXD	Received data	Inputs
3	TXD	Transmitted data	Outputs
4	DTR	Data terminal ready	Outputs
5	GND	Signal ground	—
6	DSR	Data set ready	Inputs
7	RTS	Request to send	Outputs
8	CTS	Permission to send	Inputs
9	RI	Ring indicator	Inputs

4.12 I/O Connector

I/Os are connectors for user input/output devices.

I/O	Point	Bit Number
Inputs	24	0-23
Outputs	16	0-15

- For details on expansion I/Os installed in the option unit, refer to the following section.

Expansion I/O Boards

- When wiring, refer to the following section to prevent noise generation.

Key Points for Noise Reduction

- By default, remote functions are assigned to the I/O of input bit numbers 0 to 7 and output bit numbers 0 to 8. For details, refer to the following section.

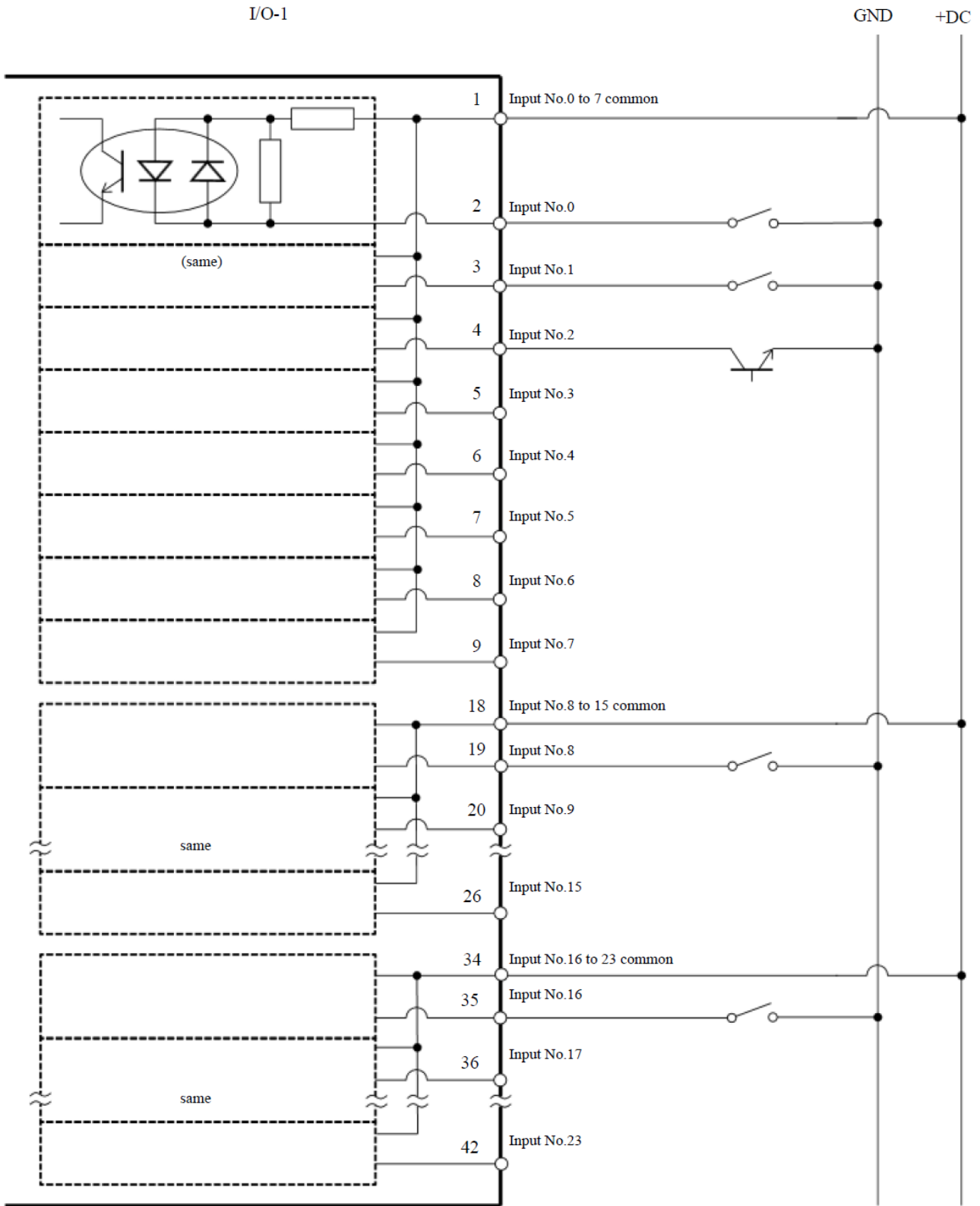
I/O Remote Settings

4.12.1 Input Circuit

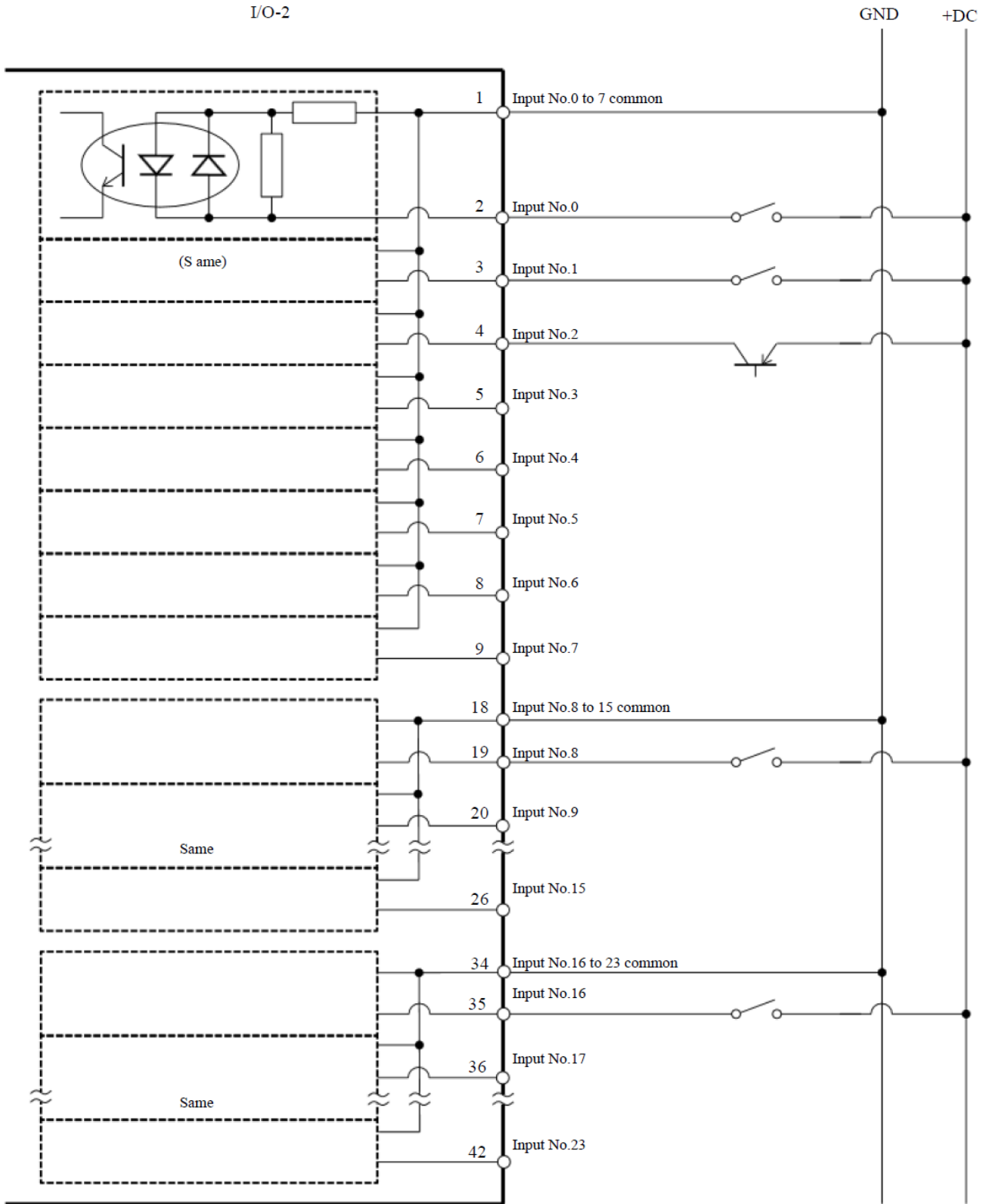
- Input voltage range: +12 to 24 V $\pm 10\%$
- ON voltage: +10.8 V (Min.)
- OFF voltage: +5 V (Max.)
- Input current: 10 mA Typ. at +24 V input

The input circuit uses a bidirectional photocoupler, which allows the following two types of wiring.

4.12.1.1 Input Circuit Diagram and Wiring Example 1



4.12.1.2 Input Circuit Diagram and Wiring Example 2



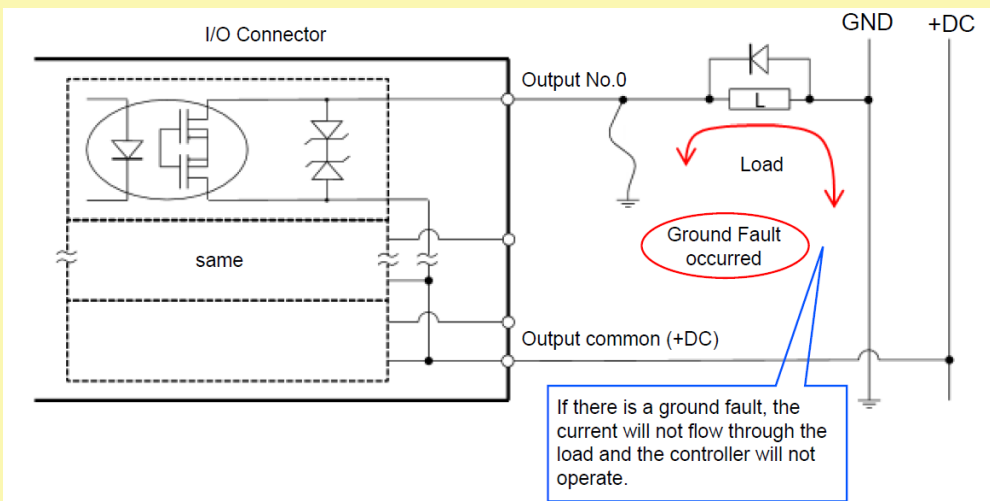
4.12.2 Output Circuit

- Rated output voltage: +12 V to 24 V ±10%.
- Maximum output current: 100 mA per output
- Output driver: PhotoMOS relay
- On-resistance (average): 23.5 Ω or less

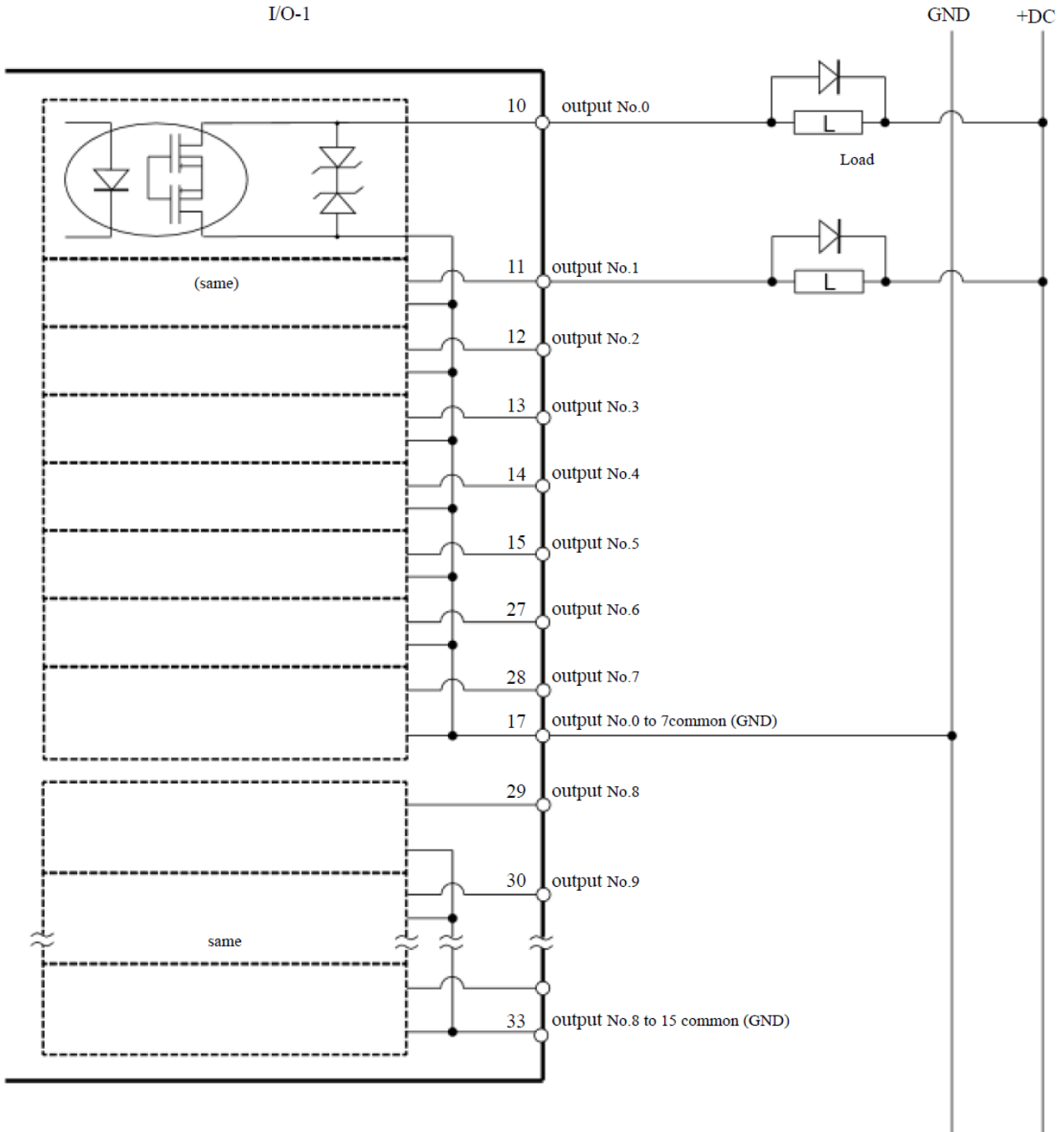
The output circuit uses a non-polarized PhotoMOS relay, which allows the following two types of wiring.

⚠ CAUTION

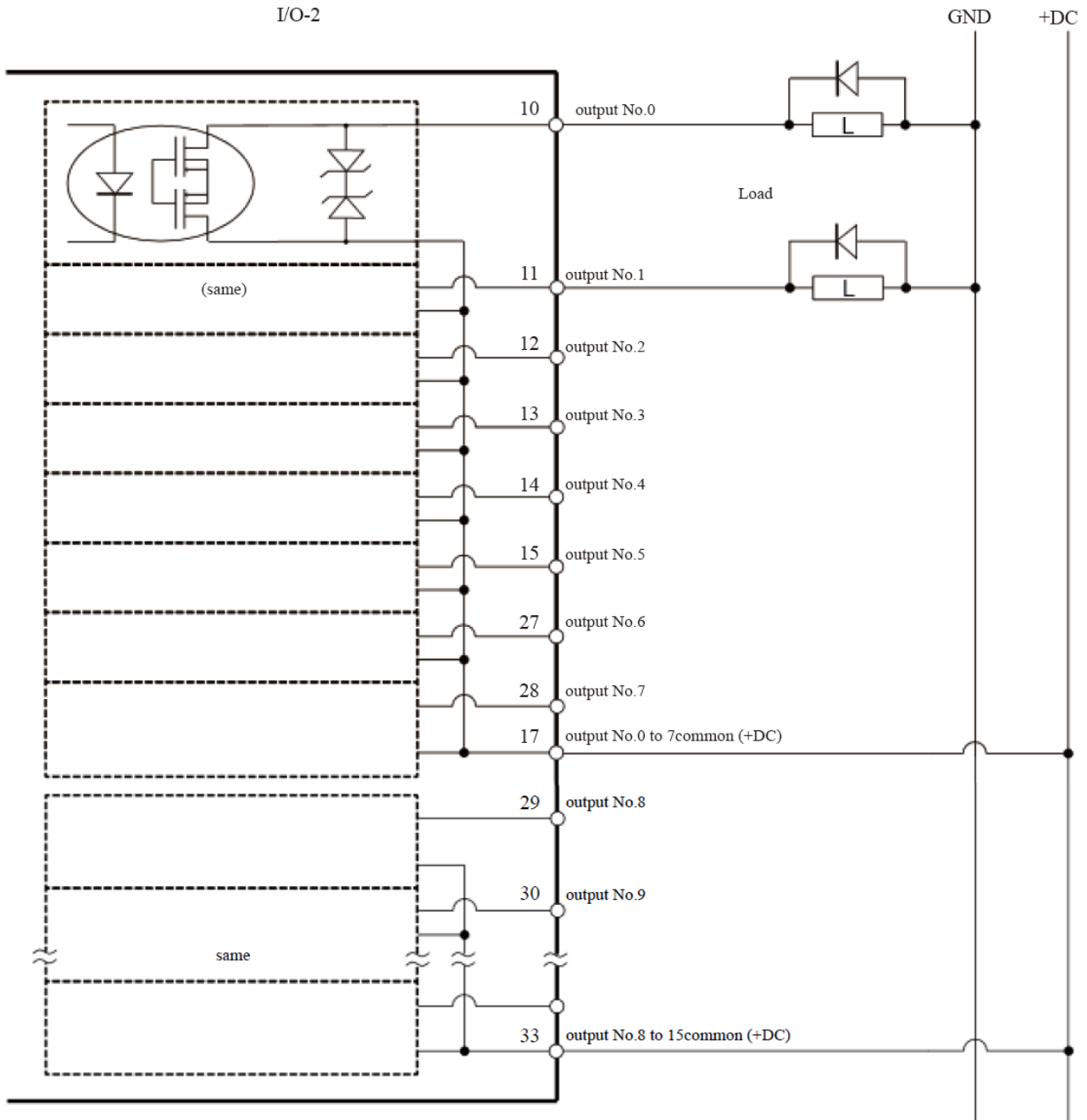
- To comply with the EU Machinery Directive, use positive common (PNP) to prevent unintended operation of the load if a ground fault occurs in the wiring between the Controller and the load.



4.12.2.1 Output circuit diagram and wiring example 1: Sink type (NPN)



4.12.2.2 Output circuit diagram and wiring example 2: Source type (PNP)



4.12.3 Signal Arrangement

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

By default, the remote functions shown in parentheses () are assigned to the I/O of inputs 0 to 7 and outputs 0 to 8. To assign remote functions, refer to the following section.

I/O Remote Settings

Connector Name	Standard
I/O Connector (Controller side)	D-sub 50-pin male Mating screw lock part #4 - 40

* I/O connectors, I/O cables, and terminal blocks are available as options.

* I/O connectors are provided as standard at shipping.

4.13 I/O Remote Settings

This section describes the functions and timing of the input/output signals.

By assigning remote functions to Standard I/O, Expansion I/O, and Fieldbus I/O, the robot system can be controlled from user-provided operating devices or sequencers.

By default, remote functions are assigned to the I/O of input numbers 0 to 7 and output numbers 0 to 8.

To be able to accept remote input from an external source, the control device must be set to remote in addition to assigning the remote function.

The I/O numbers where remote functions are assigned can be changed by the user.

For the setting procedure, refer to the following manual or online help.

"Epson RC+ User's Guide - Remote Control"

CAUTION

- When using I/O with remote settings, pay attention to the following points. Using I/O with remote settings without satisfying the requirements may lead to system failure or safety issues.
 - This signal is not a safety signal. Do not use it for safety-related functions.
 - When making settings, do not make a mistake in the relationship between function assignments and wiring.
 - Be sure to check the correspondence between the functions and wiring before supplying power.
 - When checking operation, try to anticipate configuration or wiring errors. If the Manipulator performs an abnormal operation due to a setting or wiring error, do not hesitate to immediately stop Manipulator operation by pressing the emergency stop switch or by other means.

KEY POINTS

- The remote function is enabled even when virtual I/O mode is enabled.
- When making the remote settings for the I/O, make a record of the settings or save them as file data.
- When remote functions are assigned to Fieldbus I/O, their responsiveness varies depending on the communication speed of the fieldbus. For details on the responsiveness of fieldbus, refer to the following manual.

"Robot Controller Option Fieldbus I/O"

4.13.1 I/O Signal Functions

By default, remote functions are assigned to the I/O of input numbers 0 to 7 and output numbers 0 to 8.
 To change the function assignments from the default settings, the settings must be made using Epson RC+.
 An expansion I/O board or Fieldbus I/O board is required to output all functions.

4.13.1.1 Inputs

Remote input enables external operation of Manipulators and Controllers by inputting signals when valid conditions specified for each function are met.

To be able to accept remote input from an external source, the control device must be set to remote in addition to assigning the remote function. "AutoMode output" is turned on when the remote input can be accepted from an external source.

Signals other than "SelProg" execute their respective functions when the input acceptance condition is satisfied at the rising edge of the signal. Functions are performed automatically, and so there is no need to create special programs.

KEY POINTS

- If an error occurs, execute "Reset" to clear the error state before executing a remote input command. Use "Error output" and "Reset input" to allow the remote device to monitor and clear error states.
- If remote input commands do not meet the input acceptance condition, a CmdError signal outputs. The CmdError signal is not set to remote I/O output signal by default. When you use the remote function, set the CmdError signal to the remote I/O output signal.

Function Name	Default	Description	Input Acceptance Condition (*1)
Start	0	Execute the function selected in SelProg (*2) (*3)	Ready output ON Error output OFF EStopOn output OFF SafeguardOn output OFF EStopOff output ON Pause input OFF Stop input OFF
SelProg1	1	Specify Main function number to be executed (*2)	-
SelProg2	2		
SelProg4	3		
SelProg8	Not set		
SelProg16	Not set		
SelProg32	Not set		
Stop	4	Abort all tasks and commands	-
Pause	5	Pause all tasks (*4)	Running output ON

Function Name	Default	Description	Input Acceptance Condition (*1)
Continue	6	Resume paused task	Paused output ON Pause input OFF Stop input OFF
Reset	7	Emergency stop reset and error reset (*5)	Ready output ON
Shutdown	Not set	Shut down system	-
ForcePowerLow	Not set	Operate under a forced low power function Robot operates at low power Does not accept Power High control by commands, etc. Performs the following operations depending on Controller environment settings Stop or pause all tasks and commands (*6)	Always This input is accepted even when AutoMode output is OFF.
SelRobot	Not set	Change output conditions for MotorsOn, AtHome, PowerHigh, and MCalReqd (*7)	-
SelRobot1 SelRobot2 SelRobot4 SelRobot8 SelRobot16	Not set	Specify robot number to execute command (*8)	-
SetMotorOn	Not set	Robot motor ON (*8) (*9)	Ready output ON EStopOn output OFF SafeguardOn output OFF EStopOff output ON SetMotorOff input OFF
SetMotorOff	Not set	Robot motor OFF (*8)	Ready output ON
SetPowerHigh	Not set	Set robot power mode to High (*8)	Ready output ON EStopOn output OFF SafeguardOn output OFF EStopOff output ON SetPowerLow input OFF
SetPowerLow	Not set	Set robot power mode to Low (*8)	Ready output ON

Home	Not set	Move robot arm to user-defined home position	Ready output ON Error output OFF EStopOn output OFF SafeguardOn output OFF EStopOff output ON MotorsOn output ON Pause input OFF Stop input OFF
MCal	Not set	Run MCal (*8) (*10)	Ready output ON Error output OFF EStopOn output OFF SafeguardOn output OFF EStopOff output ON MotorsOn output ON Pause input OFF Stop input OFF
Recover	Not set	Perform a recovery operation to the position when the safeguard was opened after the safeguard was closed	Paused output ON Error output OFF EStopOn output OFF SafeguardOn output OFF EStopOff output ON RecoverReqd output ON Pause input OFF Stop input OFF
ResetAlarm	Not set	Reset alarm (*11)	-
SelAlarm1 SelAlarm4 SelAlarm8	Not set	Specify alarm number to reset (*12)	-
ALIVE	Not set	Input signal for alive monitoring of the Controller The same signal as the input is output to the output-side ALIVE. The master device can perform alive monitoring of the Controller by periodically switching inputs and checking output signals.	-

(*1) "AutoMode output" ON is omitted because it is a common input acceptance condition for all.

(*2) "Start input" executes the function specified by the 6 bits "SelProg1, 2, 4, 8, 16, 32."

Function Name	SelProg1	SelProg2	SelProg4	SelProg8	SelProg16	SelProg32
Main	0	0	0	0	0	0

Function Name	SelProg1	SelProg2	SelProg4	SelProg8	SelProg16	SelProg32
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) Do not run the Restart command of the SPEL+ program and the remote input Start signal at the same time. Running programs in duplicate may cause a 2503 error to occur.

(*4) "NoPause task" and "NoEmgAbort task" do not pause.

For details, refer to the following manual or online help.

"Epson RC+ Language Reference - Pause"

(*5) I/O outputs are also turned off and robot parameters are initialized.

(*6) This performs all tasks and commands, robot power modes, and PowerHigh command operations according to the setting values in the Controller environment settings.

Environment settings (1): "Low power at ForcePowerLow signal OFF"

Environment settings (2): "Pause tasks at ForcePowerLow signal change"

For details on Controller environment settings, refer to the following manual.

"Epson RC+ User's Guide - [Setup] - [System Configuration] - [Controller] - [Preferences] under [System Configuration] Command (Setup Menu)."

Environment settings (1)	Environment settings (2)	ForcePowerLow Signal Change	All tasks and commands	Robot power mode	PowerHigh command
0	0	1->0	Stop	Low only	Accept
0	0	0->1	Stop	Low only	Not accepted
0	1	1->0	Operation continues	High/Low	Accept
0	1	0->1	Pause	Low only	Not accepted
1	0	1->0	Stop	Low only	Not accepted
1	0	0->1	Stop	Low only	Accept
1	1	1->0	Pause	Low only	Not accepted
1	1	0->1	Operation continues	High/Low	Accept

(*7) This switches the output conditions for MotorsOn, AtHome, PowerHigh, and MCalReqd.

The conditions are selected using SelRobot-SelRobot16, and this signal can be set to switch the output conditions.

Once a selection is made, the condition is retained until it is switched again or until the Controller is turned off and restarted.
The default is all robots selected.

(*8) If multiple robots are connected to the Controller, the value specified by the 5 bits "SelRobot1, 2, 4, 8, 16" corresponds to the robot number.

Robot No.	SelRobot1	SelRobot2	SelRobot4	SelRobot8	SelRobot16
0(All)	0	0	0	0	0
1	1	0	0	0	0
2	0	1	0	0	0
3	1	1	0	0	0
:					
13	1	0	1	1	0
14	0	1	1	1	0
15	1	1	1	1	0
16	0	0	0	0	1

0=OFF, 1=ON

(*9) Robot parameters are also initialized.

For details, refer to the following manual or online help.

"Epson RC+ Language Reference - Motor"

(*10) For details, refer to the following manual or online help.

"Epson RC+ Language Reference - MCal"

(*11) The conditions are selected using SelAlarm1-SelAlarm8, and this signal can be set to clear a specified alarm.

(*12) The value specified by the 4 bits of "SelAlarm1, 2, 4, 8" corresponds to the alarm number.

Alarm Number	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

For the greasing locations, refer to the following manual.

"Manipulator Manual"

4.13.1.2 Outputs

Remote output is a function that outputs the current Manipulator status, Controller status, and operation mode to an external device from the Controller.

Remote output always outputs the status of the assigned function externally, regardless of the control device settings. Output is performed automatically, and so there is no need to create a special program.

Function Name	Default	Description
Ready	0	ON when Controller startup is complete and no tasks are running
Running	1	ON when task is running However, OFF when "Paused output" is ON
Paused	2	ON when paused task is present
Error	3	ON when error has occurred "Reset input" is required to recover from an error state. (*1)
EStopOn	Not set	OFF except in emergency stop state ON in emergency stop state OFF in Controller power off state (*2)(*3)
SafeguardOn	5	ON when safeguard is open
SError	6	ON when a critical error has occurred If a critical error has occurred, it cannot be recovered using "Reset input." The Controller must be restarted. (*1)
Warning	7	ON when warning has occurred Even if a warning has occurred, the task can be executed as usual. However, take corrective action to address the cause of the warning as soon as possible. (*1)
EStopOff	8	ON except in an emergency stop state OFF in emergency stop state OFF in Controller power off state (*3)
MotorsOn	Not set	ON when robot motors are turned on (*4)
AtHome	Not set	ON when robot is in home position (*4)
PowerHigh	Not set	ON when robot power mode is High (*4)
MCalReqd	Not set	ON when robot has not performed MCal (*4)
RecoverReqd	Not set	ON when even one robot is waiting to perform the recovery operation after the safeguard was closed
RecoverInCycle	Not set	ON when the recovery operation is running for at least one robot
WaitingRC	Not set	ON when Controller is waiting for connection to RC+
CmdRunning	Not set	ON during input command execution
CmdError	Not set	ON when input command was not accepted

Function Name	Default	Description
CurrProg1 CurrProg2 CurrProg4 CurrProg8 CurrProg16 CurrProg32	Not set	Outputs the main function number running or last executed (*5)
AutoMode	Not set	ON when remote input can be accepted (*6)
TeachMode	Not set	ON when in TEACH mode (*3)
TestMode	Not set	ON when in TEST mode
EnableOn	Not set	ON when enable switch is on (*3)
ErrorCode1 to ErrorCode8192	Not set	Output the error number
InsideBox1 to InsideBox15	Not set	ON when robot is inside the entry detection area (*7)
InsidePlane1 to InsidePlane15	Not set	ON when robot is on the entry detection plane (*8)
Alarm	Not set	ON when an alarm has occurred (*9)
Alarm1	Not set	ON when Controller battery alarm has occurred (*10)
Alarm2	Not set	ON when robot battery alarm has occurred (*10)
Alarm3	Not set	ON when robot grease alarm has occurred (*10) (*11)
Alarm4	Not set	Reserved
Alarm5	Not set	Reserved
Alarm6	Not set	Reserved
Alarm7	Not set	Reserved
Alarm8	Not set	Reserved
Alarm9	Not set	Reserved
PositionX	Not set	Outputs the current X-coordinate in the world coordinate system. (*12) (*13)
PositionY	Not set	Outputs the current Y-coordinate in the world coordinate system. (*12) (*13)
PositionZ	Not set	Outputs the current Z-coordinate in the world coordinate system. (*12) (*13)
PositionU	Not set	Outputs the current U-coordinate in the world coordinate system. (*12) (*13)
PositionV	Not set	Outputs the current V-coordinate in the world coordinate system. (*12) (*13)
PositionW	Not set	Outputs the current W-coordinate in the world coordinate system. (*12) (*13)
Torque1	Not set	Outputs the current torque value of Joint #1. (*12) (*13)
Torque2	Not set	Outputs the current torque value of Joint #2. (*12) (*13)

Function Name	Default	Description
Torque3	Not set	Outputs the current torque value of Joint #3. (*12) (*13)
Torque4	Not set	Outputs the current torque value of Joint #4. (*12) (*13)
Torque5	Not set	Outputs the current torque value of Joint #5. (*12) (*13)
Torque6	Not set	Outputs the current torque value of Joint #6. (*12) (*13)
CPU	Not set	Outputs the CPU load rate for the user program. (*14)
ESTOP	Not set	Outputs the number of times that an emergency stop has been performed.
ALIVE	Not set	Output signal for alive monitoring of the Controller Outputs the signal that was input by the input-side ALIVE. The master device can perform alive monitoring of the Controller by periodically switching inputs and checking output signals.
ForceControlOn	Not set	ON when robot is running the force control function (*4)
ExtCmdGet	Not set	Extended remote IO command. For details, refer to the following manual. "Remote Control Reference - Remote I/O to Be Used"
ExtRespSet	Not set	
ExtCmdResult	Not set	
ExtError	Not set	
ExtResp_0-15	Not set	
ExtResp_16-31	Not set	
ExtResp_32-47	Not set	
ExtResp_48-63	Not set	
ExtResp_64-79	Not set	
ExtResp_80-95	Not set	
ExtResp_96-111	Not set	
ExtResp_112-127	Not set	

(*1) The correspondence between Error, SError, and Warning outputs and the corresponding status/error numbers are shown below.

Output Function Name	Error Numbers
Error	1000~8999
SError	9000~9999
Warning	410~999

For details on status numbers/error numbers, refer to the following manual.
"Status Code/Error Code List"

(*2) EStopOn is not recommended because the outputs for the emergency stop and Controller power off states do not match. To output the emergency stop state, assign EStopOff.

(*3) Do not the following signals for safety-related functions. The signals do not meet Cat 3&PLd. EStopOn, EStopOff, TeachMode, EnableOn

(*4) The following output is produced under the conditions selected by SelRobot. After switching the conditions by SelRobot, wait 40 ms before inputting the data.

Function Name	State of SelRobot1-SelRobot16 at SelRobot Input	
	0: Selects All Robots	1 to 16: Selects Robot Number
MotorsOn	ON when any of the robot's motors is on	ON when the selected robot motor is on
AtHome	ON when all robots are at the home position	ON when the selected robot is at the home position
PowerHigh	ON when the power mode for any robot is High	ON when the power mode of the selected robot is High
MCalReqd	ON when any robot has not performed MCal	ON when the selected robot has not performed MCal

(*5) Outputs the function number that is being executed or was last executed using the 6 bits of "CurrProg1, 2, 4, 8, 16, 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

(*6) Remote input can be accepted in the following two cases:

- When in automatic operation mode and the control device is remote
- When in program mode and remote I/O is enabled

(*7) For details, refer to the following manual or online help. "Epson RC+ Language Reference - Box"

(*8) For details, refer to the following manual or online help. "Epson RC+ Language Reference - Plane"

(*9) This is set to ON whenever Controller alarm information or robot alarm information is present.

(*10) The occurrence of the battery alarm and grease alarm is monitored in five-minute cycles, and so the output timing is different from the occurrence of Controller alarms.

The output may occur up to five minutes after the Controller alarm occurs.

Alarm is turned on when the Controller or Manipulator battery alarm or grease alarm occurs when "Maintenance" is enabled. For details on Maintenance, refer to the following section.

Alarm Function

(*11) For the greasing locations, refer to the following manual.

"Manipulator Manual"

(*12) If SelRobot1, SelRobot2, SelRobot4, SelRobot8, or SelRobot16 is set, information on the selected robot is output. If nothing is set, information on robot 1 is output.

(*13) This is output in Real format.

(*14) The total user-created task load ratio is output. For the CPU load ratio, see the Task Manager.

4.13.2 Timing Charts

4.13.2.1 Input Signal Notes

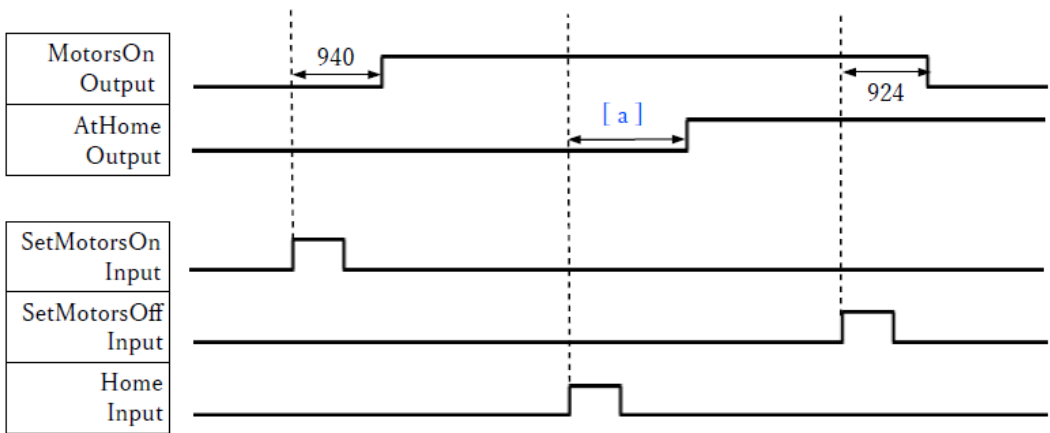
The timing charts show the timing for the Controller's key operations. Be sure to follow the timing chart when inputting signals.

However, note that the times in the charts are approximate. The time varies depending on the number of Manipulators, the number of tasks running, the Controller's CPU speed, and other factors.

Remote signals should be generated by pulse input, and each input should be designed to avoid overlapping as much as possible.

The pulse width of an input signal should be at least 25 msec, and input with chattering should be avoided.

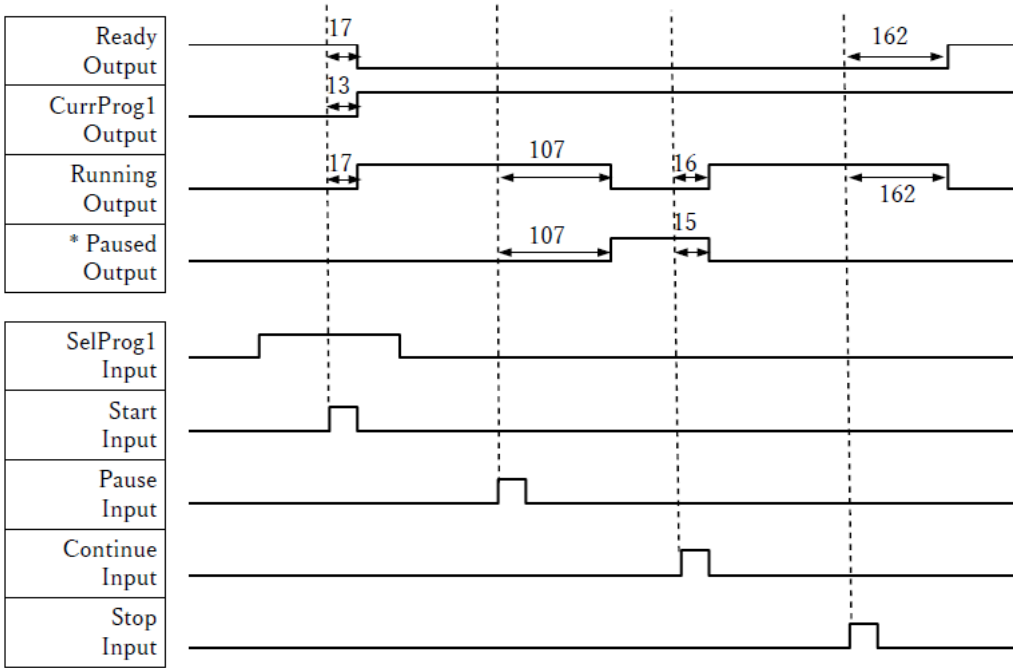
4.13.2.2 Timing for Operation Execution Sequence



(Units: msec)

Symbol	Description
a	Depends on the Home motion command

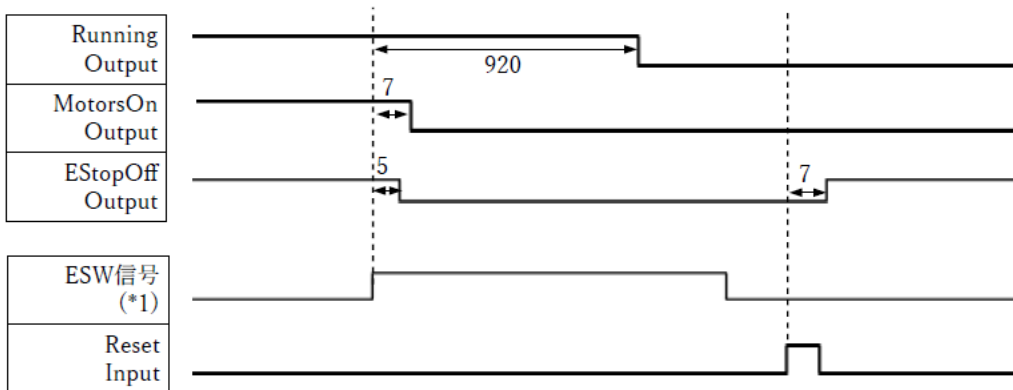
4.13.2.3 Timing for Program Execution Sequence



(Units: msec)

* This varies depending on the Quick Pause (QP) setting and the program operation state at PAUSE input.

4.13.2.4 Timing for Emergency Stop Sequence



(Units: msec)

(*1) This is the logical signal that indicates the timing of Controller internal processing.

For more information on the input signal names and operation conditions, refer to the following section.

[Signal Arrangement and Electrical Specifications](#)

4.14 R-I/O Connector

The R-I/O connector is used to connect the input signals required for real-time I/O functions.

	Point	Bit Number
Inputs	2	24, 25

By inputting a trigger signal to the R-I/O, the position of the moving robot at the instant when the trigger was generated can be retained and acquired with high accuracy. By combining this functionality with Vision, applications can be created that perform everything from workpiece pickup to alignment and installation without stopping the robot.

For details, refer to the following manual.

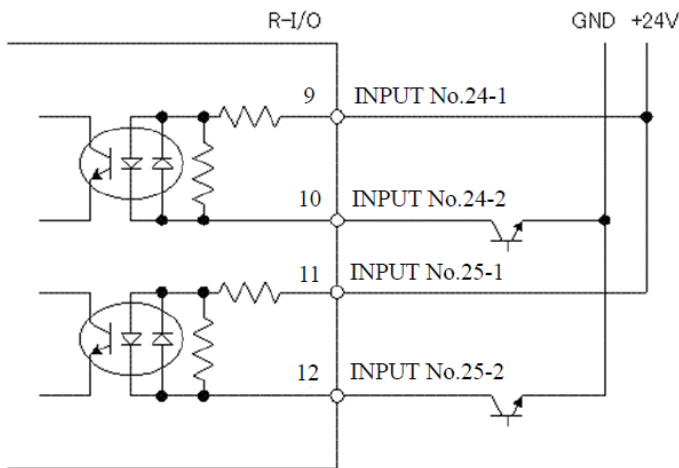
"Epson RC+ User's Guide - Real-time I/O"

4.14.1 Input Circuit

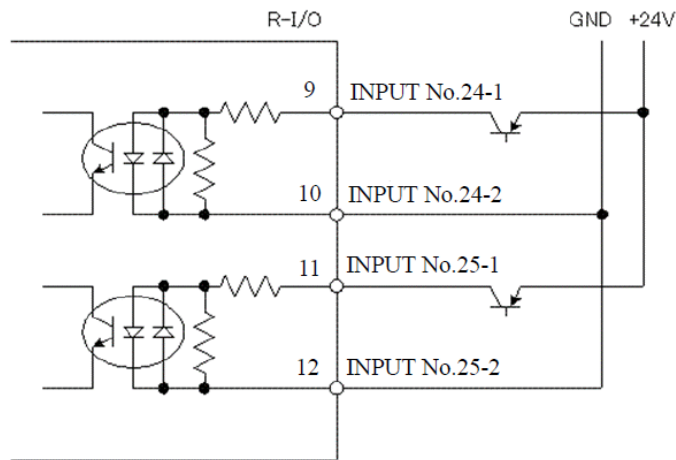
- Input voltage range: +24 V ±10%
- Input current: 10 mA Typ. at +24 V input

The following two types of wiring are possible for the input circuits.

Input circuit diagram and wiring example 1



Input circuit diagram and wiring example 2



4.14.2 Signal Arrangement

⚠ CAUTION

- When using R-I/O, pay attention to the following points. Using I/O with remote settings without satisfying the requirements may lead to system failure or safety issues.
 - Use shielded cables, and route them as far away as possible from noise sources in the surrounding area. Refer to the following section.

Key Points for Noise Reduction

 - Always check the wiring before supplying power.

Pin No.	Signal Name
9	Input No. 24-1
10	Input No. 24-2
11	Input No. 25-1
12	Input No. 25-2
1-8, 13-15	Not used

Do not connect anything to pins 1-8 or 13-15.

Connector Name	Standard
R-I/O Connector (Controller side)	D-sub 15-pin male Mating screw lock part #4 - 40

4.15 Option Slots

4.15.1 What is an Option Slot?

An option slot is a slot for installing an option board. Up to three option boards can be installed on the Controller. The following six types of option boards are available.

- Expansion I/O Boards
- Fieldbus I/O Board
- RS-232C Board
- PG Board
- Analog I/O Board
- Force Sensor I/F Board

4.15.2 Expansion I/O Boards

4.15.2.1 Expansion I/O Boards

Expansion I/O boards can enable an additional 24 inputs and 16 outputs per board.

Up to four I/O boards can be installed.

I/O numbers are assigned as shown in the following table. (Bit numbers are assigned from CN1.)

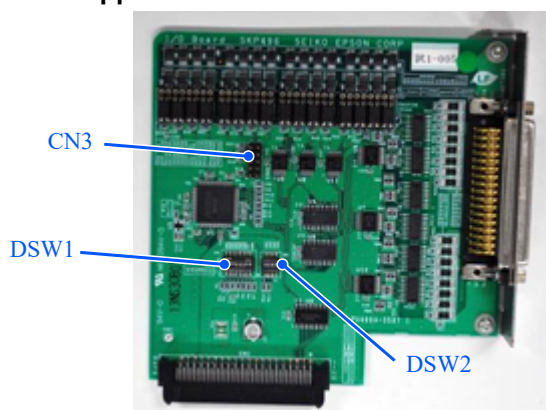
Input Bit Number	Output Bit Number	Corresponding Hardware
0 to 23	0 to 15	Standard I/O
64 to 87	64 to 79	Expansion I/O, 1st board
96 to 119	96 to 111	Expansion I/O, 2nd board
128 to 151	128 to 143	Expansion I/O, 3rd board
160 to 183	160 to 175	Expansion I/O, 4th board

There are following three types of expansion I/O boards.

- Sink type (R12NZ9003Q)
- Source type (R12NZ9003P)
- Nonpolar type (R12NZ901FN)

4.15.2.2 Board Settings (Expansion I/O Board)

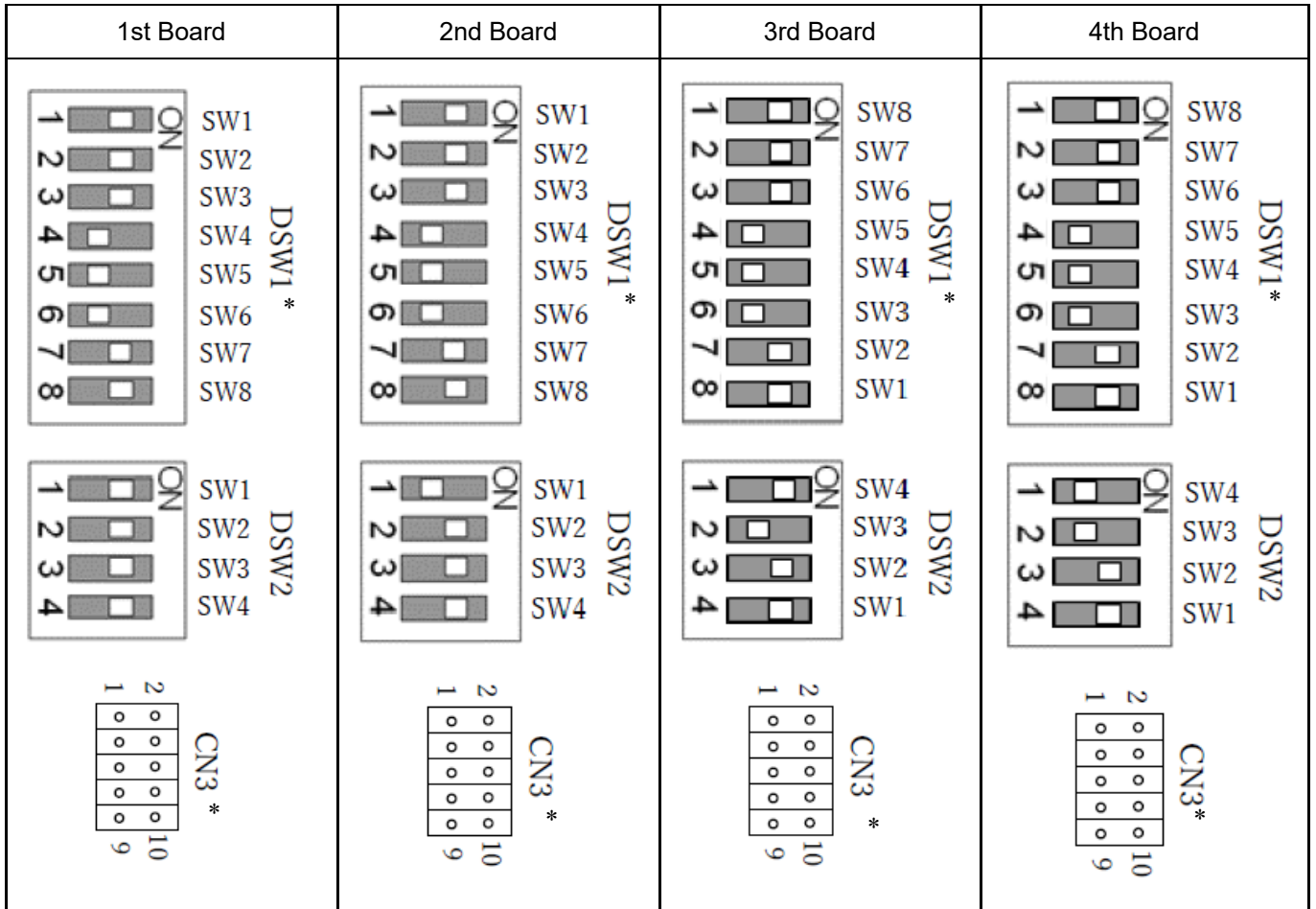
Board appearance



The image above is the board for Source types. Depending on the output type, the switch position may differ.

Switch and jumper settings

Set DSW1 and DSW2. CN3 is all open.



* Nonpolar type does not have DSW1 and CN3.

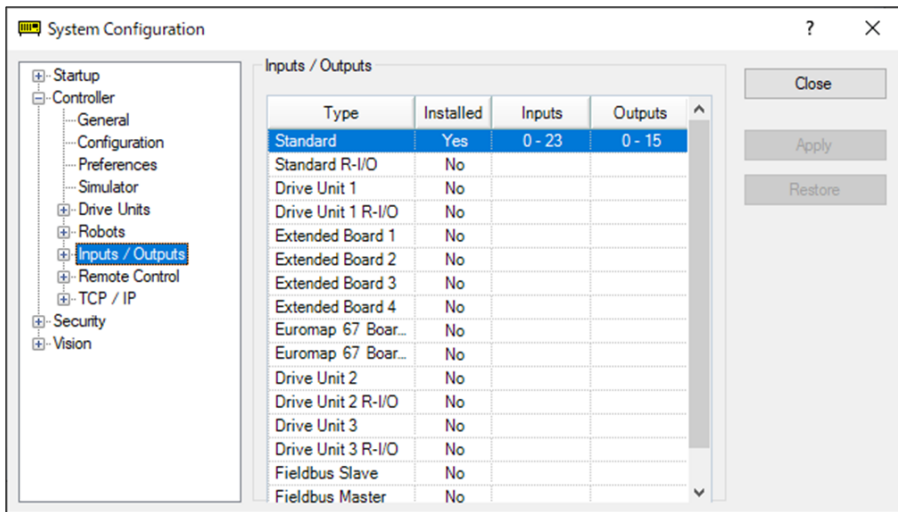
4.15.2.3 Checking with Epson RC+ (Expansion I/O Board)

When an expansion I/O board is installed in an option unit, the Controller software automatically recognizes the expansion I/O board. Therefore, no software configuration is required.

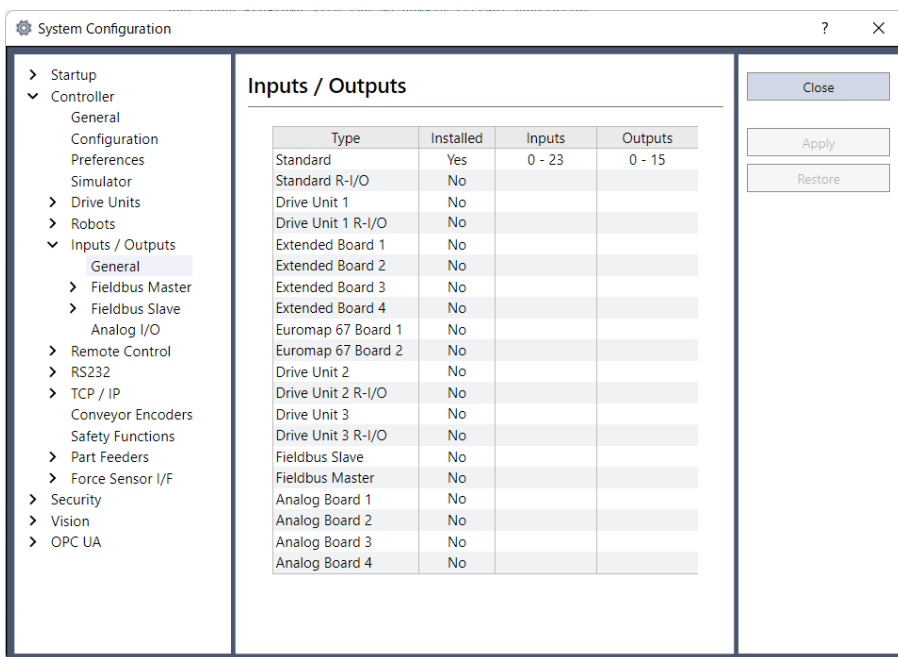
You can confirm on the Epson RC+ screen that the board was correctly recognized.

1. In the Epson RC+ menu, select [Setup] - [System Configuration] to display the [System Configuration] dialog box.

EPSON
RC+ 7.0



Epson
RC+ 8.0



2. Select [Controller] - [Inputs / Outputs].

3. Make sure that the installation is set to "Yes."

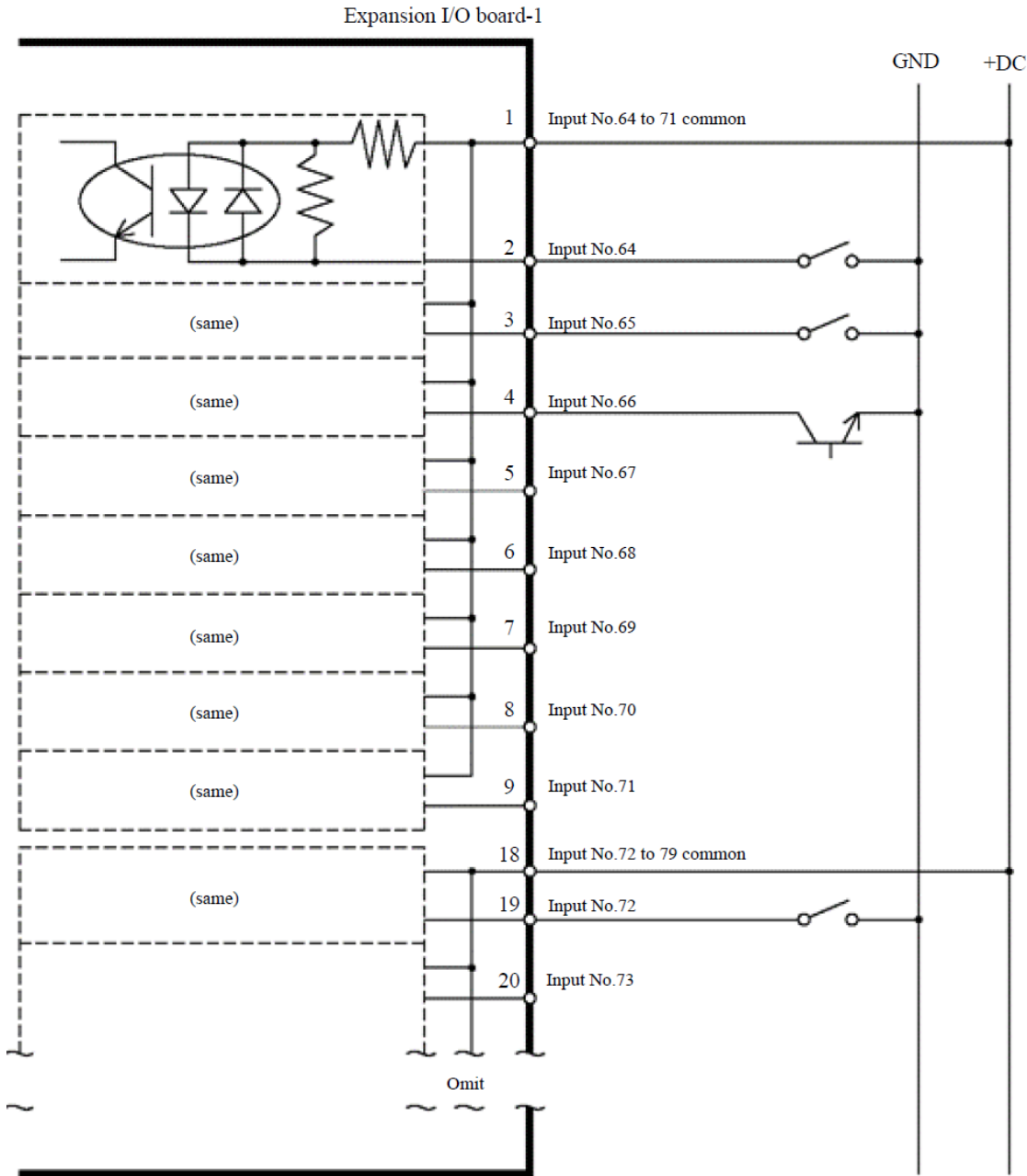
The expansion I/O board is recognized by the Controller software. The corresponding inputs and outputs can be used.

4.15.2.4 Input Circuit (Expansion I/O Board)

- Input voltage range: +12 to 24 V \pm 10%
- ON voltage: +10.8 V (Min.)
- OFF voltage: +5 V (Max.)
- Input current: 10 mA Typ. at +24 V input

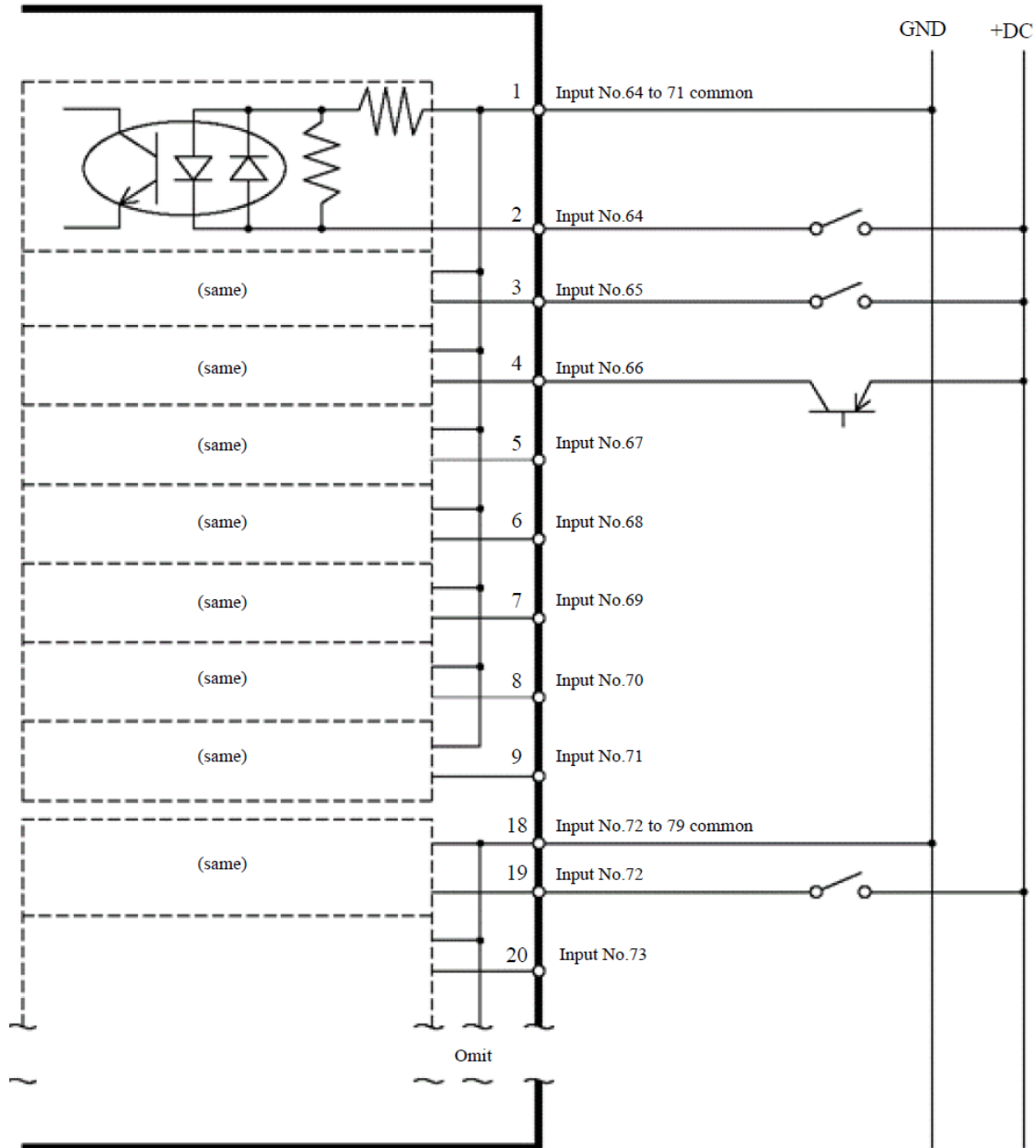
The input circuit uses a bidirectional photocoupler, which allows the following two types of wiring.

Input circuit diagram and wiring example 1: Source type



Input circuit diagram and wiring example 2: Sink type

Expansion I/O board-1



4.15.2.5 Output Circuit (Expansion I/O Board)

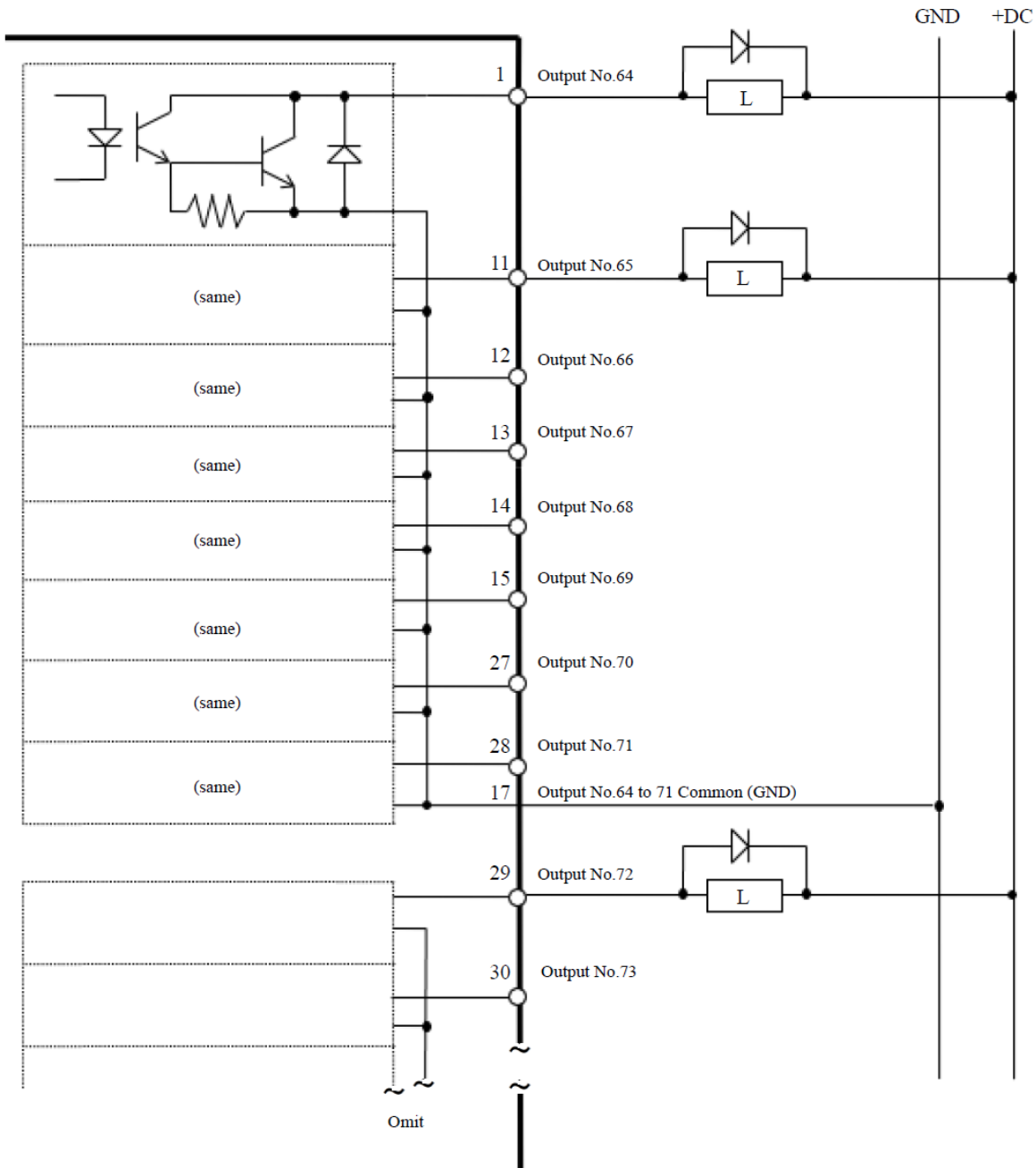
4.15.2.5.1 Output Circuit (Expansion I/O Board) Sink Type/Source Type

- Rated output voltage: +12 V to 24 V \pm 10%
- Maximum output current: Typ. 100 mA per output
- Output driver: Photocoupler

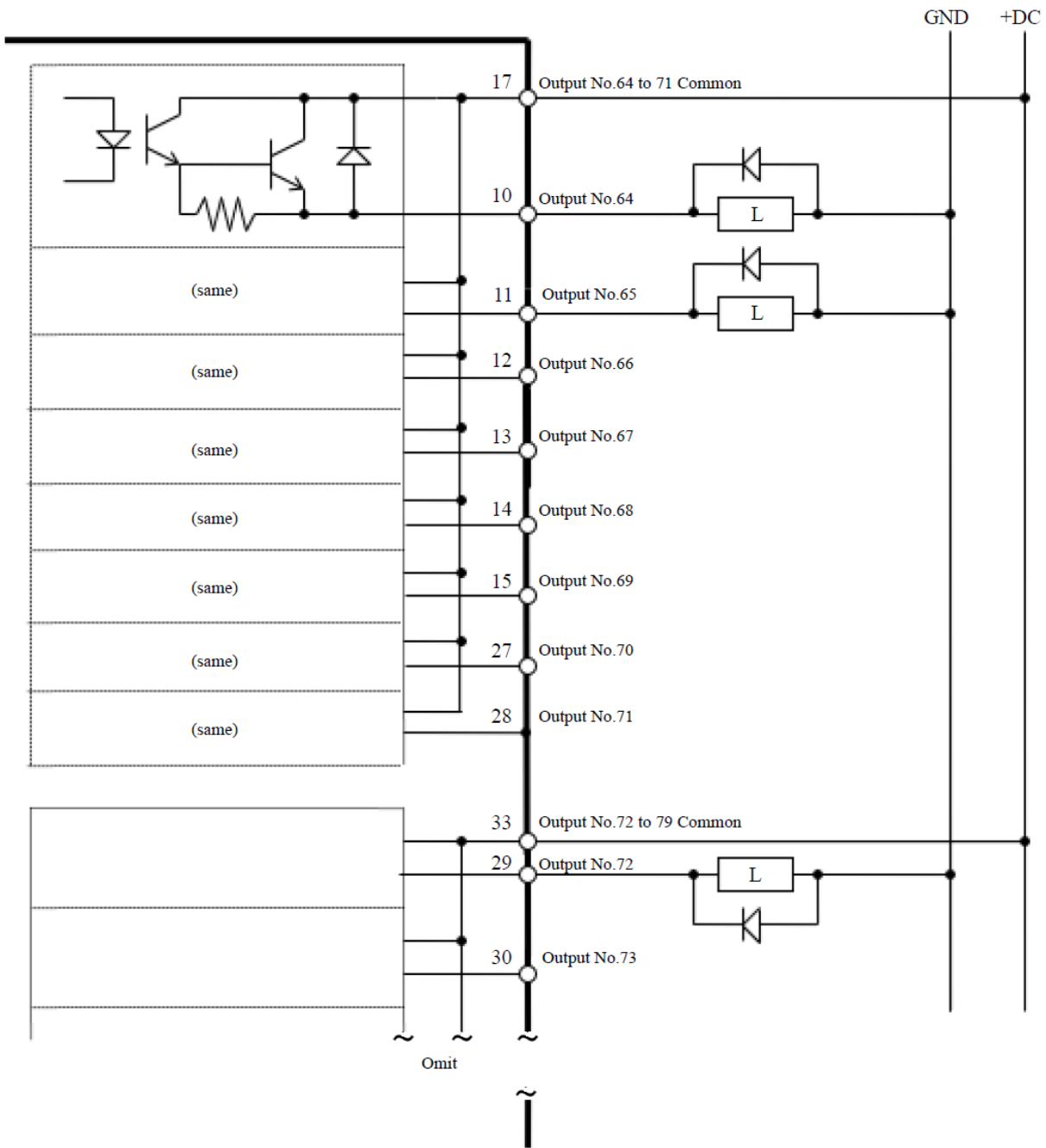
CAUTION

- There are two types of output circuits: sink type and source type. These types are set at factory shipping. Before wiring, check that the I/O output type matches that of the external connected device. If wiring is performed to the wrong output type, components on the board will be damaged and the robot system will not function properly.
- To comply with the EU Machinery Directive, use the wiring in Wiring Example 2: Source Type. If wiring is performed incorrectly, the Manipulator may not function properly and safety issues may occur.
- The output circuit has no built-in short-circuit or reverse-connection protection circuits. Be careful that wiring mistakes do not occur. If the wiring is performed incorrectly, components on the board may be damaged and the robot system may not function properly.

Output Circuit Diagram and Wiring Example 1: Sink Type (NPN)



Output Circuit Diagram and Wiring Example 2: Source Type (PNP)



4.15.2.5.2 Output Circuit (Expansion I/O Board) Nonpolar Type

Details about output circuit on Nonpolar type (R12NZ901FN), refer to the following.

Output Circuit

4.15.2.6 Signal Arrangement (Expansion I/O Board)

This is the signal arrangement table for the first expansion I/O board.

Connector 1 signal arrangement

Pin Number	Signal Name	Pin Number	Signal Name
1	Input common No. 64 to 71	26	Input No. 79
2	Input No. 64	27	Output No. 70
3	Input No. 65	28	Output No. 71
4	Input No. 66	29	Output No. 72
5	Input No. 67	30	Output No. 73
6	Input No. 68	31	Output No. 74
7	Input No. 69	32	Not used
8	Input No. 70	33	Output common No. 72 to 79
9	Input No. 71	34	Input common No. 80 to 87
10	Output No. 64	35	Input No. 80
11	Output No. 65	36	Input No. 81
12	Output No. 66	37	Input No. 82
13	Output No. 67	38	Input No. 83
14	Output No. 68	39	Input No. 84
15	Output No. 69	40	Input No. 85
16	Not used	41	Input No. 86
17	Output common No. 64 to 71	42	Input No. 87
18	Input common No. 72 to 79	43	Output No. 75
19	Input No. 72	44	Output No. 76
20	Input No. 73	45	Output No. 77

Pin Number	Signal Name	Pin Number	Signal Name
21	Input No. 74	46	Output No. 78
22	Input No. 75	47	Output No. 79
23	Input No. 76	48	Not used
24	Input No. 77	49	Not used
25	Input No. 78	50	Not used

Connector Name	Standard
I/O Connector (Controller side)	D-sub 50-pin male Mating screw lock part #4 - 40

* I/O connectors, I/O connector cables, terminal blocks, and I/O connector kits are available as options.

This is the signal arrangement table for the second expansion I/O board.

Connector 1 signal arrangement

Pin Number	Signal Name	Pin Number	Signal Name
1	Input common No. 96 to 103	26	Input No. 111
2	Input No. 96	27	Output No. 102
3	Input No. 97	28	Output No. 103
4	Input No. 98	29	Output No. 104
5	Input No. 99	30	Output No. 105
6	Input No. 100	31	Output No. 106
7	Input No. 101	32	Not used
8	Input No. 102	33	Output common No. 104 to 111
9	Input No. 103	34	Input common No. 112 to 119
10	Output No. 96	35	Input No. 112
11	Output No. 97	36	Input No. 113
12	Output No. 98	37	Input No. 114
13	Output No. 99	38	Input No. 115
14	Output No. 100	39	Input No. 116
15	Output No. 101	40	Input No. 117
16	Not used	41	Input No. 118
17	Output common No. 96 to 103	42	Input No. 119
18	Input common No. 104 to 111	43	Output No. 107
19	Input No. 104	44	Output No. 108
20	Input No. 105	45	Output No. 109

Pin Number	Signal Name	Pin Number	Signal Name
21	Input No. 106	46	Output No. 110
22	Input No. 107	47	Output No. 111
23	Input No. 108	48	Not used
24	Input No. 109	49	Not used
25	Input No. 110	50	Not used

Connector Name	Standard
I/O Connector (Controller side)	D-sub 50-pin male Mating screw lock part #4 - 40

* I/O connectors, I/O connector cables, terminal blocks, and I/O connector kits are available as options.

This is the signal arrangement table for the third expansion I/O board.

Connector 1 signal arrangement

Pin Number	Signal Name	Pin Number	Signal Name
1	Input common No. 128 to 135	26	Input No. 143
2	Input No. 128	27	Output No. 134
3	Input No. 129	28	Output No. 135
4	Input No. 130	29	Output No. 136
5	Input No. 131	30	Output No. 137
6	Input No. 132	31	Output No. 138
7	Input No. 133	32	Not used
8	Input No. 134	33	Output common No. 136 to 143
9	Input No. 135	34	Input common No. 144 to 151
10	Output No. 128	35	Input No. 144
11	Output No. 129	36	Input No. 145
12	Output No. 130	37	Input No. 146
13	Output No. 131	38	Input No. 147
14	Output No. 132	39	Input No. 148
15	Output No. 133	40	Input No. 149
16	Not used	41	Input No. 150
17	Output common No. 128 to 135	42	Input No. 151
18	Input common No. 136 to 143	43	Output No. 139
19	Input No. 136	44	Output No. 140
20	Input No. 137	45	Output No. 141

Pin Number	Signal Name	Pin Number	Signal Name
21	Input No. 138	46	Output No. 142
22	Input No. 139	47	Output No. 143
23	Input No. 140	48	Not used
24	Input No. 141	49	Not used
25	Input No. 142	50	Not used

Connector Name	Standard
I/O Connector (Controller side)	D-sub 50-pin male Mating screw lock part #4 - 40

* I/O connectors, I/O connector cables, terminal blocks, and I/O connector kits are available as options.

4.15.3 Fieldbus I/O Board

The following types of Fieldbus I/O are supported:

- DeviceNet™
- PROFIBUS-DP
- PROFINET
- CC-LINK
- EtherNet/IP™
- EtherCAT®
- Modbus (This is not an option. It is a standard feature.)

For details, refer to the following manual.

"Robot Controller Option Fieldbus I/O"

"Epson RC+ User's Guide - Fieldbus Slave I/O"

4.15.4 RS-232C Board

4.15.4.1 RS-232C Board

The Controller is equipped with one RS-232C port as standard.

To communicate with external devices using two or more RS-232C ports, an RS-232C board must be installed in an option slot.

Each expansion RS-232C board can add two ports. Up to two expansion RS-232C boards can be installed for adding up to four ports.

When using the force sensor I/F board, the RS-232C board can be expanded to a maximum of one board and two ports.

Port numbers

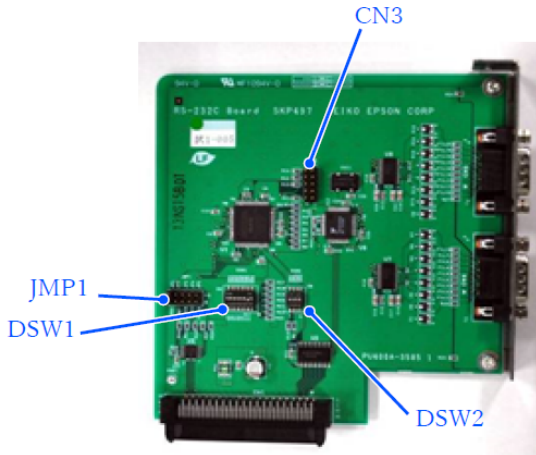
Port numbers are assigned as shown in the following table.

Port Number	Supported Hardware
#2, #3	RS-232C, 1st board

Port Number	Supported Hardware
#4 , #5	RS-232C, 2nd board

4.15.4.2 Board Settings (RS-232C)

Board appearance



Switch and jumper settings

Set DSW1, DSW2, and JMP1.

CN3 is all open.

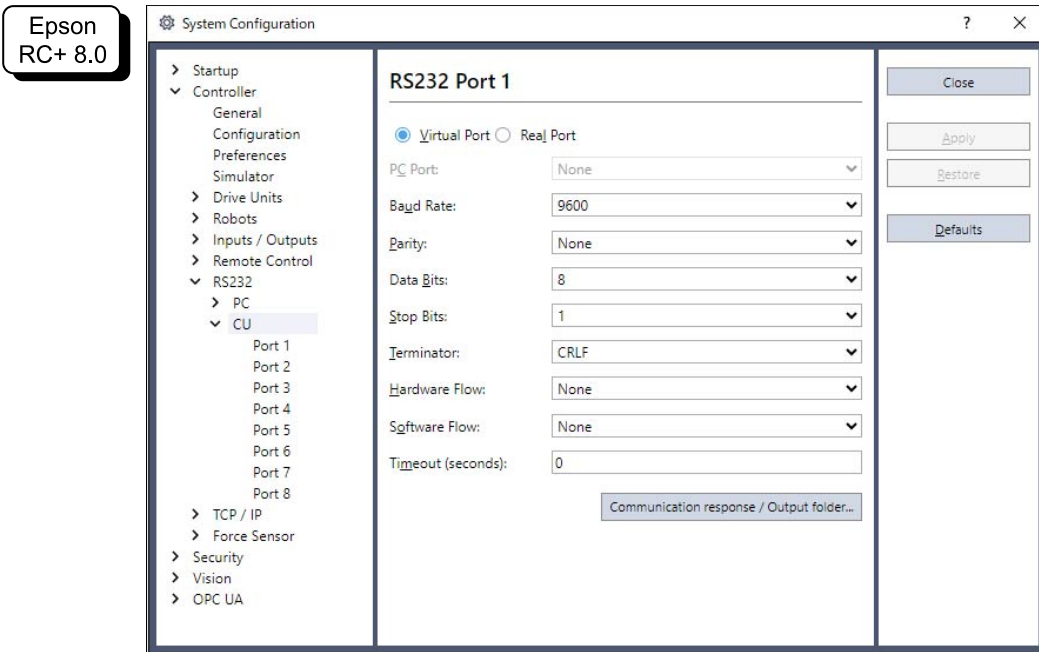
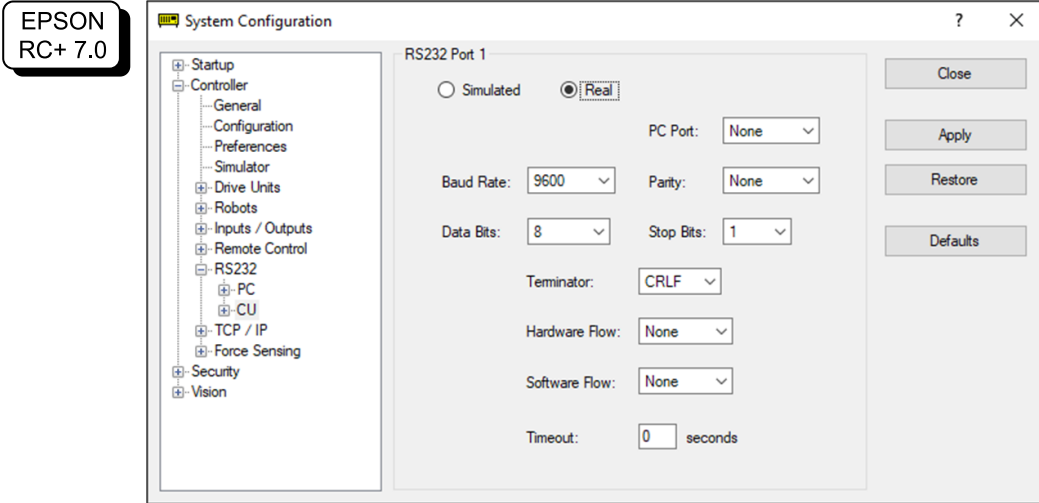
1st Board	2nd Board
<p> 1 2 IRQ5 <input checked="" type="checkbox"/> JP1 IRQ7 <input type="checkbox"/> JP2 IRQ10 <input type="checkbox"/> JP3 IRQ11 <input type="checkbox"/> JP4 IRQ15 <input type="checkbox"/> JP5 JMP1 </p> <p> 1 ON SW1 2 ON SW2 3 ON SW3 4 ON SW4 5 ON SW5 6 ON SW6 7 ON SW7 8 ON SW8 DSW1 </p> <p> 1 ON SW1 2 ON SW2 3 ON SW3 4 ON SW4 DSW2 </p> <p> 1 2 1 2 3 4 5 6 7 8 9 10 CN3 </p>	<p> 1 2 IRQ5 <input type="checkbox"/> JP1 IRQ7 <input checked="" type="checkbox"/> JP2 IRQ10 <input type="checkbox"/> JP3 IRQ11 <input type="checkbox"/> JP4 IRQ15 <input type="checkbox"/> JP5 JMP1 </p> <p> 1 ON SW1 2 ON SW2 3 ON SW3 4 ON SW4 5 ON SW5 6 ON SW6 7 ON SW7 8 ON SW8 DSW1 </p> <p> 1 ON SW1 2 ON SW2 3 ON SW3 4 ON SW4 DSW2 </p> <p> 1 2 1 2 3 4 5 6 7 8 9 10 CN3 </p>

4.15.4.3 Checking from Epson RC+ (RS-232C)

When an RS-232C board is installed in the Controller's option unit, the Controller software automatically recognizes the RS-232C board. Therefore, no software configuration is required.

You can confirm on the Epson RC+ screen that the board was correctly recognized.

1. In the Epson RC+ menu, select [Setup] - [System Configuration] to display the [System Configuration] dialog box.



2. Select [RS232] - [CU].

4.15.4.4 Communication Settings (RS-232C)

The available communication settings are shown in the following table.

Item	Specifications
Communication speed	110, 300, 600, 1200, 2400, 4800, 9600, 14400, 19200, 38400, 57600, 115200
Data bit length	7, 8
Stop bit length	1, 2
Parity	odd, even, none

Item	Specifications
Terminator	CR, LF, CRLF

For details on how to use the RS-232C communication function from the robot application, refer to the following manual or online help.

"Epson RC+ User's Guide - RS-232C Communications"

4.15.4.5 Communication Cable (RS-232C)

Communication cables must be provided by the customer.

Connector Name	Standard
RS-232C connector (Controller side)	D-Sub 9-pin male Mating screw lock part #4 - 40

KEY POINTS

Use twisted pair shielded wires for cables.

The shield should be clamped to the hood for noise reduction.

The pin assignment of the RS-232C connector is shown in the following table.

Pin Number	Signal	Function	Signal Direction
1	DCD	Carrier send	Inputs
2	RXD	Received data	Inputs
3	TXD	Transmitted data	Outputs
4	DTR	Data terminal ready	Outputs
5	GND	Signal ground	—
6	DSR	Data set ready	Inputs
7	RTS	Request to send	Outputs
8	CTS	Permission to send	Inputs
9	RI	Ring indicator	Inputs

4.15.5 PG Board

A PG board can be used in two ways. For details, refer to the following manuals.

- When using as a conveyor encoder
For details, refer to the following manual.
"Epson RC+ User's Guide - Conveyor Tracking"
- When using as a PG motion system
For details, refer to the following manual.
"Robot Controller Option PG Motion System"

4.15.6 Analog I/O Board

4.15.6.1 Analog I/O Board

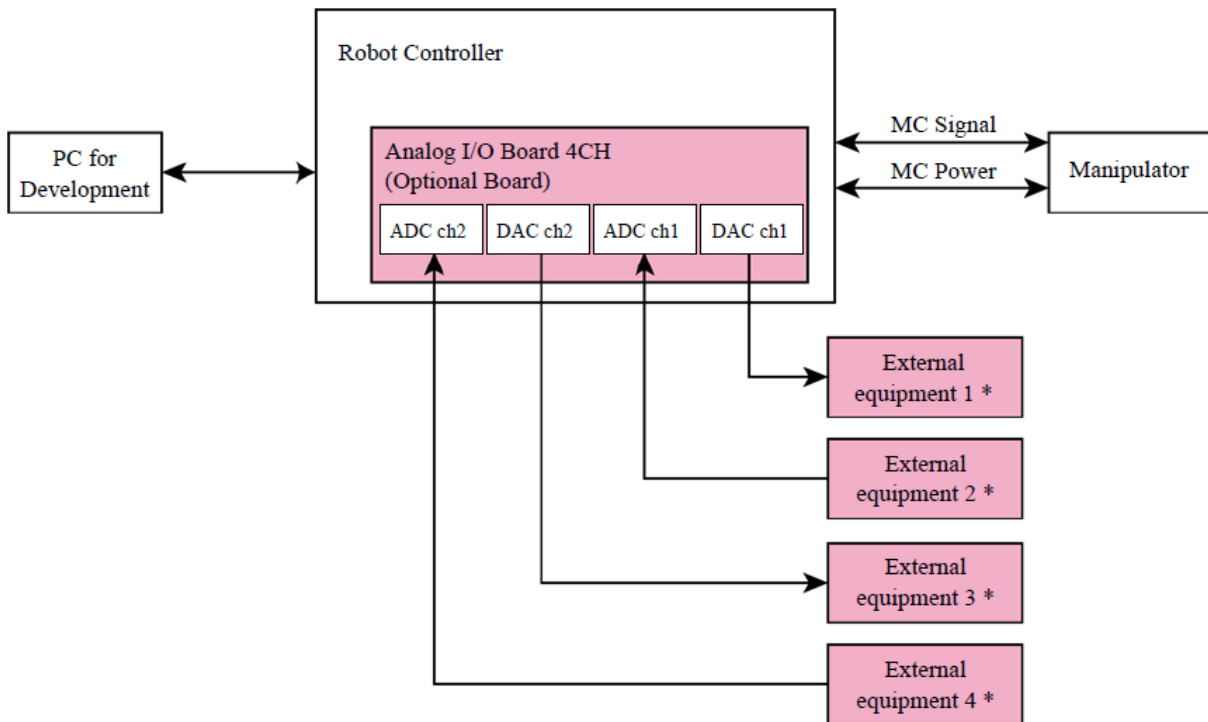
Installing an analog I/O board in an option slot enables usage of analog input/output functions. Up to three analog I/O boards can be installed in the option slots.

- Analog I/O board (1CH): "DAC: 1ch" is available per board
- Analog I/O board (4CH): "DAC: 2ch, ADC: 2ch" is available per board

DAC: Analog signal output (voltage/current)

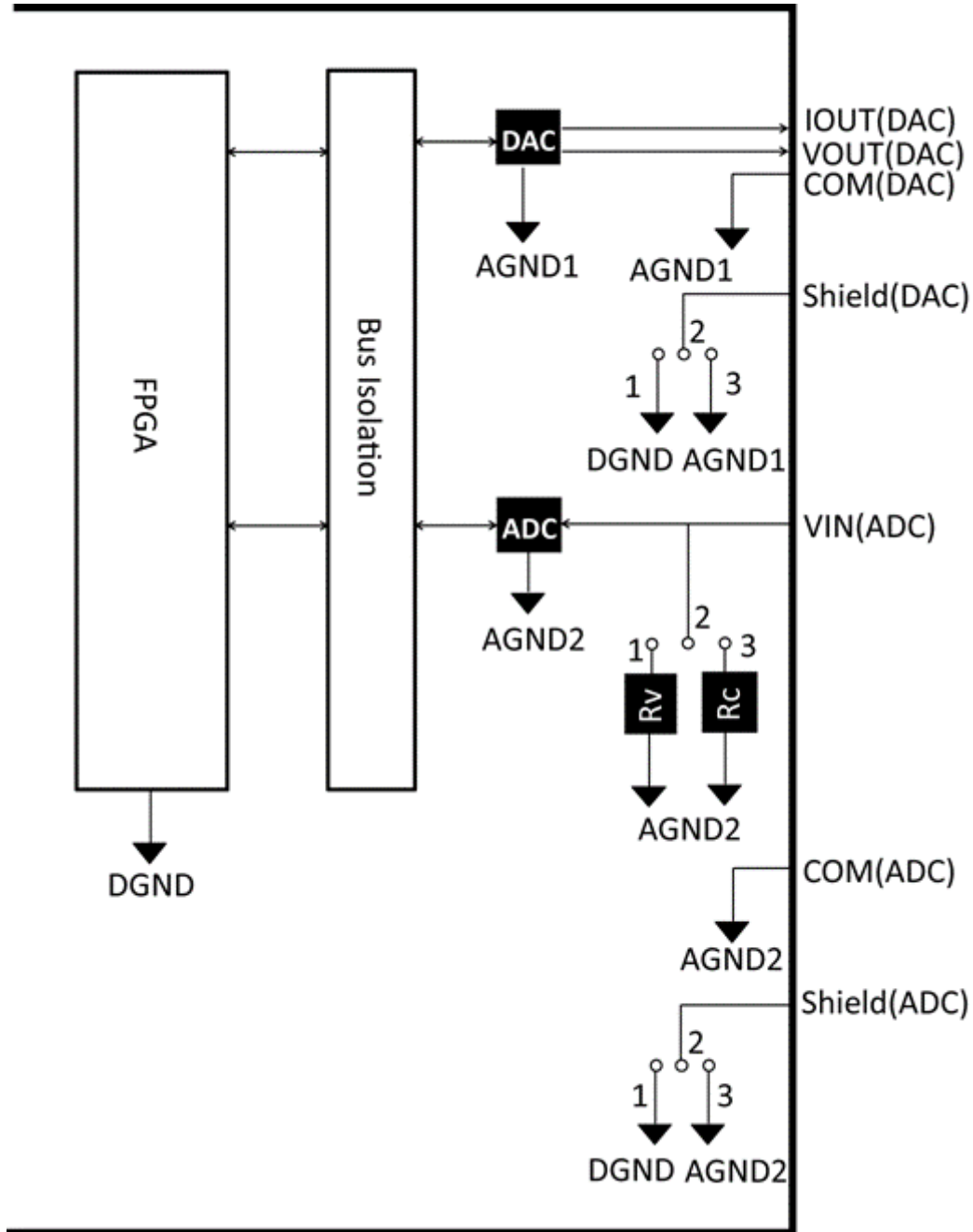
ADC: Analog signal input (voltage/current)

Connection example of analog I/O board (4CH)



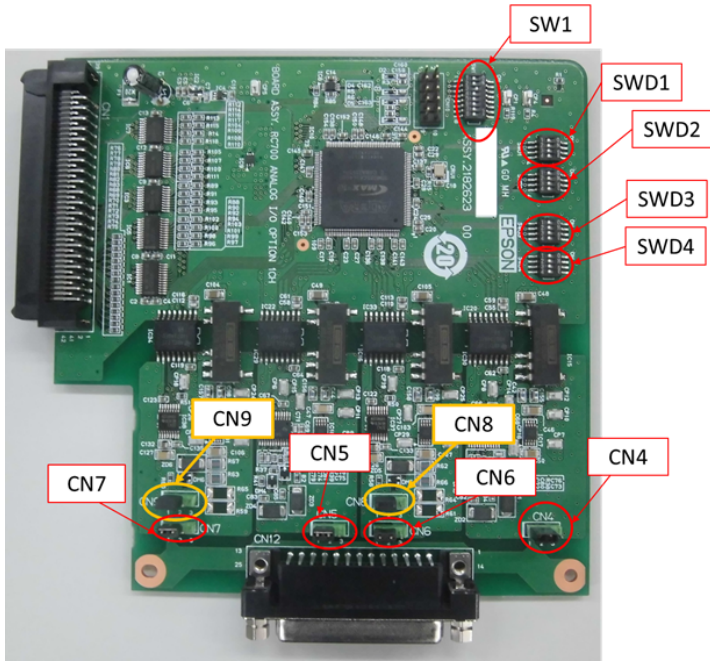
* Voltage/current input

Schematic overview of analog I/O board



Rv: Voltage input terminating resistor (100 kΩ), Rc: Current input terminating resistor

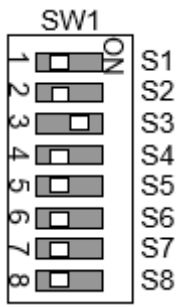
4.15.6.2 Board Settings (Analog I/O Board)



Switch and jumper settings

1. Address setting (SW1): Optional board addresses

Settings	S1	S2	S3	S4	S5	S6	S7	S8
1st Board	Off	Off	On	Off	Off	Off	Off	Off
2nd Board	Off	On	Off	Off	Off	Off	Off	Off
3rd Board	On	Off	Off	Off	Off	Off	Off	Off



S5 to S8: Not used. Leave these at OFF.

2. Analog output: Settings

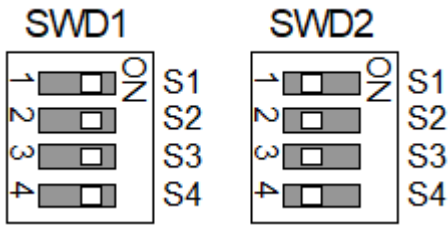
Current-voltage selector switch (SWD1): Voltage/current output

Range selector switch (SWD2): Output range

Channel	Output Mode	Range Setting	SWD1 (Current-Voltage Selector)			
			S1	S2	S3	S4
DAC 1ch	Voltage output mode	±5 V	On	Not used	Not used	Not used
		±10 V	On			
		0 to 5 V	On			
		0 to 10 V *	On			
	Current output mode	0 to 20 mA	Off			
		4 to 20 mA	Off			
DAC 2ch	Voltage output mode	±5 V	Not used	On	Not used	Not used
		±10 V		On		
		0 to 5 V		On		
		0 to 10 V *		On		
	Voltage output mode	0 to 20 mA		Off		
		4 to 20 mA		Off		

Channel	Output Mode	Range Setting	SWD2 (Range Switching)			
			S1	S2	S3	S4
DAC 1ch	Voltage output mode	±5 V	On	On	Not used	Not used
		±10 V	On	Off		
		0 to 5 V	Off	On		
		0 to 10 V *	Off	Off		
	Current output mode	0 to 20 mA	On	On		
		4 to 20 mA	Off	Off		
DAC 2ch	Voltage output mode	±5 V	Not used	Not used	On	On
		±10 V			On	Off
		0 to 5 V			Off	On
		0 to 10 V *			Off	Off
	Current output mode	0 to 20 mA			On	On
		4 to 20 mA			Off	Off

* Default: DAC default settings (voltage output: 0 to 10 V)



3. Analog input: Settings

Current-voltage selector jumper (CN8/CN9): Current input/voltage input

- Short pins 1-2: Voltage input setting
- Short pins 2-3: Current input setting

Current-voltage selector switch (SWD1): Current input/voltage input

Range selector switch (SWD3): Input range

Channel	Input Mode	Range Setting	SWD1 (Current-Voltage Selector)			
			S1	S2	S3	S4
ADC 1ch	Voltage input mode	±5.12 V	Not used	Not used	On	Not used
		±10.24 V			On	
		0 to 5.12 V			On	
		0 to 0.24 V *			On	
	Current input mode	0 to 24 mA			Off	
ADC 2ch	Voltage input mode	±5.12 V	Not used	Not used	Not used	On
		±10.24 V				On
		0 to 5.12 V				On
		0 to 10.24 V *				On
	Current input mode	0 to 24 mA				Off

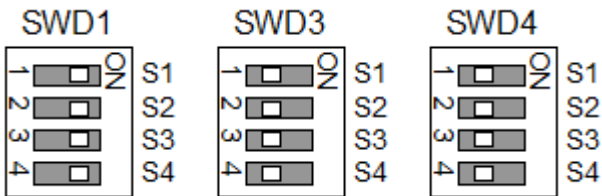
Channel	Input Mode	Range Setting	CN8 (Current-Voltage Selector)	CN9 (Current-Voltage Selector)
ADC 1ch	Voltage input mode	±5.12 V	Short 1-2	Not used
		±10.24 V	Short 1-2	
		0 to 5.12 V	Short 1-2	
		0 to 10.24 V *	Short 1-2	
	Current input mode	0 to 24 mA	Short 2-3	

Channel	Input Mode	Range Setting	CN8 (Current-Voltage Selector)	CN9 (Current-Voltage Selector)
ADC 2ch	Voltage input mode	±5.12 V	Not used	Short 1-2
		±10.24 V		Short 1-2
		0 to 5.12 V		Short 1-2
		0 to 10.24 V *		Short 1-2
	Current input mode	0 to 24 mA		Short 2-3

Channel	Input Mode	Range Setting	SWD3 (Range Switching)				SWD4
			S1	S2	S3	S4	
ADC 1ch	Voltage input mode	±5.12V	On	On	Not Use	Not Use	Off
		±10.24 V	On	Off			
		0 to 5.12 V	Off	On			
		0 to 10.24V *	Off	Off			
	Current input mode	0 to 24mA	Off	On			
ADC 2ch	Voltage input mode	±5.12V	Not Use	Not Use	On	On	Off
		±10.24V			On	Off	
		0 to 5.12V			Off	On	
		0 to 10.24V *			Off	Off	
	Current input mode	0 to 24mA			Off	On	

SWD4: Not used. Leave this at OFF.

* Default: ADC default setting (voltage input 0 to 10.24 V)



4. Shield settings

Shield "frame ground" and "user ground": CN4, CN5, CN6, CN7

- Short pins 1-2: Frame ground (FG) shield setting
Used to discharge shield noise to the Robot Controller side
- Short pins 2-3 : User ground (UG) shield setting
Used to isolate the shield between the external connection device and the Robot Controller
Also used to discharge shield noise to the external connection device side

User ground (UG): Analog ground (AGND) on the external connection device side

Frame ground (FG): Digital ground (DGND) inside the Robot Controller

Channel	Settings	CN4	CN5	CN6	CN7
DAC1ch	FG shield *	Short 1-2	Not Use	Not Use	Not Use
	UG shield	Short 2-3			
DAC2ch	FG shield *	Not Use	Short 1-2	Not Use	Not Use
	UG shield		Short 2-3		
ADC1ch	FG shield *	Not Use	Not Use	Short 1-2	Not Use
	UG shield			Short 2-3	
ADC2ch	FG shield *	Not Use	Not Use	Not Use	Short 1-2
	UG shield				Short 2-3

* Default

4.15.6.3 Checking with Epson RC+ (Analog I/O Board)

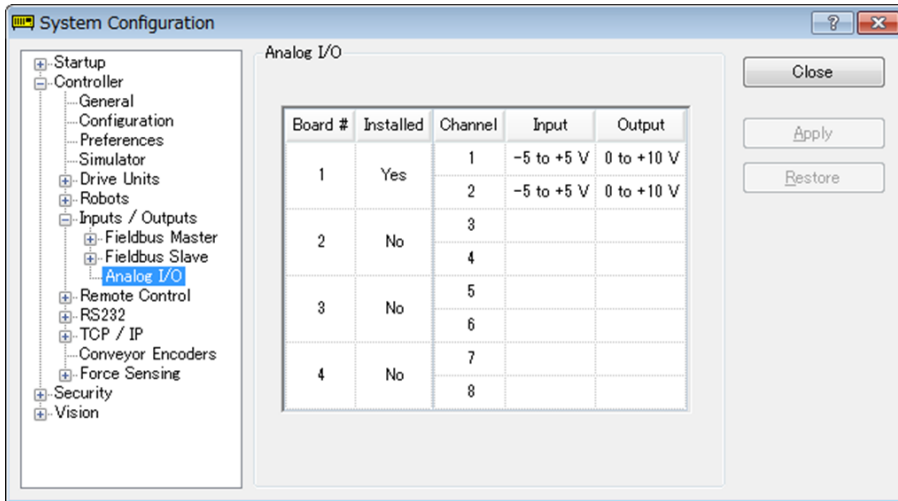
When an analog I/O board is installed in the Controller's option unit, the Controller software automatically recognizes the analog I/O board. Therefore, no software configuration is required.

You can confirm on the Epson RC+ screen that the board was correctly recognized.

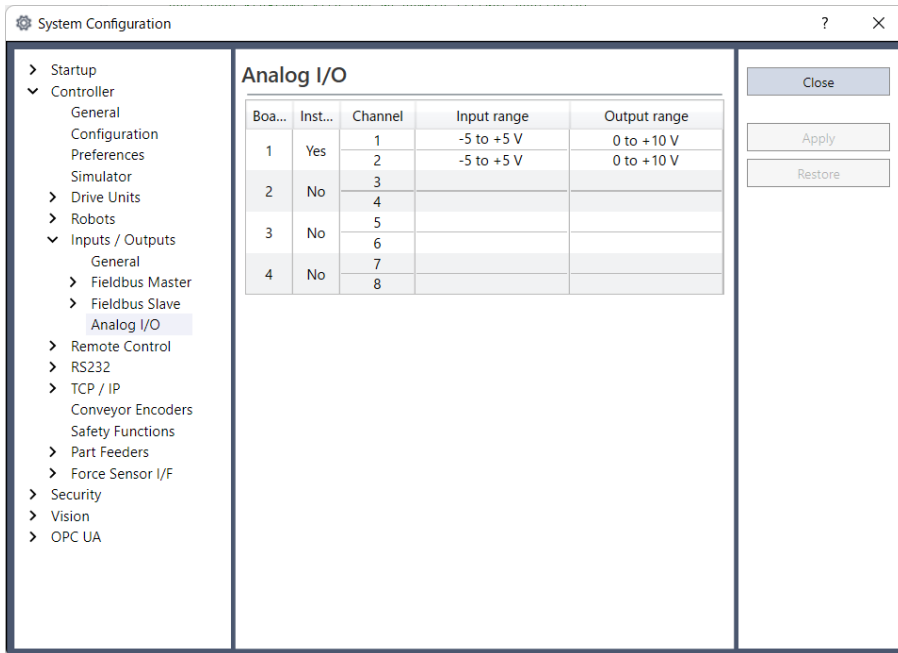
1. In the Epson RC+ menu, select [Setup] - [System Configuration] to display the [System Configuration] dialog box.

2. Select [Controller] - [Inputs / Outputs] - [Analog I/O].

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4.15.6.4 Input Circuit (Analog I/O Board)

- Input resolution: 16 bits
- Input range (voltage): 0 to 5.12 V, 0 to 10.24 V, ±5.12 V, ±10.24 V
- Input range (current): 0 to 24 mA
- Input impedance (voltage/current): approx. 100 kΩ/approx. 422 Ω
- Input pin absolute rated voltage: ±11 V
- Isolation specifications: Channel-to-channel isolation, bus isolation

4.15.6.5 Output Circuit (Analog I/O Board)

- Output resolution: 16 bits
- Output range (voltage): 0 to 5 V, 0 to 10 V, ±5 V, ±10 V
- Output range (current): 0 to 20 mA, 4 to 20 mA
- Output impedance (voltage/current): approx. 17 Ω/approx. 50 MΩ
- Output pin absolute rated voltage: ±11 V
- Load resistance/capacitance (@voltage output): 1 kΩ min./5 nF

- Load resistance/inductance (@current output): 300 Ω or less/50 mH or less
- Isolation specifications: Channel-to-channel isolation, bus isolation

CAUTION

- If the wiring or settings are performed incorrectly, analog input/output will not function properly.
- In environments with large amounts of external noise, the analog input/output may be affected. Check the noise environment, such as whether the cables are shielded.
- Use shielded/twisted cables.
- Never apply voltages or currents outside the input/output range to the analog input/output pins. Applying a voltage of ± 11 V or more will damage the board.
- Wiring errors or short circuits may cause components on the board to fail and malfunctions in the robot system.

4.15.6.6 Signal Arrangement (Analog I/O Board)

1CH specification

Pin Number	Signal Name	Pin Number	Signal Name
1	VOUT (DAC 1ch)	20	Shield (DAC 1ch)
2	COM (DAC 1ch)	21	IOOUT (DAC 1ch)
3	Shield (DAC 1ch)	22	COM (DAC 1ch)
4	Not used	23	Not used
5	Not used	24	Not used
6	Not used	25	Not used
7	Not used	26	Not used
8	Not used	27	Not used
9	Not used	28	Not used
10	Not used	29	Not used
11	Not used	30	Not used
12	Not used	31	Not used
13	Not used	32	Not used
14	Not used	33	Not used
15	Not used	34	Not used
16	Not used	35	Not used
17	Not used	36	Not used
18	Not used	37	Not used
19	Not used		

4CH specification

Pin Number	Signal Name	Pin Number	Signal Name
1	VOUT (DAC 1ch)	20	Shield (DAC 1ch)
2	COM (DAC 1ch)	21	IOOUT (DAC 1ch)
3	Shield (DAC 1ch)	22	COM (DAC 1ch)
4	Not used	23	Not used
5	Not used	24	Not used
6	Not used	25	Not used
7	VIN (ADC 1ch)	26	Shield (ADC 1ch)
8	COM (ADC 1ch)	27	Not used
9	Not used	28	Not used
10	Not used	29	Not used
11	VOUT (DAC 2ch)	30	Shield (DAC 2ch)
12	COM (DAC 2ch)	31	IOOUT (DAC 2ch)
13	Shield (DAC 2ch)	32	COM (DAC 2ch)
14	Not used	33	Not used
15	Not used	34	Not used
16	Not used	35	Not used
17	Not used	36	Not used
18	VIN (ADC 2ch)	37	Shield (ADC 2ch)
19	COM (ADC 2ch)		

4.15.7 Force Sensor I/F Board

4.15.7.1 Force Sensor I/F Board

To communicate with the force sensor, a force sensor I/F board must be installed in an option slot.

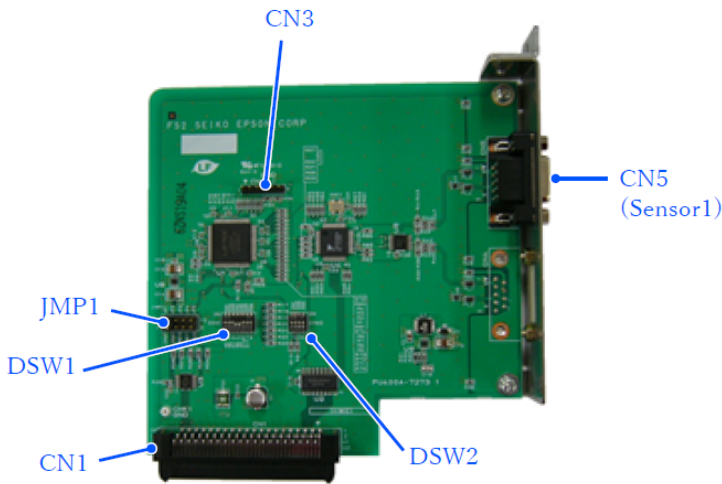
The force sensor I/F board has one port for a connector that connects to a force sensor, and only one board can be connected.

When a force sensor I/F board is used, only one expansion RS-232C board can be added.

The force sensor I/F board can be connected to all S250 series.

4.15.7.2 Board Settings (Force Sensor I/F Board)

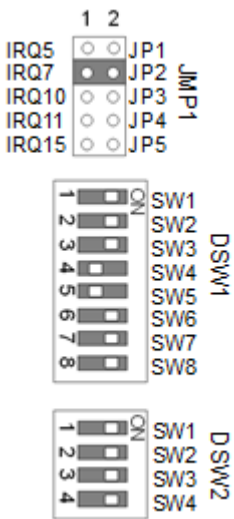
Board appearance



CN3 is all open.

Switch and jumper settings

Do not change DSW1, DSW2, or JMP1 from the following settings.



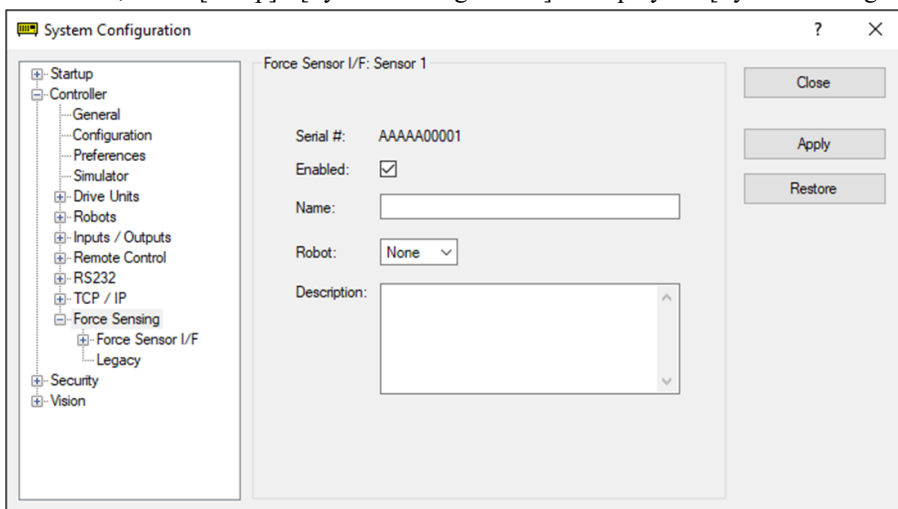
4.15.7.3 Checking from Epson RC+ (Force Sensor I/F Board)

When a force sensor I/F board is installed in the Controller's option slot, the Controller software automatically recognizes the force sensor I/F board.

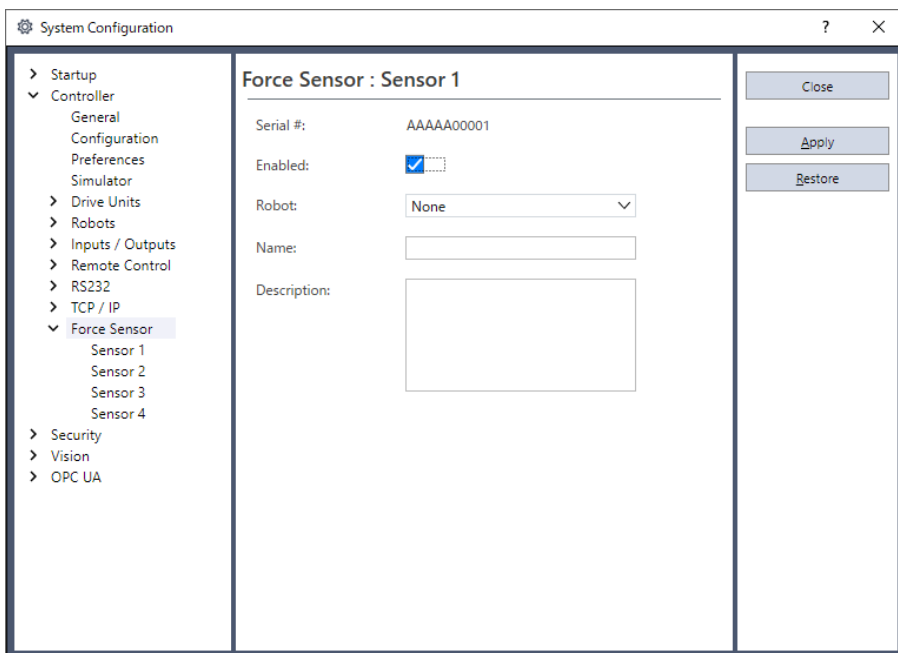
You can confirm on the Epson RC+ screen that the board was correctly recognized.

1. In the Epson RC+ menu, select [Setup] - [System Configuration] to display the [System Configuration] dialog box.

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2. Select [Force Sensing] - [Force Sensor I/F Unit].

For the setting procedure for the force sensor I/F board, refer to the following manual or online help.

"Epson RC+ Option - Force Guide Manual - Software Configuring the Force Sensor I/F Unit"

5. Periodic Inspection



Accurate inspection work is necessary to prevent breakdowns and ensure safety. This section explains when inspections should be performed and what should be inspected. Perform inspections according to the predetermined schedule.

5.1 RC700-E Periodic Inspection

5.1.1 Inspection Items and Their Inspection Frequency

For part names and their locations, refer to the following.

Part Names and Their Functions

Inspection Item	Frequency	Inspection Method	Check Method
Controller	12 months	Power down and restart	Starts up without errors
Emergency stop button	12 months	Press the emergency stop button with the motor energized	The 7-segment LED on the Controller displays EP. 
Safeguard	12 months	Operate the safeguard with the motor energized	The 7-segment LED on the Controller displays SO. 
Fan filter	1 month	Perform a visual check and clean	No dirtiness
Fan (front)	1 month	Check for operating noise, visual check of the 7-segment LED	No unusual noise, no warning 515 appears on the 7-segment LED
Fan (rear)	1 month	Check for operating noise, visual check of the 7-segment LED	No unusual noise, no warning 516 appears on the 7-segment LED
Battery	12 months	Visual check of the 7-segment LED and error LEDs	No alarms
Enable switch	12 months	When motor is turned on in teach mode, grip or release the enable switch to check if motor excitation is turned off	The indicating lamp on the Manipulator turns off For details, refer to the following manual. "Manipulator Manual"
Encoder	12 months	Confirm zero position	Manipulator is at set zero position

5.2 Backup and Restore

5.2.1 What is Controller Backup?

Various settings configured with Epson RC+ can be easily saved with the "Controller Backup."

If the settings were made incorrectly or the Controller has failed, the Controller settings can be easily recovered using the data saved with the "Controller Backup."

Be sure to always perform the "Controller Backup" after the Controller settings were changed, before maintenance, or after teaching.

Depending on the problem, it may not be possible to make a backup before maintenance work. Be sure to always back up your latest data.

KEY POINTS

RC700-E has a function called "Export Controller Status." This function can store the same data as the "Controller Backup."

The stored data can also be used as backup data for data restoration.

There are several ways to save the "Export Controller Status."

- A: Controller Backup function to a USB memory device

Refer to the following section.

Memory Port

- B: Controller settings import function

For details, refer to the following manual.

"Epson RC+ User's Guide - [Import] Command (Project Menu)"

5.2.2 Backed-up Data

The "Controller Backup" function creates the following files and saves the file data.

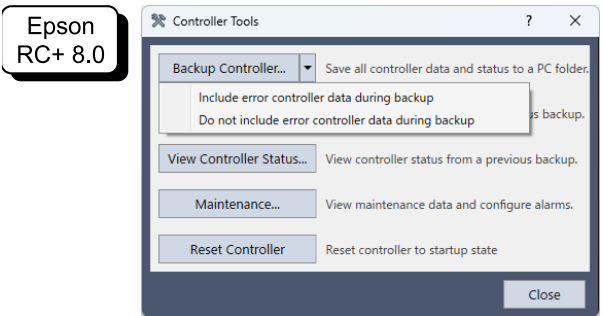
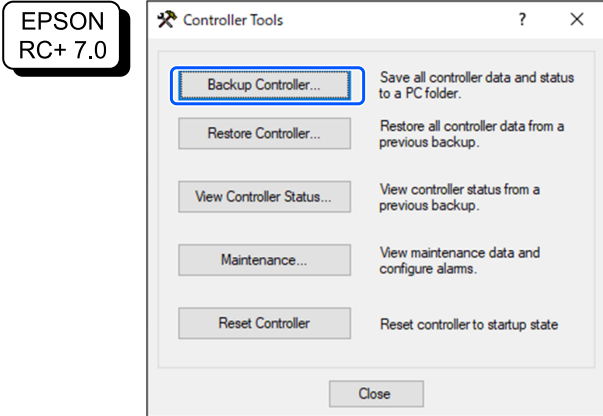
- Backup.txt
Restore information file: This file contains the information needed when restoring the Controller.
- CurrentMnp01.PRM
Robot parameters: This file stores the ToolSet and other information.
- InitFileSrc.txt
Default settings: This file stores the various settings of the Controller.
- MCSys01.MCD
Robot settings: This file stores information about the connected robot.
- All files related to the project
Project related files: These include all project files transferred to the Controller. If a program file was transferred to the Controller, the program file is included.
- GlobalPreserves.dat
Backup variables: This file stores the values of the backup variables (Global Preserve variables).
- WorkQueues.dat
Work queue information: This file stores the work queue information.

- SFConfig.txt
Safety board related files: This file stores the safety board information.
- SimObjects.dat · SimObjects.jpg · CAD.zip
Simulator data: This includes layout information, screenshot images of the entire layout, and CAD files that are being used.

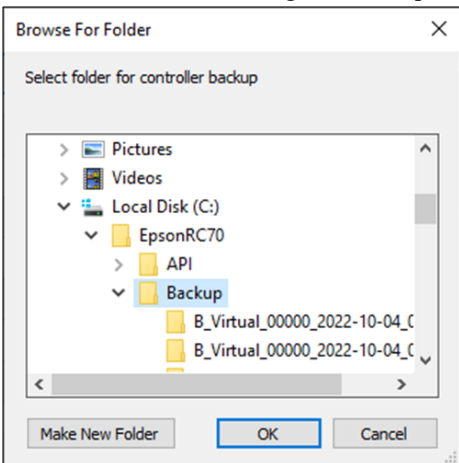
5.2.3 Backup

Controller settings can be backed up from Epson RC+.

1. From the Epson RC+ menu, select [Tools] - [Controller] to display the [Controller Tools] dialog box.



2. Click the button for the target to backup from [Backup Controller...] and display the [Browse For Folder] dialog.



3. Specify the folder where the backup data will be stored. Create a new folder if needed.

- 4. After clicking the [OK] button, a folder for storing the backup data will be created under the specified folder.
"B_Controller Type Name_Serial Number_Date and Time"

⚠ CAUTION

Do not modify the saved files with editors or other software. Operation of the robot system is not guaranteed when data is restored to the Controller.

5.2.4 Restore

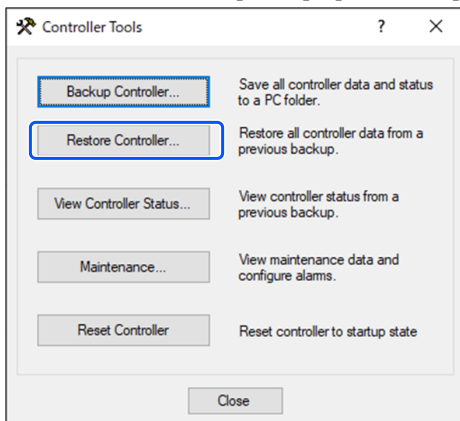
Controller settings can be restored from Epson RC+.

⚠ CAUTION

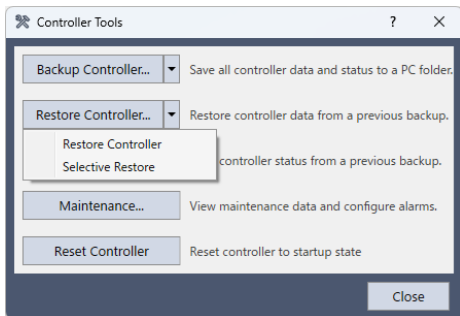
- When restoring, be sure to use the data for the same Controller that was used when making the backup.
- Do not modify the saved files with editors or other software. Operation of the robot system is not guaranteed when data is restored to the Controller.

1. From the Epson RC+ menu, select [Tools] - [Controller] to display the [Controller Tools] dialog box.

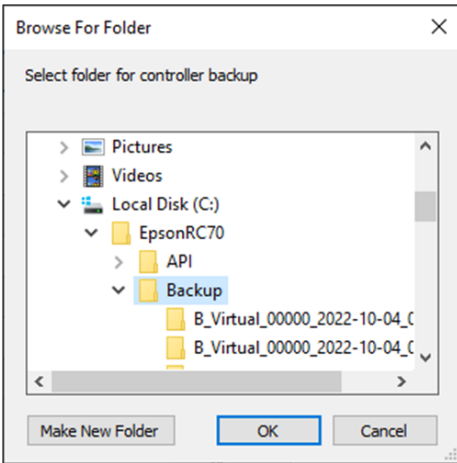
EPSON RC+ 7.0



Epson RC+ 8.0



2. Click the button for the target to restore from [Restore Controller...] and display the [Browse For Folder] dialog.



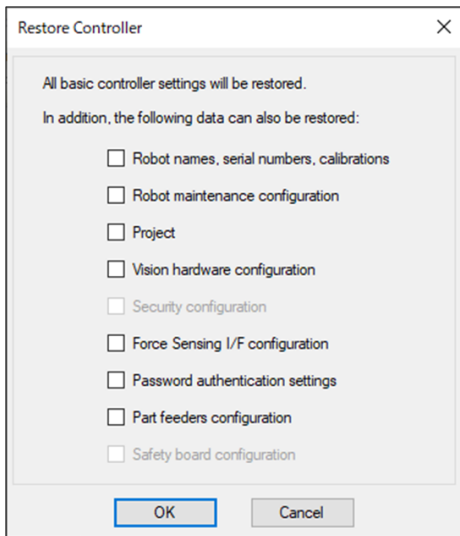
3. Specify the folder where the backup data is stored.
"B_ Controller Type Name_ Serial Number_ Date and Time"

KEY POINTS

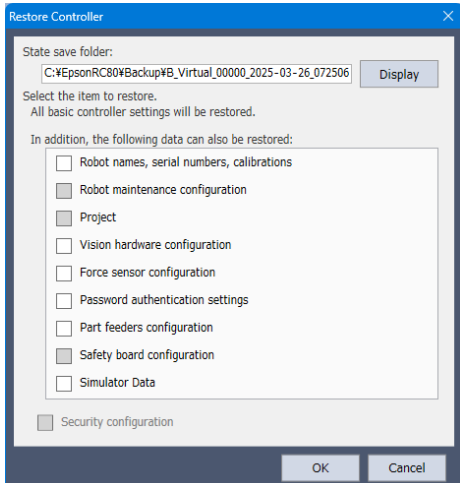
The "Controller Backup" function to the USB memory device also allows selection of the saved data.

4. Click the [OK] button to display the dialog box for selecting data to be restored.

EPSON RC+ 7.0



Epson RC+ 8.0



- **Robot names, serial numbers, calibrations**

This function also restores the robot name, robot serial number, Hofs data, and CalPls data. Note that restoring incorrect Hofs data will prevent the robot from operating at the correct position.

By default, this is not selected (check mark removed).

- **Robot maintenance configuration**

The Maintenance information files are also restored.

Refer to the following section.

- **Alarm Function**

By default, this is not selected (check mark removed).

To include the Maintenance information files, from the Epson RC+ menu, go to [Setup] - [System Configuration] - [Controller] - [Preferences], and select the [Enable robot maintenance data] checkbox. Note that if the acquired backup data is restored without selecting this checkbox, the Maintenance information will not be applied.

- **Project**

Project-related files are also restored.

By default, this is not selected (check mark removed).

When a project is restored, all backup variable (Global Preserve variable) values are initialized.

For details on how to restore backup variable values, refer to the following manual.

"Epson RC+ User's Guide - [Display Variables] Command (Run Menu)"

- **Vision hardware configuration**

The vision hardware configuration is also restored.

For details, refer to the following manual.

"Epson RC+ Option Vision Guide"

By default, this is not selected (check mark removed).

- **Security configuration**

The security configuration is also restored.

For details, refer to the following manual.

"Epson RC+ User's Guide - Security"

By default, this is not selected (check mark removed).

- **Force Sensor I/F configuration**

Force Sensor I/F configuration is also restored.

For details, refer to the following manual.

"Epson RC+ Option Force Guide"

By default, this is not selected (check mark removed).

- **Password authentication settings**

The PC connection authentication settings are also restored.

The PC connection authentication password and connection authentication disable settings are restored.

By default, this is not selected (check mark removed).

- **Safety board configuration**

Safety Function Manager starts and restores the safety board. For details, refer to the following manual.

"Robot Controller Safety Function Manual"

This data can be checked only if you are using the Controller with safety board installed. By default, this is not selected (check mark removed).

- **Simulator data**

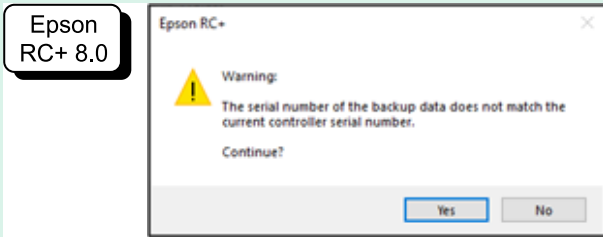
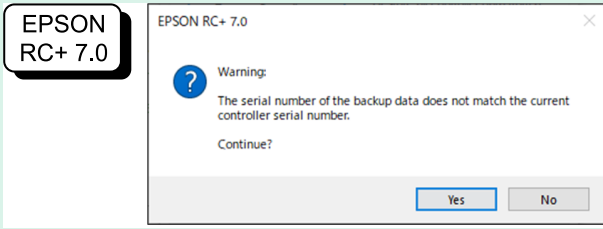
The simulator data settings will be restored. It is not checked off by default. This can be selected when simulator data is included in the backup data. It is available in the standard and premium edition.

5. Click the [OK] button to restore the system information.

KEY POINTS

- The system configuration that was saved by the Controller settings backup should be restored only on the same system (Controller settings restore).

If the user tries to restore information from a different system, the following warning dialog box appears.



Except in special cases such as replacing a Controller, you should click the [No] button to not restore the data.

- Restoring a backup that contains unsupported robot information to the target Controller will result in an error.
- Restoring "Robot names, serial numbers, calibrations" and "Safety board configuration" separately may cause an error when the Controller is started.

When an error occurs, refer to the following manual to correct it.

"Status Code/Error Code List"

- When restoring, the IP address is not restored to prevent unexpected communication interruptions due to the IP address being overwritten. The most recent IP address set to the Controller is retained.

5.3 Alarm Function

When the battery (lithium battery) is low in power, an error occurs warning of low voltage. However, the battery is not guaranteed until it is replaced, and it must be replaced immediately.

Also, the parts used in each joint part of the robot may deteriorate due to usage over time, resulting in loss of accuracy and possible breakdowns. When a robot breaks down due to deterioration of parts or other reasons, significant time and expense are incurred in repairing the robot.

To enable maintenance well in advance of warning errors, this section describes the following methods (alarms) that alert the user when it is time to perform maintenance.

KEY POINTS

When using Epson RC+ 8.0, controller firmware Ver.7.5.4.x or later is required.

5.3.1 Maintenance

The recommended replacement intervals can be set for Controller batteries, robot grease, timing belts, motors, reduction gears, and ball screw splines.

CAUTION

- Verify that the Controller's date and time are set correctly. If an incorrect date and time are set, the alarm function will not operate properly.
- If the CPU board or CF is replaced, the Maintenance information may be lost. After replacement, check the date and time in the Controller and the Maintenance information.

KEY POINTS

Maintenance is enabled at factory shipping.

If enabled, the Maintenance information for batteries, grease, timing belts, motors, reduction gears, and ball screw splines is automatically set when the robot is set up or changed.

Grease is applied to the following target location.

- Ball screw spline unit of Joint #3

When a robot is deleted, the Maintenance information is automatically deleted.

For details on how to set up the robot, refer to the following manual.

"Epson RC+ User's Guide - Setting the Robot Model"

CAUTION

Be careful when making changes to the robot. Changing the robot resets the alarm.

KEY POINTS

The Maintenance information varies depending on the Controller that has configured the robot. If the robot is replaced with a robot with a different serial number, the Maintenance information will not work properly. After replacing a robot, edit the Maintenance information.

Refer to the following section.

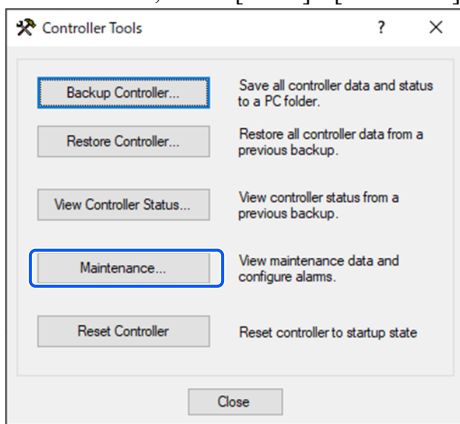
[Editing the Maintenance Information](#)

5.3.2 Viewing the Maintenance Information

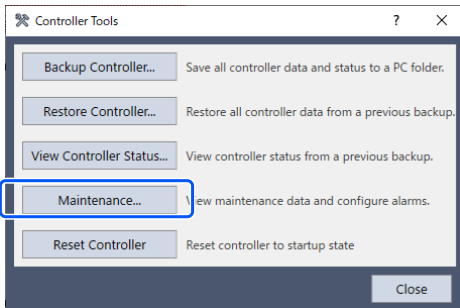
This section describes the procedure for viewing the Maintenance information that was set.

1. From the Epson RC+ menu, select [Tools] - [Controller] to display the [Controller Tools] dialog box.

EPSON
RC+ 7.0

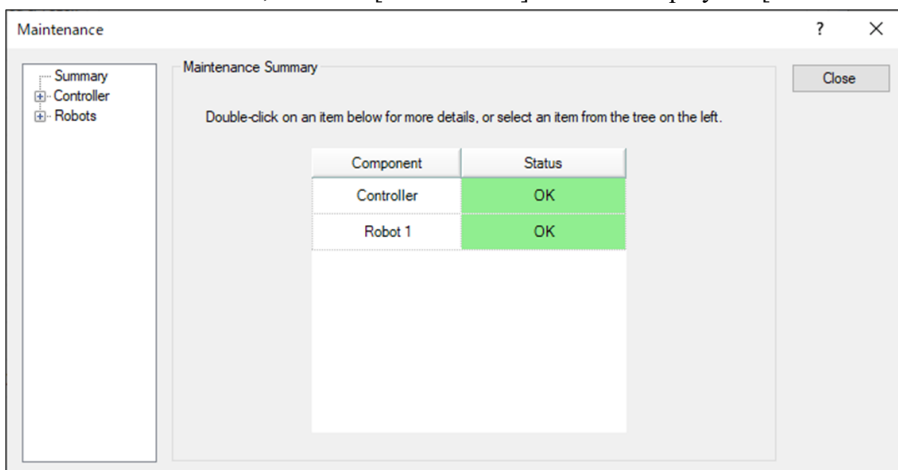


Epson
RC+ 8.0

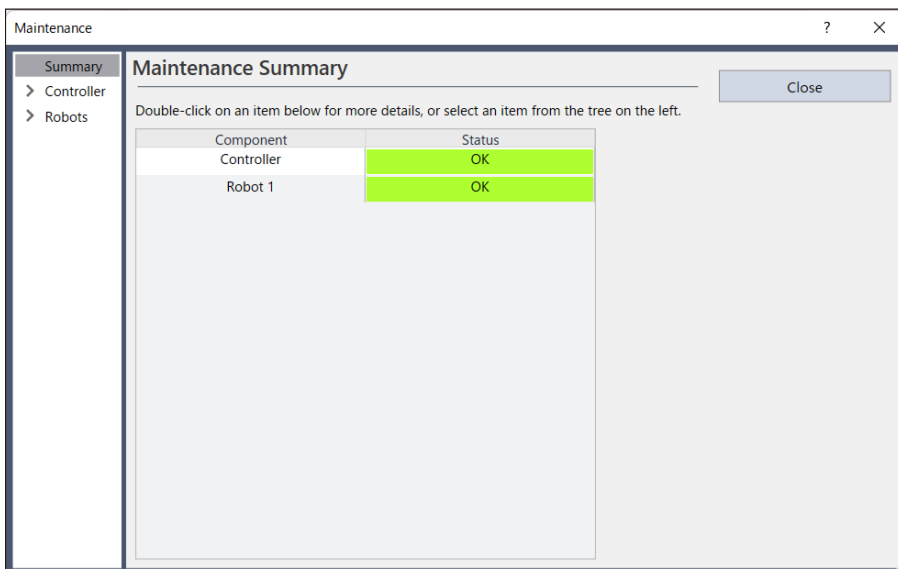


2. To view the Maintenance information, click the [Maintenance] button to display the [Maintenance] dialog box.

EPSON
RC+ 7.0



Epson
RC+ 8.0



3. Select a common or specified axis from the tree to display information on the target part.

EPSON RC+ 7.0

Part	Installation Date	Months Remaining	Consumption 0 - 100%
Battery	2020-01-23	33.3	50%

Epson RC+ 8.0

Part	Installation Date	Months Remaining	Consumption...	Status
Battery	2023-06-29	117.49	10.7	OK

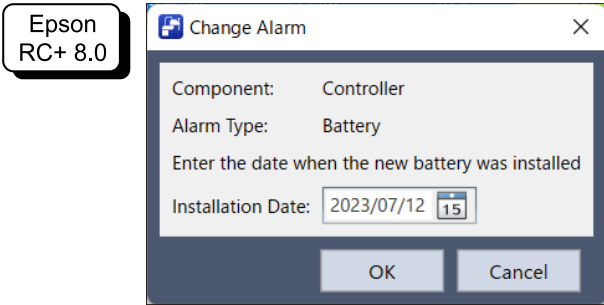
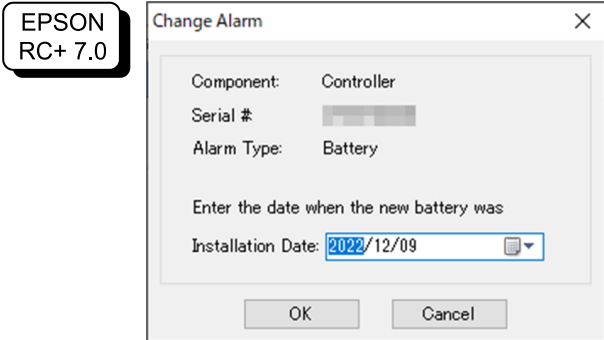
KEY POINTS

- The recommended battery replacement interval is calculated based on the battery capacity and Controller power-on time. Exceeding the recommended replacement interval may cause the battery to run out of power.
- The recommended grease replacement interval is based on the number of days that have elapsed from the last grease application date. The replacement interval may vary depending on the customer's load and other usage methods.
- The recommended replacement interval for maintenance items (timing belt, motor, reduction gear, ball screw spline) is L10 life (period up to 10% breakage probability). In the [Maintenance] dialog box, the L10 life is shown as 100%.
- The number of months remaining is calculated based on the past operation conditions.
The period used for the calculation can be set using the "HealthCalcPeriod" command. (Default: Controller power-on 7 days)
The number of remaining months may not be calculated properly until the period used for calculation has elapsed once.

5.3.3 Editing the Maintenance Information

This section describes the procedure for editing the Maintenance information that was set.

1. From the Epson RC+ menu, select [Tools] - [Controller] to display the [Controller Tools] dialog box.
2. To edit the Maintenance information, open the [Maintenance] dialog box.
3. Select a common or specified axis from the tree to display information on the target part.
4. Select the alarm to be changed, and click the [Change] button.
5. Open the [Change Alarm] dialog box, and enter one of the following dates.



- Date battery purchased or replaced
- Date grease was applied
- Date timing belt purchased or replaced
- Date motor purchased or replaced
- Date reduction gear purchased or replaced
- Date ball screw spline purchased or replaced

6. Click the [OK] button to change the specified alarm information.

KEY POINTS

An offset can be set for the wear rate of an existing part.

The following calculations should be used as a guideline for setting the offset.

1. Measures the number of available months for past operations using the "HealthRBAAnalysis" command.
2. Check the past motor power-on time in the status save viewer.
3. The following formula is used to calculate the approximate offset.

$$\text{Offset} = 100 \times \frac{\text{Motor On time}}{24 \times 30.4375 \times \text{Usable months}}$$

For details, refer to the following manual.

"Epson RC+ SPEL+ Language Reference"

5.3.4 Alarm Notification Procedure

When the recommended replacement interval or recommended greasing interval is reached for any part, the Controller enters a warning state and displays a warning message.

For details, refer to the following manual.

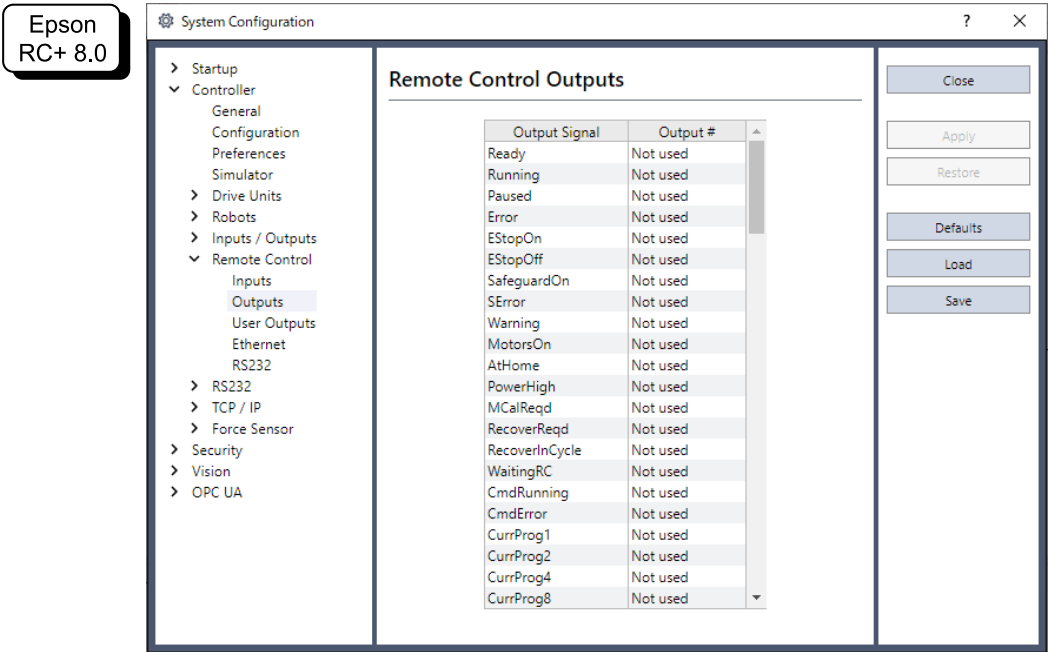
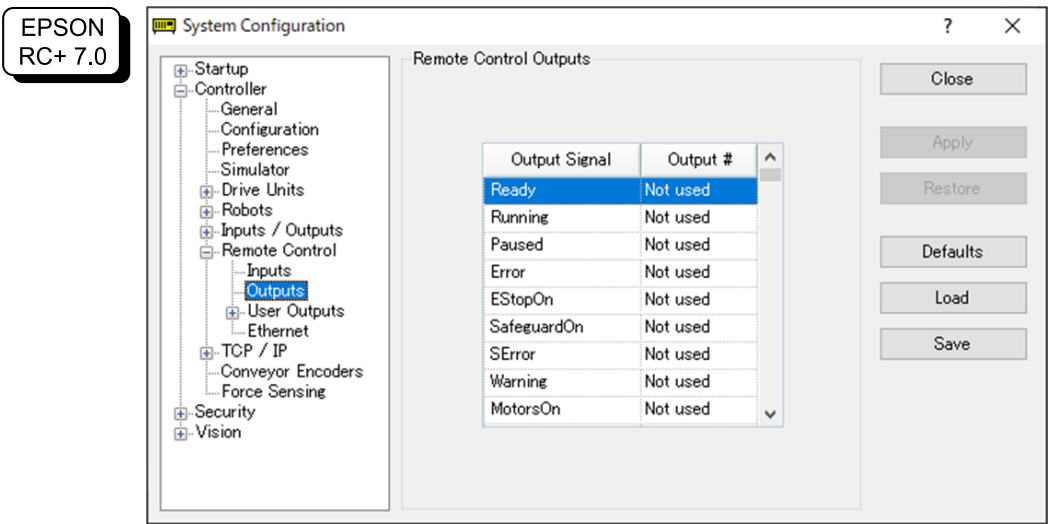
"Status Code/Error Code List"

One method of alarm notification is to set the alarm to an output bit of the remote I/O.

Remote I/O can be set from [Setup] - [System Configuration] - [Controller] - [Remote Control] in Epson RC+.

For details, refer to the following manual.

"Epson RC+ User's Guide - Remote I/O"



 **KEY POINTS**

- If an alarm occurs, the Controller enters a warning state.
- Alarm1 to Alarm9, which are set to the output bits of the remote I/O, monitor the occurrence of warnings in five-minute cycles.
- The timing of alarm occurrence and their output at the Controller is different. The alarm may be output to the remote I/O up to 5 minutes after the alarm has occurred at the Controller.

5.3.5 Resetting an Alarm

An alarm occurs when the wear rate of the component that was set reaches 100%.

 **KEY POINTS**

The alarm cannot be reset by the Reset command or by restarting the Controller.

Alarms can be reset in the one of the following ways.

- Reset operation from the [Maintenance] dialog box in Epson RC+
- HealthCtrlReset command
- HealthRBReset command

For the alarm methods, refer to the following section.

[Editing the Maintenance Information](#)

6. Appendix

6.1 Appendix A: Option Parts List

Part Name	Code	Old Code	Notes
Expansion I/O Boards (Source type)	R12NZ9003P	R12B040302	-
Expansion I/O Boards (Sink type)	R12NZ9003Q	R12B040303	-
Expansion I/O Boards (Nonpolar type)	R12NZ901FN	-	-
RS-232C Board	R12NZ9004E	R12B040726	-
DeviceNet board	R12NZ9004F	R12B040727	DeviceNet module mounted on Fieldbus board
PROFIBUS board	R12NZ9004H	R12B040729	PROFIBUS-DP module mounted on Fieldbus board
CC-Link board	R12NZ9004J	R12B040730	CC-Link module mounted on Fieldbus board
PROFINET board	R12NZ900A6	R12N747051	PROFINET module mounted on Fieldbus board
EtherNet/IP board	R12NZ900A7	R12N747061	EtherNet/IP module mounted on Fieldbus board
EtherCAT board	R12NZ900CL	-	EtherCAT module mounted on Fieldbus board
Pulse generator board	R12NZ900A8	R12N748011	-
Analog I/O board (1CH)	R12NZ900WZ	-	-
Analog I/O board (4CH)	R12NZ900X1	-	-
Force sensor I/F board (FS2)	2184536	-	-

6.2 Appendix B: Troubleshooting


This chapter describes the firmware upgrade procedure and the firmware and data file initialization procedure needed when errors in firmware or robot setting information cause the Controller to fail to start properly or to fail to connect to the development PC.

6.2.1 Upgrading Firmware

Software (firmware) and data files necessary to control the Controller and the robot are preinstalled in the Controller. Controller setting information that was set by the user from the development software is also saved in the Controller as needed.

If necessary, the firmware is available on CD-ROM and other sources. For details on how to get the firmware, please contact the supplier.

To upgrade the firmware, a development PC where the development software Epson RC+ is installed must be connected to a Controller by a USB cable. (Firmware cannot be upgraded over an Ethernet connection.)

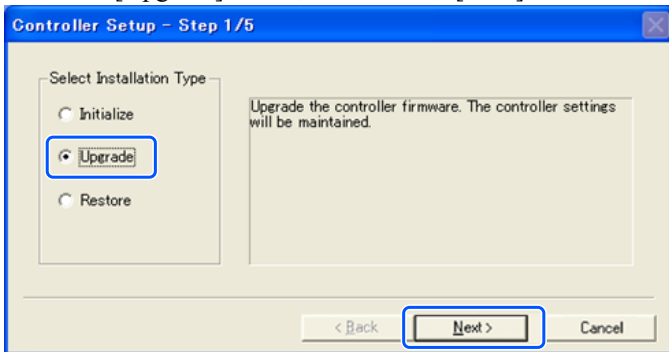
 **KEY POINTS**

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

6.2.2 Firmware Upgrade Procedure

This section explains the firmware upgrade procedure.

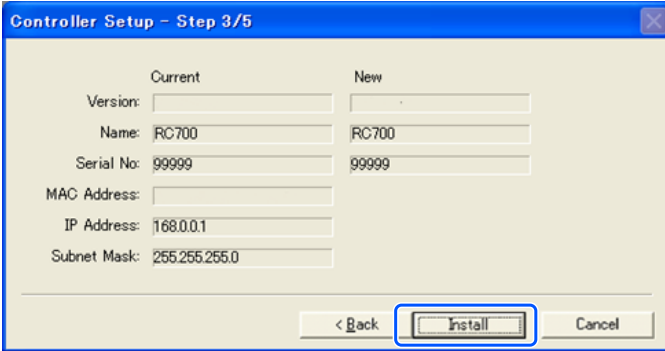
1. Connect the development PC and the Controller by a USB cable.
(Firmware cannot be upgraded over an Ethernet connection.)
2. Turn on the Controller.
(Do not start the development software Epson RC+ until the firmware upgrade process is completed.)
3. Load the "Firmware CD-ROM" to be installed into the CD-ROM drive of the development PC.
4. Execute "Ctrlsetup70.exe." The following dialog box appears.
5. Select the [Upgrade] button, and click the [Next] button.




6. Make sure that the development PC is connected to the Controller by a USB cable, and click the [Next] button.



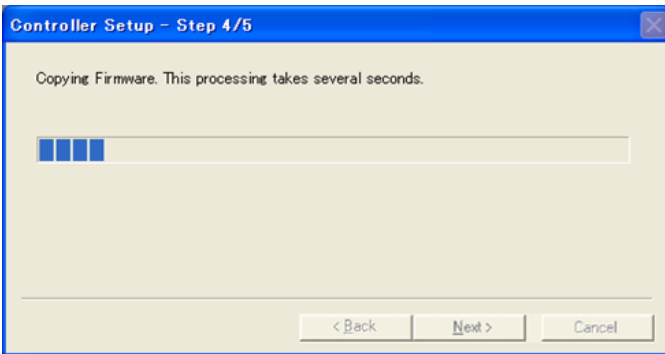
7. Check the current firmware version and the new firmware version, and click the [Install] button.



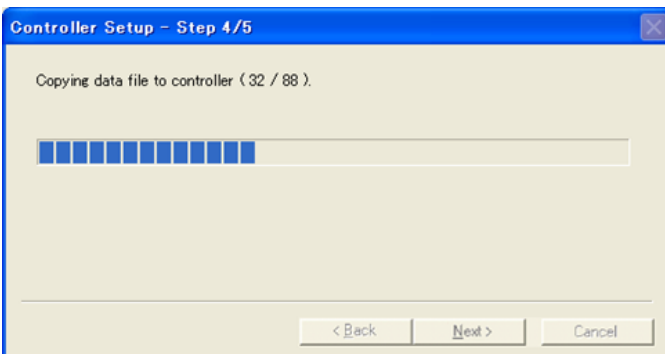
8. The firmware transfer is started. The transfer process takes several minutes to complete.

 **KEY POINTS**

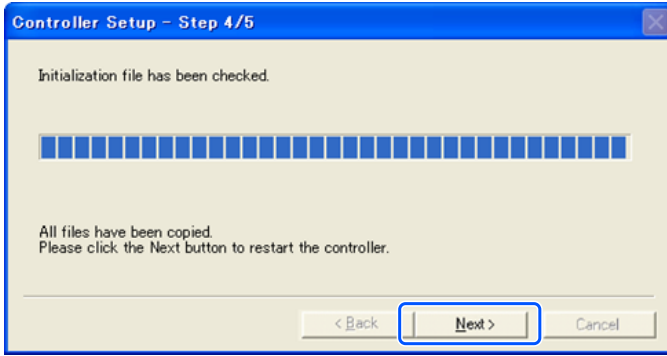
During transfer, do not disconnect the USB cable or turn off the Controller or development PC.



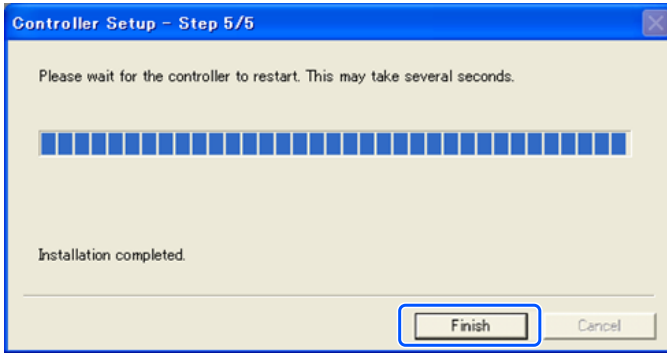
9. Next, data file transfer is started.



- 10. The following dialog box appears when the transfer process has been completed. Click the [Next] button to reboot the Controller.



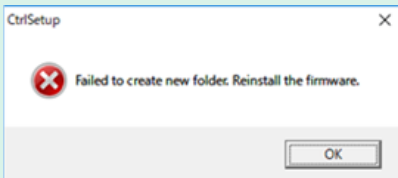
- 11. The following dialog box appears after the Controller is rebooted. Click the [Finish] button.



This completes the firmware upgrade.

KEY POINTS

When you install the firmware version 7.4.0.2 or later on the Controller where firmware before a version earlier than 7.4.0.2 was installed, the following message is displayed.



When this message is displayed, reinstall the firmware.

6.2.3 Controller Recovery

If the Controller becomes inoperable for any reason, perform the recovery operation.

KEY POINTS

Backup of the system being run is recommended beforehand to ensure that the system can be easily restored to its operational state.

Refer to the following section.

[Backup and Restore](#)

When the Controller is in an error state, it appears in one of two ways immediately after the Controller power is turned on.

- **Error state A**

The Controller automatically changes to recovery mode and the LEDs for ERROR, TEACH, and PROGRAM are turned on.

Communication with the development PC is possible, but the Controller does not operate properly.

- **Error state B**

The Controller LEDs for TEACH, AUTO, and PROGRAM do not blink.

Communication with the development PC is not possible.

The corrective actions for the error states are as follows:

- **Error state A**

Follow the procedure below to initialize the firmware.

"Firmware Initialization Procedure"

- **Error state B**

Perform the following procedure.

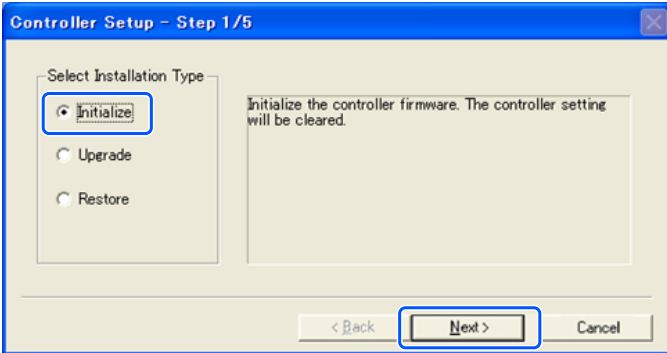
1. Turn off the Controller.
2. Turn on the Controller power while holding down the trigger button on the front side of the Controller, and continue to hold down the trigger button for about 30 seconds. (This causes the Controller to start in recovery mode.)
3. Make sure that the LEDs for ERROR, TEACH, and PROGRAM are turned on.
4. Perform the procedure from step (3) in the section below to initialize the firmware.
"Firmware Initialization Procedure"

6.2.4 Firmware Initialization Procedure

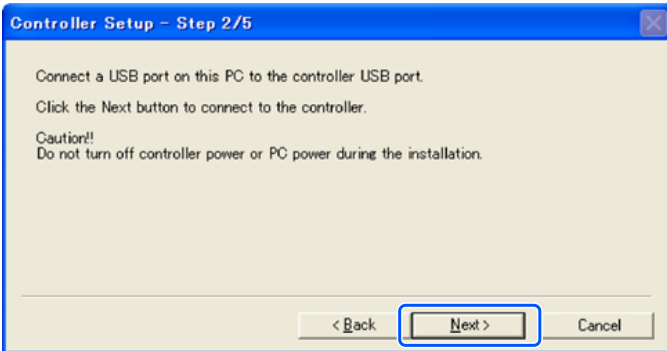
This section explains the firmware initialization procedure.

1. Connect the development PC and the Controller by a USB cable.
(Firmware cannot be upgraded over an Ethernet connection.)
2. Turn on the Controller.
(Do not start the development software Epson RC+ until the firmware upgrade process is completed.)

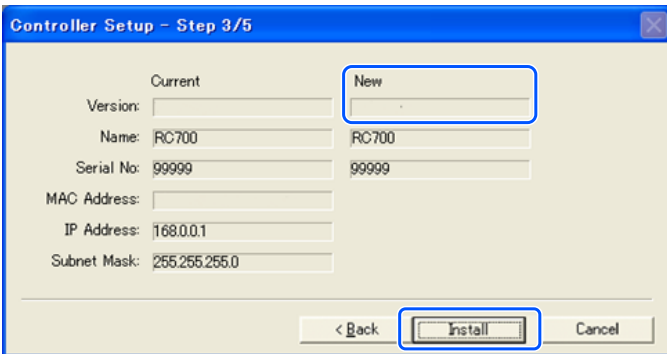
3. Load the "Firmware CD-ROM" to be installed into the CD-ROM drive of the development PC.
4. Execute "Ctrlsetup70.exe."
5. Select the [Initialize] button, and click the [Next] button.



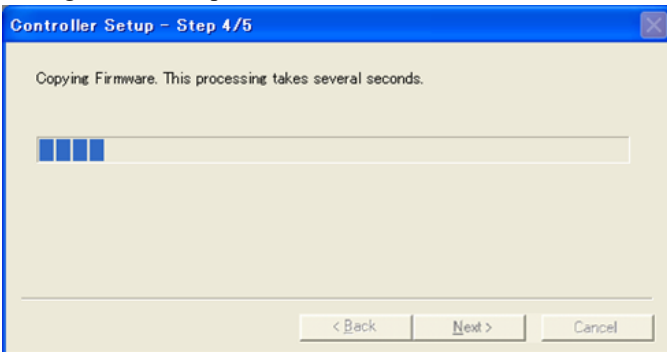
6. Make sure that the development PC is connected to the Controller by a USB cable, and click the [Next] button.



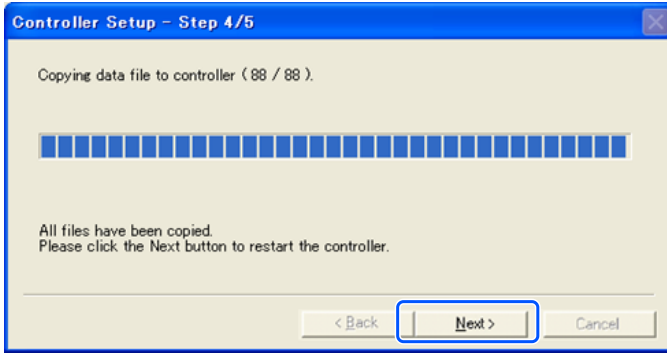
7. Check the version information, and click the [Install] button.



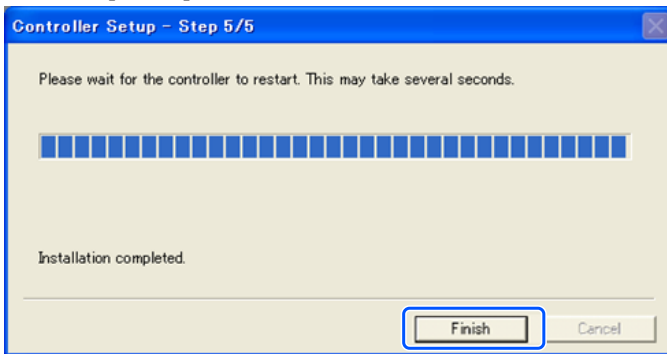
8. The firmware and data file transfer process is started. The transfer process takes several minutes to complete. During the transfer process, do not disconnect the USB cable or turn off the Controller or development PC.



9. The following dialog box appears when the transfer process has been completed. Click the [Next] button to reboot the Controller.




10. The following dialog box appears after the Controller is rebooted. Click the [Finish] button.



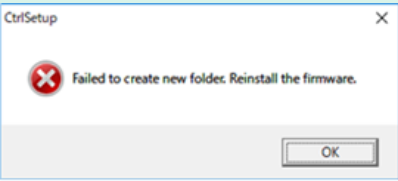
This completes the firmware initialization process.

Start Epson RC+, and restore the running system. Refer to the following section.

Backup and Restore

 **KEY POINTS**

When you install the firmware version 7.4.0.2 or later on the Controller where firmware before a version earlier than 7.4.0.2 was installed, the following message is displayed.



When this message is displayed, reinstall the firmware.

6.2.5 Addition of Confirmation Step due to Higher Security of Ethernet Connection

Starting from the following firmware version, password authentication was added for greater security when connecting Controllers and PCs.

- F/W : Ver.7.4.8.x

In the following cases, connections cannot be established with an Ethernet (PC) connector or by remote Ethernet.

- The Controller IP address is set to a global IP address

- Firmware version is 7.4.8.x or later
- EPSON RC+ 7.0 is version 7.4.7 or earlier

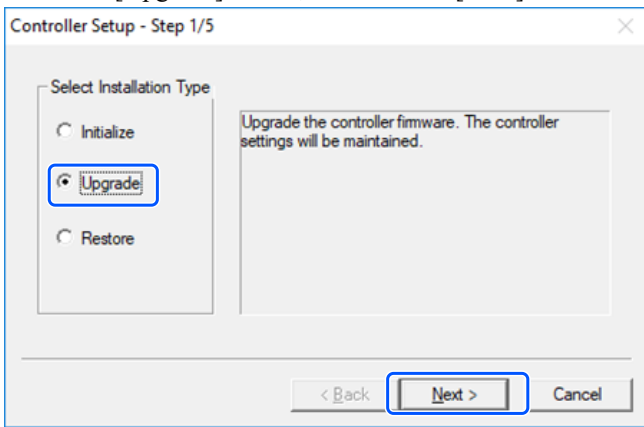
In the following cases, when the Controller firmware is upgraded, an additional step may be performed to confirm whether to continue the firmware upgrade depending on the configuration settings of the Controller. (This applies starting from step 3 below.)

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

This describes the step to confirm whether to continue the firmware upgrade.

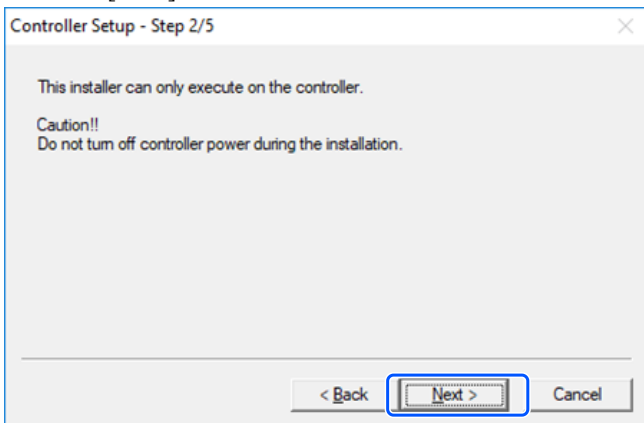
1. Load the "Firmware CD-ROM" to be installed into the CD-ROM drive of the development PC.
2. Execute "CtrlSetup70.exe."
3. The Controller setup window appears.

Select the [Upgrade] button, and click the [Next] button.



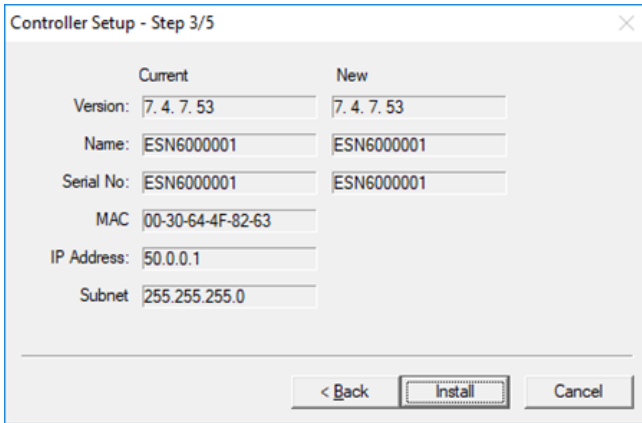
4. The Step 2 window is displayed.

Click the [Next] button.

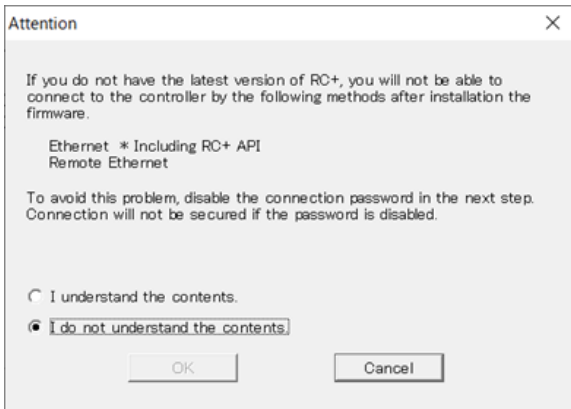


5. The Step 3 window is displayed.

- i. When the step to confirm whether to continue the firmware upgrade is not executed:
The Step 3 window is displayed.
Follow the on-screen instructions to install the firmware.



- ii. When the step to confirm whether to continue the firmware upgrade is executed:
The following window appears.

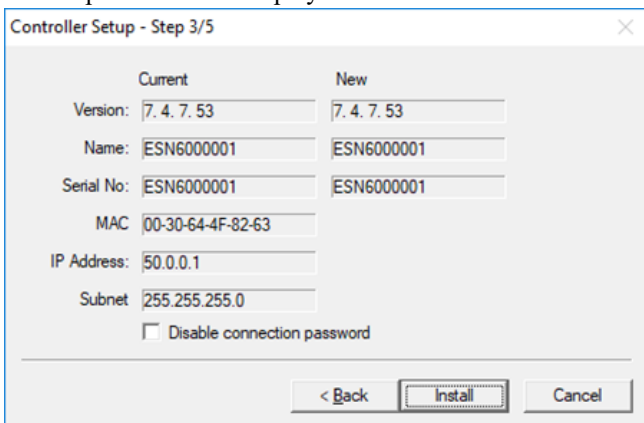


Once the [I understand the contents] button is selected, the [OK] button is enabled.

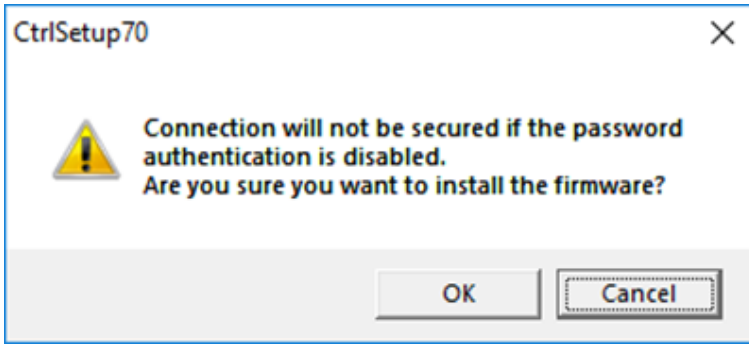
After the [OK] button is clicked, the Step 3 window is displayed. Go to step 6.

After the [Cancel] button is clicked, the Step 3 window is displayed. The [Disable connection password] checkbox and the [Install] button are grayed out and unable to be selected.

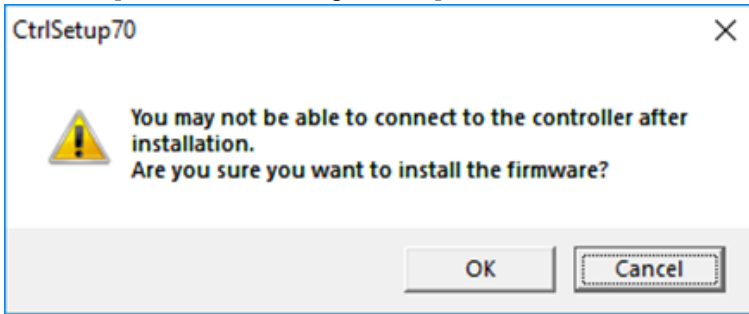
6. The Step 3 window is displayed.



- i. If the [Disable connection password] checkbox is selected, connection authentication after upgrading the firmware can be set to [Disabled].
- ii. Click the [Install] button to display the confirmation window.
When the [Disable connection password] checkbox is selected:



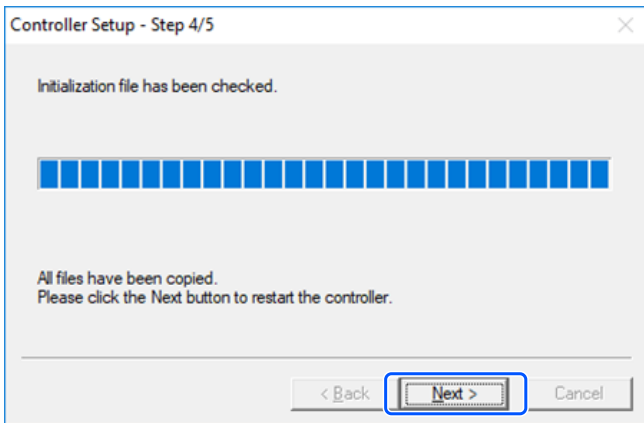
When the [Disable connection password] checkbox is not selected:



After the [OK] button is clicked, the Step 4 window is displayed. Go to step 7.
After the [Cancel] button is clicked, the confirmation window is closed.

7. Firmware installation is started.

When firmware installation is complete, click the [Next] button. The Controller is rebooted.



8. After the Controller is rebooted, the following window is displayed.

Confirm that the firmware installation is completed.
Click the [Finish] button.

